# MURRAY CENTENNIAL PUBLIC SCHOOL ADDITION

**654 County Rd. 40, Trenton, Ontario K8V 5P4**

**KAWARTHA PINE RIDGE DISTRICT SCHOOL BOARD**

# MECHANI CAL & ELECTRICAL SPECIFICATIONS
# PROJECT MANUAL VOLUME 2


**Moffet & Duncan Architects Inc.**
**Prime Consultant**

**DVM Engineering Inc.**
**Structural Engineer**

**CIMA +**
**Mechanical and Electrical Engineers**

**CIMA +**
**Site Services**

# INDEX TO SPECIFICATIONS

## PART 1 - GENERAL

### 1.1 Instructions to Bidders

.1 The Supplementary Bid Form must be uploaded to the Bidding System. Contractors shall identify all manufacturer/supplier they intend to use and must complete all information requested. Contractor shall sign and date the last page and initial and date all other pages.

.2 Should the Supplementary Bid Form not be submitted then the Contractor shall use Base Bid Manufacturers as listed.

.3 The Stipulated Bid Sum shall be for the base bid manufacturer or supplier equipment only, unless otherwise indicated. Where a choice of this equipment is given, this Contractor shall indicate the supplier or manufacturer they intend to use. Where no choice is indicated, the base bid supplier or equipment shall be used.

.4 Equipment or materials manufactured by firms named in the following listing only shall be deemed equal to the equipment or material specified provided the equipment or material will have capacity, performance, rating, construction, physical dimensions, accessories and features which, in the opinion of the Consultant, are equal to those of the specified equipment or material. The Contractor shall not indicate equipment, materials or suppliers which are not listed.

.5 Where modification to the work of other trades are not required as a result or part of the alternative offered, include the cost of said modifications in the work.

### 1.2 Mechanical Equipment List

.1 Submit the following list of Base Bid and alternative suppliers in accordance with the bid requirements:

| Spec. Reference Section | Equipment | Base Bid | Acceptable Alternate Manufacturer or Supplier | Indicate Manufacturer or Supplier |
|---|---|---|---|---|
| 23 74 13 | Roof Top Unit | AAON | Daikin Rebel<br>Engineered Air | |
| 23 82 00 | Terminal Heat Transfer Units | SIGMA | Engineered Air<br>Trane | |
| 22 11 23 | Domestic water Pumps | Bell & Gossett | Armstrong | |
| 23 34 00 | Fans | Cook | Greenheck<br>Penn<br>Carnes | |
| 23 84 00 | VFDs | Danfoss Graham | Trane TRC Series | |

SUBMITTED BY:

I / We certify that I / We have the authority to bind the company:

| | |
|---|---|
| Name of Signing Officer(s) | SIGNATURE |
| Name of Signing Officer(s) | SIGNATURE |
| Telephone Number of Signing Officers | NAME OF COMPANY |
| | ADDRESS OF COMPANY |
| | HST REGISTRATION NUMBER |
| | CORPORATE SEAL |

## PART 1 – GENERAL

1.1 General Requirements

.1 The requirements of this section shall apply to all sections in Division 22.

.2 Conform to Division 1 General Conditions.

.3 All material, labour, equipment, and services required under this section shall be the full responsibility of the Plumbing Contractor including any material, labour, equipment, and services provided by their subcontractors.

.4 Complete and submit the Supplemental Tender Form including list of equipment and materials to be used on this project and forming part of the tender documents.

1.2 Pre-Qualified Mechanical Contractors

.1 Refer to front end documents for pre-qualified mechanical contractor list. Only those pre-qualified contractors shall bid on this project.

1.3 Definitions

.1 "Supply" shall mean supply only.

.2 "Install" shall mean install and connect.

.3 "Provide" shall mean supply, install, and connect.

.4 "Drawings and Specifications" shall mean Contract Documents.

.5 "Authorities" or "Authorities having jurisdiction" shall mean all agencies that enforce the applicable laws, ordinances, rules, regulations, or codes of the Place of Work.

.6 "Work" shall mean all equipment, materials, labour, and permits to provide a complete and operational plumbing system as detailed in the drawings and specifications.

.7 "Owner" or "KPRDSB" shall mean Kawartha Pine Ridge District School Board.

1.4 Related Work

.1 Division 1 – General

.2 Division 23 – HVAC

.3 Division 26 – Electrical

.3 Division 22 specifications form a part of the Contract Documents and shall be read, interpreted, and coordinated with all other Divisions.

1.5 Intent

.1 The drawings and specifications are not a detailed set of installation instructions. Drawings and specifications are complementary to one another and that which is shown on one is as binding as that which is shown on both.

.2 The Consultant shall be immediately informed of any discrepancies between drawings and specifications leaving in doubt the true intent of the work.

.3 Supply all labour, equipment, and materials necessary to install a complete and operational

plumbing system described herein and shown on the drawings.

.4 It is the intent of these drawings and specifications to provide for a plumbing installation complete and in operating condition. The responsibility for supplying and installing all material necessary to accomplish this, except where specifically noted that such work or materials is not included, shall be part of this section.

.5 Assess and be familiar with existing site conditions prior to pricing and construction and allow for same in tender price.

.6 All work must be done by qualified, certified and experienced persons in such line of work. Trade certificates must be available on demand.

.7 All work shall be in accordance with standard industry practice accepted and recognized by the Consultant and the Trade.

.8 This Contractor shall coordinate with and cooperate with all other trades prior to installation. Where work interferes with other trades due to failure to coordinate or cooperate, the work shall be removed and relocated as approved by the Consultant at no extra cost to the Owner.

.9 The Consultant shall have the right to reject any work that does not conform to the Contract Documents and accepted standards of practice including but not limited to performance, quietness of operation and finish.

1.6 Codes, Bylaws, Standards, and Regulations

.1 The plumbing system shall comply with the latest editions and revisions of applicable codes, bylaws, standards, and regulations including but not limited to:

.1 Ontario Building Code
.2 ASHRAE
.3 Canadian Standards Association
.4 Local Building Bylaws
.5 Ontario Occupational Health and Safety Act

.2 Provide work in accordance with the requirements of all applicable government codes, local by-laws, underwriter's regulations base building standards, contract documents, and all authorities having jurisdiction.

.3 Where discrepancies occur between contract drawings and specifications and above codes and standards referred to herein, the Contractor is to notify the Consultant in writing and obtain clarification prior to proceeding with the work.

.4 Contractors shall not reduce the requirements on the contract drawings and specifications by applying any codes and standards referred to herein.

1.7 Permits and Fees

.1 Apply for, obtain, and pay for all permits, fees, connections, inspections, licenses, certificates or charges necessary including all provincial and federal taxes.

.2 Coordinate all required inspections and give necessary notice to all authorities.

.3 Upon completion of project, provide inspection certificates confirming acceptance by all authorities having jurisdiction for all applicable disciplines.

1.8 Contract Breakdown

.1 After the tenders close, submit a breakdown of the price into scope and trades to the

satisfaction of the Consultant based on the sections of the specifications.

.2 Progress claims shall be based on the breakdown. Submit in table format showing contract amount, work complete to date as percentage, previous draw, amount this draw and balance for each line item.

1.9 Shop Drawings

.1 Within two (2) weeks of award, the Contractor shall submit shop drawings of all equipment for the project.

.2 Prior to ordering of products or delivery of any products to job site, submit shop drawings electronically in PDF format to the Consultant for review and comments. Submit sufficiently in advance of construction to allow ample time for review. Size of shop drawings shall be 8.5x11". 11x17" will be acceptable where appropriate for content and scale.

.3 Submittals shall contain but not be limited to:

.1 Construction information
.2 Product data
.3 Performance data including performance curves
.4 Acoustical sound power data
.5 Dimensional layout and clearances
.6 Mounting arrangements
.7 Certification of compliance to applicable codes
.8 Operating and Maintenance information
.9 Wiring, single line and schematic diagrams (where applicable)

.4 Clearly mark each sheet of printed submittal material, using arrow, underlining or circling, to show particular sizes, dimensions, wiring diagrams, operating clearances, control diagrams, project identification, types, model numbers, ratings, capacities and options actually being proposed. Cross out non-applicable material. Note on the submittal specified features such as special tank linings, pump seals, materials or painting.

.5 **Prior to submission to the Consultant, the General and Plumbing Contractors shall review all shop drawings. By this review the Contractor represents that they have determined and verified all field measurements, field construction criteria, materials, catalogue numbers and similar data or will do so and that they have checked and coordinated each shop drawing with the requirements of the Work and of the Contract Documents.**

.6 **The Contractor's review of each shop drawing shall be indicated by his approval stamp, date and signature on the front of each page. Drawings will not be considered if not previously checked by the Plumbing Contractor.**

.7 Review comments from the Consultant. If shop drawings are modified, confirm changes before proceeding. If shop drawings are not approved, revise and resubmit changes for approval within one (1) weeks.

.8 Review of the shop drawings by the Consultant does not relieve the Contractor or his Supplier of the responsibility to provide the correct and complete equipment, material or installation.

.9 Keep one complete set of shop drawings at the job site during construction.

.10 Include stamped reviewed shop drawings in the Maintenance Manuals.

1.11 Product Delivery Schedule

.1 Within two (2) weeks from shop drawing review, a schedule must be submitted by the

Contractor showing projected delivery dates of all products to meet required construction schedule.

1.12 Construction Meetings

.1 The Plumbing Contractor shall attend all site meetings unless otherwise pre-approved.

.2 Sub-trades shall attend site meetings as requested or as required.

1.13 As-Built Drawings

.1 Refer to Section 23 05 02.

.2 Maintain accurate, neat, and clean as-built drawings on an **on-going basis** during construction to be reviewed periodically by the Consultant during construction.

.3 As-Built drawing mark-ups shall be made available at every site meeting or inspection.

.4 As-Built drawings shall include but not be limited to final location of any access doors on same for future service requirements.

.5 Upon completion of the work, submit to the Consultant for review, one (1) complete set of clear, legible, certified as-built drawings.

1.14 Reports

.1 Provide the following reports upon completion of work by certified Contractors for review and approval by the Consultant:

.1 Equipment Start-Up Reports
.2 Piping Pressure Test Reports
.3 Backflow Preventer and Cross Connection Test Reports
.4 Sprinkler/Fire Installation Conformance Letter (where applicable)
.5 Other equipment startup reports and test sheets
.6 Demonstration Reports/Logs

.2 All reports shall be dated and signed by the Technician who performed the start-up and/or tests.

1.15 Maintenance Manuals

.1 Refer to Section 23 05 02.

.2 Provide the Owner with two (2) **indexed**, hard cover maintenance manuals to local air balance industry standards plus one (1) electronic copy on labeled USB. Manuals shall contain and be tabbed in the following order:

.1 Table of Contents
.2 Contractor's, Manufacturer's and Supplier's Contact Information
.3 Warranty Letter
.4 Valve schedule
.5 Colour coding charts for access areas
.6 Reports as specified herein and as applicable
.7 Shop drawings (stamped reviewed by Consultant)
.8 Equipment maintenance instructions and manuals
.9 As-Built drawings

.3 Submit one (1) complete copy to the Consultant for review and approval. Revise based on any comments and resubmit all copies and electronic copy to Consultant.

1.16 Testing and Startup

.1 Refer to Section 22 05 92.

.2 Test and startup all equipment and work.

.3 Fully coordinate all testing and startups with all trades, the Consultant, and authorities having jurisdiction.

.4 Provide adequate notice to all parties.

1.17 Demonstration

.1 Demonstrate to the Owner on proper operation of the system.

.2 The Contractor shall arrange for all necessary personnel and equipment specialists to be in attendance for purposes of demonstration.

.3 Provide instruction by a manufacturer's representatives as required to fully demonstrate the systems.

.4 The Contractor shall arrange and coordinate all demonstration for all equipment including any Owner supplied equipment. Coordination for Owner supplied equipment shall include arrangement with supplier start-up technicians.

.5 Demonstration shall include but not be limited to:

.1 Demonstration in the normal, abnormal and emergency operation of all systems provided under this Division.
.2 Review of all necessary maintenance procedures, including winterization, of all systems provided under this Division.
.3 Provision of a documented maintenance program covering all systems provided or modified under this contract.
.4 Review of all close-out documentation including complete maintenance manuals and As-Built drawings.

.6 Prepare a Demonstration Agenda and Log for signature by all Participants. Submit to Consultant and include in Manuals.

.7 Complete and accepted maintenance manuals and As-Built drawings shall be submitted and available for use during the Demonstration.

1.18 Substantial Completion and Performance

.1 Substantial completion and performance shall be determined and awarded by the Consultant.

.2 Complete the following to the satisfaction of the Consultant prior to request for substantial performance:

.1 Fire Stopping
.2 System Testing and Startups including report
.3 Maintenance Manuals
.4 As-Built Drawings
.5 Demonstration

1.19 Warranty

.1 Provide a one (1) year full parts and labour warranty for the new system from date of

substantial completion.

.2 Submit warranty letter on Company letterhead signed by Company representative stating warranty terms including warranty period from date of substantial completion.

**PART 2 - PRODUCTS**

2.1 Materials

.1 All material used shall be new, free from defects, of quality specified, and installed in accordance with manufacturer's instructions.

.2 Major equipment shall have nameplates on the exterior of the equipment in a visible location containing manufacturer's name, model number, serial number, performance data, and electrical characteristics.

.3 The same manufacturer shall be used for types of equipment used in similar applications.

.4 It is the responsibility of the Contractor to store and protect materials supplied by this scope.

.5 Materials shall be stored in original containers.

.6 Submit to the Consultant and the Owner, current MSDS Sheets for any products being used on the job site where they exist.

.7 Remove and dispose of all redundant materials and garbage from site.

.8 Supply anchor bolts and templates for installation by other Divisions.

2.2 Selected Products and Equivalents

.1 Sections within Division 22 list "Acceptable Manufacturers" which must meet characteristics of the specified equipment and products for each section.

.2 Base specified products are specified and/or shown on the drawings, and identified by manufacturer's name, type and catalogue number.

.3 Any acceptable manufacturers from base specified products and equipment must equal or exceed the quality, finish and performance of those base specified and/or shown, and not exceed the space requirements allotted on the drawings. Include costs for any associated work to accommodate such substitutions, including the Consultant's time and revisions to the work of other divisions (i.e. electrical changes).

.4 If item or material specified is unobtainable, state in Tender proposed substitute and amount added or deducted for its use. Extra monies will not be paid for substitutions after the Contract has been awarded.

.5 If item of size indicated is unobtainable, supply next larger size without additional charge.

2.3 Quality of Product

.1 All products provided shall be listed and/or approved by relevant authorities and new, unless otherwise specified.

.2 If products specified are not listed and/or approved, obtain approval of provincial regulatory authority. Pay all applicable charges levied and make all modifications required for approval.

.3 All products provided shall be new including those not specified and shall be of a quality best suited to the purpose required and their use subject to approval by the Consultant.

2.4 Product Finishes

.1 Shop drawings shall indicate finishes. Use standard finish unless otherwise specified.

.2 Repair dents and touch up all damaged finishes with matching finish, or if required by the Consultant or Owner, completely repaint or replace damaged surface at no extra cost to the Contract.

2.5 Access Doors

.1 Provide access doors/panels as required for access, adjustment, operation, service, and maintenance.

.2 Minimum size of panels shall be 12" x 18" (300mm x 450mm). Wherever possible 24" x 24" (600mm x 600mm) panels shall be used.

.3 Access doors/panels shall have concealed hinges and screwdriver locking device.

.4 Acceptable Manufacturers:

.1 Acudor
.2 Zurn
.3 Nailor Industries
.4 Le Hage

.5 Base specification:

.1 ACCESS DOORS/COVERS - FLUSH ACCESS DOOR – DRYWALL AREA

.1 **Acudor #DW-5040 Series** flush to surface for drywall, satin coat steel with white baked enamel finish, formed door panel, flanged on four sides, 20 gauge. Galvanized frame with multiple bends and integral taping bead, 26 gauge. Concealed hinge, stainless steel screwdriver operated cam latch.

.2 ACCESS DOORS/COVERS - FLUSH ACCESS DOOR - UNIVERSAL

.1 **Acudor #UF-5000** Universal Access Doors, 14 GA. (1.7mm) steel, baked enamel prime coat, continuous concealed hinge, with positive and self-opening screwdriver operated lock.

2.6 Guards

.1 Provide guards for unprotected drives.

.2 Guards for belt drives:

.1 Expanded metal screen welded to steel frame.
.2 Minimum 1.2 mm (18 gauge) thick sheet metal tops and bottoms.
.3 40mm (1-1/2") diameter holes on both shaft centres for insertion of tachometer.
.4 Removable for servicing.

.3 Provide means to permit lubrication and use of test instruments with guards in place.

.4 Install belt guards to allow movement of motors for adjusting belt tension.

.5 Guard for flexible coupling:

.1 "U" shaped, minimum 106 mm (16 gauge) thick galvanized mild steel.
.2 Securely fasten in place.
.3 Removable for servicing.

2.7 Equipment Supports

.1 Refer to Section 22 05 29.

.2 Equipment supports not supplied by equipment manufacturer: fabricate from structural grade steel meeting requirements of – Structural Steel Section. Submit structural calculations with shop drawings.

.3 Install base mounted equipment on chamfered edge housekeeping pads, minimum of 100 mm (4") high and 150 mm (6") larger than equipment dimensions all around.

2.8 Sleeves

.1 Pipe sleeves: at points where pipes pass through masonry, concrete or fire rated assemblies and as indicated.

.2 Schedule 40 steel pipe.

.3 Sleeves with annular fin continuously welded at midpoint:

.1 Through foundation walls.
.2 Where sleeve extends above finished floor.
.3 Through fire rated walls and floors.

.4 Sizes: minimum 6mm (1/4") clearance all around, between sleeve and un-insulated pipe or between sleeve and insulation.

.5 Terminate sleeves flush with surface of concrete and masonry walls, concrete floors on grade and 25mm (1") above other floors.

.6 Fill voids around pipes:

.1 Caulk between sleeve and pipe in foundation walls and below grade floors with water proof fire retardant non-hardening mastic.
.2 Where sleeves pass through walls or floors, provide space for firestopping. Where pipes/ducts pass through fire rated walls, floors and partitions, maintain fire rating integrity.
.3 Ensure no contact between copper tube or pipe and ferrous sleeve.
.4 Fill future-use sleeves with lime plaster or other easily removable filler.
.5 Coat exposed exterior surfaces of ferrous sleeves with heavy application of zinc rich paint to CGSB 1-GP-181M+Amdt-Mar-78.

.7 Provide minimum 20-gauge duct sleeves where ducts pass through masonry concrete or fire rated assemblies. Maintain minimum 25 mm clearance all around or to the requirements of the authority having jurisdiction. Seal at all as indicated.

2.9 Fire Stopping

.1 This Contractor shall work with all other Contractors on the project in providing one common method of fire stopping all penetrations made in the fire rated assemblies.

.2 Approved fire stopping and smoke seal material in all fire separations and fire ratings within annular space between pipes, ducts, insulation and adjacent fire separation and/or fire

rating.

.3 Do not use cementious or rigid seals around penetrations for pipe, ductwork, or other plumbing items.

.4 Insulated pipes and ducts; ensure integrity of insulation and vapour barrier at fire separation.

.5 Provide materials and systems capable of maintaining effective barrier against flame, smoke and gases. Ensure continuity and integrity of fire separation.

.6 Comply with the requirements of CAN4-S115-M35, and do not exceed opening sized for which they have been tested.

.7 Systems to have an F or FT rating (as applicable) not less than the fire protection rating required for closures in a fire separation. Provide "fire wrap" blanket around services penetrating fire walls. Extent of blanket must correspond to ULC recommendations.

.8 The fire stopping materials are not to shrink, slump or sag and to be free of asbestos, halogens and volatile solvents.

.9 Firestopping materials are to consist of a component sealant applied with a conventional caulking gun and trowel.

.10 Fire stop materials are to be capable of receiving finish materials in those areas which are exposed and scheduled to receive finishes. Exposed surfaces are to be acceptable to consultant prior to application of finish.

.11 Firestopping shall be inspected and approved by local authority prior to concealment of enclosure.

.12 Install material and components in accordance with ULC certification, manufacturer's instructions and local authority.

.13 Submit product literature and insulation material on fire stopping in shop drawing and product data manual. Maintain copies of these on site for viewing by installers and Consultant.

.14 Manufacturer of product shall provide certification of installation. Submit letter to the consultant.

.15 Acceptable Manufacturers:

.1 Fryesleeve Industries Inc.
.2 General Electric Pensiil Firestop Systems
.3 International Protective Coatings Corp.
.4 Rectorseal Corporation (Metacaulk)
.5 Proset Systems
.6 3M
.7 AD Systems
.8 Hilti

.16 Ensure firestop manufacturer representative performs on-site inspections and certifies installation. Submit inspection reports/certification at time of substantial completion.

2.10 Escutcheons

.1 On pipes and ductwork passing through walls, partitions, floors and ceilings in finished areas.

.2 Chrome or nickel plated brass or Type 302 stainless steel, one piece type with set screws.

.3 Outside diameter to cover opening or sleeve.

.4 Inside diameter to fit around finished pipe.

2.11 Spare Parts

.1 Provide spare parts as specified under this Division.

.2 Provide list of equipment in maintenance manuals indicating corresponding spare parts required. List of spare parts to be signed off by receiving personnel.

2.12 Special Tools

.1 Provide one set of special tools required to service equipment as recommended by manufacturers and in accordance with Maintenance Materials Special Tools and Spare Parts.

**PART 3 - EXECUTION**

3.1 Site Examination

.1 Examine the site of work and become familiar with all features and characteristics affecting this work before submitting tender.

.2 No additional compensation will be given for extra work due to existing conditions which such examination should have disclosed.

.3 Report to the Consultant any unsatisfactory conditions which may adversely affect the proper completion of this work.

3.2 Interference and Coordination Drawings

.1 Examine the drawings and all divisions of the specifications.

.2 Prepare interference and equipment layout drawings to ensure all components will be properly accommodated within the spaces provided.

.3 Lay out the work and equipment with due regard to architectural, structural and electrical features, and service requirements.

.4 Submit interference drawings to the Consultant.

.5 Before commencing any work, obtain a ruling from the Consultant if any conflict exists, otherwise no additional compensation will be made for any necessary adjustments.

3.3 Separation of Services

.1 Contact between dissimilar metals, such as copper and aluminum, in damp or wet locations is not permitted.

.2 All pipes, ductwork and wiring shall be supported from permanent building structure. Use of other services for support is not permitted

3.4 Workplace Safety

.1 The workplace must be kept safe at all times.

.2 Conform to all ministries of labour, and health and safety regulations at all times.

.3 Use ladders and proper techniques as approved by the ministry of labour to perform all work.

.4 Cover all holes/openings and provide barriers around hazards, etc. to ensure occupants and workers are not at risk.

.5 Where work does not conform to such regulations, stop work immediately and report the situation to the Owner's representative or Consultant or rectify the situation immediately.

.6 Report any hazards or concerns to the Owner's representative immediately.

.7 Conform to Owner's safety requirements and construction regulations.

3.5 Temporary Requirements

.1 All temporary requirements to complete plumbing work during construction shall be the responsibility of the Plumbing Contractor except temporary power or water.

3.6 Location of Equipment

.1 Approximate distances and dimensions may be obtained by scaling off the drawings. Figured dimensions shall govern over scaled dimensions.

.2 Equipment locations shown on the drawings are approximate. Locations may be revised to suit construction and equipment arrangements provided design intent is not jeopardized and there is no additional cost to the Owner.

3.7 Mounting Heights

.1 Mounting height of equipment is from finished floor to equipment unless otherwise specified or indicated. Coordinate with block coursing if applicable.

.2 Where mounting heights are not indicated on the drawings, obtain verification from the Consultant before proceeding.

.3 Install plumbing equipment at the following heights unless otherwise indicated on the architectural drawings. Architectural drawings supersede heights noted below. Confirm all heights prior to installation. Where confirmation or coordination has not been done and changes are required, the Contractor shall cover all costs.

| | | |
|---|---|---|
| .1 | Wall hung lavatory | 787mm(31") to rim |
| .2 | Barrier free wall hung lavatory | 840mm(33") max to top of rim<br>737mm(29") to underside of rim front |
| .3 | Urinals (Ground Floor) | 1 @ 432mm (17") to top of rim<br>Remaining @ 533mm (21") to top of rim<br>Coordinate with Architectural Drawings & General Contractor prior to installation. |
| .4 | Urinals (Second Floor) | 1 @ 432mm (17") to top of rim<br>Remaining @ 533mm (21") to top of rim<br>Coordinate with Architectural Drawings & General Contractor prior to installation. |
| .5 | Washfountains requirements | Conform to manufacturer's installation<br><br>to meet ADA requirements |

3.8 Excavating and Backfilling

.1 Provide all excavating and backfilling inside and to 1.5m outside the building for plumbing pipes, drains and equipment. All backfilling shall be new clean granular 'A' fill brought in specifically for the purpose of backfilling to the underside of floor slab. All backfilling shall be compacted at intervals not more than 150 mm (6") layer to the satisfaction of the Consultant.

.2 Provide excavating and backfilling outside the building with granular 'A' brought in specifically for backfilling to a minimum of 450 mm (18") over the pipe. Backfilling outside building over and above the 450 mm (18") backfill as previously specified herein shall be by the Plumbing Contractor as specified under Division 2. Where backfilling outside the building is not specified under Division 2, the Plumbing Contractor shall provide new clean granular 'A' fill to grade level.

.3 Bottoms of trenches shall be excavated so that the pipe will be supported on a 150 mm (6") compacted bed of clean granular 'A' fill. Provide all necessary pumping to maintain excavation free of water.

.4 Should water be encountered during excavation, the Plumbing Contractor shall provide all labour and material, including all equipment required for dewatering the excavation. After the water has been removed, this Contractor shall install a 300 mm (12") base of compacted 50 mm (2") clear stone covered with filter cloth before installing backfill as detailed and/or as specified.

.5 Be responsible for all weather protection required to install piping and/or equipment to the satisfaction of the Consultant.

.6 Be responsible for providing all clear stone or granular 'A' material suitable for application to replace existing soil not suitable for backfilling above the 450 mm (18") bedding material.

.7 It is the responsibility of the Contractor to review the soils report. Additional work requested due to failure of soil conditions due to Contractor not reviewing report will not be entertained.

3.9 Repairs, Cutting and Restoration

.1 Patch and repair walls, floors, ceilings, and roofs with materials of same quality and appearance as adjacent surfaces unless otherwise shown. Surface finishes shall exactly match existing finishes of same materials.

.2 Each Section of this Division shall bear expense of cutting, patching, and repairing to install their work and/or replacing of work of other Sections required because of its fault, error, tardiness, or because of damage done by it.

.3 Cutting, patching, repairing, and replacing pavements, sidewalks, roads, and curbs to permit installation of work of this Division is responsibility of Section installing work.

.4 All patching, painting and making good of the existing walls, floors, ceilings, partitions and roof will be at the expense of this Contractor but performed by the Contractor specializing in the type of work involved unless otherwise noted.

3.10 Painting

.1 Refer to other Divisions for Painting unless otherwise specified herein.

.2 Apply at least one (1) coat of corrosion resistant primer paint to ferrous supports and site fabricated work.

.3 Prime and touch up marred finished paintwork to match original.

.4 Restore to new condition, or replace equipment at discretion of Consultant, finishes which have been damaged too extensively to be merely primed, painted and touched up.

3.11 Concealment

.1 All equipment, components, piping, and conduit shall be concealed in ceiling spaces, bulkheads or walls in finished areas.

.2 Exposed equipment, components, piping, and conduit installed in unfinished areas, shall be installed as high as possible. Run piping and conduit parallel to building lines, tight to roof deck and down columns.

3.12 Access Doors

.1 Provide access doors as required for access, adjustment, operation, service, and maintenance.

3.13 Clearances and Accessibility

.1 Install all work for easy access for adjustment, operation, service, and maintenance.

.2 Maintain clearances for all equipment as per local codes and manufacturer's instructions.

.3 Access panels shall be Ecuador or equivalent with concealed hinges and screwdriver locking device.

.4 Provide access panels of adequate size as required to access equipment and components in concealed areas. Do not install access doors in specialty walls or ceilings.

.5 Provide fire rated access doors where installed in fire separations to match rating of separation.

.6 Install all services in exposed areas so that a minimum head clearance of 2200mm (88") is maintained.

3.14 Equipment and System Protection

.1 Protect equipment and materials from damage in storage and on site before, during, and after installation until final acceptance.

.2 Protect equipment and system openings from dust and debris with appropriate covers that will withstand through the construction.

.3 Where equipment and system components become dirty or damaged, clean and repair to new condition to the satisfaction of the Consultant and the Owner at no expense to the Owner.

3.15 Supports

.1 Provide all miscellaneous metals and materials as required for support, hanging, anchoring, and guiding of all equipment, ductwork, piping, and all other work in Division 22.

.2 All supports must be securely mounted to structures.

.3 Refer to Section 22 05 29.

3.16 Fire Stopping

.1 Refer to Part 2 herein.

3.17 Cleaning

.1 Clean interior and exterior of all systems including strainers. Vacuum interior of ductwork and air handling units prior to turn over to Owner.

.2 In preparation for final acceptance, clean and refurbish all equipment and leave in operating condition including replacement of all filters in all air and piping systems.

3.18 Identification and Labeling

.1 All equipment, valves, panels and devices shall be labeled under this Division.

.2 Refer to Section 22 05 53.

3.19 Demonstration

.1 Refer to 1.15 herein.

3.20 Field Review and Deficiencies

.1 The Contractor shall notify the Consultant when the job is ready for field review at various stages including rough-in stages.

.2 During the course of construction, the Consultants will monitor construction and provide written reports of work progress, discussions and deficiencies.

.3 The Contractor shall correct all deficiencies within the work period prior to the next review.

.4 The Contractor shall not conceal any work until inspected. Where work was concealed, the Contractor shall remove and replace tiles, coverings or other obstructions to allow proper inspection at the Contractor's expense.

.5 Upon completion of the project the Consultant will do a final review. Upon receiving the final inspection report, the Contractor must correct and sign back the inspection report indicated all deficiencies are completed. A re-inspection will only be done once the Consultant receives this in writing. Where the Consultant performs the re-inspection and the work is not complete, the Contractor is responsible for reimbursing the Consultant for the field review. The fee for additional reviews will be at the Consultant's hourly rates plus mileage and applicable taxes to be paid directly to the Consultant prior to performing the next field review.

END OF SECTION

## PART 1 - GENERAL

1.1 Manufacturer

.1 Provide valves of same manufacturer throughout where possible.

.2 Provide valves with manufacturer's name and pressure rating clearly marked on outside of body.

1.2 Quality Assurance

.1 All valves shall meet all MSS, ANSI and ASME manufacturing standards.

1.3 Submittals

.1 Manufacturer's data and shop drawings for all valves and accessories including dimensions, pressure ratings, materials, service acceptability.

## PART 2 - PRODUCTS

2.1 General

.1 Provide valves of same manufacturer throughout where possible.

.2 All valves shall be acceptable for domestic water use, lead free.

.3 Valves shall be suitable for solder or threaded connections. Provide solder to threaded adapters where applicable.

2.2 Check Valves

.1 2 inches (50mm) and smaller: Class 125/200PSI, lead free bronze body and cap, bronze seat, solder or threaded ends. Equal to Kitz #822 and #823.

.2 2.5 inches (63mm) and larger: To Class 150, stainless steel body, hard face seat, 13% chrome, flanged ends. Equal to Kitz #150UOAM.

2.3 Ball Valves

.1 600 WOG, lead free brass, two or three piece body, chrome plate ball, full port, teflon seats, blow-out proof stem, threaded or soldered ends, lever handle. Soldered up to 3", threaded up to 4".

.2 Acceptable Manufacturers:

.1 Jenkins
.2 NH
.3 Kitz #858 & #859
.4 Red & White (Toyo) 5044A-LF & 5049-LF
.5 MAS #B3-LF and #B4-LF

2.4 Circuit Balancing Valves (CBV) – Domestic Water

.1 Provide circuit balancing valve on each domestic recirculation loop designed specifically for use in drinking water applications, NSF/ANSI 61-G rated for commercial hot water service (temperature rated to 180F / 82C) and certified by the NSF with all wetted parts stainless steel.

.2 Lead free construction in compliance with ANS/NSF-372.

.3 Series 300 stainless steel body, nickel plated brass union nut, and tamper-resistant 300 series stainless steel flow cartridge.

.4 Valve shall be suitable for minimum flow of 0.3gpm and maximum flow of 12.0 gpm, and flow rate pre-set accuracy variation of +/- 5% over 95% of the control range.

.5 Valves shall have a full body rating of 400 psi, but is suitable for working pressures with differential control ranges of 2 – 32 psi or 5 – 60 psi differential.

.6 All wetted parts shall comply with NSF/ANSI Standard 372 for minimal lead content.

.7 Compact inline design for tight installations.

.8 Acceptable Manufacturer

.1 Tour & Anderson, Victaulic ICSS, TA Series 76X, RWV 9519AB

2.5 Drain Valves

.1 Bronze compression stop with ¾" hose threaded.

.2 Brass ball valve with ¾" hose thread.

.3 Provide hose thread connection on valve or piping.

.4 Equal to #868C (Lead Free), KITZ #68AC (Non Lead Free)

2.6 Pressure Ratings

.1 Unless otherwise indicated, use valves suitable for minimum 860 kPa (125 psi) and 232°C (450°F).

**PART 3 - EXECUTION**

3.1 General

.1 All valves shall be located such that the removal of their bonnets is possible.

.2 Install valves with stems upright or horizontal, not inverted.

.3 All valves shall be installed to allow for ease of access, service and reading of devices from the floor.

3.2 Application

.1 Use ball valves on pressure gauges.

.2 Use plug cocks, globe valves, ball valves, butterfly valves, and metering valves in water systems for throttling service.

3.3 Isolation Valves

.1 Isolation valves are to be ball type valves, pipe size as required, but in no case less than 13mm (½") diameter.

.2 For equipment removal purposes. Install valves as close as possible to isolated equipment in order to minimize the amount of water lost during maintenance, replacement or drain down operations.

.3 Isolation drain valves are to be provided with combination air inlet fitting as required to relieve vacuum during draining operations.

.4 Install ball valves where approved for shutoff and isolating service, or to isolate equipment, parts of systems or vertical risers.

.5 Provide drain valves at main shutoff valves, low points of piping and equipment.

3.4 Circuit Balancing Valves (CBV) – Domestic Water

.1 The Contractor shall install a CBV on each recirculating loop.

.2 Install CBVs in accordance with manufacturer's instructions including straight pipe run upstream and downstream of CBV.

.3 Valves shall be installed with flow in the direction of the arrow on the valve body.

.4 Label ceiling tile or gypsum board ceilings where CBV is installed above ceiling. Provide access door for access where required.

3.5 Drain Valves

.1 Provide ball valves for drains on open systems.

.2 Provide unions downstream of the valve to allow breaking the piping system.

.3 Provide hose thread connection on drain valve and piping.

END OF SECTION

## PART 1 - GENERAL

1.1 Quality Assurance

.1 Domestic water pipe supports shall meet the requirements of Ontario Building Code.

## PART 2 - PRODUCTS

2.1 General Requirements

.1 Provide hangers and supports to secure equipment in place, prevent vibration, maintain grade and provide for expansion and contraction.

.2 Install supports of strength and rigidity to suit loading without unduly stressing building. Locate adjacent to equipment to prevent undue stresses in piping and equipment.

.3 Select hangers and supports for the service and in accordance with the manufacturer's recommended maximum loading. Hangers shall have a safety factor of 5 to 1.

.4 Obtain approval prior to drilling for inserts and supports for piping systems.

.5 Obtain approval prior to using percussion type fastenings.

.6 Use of other piping or equipment for hangers and supports is not permitted.

.7 Use of perforated band iron, wire or chain as hangers is not permitted.

2.2 Inserts

.1 Inserts shall be malleable iron case or galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods and lugs for attaching to forms.

.2 Size inserts to suit threaded hanger rods.

2.3 Pipe Hangers and Supports

.1 Pipe hangers shall wrap around outside of insulation for all sizes. Piping shall be provided with insulation flashing of heavy gauge metal to prevent crushing and hanger sized for exterior of insulation.

.2 Hangers:

.1 Pipe Sizes 13mm (½") to 38mm (1½"): Adjustable wrought steel ring, or plated strap.
.2 Pipe Sizes 50mm (2") and over: Adjustable wrought steel clevis.
.3 Hanger Rods: Provide steel hanger rods, threaded both ends or continuous threaded, complete with lock nuts on both ends.
.4 Saddles shall wrap around the outside of the insulation for all piping and be sized accordingly.

.3 Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods, cast iron roll and stand for hot pipe sizes 150mm (6 ") and over.

.4 Wall Support:

.1 Pipe Sizes to 75mm (3"): Cast iron hook, or fabricated bracket of 1"x1"x¼" angle bar.

.2 Pipe Sizes 100mm (4″) and over: Welded steel bracket and wrought steel clamp.

.5 Vertical Support:

.1 Steel riser clamp.

.6 Floor Support:

.1 Fabricated stand and pipe clamp or saddle.

**PART 3 – EXECUTION**

3.1 General

.1 Do not suspend hangers including wires and rods from the steel roof deck nor from other mechanical or electrical components. Support hangers from structural bearings such as beam, top chords of steel joists or structural concrete slabs. Where structural bearings do not exist, provide angle or channel iron form nearest structural bearings to support hangers.

3.2 Inserts

.1 Use inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams wherever practicable.

.2 Set inserts in position in advance of concrete work. Provide reinforcement rod in concrete for inserts carrying pipe over 100mm (4″) or ducts over 1500mm (60″) wide.

.3 Where concrete slabs form finished ceiling, finish inserts flush with slab surface.

.4 Where inserts are omitted, drill through concrete slab from below and provide rod with recessed square steel plate and nut above slab.

.5 Expansion bolt type connections will be approved under certain conditions. Obtain approval from the Consultant. Generally, pipe 50mm (2″) or smaller, and ducts less than 600mm x 300mm (24″ x 12″) will be approved, subject to adequate number of support points.

3.3 Pipe Hangers and Support

.1 Fasten hangers and supports to building structure or inserts in concrete construction.

.2 Support horizontal metallic piping as follows:

| Nominal Pipe Size | Distance Between Supports | Hanger Rod Diameter |
|---|---|---|
| 13mm (½″) | 1.8m (6′) | 9.5mm (3/8″) |
| 19 to 38mm (¾″ to 1½″) | 2.4m (8′) | 9.5mm (3/8″) |
| 50 to 63mm (2″ to 2½″) | 3.0m (10′) | 9.5mm (3/8″) |
| 63 to 100mm (3″ to 4″) | 3.6m (12′) | 13mm (½″) |
| 150 to 300mm (6″ to 12″) | 4.3m (14′) | 13mm (½″) |
| 350 to 450mm (14″ to 18″) | 5.0m (16′) | 25mm (1″) |

.3 Install hangers to provide minimum 32mm (1¼″) clear space between finished covering and adjacent work.

.4 Place a hanger within 300mm (12″) of each horizontal elbow.

.5 Use hangers which are vertically adjustable 38mm (1½″) minimum after piping is erected.

.6 Support vertical piping at every floor.

.7 Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

.8 Where practical, support riser piping independently of connected horizontal piping.

.9 Exposed piping, with less than 2.6m (8½ ft) clearance to floors shall be provided with two times the number of hangers normally required. Spacing shall be equal or adjusted for maximum benefit.

.10 Provide copper plated hangers and supports for copper piping or provide nonferrous packing between hanger or support and piping.

.11 Large capacity piping with vibration potential shall not be suspended from any building structure that will allow transfer of vibrations to the occupied spaces.

END OF SECTION

## PART 1 – GENERAL

1.1 References

.1 Canadian General Standards Board (CGSB)

.1 CAN/CGSB-1.60-M89, Interior Alkyd Gloss Enamel.
.2 CAN/CGSB-24.3-92, Identification of Piping Systems.

1.2 Product Data

.1 Submit product data in accordance with Division 1.

.2 Product data to include paint colour chips and all other products specified in this section.

1.3 Product Literature

.1 Submit product literature in accordance with Division 1.

.2 Product literature to include nameplates, labels, tags, lists of proposed legends.

## PART 2 - PRODUCTS

2.1 Manufacturer's Equipment Nameplates

.1 Metal or plastic lamacoid nameplate mechanically fastened to each piece of equipment by manufacturer.

.2 Lettering and numbers to be raised or recessed.

.3 Information to include, as appropriate:

.1 Equipment: Manufacturer's name, model, size, serial number, capacity.
.2 Motor: voltage, Hz, phase, power factor, duty, frame size.

2.2 System Nameplates

.1 Colours:

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

.2 Construction:

.1 3mm (1/8") thick laminated plastic, matte finish, with square corners, letters accurately aligned and machine engraved into core.

.3 Sizes:

.1 Conform to the following table:

| Size | Dimensions mm (") | No. of Lines mm (") | Height of Letters mm (") |
|---|---|---|---|
| 1 | 10 x 50 (3/8" x 2") | 1 (3/64") | 3 (1/8") |
| 2 | 15 x 75 (1/2" x 3") | 1 (3/64") | 6 (1/4") |
| 3 | 15 x 75 (1/2" x 3") | 2 (5/64") | 3 (1/8") |
| 4 | 20 x 100 (3/4" x 4") | 1 (3/64") | 10 (3/8") |

| | | | |
|---|---|---|---|
| 5 | 20 x 100 (3/4″ x 4″) | 2 (6/64″) | 6 (1/4″) |
| 6 | 20 x 200 (3/4″ x 8″) | 1 (3/64″) | 10 (3/8″) |
| 7 | 25 x 125 (1″ x 5″) | 1 (3/64″) | 15 (1/2″) |
| 8 | 25 x 125 (1″ x 5″) | 2 (5/64″) | 10 (3/8″) |
| 9 | 32 x 200 (1-1/4″ x 8″) | 1 (3/64″) | 20 (3/4″) |

.2 Use maximum of 25 letters/numbers per line.

.4 Locations:

.1 Equipment in Mechanical Rooms: Use size #9.
.2 Equipment above ceiling: Use size #1 riveted to ceiling suspension system.

2.3 Identification of Piping Systems

.1 Identify contents by background colour marking, pictogram (as necessary), legend; direction of flow by arrows. To CAN/CGSB 24.3 except where specified otherwise.

.2 Legend:

.1 Block capitals to sizes and colours listed in CAN/CGSB-24.3.

.3 Arrows showing direction of flow:

.1 Outside diameter of pipe insulation less than 75 mm (3″): 100 mm (4″) long x 50 mm (2″) high.
.2 Outside diameter of pipe or insulation 75 mm (3″) and greater: 150 mm (6″) long x 50 mm (2″) high.
.3 Use double-headed arrows where flow is reversible.

.4 Extent of background colour marking:

.1 To full circumference of pipe or insulation.
.2 Length to accommodate pictogram, full length of legend and arrows.

.5 Materials for background colour marking, legend, arrows:

.1 Pipes and tubing 20 mm (3/4″) and smaller: Waterproof and heat-resistant pressure sensitive plastic marker tags.
.2 All other pipes: Pressure sensitive vinyl with protective overcoating, waterproof contact adhesive undercoating suitable for ambient of 100% RH and continuous operating temperature of 150°C (300°F) and intermittent temperature of 200°C (395 °F).

.6 Colours and Legends:

.1 Where not listed, obtain direction from Consultant.
.2 Colours for legends, arrows:

| Background colour | Legend | Arrows |
|---|---|---|
| Yellow | White | Black |
| Green | White | Black |
| Red | White | Black |

2.4 Concrete Pads for Mechanical Equipment

.1 General Contractor to paint all sides and top 12″ (300mm) edge of all concrete pads for mechanical equipment with two (2) coats of yellow paint. Paint colour to match Benjamin Moore Safety Yellow #343.

2.5 Valves, Controllers

.1 Brass tags with 15mm (1/2") stamped identification data filled with black paint.

.2 Include flow diagrams for each system, of approved size, showing charts and schedules with identification of each tagged item, valve type, service, function, normal position, location of tagged item.

.3 Provide coloured adhesive label indication on ceiling grid to locate valves/equipment above. Label description to match device. Size, colour and description to be pre-approved by Consultant.

2.6 Language

.1 Identification to be in English.

**PART 3 - EXECUTION**

3.1 Timing

.1 Provide identification only after all painting specified has been completed.

3.2 Installation

.1 Perform work in accordance with CAN/CGSB-24.3 except as specified otherwise.

.2 Provide ULC and/or CSA registration plates as required by respective agency.

3.3 Nameplates

.1 Locations:

.1 In conspicuous location to facilitate easy reading and identification from operating floor.

.2 Standoffs:

.1 Provide for nameplates on hot and/or insulated surfaces.

.3 Protection:

.1 Do not paint, insulate or cover in any way.

3.4 Location of Identification on Piping Systems

.1 On long straight runs in open areas in boiler rooms, equipment rooms, galleries, tunnels not more than 1.7 m (5'-8") intervals and more frequently if required to ensure that at least one is visible from any one viewpoint in operating areas and walking aisles.

.2 Adjacent to each change in direction.

.3 At least once in each small room through which piping passes.

.4 On both sides of visual obstruction or where run is difficult to follow.

.5 On both sides of separations such as walls, floors, partitions.

.6 Where system is installed in pipe chases, ceiling spaces, galleries, other confined spaces, at

entry and exit points, and at each access opening.

.7 At beginning and end points of each run and at each piece of equipment in run.

.8 Identification to be easily and accurately readable from usual operating areas and from access points. Position of identification to be approximately at right angles to most convenient line of sight, considering operating positions, lighting conditions, risk of physical damage or injury and reduced visibility over time due to dust and dirt.

3.5 Valves

.1 Valves, except at plumbing fixtures or where in plain sight of equipment they serve: Secure tags with non-ferrous chains or close "S" hooks.

.2 Install one copy of flow diagrams, valve schedules mounted in frame behind non-glare glass where directed by Consultant. Provide one copy (reduced in size if required) in each operating and maintenance manual.

.3 Number valves in each system consecutively.

END OF SECTION

## PART 1 - GENERAL

1.1 Quality Assurance

.1 Test equipment and material where specified required by authorities having jurisdiction to demonstrate its proper and safe operation.

.2 Test procedures shall be in accordance with applicable portions of:

.1 Ontario Building Code
.2 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
.3 American Society of Mechanical Engineers
.4 Ontario Ministry of Health
.5 Local codes and ordinances
.6 Other recognized test codes

.3 Provide additional tests and re-testing as required and requested by the Consultant or Owner.

1.2 Submittals

.1 Obtain certificates of approval and acceptance from authorities having jurisdiction and include in Operating and Maintenance Manuals.

.2 On completion of mechanical installation, provide certification of tests with detailed data as required. Itemize tests as to time performed and personnel responsible. Include a copy of field data in Operating and Maintenance Manuals.

1.3 Liability

.1 During tests, assume responsibility for damages in the event of injury to personnel, building or equipment and bear costs for liability, repairs and restoration.

## PART 2 – PRODUCTS

2.1 All equipment and products necessary to perform tests shall be covered under this Division at no cost to the Owner.

## PART 3 - EXECUTION

3.1 Pressure Tests

.1 Piping, fixtures or equipment shall not be concealed or covered until inspected and approved by the Consultant.

.2 Provide equipment, materials and labour for tests. Use test instruments from approved laboratory or manufacturer and furnish certificate showing degree of accuracy.

.3 Test equipment and material where specified required by authorities having jurisdiction to demonstrate its proper and safe operation.

.4 Provide four (4) days notice to the Consultant before tests.

.5 Carry out hydraulic tests for eight (8) hours and maintain pressure. Where leakage occurs, repair and retest.

.6 Domestic Water Piping: Test to 1½ times maximum working pressure or 1034 kPa (150 psi) water pressure measured at system low point.

.7 Drainage Systems: Test by filling with water to produce water pressure of 35 kPa (5 psi) minimum and 83 kPa (12 psi) maximum. Check for proper grade and obstruction by ball test, or other approved means.

3.2 Equipment Tests

.1 Perform testing of all equipment as per manufacturer's recommendations and requirements under full operational ranges and submit reports.

.2 Use the services of a qualified Technician and submit report. Use the services of manufacturer's representative for major equipment.

3.3 Test Reports

.1 Submit all test reports to Consultant as specified herein within one (1) week of each test completion.

.2 Include a copy of all test reports in the manuals.

END OF SECTION

## PART 1 - GENERAL

1.1 Work Included

.1 Piping Insulation

.2 Adhesives, Tie wires, Tapes

.3 Recovering

1.2 Quality Assurance

.1 All workers engaged in the application of insulation shall be journeymen, or indentured apprentices working under a journeyman who is on the site. Trades Qualification certificates must be submitted prior to commencing work and must be on site for inspection.

1.3 Job Conditions

.1 Deliver material to job site in original non-broken factory packaging, labeled with manufacturer's density and thickness.

.2 Perform work at ambient and equipment temperatures as recommended by the adhesive manufacturer. Make good separation of joints or cracking of insulation due to thermal movement or poor workmanship.

1.4 Acceptable Manufacturers:

.1 Fibreglass Canada

.2 Knauf

.3 Mason

.4 Pittsburg Corning

## PART 2 - PRODUCTS

2.1 General

.1 Adhesives, Insulation, Coatings, Sealers and Recovering Jackets shall have composite fire and smoke hazard ratings not exceeding 25 for flame spread and 50 for smoke developed.

.2 Adhesives, coatings and sealers shall be waterproof.

2.2 Materials

.1 Insulation shall be precovered, preformed insulation complete with foil or kraft all purpose jacket unless otherwise noted.

.2 Insulation shall be 1” thick unless otherwise noted.

.3 Cold Piping: Fine fibrous glass insulation with factory applied vapour barrier jacket, molded to conform to piping, "K" value at 0.24 btu/in/sq ft/deg F/hr.

.4 Hot and Tempered Water Piping: Fine fibrous glass insulation with factory applied general purpose jacket, molded to conform to ping, "K" value at 0.24 btu/in/sq. ft/deg. F/hr.

.5 Condensate Piping: Fine fibrous glass insulation with factory applied vapour barrier jacket, molded to conform to piping, "K" value at 0.24 btu/in/sq ft/deg F/hr.

.6 Roof Drainage: Flexible fibrous glass insulation, "K" value at 0.26 btu/in/sq ft/deg F/hr.

.7 Recovering Jackets in all Exposed Areas (i.e. Mechanical Rooms, etc.): PVC pre-formed.

**PART 3 - EXECUTION**

3.1 Preparation

.1 Do not install covering before piping and equipment has been tested and approved.

.2 Ensure surface is clean and dry prior to installation. Ensure insulation is dry before and during application. Finish with systems at operating conditions.

3.2 Installation

.1 In non fire rated surfaces, ensure insulation is continuous through inside walls. Pack around pipes with fireproof self-supporting insulation material, properly sealed.

.2 Finish insulation neatly at hangers, supports and other protrusions.

.3 Provide recovering jackets on exposed insulation as specified herein.

.4 Coat recovering jacket with two coats of waterproof fire retardant coating.

.5 Do not install and seal vapour proof insulation if ambient air has a high humidity.

.6 Pipe hangers shall wrap around outside of insulation for all sizes. Piping shall be provided with insulation flashing of heavy gauge metal to prevent crushing and hanger sized for exterior of insulation.

3.3 Domestic Water Piping – Hot, Cold and Tempered

.1 Insulate all new domestic *hot, cold and tempered* water piping.

.2 Re-insulate all existing domestic *hot, cold and tempered* water piping with areas of work (washrooms and custodial rooms, and classroom areas at new sinks). The existing insulation shall be removed and replaced.

.3 Insulate valves, unions, flanges, strainers, flexible connections and expansion joints for all cold water systems. Not required for hot or tempered water systems.

.4 Cover elbows, tees and similar fittings with equivalent thickness of insulation material.

3.4 Condensate Piping

.1 Insulate all new condensate piping off heat pumps and other mechanical equipment.

.2 Cover elbows, tees and similar fittings with equivalent thickness of insulation material.

3.5 Roof Drainage

.1 Insulate all roof hoppers.

.2 Insulate all new roof drainage piping including horizontal *and* vertical piping.

END OF SECTION

## PART 1 - GENERAL

1.1 Quality Assurance

.1 Water piping shall meet the requirements of the Ontario Building Code and Municipal Codes.

.2 Pipe fittings shall conform to the following standards:

.1 ANSI B36.10, ASTM-197-47 (Materials)
.2 ANSI B16.24, ANSI/ASME B16.15, ANSI B16.8, ANSI/ASME B16.22 (Copper Fittings)

1.2 Reference Standards and Codes

.1 Ontario Building Code
.2 ASTM
.3 CSA
.4 ANSI
.5 ULC
.6 Local Codes and Requirements

1.3 Firestop Sealants and Collars

.1 Standard method of fire tests of firestop system CAN4-S115-M85.

.2 UL Classified and/or FM Systems Approved and tested to the requirements of ASTM E814 (UL1479).

.3 Seals, assemblies and materials for penetration of fire rated surfaces shall be listed by FM and certified by UL or ULC for the service application.

1.4 Submittals

.1 Firestop materials: Submit service limitations, installation instructions, UL certification and FM listing.

.2 Fire rated penetration seals: Submit dimensional data, service limitations, installation instructions, UL certification and FM listing.

## PART 2 – PRODUCTS

2.1 Domestic Water (Aboveground)

.1 Domestic water pipe shall be Type “L” hard drawn copper tubing, conforming to ASTM B88.

.2 Fittings shall be wrought copper, solder joint, pressure type. Make soldered joints on copper tubing for potable water using lead free solder and matching flux.

.3 Solder to threaded adapters shall be provided at screwed valves or equipment.

.4 Unions shall be all bronze construction with ground joint and either solder joint or screwed ends as required. Provide dielectric unions or couplings at all connections between copper tubing and ferrous piping.

.5 Provide commercial type water hammer arrestors on all plumbing lines serving fixtures and equipment with quick closing or solenoid valves.

.6 Exposed plumbing brass and metal work shall be heavy chromium plated (including under countertops without cabinets).

.7 Hot, cold and tempered water piping to fixtures shall be flexible copper tube complete with angle type screwdriver stop, reducer, and escutcheon plate.

.8 Provide isolation valves on domestic water piping to each group of fixtures.

2.2 Domestic Water (Underground)

.1 50mm (2") and smaller: Copper Type K

.2 100mm (4") and larger: Listed PVC

2.3 Water Hammer Arrestors

.1 Refer to 22 42 00 (where applicable).

2.4 Solder

.1 Potable water systems shall be lead free.

2.5 Condensate Piping

.1 Type K or L hard copper complete with cast brass or wrought copper drainage fittings with solder joints

2.6 Aboveground Drainage, Venting and Storm

.1 Pipe up to and including 50mm (2") for services **except Urinals** shall be:

.1 Copper DWV pipe complete with cast brass or wrought copper drainage fittings with solder joints, use 50/50 solder and matching flux for copper drain, waste, and vent piping or
.2 Cast iron MJ pipe with MJ fittings and stainless steel clamps. Clamps shall be two-band type.

.2 Pipe up to and including 50mm (2") **for Urinals** shall be:

.1 PVC DWV for any piping underground or concealed in walls.
.2 PVC XFR for any piping in pipe chases, ceilings spaces or other open areas.
.3 NOTE: PVC DWV or XFR is not acceptable in any other applications.

.3 Pipe 75mm (3") and up shall be:

.1 PVC DWV 40 System 15 complete with PVC drainage fittings with solvent weld joints (in concealed areas only, not acceptable in ceilings spaces) or
.2 Cast iron MJ pipe with MJ fittings and stainless steel clamps. Clamps shall be two-band type.

2.7 Drainage System (Underground)

.1 Pipe up to and including 75mm (3") shall be:

.1 ULC certified PVC 40 DWV pipe to CAN/CSA B181.2 complete with PVC DWV fittings to CAN/CSA B181.2 with solvent weld joint.

.2 Pipe 75mm (3") up to and including 100mm (4") shall be:

.1 ULC certified PVC 40 DWV pipe to CAN/CSA B181.2 complete with PVC DWV fittings to CAN/CSA B181.2 with solvent weld joint, or
.2 ULC certified PVC SDR 28/35 BDS pipe to CAN/CSA B182.1 complete with PVC BDS

fittings to CAN/CSA B182.2 with solvent weld joints.

.3 Pipe 125mm (6") and up shall be:

.1 ULC certified PVC SDR 28/35 sewer pipe to CAN/CSA B182.2 complete with PVC fittings to CAN/CSA B182.2 with ring gasket joints.

2.8 Cleanouts

.1 Refer to Section 22 13 19.

2.9 Plumbing Vent Stacks

.1 Plumbing vent stacks shall be 18" (457 mm) high, vandal proof, 0.064" (1.6 mm) mill finish 1100-0T alloy aluminum, to CSA B272-93, with aluminum hood and perforated collar, thick pre-molded urethane insulation liner and EPDM Base Seal, bituminous painted deck flange or to match type of roofing system. Equal to Thaler SJ-31, STACK JACK Flashing.

2.10 Sprinkler/Fire Piping

.1 Pipe, fittings, hangers and supports shall conform to NFPA 13 and NFPA 14.

.2 Sprinkler piping shall be steel schedule 40.

.3 Piping 2" and under shall be screwed fittings. Piping 2.5" and over shall be grooved with firelock fittings or welded.

2.11 Firestop Sealants and Collars

.1 Provide firestop sealants around all pipe penetrations through rated separations.

.2 Provide firestop collars for all combustible pipe penetrations through rated separations (where combustible piping is approved).

.3 Intumescent insert: Flexible, elastomeric strip, two stage expansion, designed to firestop penetrations in fire-rated walls and floors and floor/ceiling assemblies.

.4 Provide a minimum of 15 times free expansion.

.5 Sealants shall not contain water soluble expansion ingredients.

**PART 3 - EXECUTION**

3.1 General

.1 Apply for permit before beginning any work. Have drawings approved for construction by authorities having jurisdiction or local agencies prior to beginning work.

.2 Review all inverts and elevations before beginning any installation.

.3 Do not suspend hangers including wires and rods from the steel roof deck nor from other mechanical or electrical components. Support hangers from structural bearings such as beam, top chords of steel joists or structural concrete slabs. Where structural bearings do not exist, provide angle or channel iron form nearest structural bearings to support hangers.

.4 Refer to Section 22 05 29 for Hangers and Supports.

.5 Have entire installation inspected, at various stages where required, to ensure approval at

completion of project.

.6 Provide clearance for proper installation of insulation and for access to components including but not limited to valves and drains.

.7 Maintain proper grades on piping for proper drainage and provide valves at all low points.

.8 All sanitary lines shall be sloped minimum 1:50 unless otherwise approved.

.9 All exposed piping to run parallel to walls and in a neat and orderly fashion to maintain headroom. Group piping where possible.

.10 Do not run combustible or non-approved pipe through fire separations or return air ceiling plenums. Use approved materials and methods only.

.11 Provide drain valves at low points where required.

.12 Install piping to allow for expansion and contraction and to eliminate stress on equipment, piping, or connections.

.13 Provide isolation valves or shutoff valves at all equipment.

.14 Provide cleanouts as indicated on drawings and as required by code. Floor cleanouts are not approved in finished floor areas unless otherwise noted. Ensure adequate clearance to all cleanouts.

.15 Provide sleeves for piping passing through floor slab. Caulk around piping and fill entire space between piping and floor slab with approved fire retardant material to maintain required fire rating where necessary.

.16 Provide fire stop sealant at all pipe penetrations through fire separations.

.17 Install reduced pressure double check valve assembly to isolate domestic system from hydronic system, where indicated on drawings and as required by code.

3.2 Grades, Routes and Installations

.1 All sanitary lines shall be sloped 1:50 unless otherwise specified.

.2 Route piping in orderly manner and maintain proper grades. Install to conserve headroom and interfere as little as possible with use of space.

.3 Run exposed piping parallel to walls. Group piping wherever practical at common elevations.

.4 Install concealed pipes close to the building structure to keep furrings to a minimum.

3.3 Roof Jacks

.1 Provide roof jacks as required, and in compliance with the roofing specifications. Generally, SBS torch down roofing requires aluminum roof jacks. Conventional bituminous roofing accepts lead or aluminum roof jacks.

.2 Flash pipes projecting above finished roof surface with approved material.

3.4 Flashing

.1 Flash all mechanical equipment passes through weather or waterproofed walls and roofs.

.2 Flash floor drains over finished areas by extending flashing 250mm (10") clear on sides. Fasten flashing to drain clamp device. Use lead sheet or approved nonmetallic waterproofing membrane.

3.5 Sleeves

.1 Provide and set sleeves required for piping.

.2 Set sleeves in position in advance of other work. Provide suitable reinforcing around sleeves.

.3 Extend sleeves through potentially wet floors 50mm above finished floor level. Caulk sleeves full depth and provide floor plate.

.4 Where piping passes through floor, ceiling or wall, close off space between pipe and sleeve with noncombustible insulation or approved non-combustible insulation, fire rated as required to match the rating of the penetrated surface. Provide tight fitting metal caps on both sides.

.5 Install chrome plated escutcheons where piping passes through finished surfaces including millwork.

.6 Size large enough to allow for movement due to expansion and to provide for continuous insulation.

3.6 Firestop Sealants and Collars

.1 Clean all concrete, masonry and stone penetrations of all contaminants and impurities, concrete form release agents, water repellents, oils, surface dirt and rust, scale, all old sealants and other surface treatments.

.2 Metal surfaces shall be cleaned by wiping them with an oil- free absorbent cloth saturated with solvent such as xylol or toluol. Do not use alcohols.

.3 Do not apply to polycarbonates or to building materials that bleed oils, plasticizers or solvents, or where sealant is not exposed to atmospheric moisture, or to surfaces which have been or will be painted.

.4 Collars are to be installed with steel fasteners or steel expansion anchors. Low melting temperature anchors of lead, plastic or aluminum are not approved.

.5 Installation only when temperatures are between 4°C (40°F) and 37°C (98°F).

3.7 Identification

.1 Identify all piping with type of service and arrows.

.2 Refer to Section 22 05 53.

3.8 Testing

.1 Refer to Section 22 05 92.

3.9 Cleaning

.1 Thoroughly flush domestic water systems upon completion of work.

3.10 Sprinkler/Fire

.1 Contractor shall install in conformance with NFPA 13 and 14.

.2 Contractor shall provide installation conformance letter upon completion of work.

END OF SECTION

## PART 1 - GENERAL

1.1 Submittals

.1 Refer to Section 22 05 01 – Plumbing General Requirements.

.2 Submit certified pump curves with shop drawings showing pump performance characteristics with pump and system operating point plotted. Include NPSH when applicable.

1.2 Quality Assurance

.1 Pumps shall be alignment certified.

.2 Ensure pumps operate at specified system fluid temperatures. Operate within 25% of midpoint of published maximum efficiency curve.

1.3 Acceptable Manufacturers

.1 Manufacturers of pumps whose products are approved in principle, but subject to requirements of drawings and specifications are:

.1 ITT – Bell & Gossett
.2 Armstrong

## PART 2 - PRODUCTS

2.1 General

.1 Statically and dynamically balance rotating parts.

.2 Construction shall permit complete servicing without breaking piping or motor connections.

.3 Pumps shall operate at 1,750 rpm unless specified otherwise.

.4 Pump connections shall be flanged for sizes 63mm (2½") and over, and grooved or union connections for sizes 50mm (2") and under.

.5 Units shall be completely factory wired, tested and name-plated before shipment. Pump manufacturer shall be ISO-9001 certified.

.6 Pumps shall meet types, sizes, capacities, and characteristics as scheduled on the Equipment Schedule drawings. Refer to schedules for unit performance.

.7 Units shall be specifically designed for chilled water and hot water heating systems as indicated on the drawings. Complete unit shall be ETL- Canada listed.

.8 Pumps shall be designed for operation at 225° F and 175 PSIG working pressure unless scheduled otherwise on the drawings.

2.2 In-Line Domestic Water Circulating Pumps

.1 Provide, as shown on the plans, Astro MultiSpeed series circulating pump model with all bronze construction and Noryl impeller.

.2 Pump shall be ULC 778, CSA 22.2, NSF 61, and NSF 372 certified for Canada (lead content of all wetted surface is 0.25% or less.)

.3 Electrical: 115V/single phase/60 Hz and cETL listed.

## PART 3 – EXECUTION

3.1 General

.1 Install pumps in accordance with manufacturer's guidelines.

.2 For inline circulating pumps, support piping adjacent to pump such that no weight is carried on pump casings. Do not provide supports directly on pump casings. Provide supports under elbows on pump suction and discharge line sizes 75mm (3") and over.

.3 Install valves as per detail on drawings.

.4 All electrical wiring and accessories, including power wiring from motor control centers and/or motor starter to driven motor, shall be installed in accordance with the requirements specified by Division 26 and the local electrical authority.

.5 Perform startup to confirm proper operation and rotation.

.6 Remove any temporary strainers after flushing is complete and leave in mechanical room for inspection/confirmation by the Consultant.

END OF SECTION

## PART 1 - GENERAL

1.1 General Requirements

.1 Provide materials, equipment and labour to install plumbing as required by Provincial and local codes as specified herein.

.2 Provide water and drainage connections to equipment specified in other sections of this specification.

1.2 Quality Assurance

.1 Provide new equipment, CSA approved.

1.3 Submittals

.1 Submit shop drawings to the Consultant for review prior to ordering or installation.

.2 Shop drawings shall include manufacturer, model numbers, performance data, and indicate conformance to above reference standards.

.3 Fixtures and Cleanouts: Dimensions and installation details

.4 Floor drains: Accessories, dimensions and installation details

.5 One copy of all stamped reviewed shop drawings shall be included in maintenance manual.

1.4 Acceptable Manufacturers:

.1 Watts

.2 Zurn

.3 Ancon

.4 Smith

## PART 2 – PRODUCTS

2.1 Plumbing Drains

.1 Refer to Plumbing Fixture Schedule on Drawings.

## PART 3 - EXECUTION

3.1 Installation

.1 Drainage lines 75mm (3") and less shall slope at 2% grade unless otherwise shown on drawings. All lines 100mm (4") and larger shall slope at 1%.

3.2 Cleanouts

.1 Ensure ample clearance at cleanout for rodding of drainage systems.
.2 Provide cleanouts at the base of each stack.

3.3 Floor Drains

.1 Provide trap primer connected to intermittent operating cold water service on suitable fixture.

.2 Provide sealed drains where indicated.

.3 Set drain at elevation to allow finished floor to slope to mouth. Coordinate setting elevation with floor finish thickness and General Contractor prior to installation.

.4 Provide flashing of sheet lead or approved nonmetallic membrane where floor drains are located over occupied spaces.

.5 All floor drains and trap primer lines shall be covered, sealed and protected during construction to ensure construction waste or other debris does not fall in. If any drainage problems occur due to floor drains not being covered, the Contractor shall rectify at no cost to the Owner.

3.4 Trap Seal Primers

.1 Coordinate location of all trap seal primers with site and drawings.

.2 Coordinate 120V power connection with Electrical Contractor.

3.5 Roof Drains

.1 Coordinate roof drain locations with Architectural Drawings and General Contractor prior to installation. Report any discrepancies to Consultant. Any changes resulting from lack of coordination will be the Contractor's responsibility.

END OF SECTION

## PART 1 - GENERAL

1.1 Requirements

.1 Plumbing fixtures shall meet the following requirements where applicable:

.1 Ontario Building Code
.2 Local Codes and Requirements including barrier free

1.2 Codes and Standards

.1 CAN 3-B45

.2 CSA B125

1.3 Submittals

.1 Shop Drawings:

.1 Submit shop drawings to the Consultant for review prior to ordering or installation.
.2 Shop drawings shall include manufacturer, model numbers, performance data, and indicate conformance to above reference standards.
.3 One copy of all stamped reviewed shop drawings shall be included in maintenance manual.

.2 Operation and Maintenance Data:

.1 Provide operation and maintenance literature for all equipment indicating manufacturer and model of equipment, instructions for operation and maintenance of same, and parts list.
.2 Operation and maintenance data shall be included in the maintenance manual.

## PART 2 - PRODUCTS

2.1 Fixtures

.1 Determine fixture quantity and location from Architectural Drawings. Refer to and provide plumbing fixtures as per schedule.

.2 Refer to Section 22 05 01 for mounting heights. Coordinate with Architectural Drawings and General Contractor prior to installation.

.3 Report any discrepancies of fixtures and mounting heights between Architectural Drawings and Plumbing Drawings/Schedule/Specification to the Consultant.

.4 Plumbing Fixtures shall be approved for intended application.

.5 Fixtures and trim of same type to be of one manufacturer.

.6 Where particular fixture or piece of trim is identified by a manufacturers' catalogue designation this reference is to establish standard and fixture or trim from manufacturers listed below is equally acceptable when conforming to the same level of quality.

.7 Finished surfaces to be clear, smooth and bright, and guaranteed not to craze, discolour or scale.

.8 Visible parts of faucets, escutcheons, wastes, strainers, traps, shower heads, supplies and stops to be chrome plated.

.9 Floor mounted water closets to be fitted with china bolt caps.

.10 Swing spouts for sinks shall be sized so spout does not swing beyond sides of bowl. Spouts for sinks shall have stopper to prevent spout from swinging past back of bowl.

.11 Water supply faucet spouts to be fitted with modulators (non-aerating).

.12 Fixtures to be ordered to suit construction schedule.

.13 Acceptable Manufacturers:

.1 Vitreous China (water closets, urinals and lavatories): American Standard, Kohler, Vortens
.2 Wall Carriers: Watts, Zurn
.3 Toilet Seats: Centoco, Olsonite, Bemis
.4 Faucets: Moen, Sloan, Chicago Faucets, Delta Commercial, Zurn
.5 Flush Valves: Commercial Moen, Sloan, Chicago Faucets, Delta
.6 Stainless Steel Sinks: Franke/Kindred, Steel Queen, Elkay
.7 Washfountains: Bradley
.8 Drinking Fountains: Haws, Aquarius
.9 Drinking Fountains (Bottle filler): Elkay
.10 Mop Sinks: Stern Williams, Fiat
.11 Eyewash Stations: Haws, Guardian, Speakman, Bradley
.12 Hosebibbs: Watts, Zurn
.13 Thermostatic Mixing Valves: Lawler, Delta, Haws, Symmons, Powers

2.2 Trim

.1 Provide trim for plumbing fixtures as per schedule.

.2 Trim to be suitable for exposed piping application where applicable.

.3 Acceptable Manufacturers: McGuire, Cambridge Brass, Delta, Zurn

2.3 Plumbing Fixtures

.1 Refer to Plumbing Fixture Schedule on drawings.

**PART 3 - EXECUTION**

3.1 Installation

.1 Support fixtures level and square and connect with supplies, drains, traps and vents. Provide trap easily accessible for service and cleaning.

.2 Hot water taps to be on left side.

.3 Fixtures on outside walls to have water supplies in insulated chase.

.4 Exposed supply tail pieces, drains and traps on handicapped fixtures are to be insulated and/or covered in conformance with the Ontario Building Code.

.5 Completely remove and reinstall existing fixtures which are indicated to remain and connect to drain, vent, hot and cold water supply piping, to approval of authorities. Provide new seals and "O" rings.

.6 Accurately lay out roughing-in. Offsets will not be accepted.

.7 Provide fixtures complete with necessary trim, including traps, faucets, supplies, stops, strainers and escutcheons. Any exposed trim shall be chrome.

.8 Provide chrome plated rigid or flexible connections with screwdriver stops, reducers, and escutcheons.

.9 Provide trap easily accessible for service and cleaning.

.10 Provide independent threaded check valves on the hot and cold water supply lines to all thermostatic and pressure balancing faucets prior to mixing valves.

.11 Provide hot water recirculation lines within 1200 mm (48 in) of all plumbing fixtures equipped with thermostatic mixing valves.

.12 Seal fixtures and trim to counters using continuous strip of "Plumber's Dope".

.13 Install vacuum breakers on plumbing lines where contamination of domestic water may occur. Generally necessary on flush valves and janitor sink trim and shall be integral to fixtures as per schedule.

.14 Install prefabricated shower units with additional support by applying a heavy donut or furrow of wet cement, just prior to unit installation and level unit so that the cement will form a firm support between the floor and the unit.

.15 Provide caulking around mounting face to seal with clear or white silicone.

.16 Thoroughly clean all plumbing fixtures and trim at completion of the project.

3.2 Fixture Supports

.1 Install wall mounted fixtures with approved wall carriers, model to suit installation.

.2 Provide plates, brackets, wall carriers, cleats, and supports to rigidly secure fixtures in place.

.3 Fasten wall brackets with bolts attached to double steel supporting plates.

.4 Bolt fixture to wall through cored holes under lavatory wall flange, using chrome plated carriage bolts with integral washers, and expansion shields.

.5 Install extra heavy chair carriers for fixtures not directly supported from floor.

.6 Conceal vertical supports and baseplates in wall construction.

.7 All floor mounted plumbing fixtures (such as water closet bowls, service sinks, mop receptors, and pre-fabricated shower units) to be set in mastic.

3.3 Mounting Heights

.1 Refer to Section 22 05 01 and Architectural Drawings/Details for mounting heights. Report any discrepancies.

3.4 Protection

.1 Plumbing fixtures and trim to be covered with plywood, cardboard or heavy paper and kept protected before, during and after installation and until work is completed and accepted.

.2 Clean fixtures and trim immediately prior to building completion.

END OF SECTION

## PART 1 – GENERAL

1.1 General Requirements

.1 The requirements of this section shall apply to all sections in Division 23.

.2 Conform to Division 1 General Conditions.

.3 All material, labour, equipment, and services required under this section shall be the full responsibility of the Mechanical Contractor including any material, labour, equipment, and services provided by their subcontractors.

.4 Complete and submit the Supplemental Tender Form including list of equipment and materials to be used on this project and forming part of the tender documents.

1.2 Definitions

.1 "Supply" shall mean supply only.

.2 "Install" shall mean install and connect.

.3 "Provide" shall mean supply, install, and connect.

.4 "Drawings and Specifications" shall mean Contract Documents.

.5 "Authorities" or "Authorities having jurisdiction" shall mean all agencies that enforce the applicable laws, ordinances, rules, regulations, or codes of the Place of Work.

.6 "Work" shall mean all equipment, materials, labour, and permits to provide a complete and operational mechanical system as detailed in the drawings and specifications.

.7 "Owner" or "KPRDSB" shall mean Kawartha Pine Ridge District School Board.

1.3 Related Work

.1 Division 1 – General

.2 Division 22 - Plumbing

.3 Division 26 – Electrical

.5 Division 23 specifications form a part of the Contract Documents and shall be read, interpreted, and coordinated with all other Divisions.

1.4 Intent

.1 The drawings and specifications are not a detailed set of installation instructions. Drawings and specifications are complementary to one another and that which is shown on one is as binding as that which is shown on both.

.2 The Consultant shall be immediately informed of any discrepancies between drawings and specifications leaving in doubt the true intent of the work.

.3 Supply all labour, equipment, and materials necessary to install a complete and operational mechanical system described herein and shown on the drawings.

.4 It is the intent of these drawings and specifications to provide for a mechanical installation complete and in operating condition. The responsibility for supplying and installing all

material necessary to accomplish this, except where specifically noted that such work or materials is not included, shall be part of this section.

.5 Assess and be familiar with existing site conditions prior to pricing and construction and allow for same in tender price.

.6 All work must be done by qualified, certified and experienced persons in such line of work. Trade certificates must be available on demand.

.7 All work shall be in accordance with standard industry practice accepted and recognized by the Consultant and the Trade.

.8 This Contractor shall coordinate with and cooperate with all other trades prior to installation. Where work interferes with other trades due to failure to coordinate or cooperate, the work shall be removed and relocated as approved by the Consultant at no extra cost to the Owner.

.9 The Consultant shall have the right to reject any work that does not conform to the Contract Documents and accepted standards of practice including but not limited to performance, quietness of operation and finish.

1.5 Codes, Bylaws, Standards, and Regulations

.1 The mechanical system shall comply with the latest editions and revisions of applicable codes, bylaws, standards, and regulations including but not limited to:

.1 Ontario Building Code
.2 ASHRAE
.3 SMACNA
.4 NFPA
.5 Canadian Standards Association
.6 Canadian Gas Association
.7 Local Building Bylaws
.8 Ontario Occupational Health and Safety Act

.2 Provide work in accordance with the requirements of all applicable government codes, local by-laws, underwriter's regulations base building standards, contract documents, and all authorities having jurisdiction.

.3 Where discrepancies occur between contract drawings and specifications and above codes and standards referred to herein, the Contractor is to notify the Consultant in writing and obtain clarification prior to proceeding with the work.

.4 Contractors shall not reduce the requirements on the contract drawings and specifications by applying any codes and standards referred to herein.

1.6 Permits and Fees

.1 Apply for, obtain, and pay for all permits, fees, connections, inspections, licenses, certificates or charges necessary including all provincial and federal taxes.

.2 Coordinate all required inspections and give necessary notice to all authorities.

.3 Upon completion of project, provide inspection certificates confirming acceptance by all authorities having jurisdiction for all applicable disciplines.

1.7 Contract Breakdown

.1 After the tenders close, submit a breakdown of the price into scope and trades to the

satisfaction of the Consultant based on the sections of the specifications.

.2 Breakdown shall include but not be limited to:

.1 Mobilization and shop drawing submission (maximum $5,000)
.2 Underground plumbing and drainage (including storm)
.3 Above ground plumbing and drainage
.4 Plumbing Fixtures
.5 Hot Water Tank and Pump
.6 Sprinkler System
.7 Heating Piping
.8 Pipe Insulation
.9 Roof top Units
.10 Terminal heating units
.11 Fans
.12 Grilles and Diffusers
.13 Ductwork
.14 Duct Insulation
.15 Controls
.16 Testing, Startup & Training
.17 Balancing
.18 Close-out Submittals – Manuals & As-builts (minimum $5,000)

.3 Progress claims shall be based on the breakdown. Submit in table format showing contract amount, work complete to date as percentage, previous draw, amount this draw and balance for each line item.

1.8 Shop Drawings

.1 Within thirty (30) days of award, the Contractor shall submit shop drawings of all equipment for the project. Partial submittals will not be accepted.

.2 Prior to ordering of products or delivery of any products to job site, submit shop drawings electronically in PDF format to the Consultant for review and comments. Submit sufficiently in advance of construction to allow ample time for review. Size of shop drawings shall be 8.5x11". 11x17" will be acceptable where appropriate for content and scale.

.3 Submittals shall contain but not be limited to:

.1 Construction information
.2 Product data
.3 Performance data including performance curves
.4 Acoustical sound power data
.5 Dimensional layout and clearances
.6 Mounting arrangements
.7 Certification of compliance to applicable codes
.8 Operating and Maintenance information
.9 Wiring, single line and schematic diagrams (where applicable)

.4 Clearly mark each sheet of printed submittal material, using arrow, underlining or circling, to show particular sizes, dimensions, wiring diagrams, operating clearances, control diagrams, project identification, types, model numbers, ratings, capacities and options actually being proposed. Cross out non-applicable material. Note on the submittal specified features such as special tank linings, pump seals, materials or painting.

.5 **Prior to submission to the Consultant, the Contractor shall review all shop drawings. By this review the Contractor represents that they have determined and verified all field measurements, field construction criteria, materials, catalogue numbers and similar data or**

**will do so and that they have checked and coordinated each shop drawing with the requirements of the Work and of the Contract Documents.**

.6 **The Contractor's review of each shop drawing shall be indicated by his approval stamp, date and signature on the front of each page. Drawings will not be considered if not previously checked by the Mechanical Contractor.**

.7 Review comments from the Consultant. If shop drawings are modified, confirm changes before proceeding. If shop drawings are not approved, revise and resubmit changes for approval within two (2) weeks.

.8 Review of the shop drawings by the Consultant does not relieve the Contractor or his Supplier of the responsibility to provide the correct and complete equipment, material or installation.

.9 Keep one complete set of shop drawings at the job site during construction.

.10 Include stamped reviewed shop drawings in the Maintenance Manuals.

1.9 Product Delivery Schedule

.1 Within two (2) weeks from shop drawing review, a schedule must be submitted by the Contractor showing projected delivery dates of all products to meet required construction schedule.

1.10 Construction Meetings

.1 The Mechanical Contractor shall attend all site meetings unless otherwise pre-approved.

.2 Sub-trades shall attend site meetings as requested or as required.

1.11 Record Drawings

.1 Refer to Section 23 05 02.

.2 Maintain accurate, neat, and clean record drawings on an **on-going basis** during construction to be reviewed periodically by the Consultant during construction.

.3 Record drawing mark-ups shall be made available at every site meeting or inspection.

.4 Record drawings shall include but not be limited to final location of any access doors on same for future service requirements.

.5 Prior to Substantial Performance submit a complete set of record drawings in AutoCAD format. The Contractor is responsible for drafting all as-built conditions in AutoCAD. Any changes shall be drafted using layers, fonts, etc to match the original drawings. No new layers or fonts shall be used or created. The base electronic AutoCAD files will be made available from the Consultant. Make any changes as requested by the Consultant after review.

1.12 Reports

.1 Provide the following reports upon completion of work by certified Contractors for review and approval by the Consultant:

.1 Equipment Start-Up Reports
.2 Balance Report (Air and Water)
.3 Duct Leakage Test Report

.4 Piping Pressure Test Reports (Gas, Hot Water Heating, Domestic)
.5 VFD Startup Report
.6 Chemical Treatment Test Report
.7 Backflow Preventer Test Report
.8 Guardian III Test Report
.9 Sprinkler Material and Test Certificates
.10 Sprinkler Engineer Sign-Off Letter
.11 Other equipment startup reports and test sheets certified by the manufacturer or a qualified technician
.12 Demonstration and Training Reports/Logs

.2 All reports shall be dated and signed by the Technician who performed the start-up and/or tests.

1.13 Maintenance Manuals

.1 Refer to Section 23 05 02.

.2 Provide the Owner with two (2) **indexed**, hard cover maintenance manuals to local air balance industry standards plus one (1) electronic copy on labeled CD or on memory stick. Manuals shall contain and be tabbed in the following order:

.1 Table of Contents
.2 Contractor's, Manufacturer's and Supplier's Contact Information
.3 Warranty Letter
.4 Valve schedule
.5 Colour coding charts for access areas
.6 Reports as specified herein and as applicable
.7 ALL stamped approved shop drawings – Include a tab and blank section for any Owner supplied equipment
.8 Equipment maintenance instructions and manuals
.9 Record drawings

.3 Submit one (1) complete copy to the Consultant for review and approval. Revise based on any comments and resubmit all copies and electronic copy to Consultant.

1.14 Testing and Startup

.1 Refer to Sections 23 05 92 under this Division.

.2 Test and startup all equipment and work.

.3 Fully coordinate all testing and startups with all trades, the Consultant, and authorities having jurisdiction.

.4 **The Controls Contractor shall be present during all equipment start-ups. Coordinate scheduling with Controls Contractor.**

.5 Provide adequate notice to all parties.

1.15 Demonstration and Training

.1 Demonstrate and train the Owner on proper operation of the system.

.2 Refer to Section 23 09 23 for additional training requirements for Controls.

.3 The Contractor shall arrange for all necessary personnel and equipment specialists to be in attendance for purposes of demonstration and training.

.4 Provide instruction by a manufacturer's representatives as required to fully demonstrate the systems.

.5 Demonstration and Training shall include but not be limited to:

.1 Training in the normal, abnormal and emergency operation of all systems provided under this Division.
.2 Review of all necessary maintenance procedures, including winterization, of all systems provided under this Division.
.3 Provision of a documented maintenance program covering all systems provided or modified under this contract.
.4 Review of all close-out documentation including complete maintenance manuals and record drawings.

.6 Prepare a Training Agenda and Log for signature by all Participants. Submit to Consultant and include in Manuals.

1.16 Substantial Completion and Performance

.1 Substantial completion and performance shall be determined and awarded by the Consultant.

.2 Complete the following to the satisfaction of the Consultant prior to request for substantial performance:

.1 Fire Dampers and Fire Stopping
.2 System Testing and Startups including report
.3 Balancing including report
.4 Maintenance Manuals
.5 Record Drawings
.6 Demonstration and Training

1.17 Warranty

.1 Provide a one (1) year full parts and labour warranty for the new system from date of substantial completion.

.2 Submit warranty letter on Company letterhead signed by Company representative stating warranty terms including warranty period from date of substantial completion.

**PART 2 - PRODUCTS**

2.1 Materials

.1 All material used shall be new, free from defects, of quality specified, and installed in accordance with manufacturer's instructions.

.2 Major equipment shall have nameplates on the exterior of the equipment in a visible location containing manufacturer's name, model number, serial number, performance data, and electrical characteristics.

.3 The same manufacturer shall be used for types of equipment used in similar applications.

.4 It is the responsibility of the Contractor to store and protect materials supplied by this scope.

.5 Materials shall be stored in original containers.

.6 Submit to the Consultant and the Owner, current MSDS Sheets for any products being used on the job site where they exist.

.7 Remove and dispose of all redundant materials and garbage from site.

.8 Supply anchor bolts and templates for installation by other Divisions.

2.2 Selected Products and Equivalents

.1 Sections within Division 23 list "Acceptable Manufacturers" which must meet characteristics of the specified equipment and products for each section.

.2 Base specified products are specified and/or shown on the drawings, and identified by manufacturer's name, type and catalogue number.

.3 Any alternate manufacturers from base specified products and equipment must equal or exceed the quality, finish and performance of those base specified and/or shown, and not exceed the space requirements allotted on the drawings. Include costs for any associated work to accommodate such substitutions, including the Consultant's time and revisions to the work of other divisions (i.e. electrical changes).

.4 If item or material specified is unobtainable, state in Tender proposed substitute and amount added or deducted for its use. Extra monies will not be paid for substitutions after the Contract has been awarded.

.5 If item of size indicated is unobtainable, supply next larger size without additional charge.

2.3 Quality Of Product

.1 All products provided shall be listed and/or approved by relevant authorities and new, unless otherwise specified.

.2 If products specified are not listed and/or approved, obtain approval of provincial regulatory authority. Pay all applicable charges levied and make all modifications required for approval.

.3 All products provided shall be new including those not specified and shall be of a quality best suited to the purpose required and their use subject to approval by the Consultant.

2.4 Product Finishes

.1 Shop drawings shall indicate finishes. Use standard finish unless otherwise specified.

.2 Repair dents and touch up all damaged finishes with matching finish, or if required by the Consultant or Owner, completely repaint or replace damaged surface at no extra cost to the Contract.

2.5 Access Doors

.1 Provide access doors/panels as required for access, adjustment, operation, service, and maintenance.

.2 Minimum size of panels shall be 12" x 18" (300mm x 450mm). Wherever possible 24" x 24" (600mm x 600mm) panels shall be used.

.3 Access doors/panels shall have concealed hinges and screwdriver locking device.

.4 ACCESS DOORS/COVERS - FLUSH ACCESS DOOR – DRYWALL AREA

.1 **Acudor #DW-5040 Series** flush to surface for drywall, satin coat steel with white baked enamel finish, formed door panel, flanged on four sides, 20 gauge. Galvanized frame with multiple bends and integral taping bead, 26 gauge. Concealed hinge, stainless steel screwdriver operated cam latch.

.5 ACCESS DOORS/COVERS - FLUSH ACCESS DOOR - UNIVERSAL

.1 **Acudor #UF-5000** Universal Access Doors, 14 GA. (1.7mm) steel, baked enamel prime coat, continuous concealed hinge, with positive and self-opening screwdriver operated lock.

2.6 Motors

.1 Provide high efficiency motors for mechanical equipment as specified.

.2 If delivery of specified motor will delay delivery or installation of any equipment, install a motor approved by Consultant for temporary use. Final acceptance of equipment will not occur until specified motor is installed.

.3 Motors under 373W, (1/2hp): speed as indicated, continuous duty, built-in overload protection, resilient mount, single phase, voltage as indicated.

.4 Motors 373W, (1/2hp) and larger: EEMAC Class B, squirrel cage induction, speed as indicated, continuous duty, drip proof, ball bearing, maximum temperature rise 40°C (72°F), 3 phase, voltage as indicated.

2.7 Belt Drives

.1 Fit reinforced belts in sheave matched to drive. Multiple belts to be matched sets.

.2 Use cast iron or steel sheaves secured to shafts with removable keys unless otherwise specified.

.3 For motors under 7.5kW (10hp): standard adjustable pitch drive sheaves, having plus or minus 10% range. Use mid-position of range for specified r/min.

.4 For motors 7.5kW (10hp and over: sheave with split tapered bushing and keyway having fixed pitch unless specifically required for item concerned. Provide sheave of correct size to suit balancing.

.5 Minimum drive rating: 1.5 times nameplate rating on motor. Keep overhung loads within manufacturer's design requirements on prime mover shafts.

.6 Motor slide rail adjustment plates to allow for centre line adjustment.

.7 Provide sheave changes as required for final air balancing.

2.8 Guards

.1 Provide guards for unprotected drives.

.2 Guards for belt drives:

.1 Expanded metal screen welded to steel frame.
.2 Minimum 1.2 mm (18 gauge) thick sheet metal tops and bottoms.
.3 40mm (1-1/2") diameter holes on both shaft centres for insertion of tachometer.

.4 Removable for servicing.

.3 Provide means to permit lubrication and use of test instruments with guards in place.

.4 Install belt guards to allow movement of motors for adjusting belt tension.

.5 Guard for flexible coupling:

.1 "U" shaped, minimum 106 mm (16 gauge) thick galvanized mild steel.
.2 Securely fasten in place.
.3 Removable for servicing.

.6 Unprotected fan inlets or outlets:

.1 Wire or expanded metal screen, galvanized, 20 mm (3/4") mesh.
.2 Net free area of guard: not less than 80% of fan openings.
.3 Securely fasten in place.
.4 Removable for servicing.

2.9 Equipment Supports

.1 Equipment supports supplied by equipment manufacturer: specified elsewhere in Division 23.

.2 Equipment supports not supplied by equipment manufacturer: fabricate from structural grade steel meeting requirements of – Structural Steel Section. Submit structural calculations with shop drawings.

.3 Install base mounted equipment on chamfered edge housekeeping pads, minimum of 100 mm (4") high and 150 mm (6") larger than equipment dimensions all around.

2.10 Sleeves

.1 Pipe sleeves: at points where pipes pass through masonry, concrete or fire rated assemblies and as indicated.

.2 Schedule 40 steel pipe.

.3 Sleeves with annular fin continuously welded at midpoint:

.1 Through foundation walls.
.2 Where sleeve extends above finished floor.
.3 Through fire rated walls and floors.

.4 Sizes: minimum 6mm (1/4") clearance all around, between sleeve and un-insulated pipe or between sleeve and insulation.

.5 Terminate sleeves flush with surface of concrete and masonry walls, concrete floors on grade and 25mm (1") above other floors.

.6 Fill voids around pipes:

.1 Caulk between sleeve and pipe in foundation walls and below grade floors with water proof fire retardant non-hardening mastic.
.2 Where sleeves pass through walls or floors, provide space for firestopping. Where pipes/ducts pass through fire rated walls, floors and partitions, maintain fire rating integrity.
.3 Ensure no contact between copper tube or pipe and ferrous sleeve.

.4 Fill future-use sleeves with lime plaster or other easily removable filler.

.5 Coat exposed exterior surfaces of ferrous sleeves with heavy application of zinc rich paint to CGSB 1-GP-181M+Amdt-Mar-78.

.7 Provide minimum 20 gauge duct sleeves where ducts pass through masonry concrete or fire rated assemblies. Maintain minimum 25 mm clearance all around or to the requirements of the authority having jurisdiction. Seal at all as indicated.

2.11 Fire Stopping

.1 This Contractor shall work with all other Contractors on the project in providing one common method of fire stopping all penetrations made in the fire rated assemblies.

.2 Approved fire stopping and smoke seal material in all fire separations and fire ratings within annular space between pipes, ducts, insulation and adjacent fire separation and/or fire rating.

.3 Do not use cementious or rigid seals around penetrations for pipe, ductwork, or other mechanical items.

.4 Insulated pipes and ducts; ensure integrity of insulation and vapour barrier at fire separation.

.5 Provide materials and systems capable of maintaining effective barrier against flame, smoke and gases. Ensure continuity and integrity of fire separation.

.6 Comply with the requirements of CAN4-S115-M35, and do not exceed opening sized for which they have been tested.

.7 Systems to have an F or FT rating (as applicable) not less than the fire protection rating required for closures in a fire separation. Provide “fire wrap” blanket around services penetrating fire walls. Extent of blanket must correspond to ULC recommendations.

.8 The fire stopping materials are not to shrink, slump or sag and to be free of asbestos, halogens and volatile solvents.

.9 Firestopping materials are to consist of a component sealant applied with a conventional caulking gun and trowel.

.10 Fire stop materials are to be capable of receiving finish materials in those areas which are exposed and scheduled to receive finishes. Exposed surfaces are to be acceptable to consultant prior to application of finish.

.11 Firestopping shall be inspected and approved by local authority prior to concealment of enclosure.

.12 Install material and components in accordance with ULC certification, manufacturer’s instructions and local authority.

.13 Submit product literature and insulation material on fire stopping in shop drawing and product data manual. Maintain copies of these on site for viewing by installers and Consultant.

.14 Manufacturer of product shall provide certification of installation. Submit letter to the consultant.

.15 Acceptable Manufacturers:

.1 Fryesleeve Industries Inc.
.2 General Electric Pensiil Firestop Systems
.3 International Protective Coatings Corp.
.4 Rectorseal Corporation (Metacaulk)
.5 Proset Systems
.6 3M
.7 AD Systems
.8 Hilti

.16 Ensure firestop manufacturer representative performs on-site inspections and certifies installation. Submit inspection reports/certification at time of substantial completion.

2.12 Escutcheons

.1 On pipes and ductwork passing through walls, partitions, floors and ceilings in finished areas.

.2 Chrome or nickel plated brass or Type 302 stainless steel, one piece type with set screws.

.3 Outside diameter to cover opening or sleeve.

.4 Inside diameter to fit around finished pipe.

2.13 Spare Parts

.1 Provide spare parts as specified under this Division.

.2 Provide list of equipment in maintenance manuals indicating corresponding spare parts required. List of spare parts to be signed off by receiving personnel.

2.14 Special Tools

.1 Provide one set of special tools required to service equipment as recommended by manufacturers and in accordance with Maintenance Materials Special Tools and Spare Parts.

**PART 3 - EXECUTION**

3.1 Site Examination

.1 Examine the site of work and become familiar with all features and characteristics affecting this work before submitting tender.

.2 No additional compensation will be given for extra work due to existing conditions which such examination should have disclosed.

.3 Report to the Consultant any unsatisfactory conditions which may adversely affect the proper completion of this work.

3.2 Interference and Coordination Drawings

.1 Examine the drawings and all divisions of the specifications.

.2 Prepare interference and equipment layout drawings to ensure all components will be properly accommodated within the spaces provided.

.3 Lay out the work and equipment with due regard to architectural, structural and electrical features, and service requirements.

.4 Submit interference drawings to the Consultant.

.5 Before commencing any work, obtain a ruling from the Consultant if any conflict exists, otherwise no additional compensation will be made for any necessary adjustments.

3.3 Separation of Services

.1 Contact between dissimilar metals, such as copper and aluminum, in damp or wet locations is not permitted.

.2 All pipes, ductwork and wiring shall be supported from permanent building structure. Use of other services for support is not permitted

3.4 Workplace Safety

.1 The workplace must be kept safe at all times.

.2 Conform to all ministries of labour, and health and safety regulations at all times.

.3 Use ladders and proper techniques as approved by the ministry of labour to perform all work.

.4 Cover all holes/openings and provide barriers around hazards, etc. to ensure occupants and workers are not at risk.

.5 Where work does not conform to such regulations, stop work immediately and report the situation to the Owner's representative or Consultant or rectify the situation immediately.

.6 Report any hazards or concerns to the Owner's representative immediately.

.7 Conform to Owner's safety requirements and construction regulations.

3.5 Temporary Requirements

.1 All temporary requirements to complete mechanical work during construction shall be the responsibility of the Mechanical Contractor except temporary power or water.

3.6 Location of Equipment

.1 Approximate distances and dimensions may be obtained by scaling off the drawings. Figured dimensions shall govern over scaled dimensions.

.2 Equipment locations shown on the drawings are approximate. Locations may be revised to suit construction and equipment arrangements provided design intent is not jeopardized and there is no additional cost to the Owner.

3.7 Mounting Heights

.1 Mounting height of equipment is from finished floor to equipment unless otherwise specified or indicated. Coordinate with block coursing if applicable.

.2 Where mounting heights are not indicated on the drawings, obtain verification from the Consultant before proceeding.

.3 Install mechanical equipment at the following heights unless otherwise indicated on the architectural drawings:

| | | |
|---|---|---|
| .1 | Fire Extinguishers | 1.5m(5') to top of extinguisher (with or without cabinets) |
| .2 | Backflow Preventers | 900-1200mm (3'-4') to centerline |

3.8 Welding, Grinding, Noisy Work, Odours

.1 No welding, grinding, other noisy work or work generating odours shall be done during regular operating/school hours.
.2 All above work shall be done after hours or on weekends outside of regular hours.
.3 Submit hot work permit prior to any welding.

3.9 Repairs, Cutting and Restoration

.1 Patch and repair walls, floors, ceilings, and roofs with materials of same quality and appearance as adjacent surfaces unless otherwise shown. Surface finishes shall exactly match existing finishes of same materials.

.2 Each Section of this Division shall bear expense of cutting, patching, and repairing to install their work and/or replacing of work of other Sections required because of its fault, error, tardiness, or because of damage done by it.

.3 Cutting, patching, repairing, and replacing pavements, sidewalks, roads, and curbs to permit installation of work of this Division is responsibility of Section installing work.

.4 All patching, painting and making good of the existing walls, floors, ceilings, partitions and roof will be at the expense of this Contractor, but performed by the Contractor specializing in the type of work involved unless otherwise noted.

3.10 Painting

.1 Refer to other Divisions for Painting unless otherwise specified herein.

.2 Apply at least one (1) coat of corrosion resistant primer paint to ferrous supports and site fabricated work.

.3 Prime and touch up marred finished paintwork to match original.

.4 Paint all new concrete pads for mechanical equipment with 2 coats of yellow paint on all sides and top 12" (300mm) edge

.5 Restore to new condition, or replace equipment at discretion of Consultant, finishes which have been damaged too extensively to be merely primed, painted and touched up.

3.11 Concealment

.1 All equipment, components, piping, and conduit shall be concealed in ceiling spaces, bulkheads or walls in finished areas.

.2 Exposed equipment, components, piping, and conduit installed in unfinished areas, shall be installed as high as possible. Run piping and conduit parallel to building lines, tight to roof deck and down columns.

3.12 Access Doors

.1 Provide access doors as required for access, adjustment, operation, service, and maintenance.

3.13 Clearances and Accessibility

.1 Install all work for easy access for adjustment, operation, service, and maintenance.

.2 Maintain clearances for all equipment as per local codes and manufacturer's instructions.

.3 Access panels shall be Acudor or equivalent with concealed hinges and screwdriver locking device.

.4 Provide access panels of adequate size as required to access equipment and components in concealed areas. Do not install access doors in specialty walls or ceilings.

.5 Provide fire rated access doors where installed in fire separations to match rating of separation.

.6 Install all services in exposed areas so that a minimum head clearance of 2200mm (88") is maintained.

3.14 Equipment and System Protection

.1 Protect equipment and materials from damage in storage and on site before, during, and after installation until final acceptance.

.2 Protect equipment and system openings from dust and debris with appropriate covers that will withstand through the construction.

.3 Where equipment and system components become dirty or damaged, clean and repair to new condition to the satisfaction of the Consultant and the Owner at no expense to the Owner.

3.15 Supports

.1 Provide all miscellaneous metals and materials as required for support, hanging, anchoring, and guiding of all equipment, ductwork, piping, and all other work in Division 23.

.2 All supports must be securely mounted to structures.

.3 Refer to Section 23 05 29.

3.16 Fire Stopping

.1 Refer to Part 2 herein.

3.17 Cleaning

.1 Clean interior and exterior of all systems including strainers. Vacuum interior of ductwork and air handling units prior to turn over to Owner.

.2 In preparation for final acceptance, clean and refurbish all equipment and leave in operating condition including replacement of all filters in all air and piping systems.

3.18 Owner Supplied Equipment

.1 Connect to equipment supplied by the Owner and make operable.

3.19 Identification and Labeling

.1 All equipment, valves, panels and devices shall be labeled under this Division.

.2 Refer to Section 23 05 53.

3.20 TSSA Inspection

.1 Prior to final completion of the project, this Contractor shall make application, arrange, and pay for a TSSA Inspection of all piping systems and equipment installations, including, but not limited to refrigeration, fuel piping, heating plant, and associated equipment installed under the contract.

.2 Provide a copy of the TSSA Report in the maintenance manuals for each system.

3.21 Field Review and Deficiencies

.1 The Contractor shall notify the Consultant when the job is ready for field review at various stages including rough-in stages.

.2 During the course of construction, the Consultants will monitor construction and provide written reports of work progress, discussions and deficiencies.

.3 The Contractor shall correct all deficiencies within the work period prior to the next review.

.4 The Contractor shall not conceal any work until inspected. Where work was concealed, the Contractor shall remove and replace tiles, coverings or other obstructions to allow proper inspection at the Contractor's expense.

.5 Upon completion of the project the Consultant will do a final review. Upon receiving the final inspection report, the Contractor must correct and sign back the inspection report indicated all deficiencies are completed. A re-inspection will only be done once the Consultant receives this in writing. Where the Consultant performs the re-inspection and the work is not complete, the Contractor is responsible for reimbursing the Consultant for the field review. The fee for additional reviews will be at the Consultant's hourly rates plus mileage and applicable taxes to be paid directly to the Consultant prior to performing the next field review.

END OF SECTION

## PART 1 - GENERAL

1.1 Work Included

.1 Operating and Maintenance Manuals

.2 Assembly of equipment details sheets and shop drawings including Owner supplied equipment

.3 Assembly of equipment and systems operating and maintenance instructions

.4 Assembly of equipment start up and performance tests and reports

.5 Assembly of Balancing Report

.6 Assembly of final inspection certificates

.7 As Built Drawings

1.2 Related Work

.1 Division 1

.2 General Mechanical Requirements – Section 22 05 01 and 23 05 01.

## PART 2 - PRODUCTS

2.1 Operation and Maintenance Materials

.1 Provide two (2) 8½" x 11", 3 ring type catalogue binders, labeled front and spine, with plastic tab dividers and Table of Contents. Also provide one (1) complete manual in electronic PDF format on labeled CD or on memory stick.

.2 Manufacturer's data section is to be indexed and ordered to exactly match the sections of the specifications. Each section of the manufacturer's data section is to include an up to date copy of the equipment schedule for that section. The schedule is to be revised to suit all addenda, change orders and field changes, as well as manufacturers and model numbers matching the equipment supplied.

.3 Assemble or develop complete and correct documentation for the operation and maintenance information for equipment and systems provided.

.4 Assemble or develop copies of all certified shop drawings and material required to complete the documentation. This generally includes but is not limited to the following:

.1 Table of Contents
.2 Contractor's, Manufacturer's and Supplier's Contact Information
.3 Warranty Letter
.4 Valve schedule
.5 Colour coding charts for access areas
.6 Reports:

.1 Equipment Start-Up Reports
.2 Balance Report (Air and Water)
.3 Duct Leakage Test Report
.4 HVAC Systems Cleaning Report (where applicable)
.5 Piping Pressure Test Reports (Gas, Hydronic, Refrigeration)

.6 VFD Startup Report
.7 Chemical Treatment Test Report
.8 Backflow Preventer Test Report
.9 Guardian III Test Report
.10 Sprinkler Material and Test Certificates
.11 Sprinkler Engineer Sign-Off Letter
.12 Other equipment startup reports and test sheets certified by the manufacturer or a qualified technician
.13 Demonstration and Training Reports/Logs

.7 ALL stamped approved shop drawings – Include a tab and blank section for any Owner supplied equipment
.8 Maintenance instructions, requirements and schedule
.9 As Built Drawings

2.2 As Built Drawings

.1 As Built Drawings shall be kept up-to-date on an ongoing basis during construction for periodic review by the Consultant. As Built drawings shall always be kept in the same location on site known to the Consultant.

.2 Contractors shall certify that final reproducible As Built drawings to be correct by notation and signature on the drawings.

.3 As Built Drawings shall precisely identify the configuration, size and location of all systems and equipment installed under this Division, including but not limited to:

.1 Heating: shut off valves, balancing valves, piping, access doors.
.2 Controls: controllers, panels, devices, relay cabinets, sensors, thermostats, valve operators, wiring and conduit runs complete with legend.
.3 Miscellaneous: actual room names and numbers, schematic diagrams, riser diagrams.

.4 As Built Drawings must be submitted in AutoCAD as specified herein.

2.3 Balance Reports

.1 Refer to Section 23 05 93 – Balancing.

.2 Include a copy of Balance Report in Operating and Maintenance Manuals including duct leakage tests.

2.4 Test and Start-Up Reports

.1 Refer to section 23 05 92 – Testing, and Section 23 05 01 – General Mechanical Requirements.

.2 Include a copy of all test and start-up reports in Operating and Maintenance Manuals.

.3 Obtain final copies of any 3rd Party test reports for inclusion in Operating and Maintenance Manuals.

2.5 Demonstration and Training Reports

.1 Refer to Section 23 05 01 – General Mechanical Requirements, and 23 08 00 – Commissioning.

.2 Include a copy of all Training literature in the Operating and Maintenance Manuals.

.3 Include a copy of the signed and dated Training Log.

## PART 3 - EXECUTION

3.1 General

.1 A hard copy of the maintenance manual shall be provided immediately upon completion of startup and testing for review by the third party Commissioning Agent and for use during the Demonstration and Training. The Manual shall include all test and start-up reports. Substantial Completion will not be awarded until the manual is submitted and accepted.

.2 The Consultant and Commissioning Agent will review the manual and provide any comments or changes required. The Contractor shall revise and finalize all manuals within three (3) weeks.

.3 Substantial Performance will not be granted until the final hard copies and electronic copy of the complete manual have been submitted by the Contractor and reviewed and accepted by the Consultant.

.4 Submit a draft copy of the manual to the Consultant for review prior to final submission of all copies.

.5 Provide two (2) final hard copies and one (1) electronic copy in PDF format to the Consultant for final acceptance.

3.2 As Built Drawings

.1 Prior to Substantial Performance submit a complete set of As Built drawings in AutoCAD format. The Contractor is responsible for drafting all As Built conditions in AutoCAD. Any changes shall be drafted using layers, fonts, etc to match the original drawings. No new layers or fonts shall be used or created. The base electronic AutoCAD files will be made available from the Consultant. Make any changes as requested by the Consultant after review.

.2 Substantial performance will not be granted until the As Built drawings have been submitted to the Consultant.

END OF SECTION

## PART 1 - GENERAL

1.1 Work Included

.1 Pressure gauges and pressure gauge taps

.2 Thermometers and thermometer wells

.3 Combination instrumentation taps and gauges

1.2 Submittals

.1 Refer to Section 23 05 01.

.2 Submit shop drawings for gauges and thermometers complete with a list which indicates use, operating range, and suitable range of each.

## PART 2 - PRODUCTS

2.1 General

.1 All gauges and thermometers shall be calibrated and shall display in either/both metric and imperial units.

2.2 Acceptable Manufacturers

.1 Weiss

.2 Winters

2.3 Pressure Gauges

.1 Steel case, liquid filled, 100mm (4") diameter, phosphor bronze bourdon tube brass movement, extruded brass socket, accurate to 1.5%.

2.4 Pressure Gauge Taps

.1 Provide brass needle or gate valve.

2.5 Digital Thermometers

.1 Thermometers shall be equal to Weiss Instruments solar digital vari-angle type, model DVU35 complete with CWE35-75BS well.

| | | |
|---|---|---|
| .1 | Case: | Hi-impact ABS |
| .2 | Range (with F/C switch): | -50/300°F (-40/450°C) |
| .3 | Display: | ½" LCD digits, wide ambient formula |
| .4 | Accuracy: | 1% of reading or 1° whichever is greater |
| .5 | Resolution: | 1/10° between -19.9/199.9°F (-28/93°C) |
| .6 | Recalibration: | Through case potentiometer adjustment |
| .7 | Lux Rating: | 10 Lux (one foot-candle) |
| .8 | Update: | 10 seconds |
| .9 | Ambient Operating: | -30/140°F (-35/60°C) |
| .10 | Ambient Temp Error: | 0 |
| .11 | Humidity: | 100% |
| .12 | Sensor: | Glass passivated thermistor – NTC |
| .13 | Stem Assemblies: | Industrial glass full conformance with Fed |

Spec GG-T-321D. Fully interchangeable with Industrial Glass Thermometers.

.2 Thermowells shall be brass separable socket, ¾" NPT, complete with gasket and cap, size as required.

.3 Provide tilt adjustment to view without climbing from floor.

2.6 Stem Type Thermometers

.1 11" long, adjustable scale, red indicator, brass separable socket.

.2 Well: Brass separable socket complete with gasket and cap, size as required.

.3 Provide tilt adjustment on devices if required to view without climbing from floor.

2.7 Sensor Wells

.1 Sensor wells shall be supplied by the Controls Contractor and turned over to the Heating Contractor under this Section for installation.

**PART 3 - EXECUTION**

3.1 Pressure Gauges

.1 Install where indicated on drawings complete with ball valve.

.2 Provide only one pressure gauge per pump. Install common header, ½ " diameter pipe, complete with four control ball valves to allow selection of pressure reading from each of the following points. Refer to schematic diagram.

.1 before strainers
.2 on pump suction
.3 on pump discharge
.4 on check valve discharge if so equipped

3.2 Pressure Gauge Taps:

.1 Both sides of two-way control valves

.2 All lines to three-way control valves

.3 All lines to control valves 25 mm and larger

.4 As shown on drawings.

3.3 Thermometers

.1 Install digital type unless otherwise indicated.

.2 Install thermometers so they can be easily read from floor level. If this cannot be accomplished, install remote reading units.

.3 Install in locations allowing ease of accurate observation without obstruction, light glare or danger to the reading technicians.

.4 Provide tilt adjustment on devices to view without climbing from floor.

.5 Thermometers are to be installed in thermowells so that they can be replaced without draining the system.

3.4 Sensor Wells

.1 Sensor wells shall be supplied by the Controls Contractor and turned over to the Heating Contractor under this Section for installation.

END OF SECTION

## PART 1 - GENERAL

1.1 Manufacturer

.1 Provide valves of same manufacturer throughout where possible.

.2 Provide valves with manufacturer's name and pressure rating clearly marked on outside of body.

1.2 Quality Assurance

.1 Valves for gas service shall be trimmed and approved for specified service.

.2 All valves shall meet all MSS, ANSI and ASME manufacturing standards.

1.3 Submittals

.1 Refer to Section 23 05 01 – HVAC General Requirements.

.2 Manufacturer’s data and shop drawings for all valves and accessories including dimensions, pressure ratings, materials, service acceptability.

## PART 2 - PRODUCTS

2.1 General

.1 All valves must be of threaded or flanged type.

.2 Valves 300mm (12”) and larger located with stem in the horizontal position shall be drilled and taped to accommodate a drain valve and equalizing bypass valve assembly.

.3 No yellow brass valves will be allowed.

.4 Wafer style valves (except check valves) are not allowed.

2.2 Valve Connections

.1 Provide valves suitable to connect to adjoining piping as specified for pipe joints. Use pipe size valves.

.2 Thread pipe sizes 50mm (2”) and smaller.

.3 Flange pipe sizes 63mm (2½”) and larger.

.4 Solder or screw to solder adaptors for copper piping.

.5 Use grooved body valves with mechanical grooved jointed piping where approved only.

.6 Provide butterfly valves with tapped lug body when used for isolating service.

2.3 Check Valves

.1 Bronze, swing disc, solder or screwed ends.

.2 Iron body, bronze trim, swing disc, renewable disc and seat, flanged ends.

.3 Iron body, bronze trim, spring loaded, renewable composition disc, flanged ends.

.4 Acceptable Models:

.1 Jenkins 587J
.2 NH T651
.3 Kitz #78
.4 Red & White (Toyo) #435

.5 Grooved end (where approved), working pressure to 300 psi (2065 kPa): Sizes 2-4" – Ductile iron body and 316 stainless steel clapper. EPDM, Nitrile or optional Viton Bumper & Bonnet seals. Stainless steel wetted parts. Manufacturer: Victaulic Series 716; Sizes 4-14" – Ductile iron disc, elastomer encapsulated suited for the intended service, stainless steel spring and shaft, welded-in nickel seat. Valve inlet is drilled, with venturi-like taps and plugged for flow kit (included with valve). Twin taps on both sides of valve for meter connections and flow measurement. Manufacturer: Victaulic Series 779.

2.4 Butterfly Valves

.1 Iron body, lug pattern, bronze or stainless steel disc, resilient replaceable EPDM liner seat, plain flanged or grooved ends.

.2 Acceptable Models:

.1 Jenkins 2232ELJ (Lever) 2232EGJ (Gear)
.2 NH 45-313321 (Lever) 45-313322 (Gear)
.3 Kitz #6122-EL (Lever) #6122-EG (Gear)
.4 Kitz #6141-EL (Lever) #6141-EG (Gear)
.5 Red & White (Toyo) #918BESL (Lever) #918-BESG (Gear)
.6 Crane Model 44

.3 Grooved end (where approved): 2.5" and larger where grooved end piping systems are allowed, shall be rated to 300 psi and be both bi-directional and dead-end service capable to full rated pressure. Body material shall be ductile iron with blow-out proof stainless steel stems and electroless nickel coated ductile iron disc. Seat material shall be EPDM (or lubricated nitrile or fluoroelastomer) and have a full 360° continuous contact with the seating surface. Stem seals shall be of the same material grade as the seats. Disc shall be offset from the centerline of the stems and shall be connected to the stem without the use of fasteners or pins. Acceptable manufacturers: Victaulic Vic-300 MasterSeal, Vic-300 AGS.

2.5 Control Valves

.1 Refer to Section 23 09 23.

.2 Control valves to be supplied by the Controls Contractor and turned over to the HVAC Contractor for installation.

2.6 Ball Valves

.1 Up to 38mm (1½"): Forged bronze body, delrin seat and seals, chrome plated ball, forged steel pin, screwed ends, 1206 kPa (175 psi). Acceptable material: Victaulic Series 722.

.2 Tail piece supply isolation valves: ball type valves, angle configuration, screw driver operated, compression fittings or threaded as required, chrome plated if exposed.

.3 Acceptable Models:

.1 Jenkins
.2 NH
.3 Kitz #58 amd #59

.4 Red & White (Toyo) #5044A and #5049A
.5 MAS #B3 and #B4

2.7 Gate Valves

.1 Bronze, inside screw, double wedge or disc, solder or screwed ends.

.2 Over 100mm (4"): Iron body, bronze trim, rising stem, OS&Y solid wedge, flanged ends.

.3 Acceptable Models:

.1 Jenkins 454J
.2 NH T504
.3 Kitz #72
.4 Red & White (Toyo) #421

2.8 Globe or Angle Valves

.1 Bronze, renewable composition disc, solder or screwed ends.

.2 Over 100mm (4"): Iron body, bronze trim, rising stem, OS&Y, renewable composition disc, flanged ends.

.3 Acceptable Models:

.1 Jenkins 2342J
.2 NH T731
.3 Kitz #726
.4 Red & White (Toyo) #400

2.9 Circuit Balancing Valves (CBV)

.1 Valves shall be Y-pattern globe style design with provision for connecting a portable differential (ft. of head) pressure meter.

.2 Valves shall have all metal parts of nonferrous, pressure die cast, nonporous Ametal.

.3 The valves shall be suitable for the following functions:

.1 Precise flow measurement
.2 Precise flow balancing
.3 Positive shut-off with no drip seat eliminating the need of an additional isolation valve.
.4 Drain connection using ¾" NPT hose end thread.

.4 Valves shall have four (4) 360° adjustment turns of the handwheel for precise setting with hidden memory to provide a temper-proof balancing setting. Handwheel shall have digital readout. The handwheel can be installed in any position without affecting performance.

.5 For sizes ½" to 2":

.1 300 PSI, Y-pattern, globe type with soldered or threaded ends, non-ferrous Ametal brass copper alloy body, EPDM o-ring seals.
.2 4-turn digital readout handwheel for balancing, hidden memory feature with locking tamper-proof setting, and connections to portable differential meter.
.3 Acceptable Manufacturer: IMI Hydronic Series 786 STAS (solder), 787 STAD (threaded) or 78K (MxF) or Armstrong equal.

.6 For sizes 2½" to 16":

.1 300 PSI, Y-pattern, globe type with flanged or grooved ends, ASTM A536 ductile iron body, all other parts of Ametal brass copper alloy, EPDM o-ring seals.
.2 8, 12, 16, 20 or 22 turn digital readout handwheel for balancing, hidden memory feature with locking tamper-proof setting, and connections to portable differential meter.
.3 Acceptable Manufacturer: IMI Hydronic Series 788 STAF (flanged) or 789 STAG (grooved) or Armstrong equal.

.7 Acceptable Manufacturers

.1 IMI Hydronics
.2 Armstrong

.8 Circuit Balancing Valve sizing (schedule based on IMI):

| | Nominal Flow | | | |
|---|---|---|---|---|
| **Size** | **Min.** | **Max.** | **Min.** | **Max.** |
| (in) | (gpm) | (gpm) | (l/s) | (l/s) |
| ½ | 0.6 | 2.8 | 0.038 | 0.177 |
| ¾ | 2.0 | 6.0 | 0.126 | 0.379 |
| 1 | 3.9 | 10.0 | 0.246 | 0.631 |
| 1-¼ | 5.0 | 15.0 | 0.316 | 0.947 |
| 1-½ | 6.6 | 20.0 | 0.416 | 1.262 |
| 2 | 12.6 | 36.0 | 0.795 | 2.272 |
| 2-½ | 38.0 | 100.0 | 2.398 | 6.310 |
| 3 | 31.0 | 130.0 | 1.956 | 8.203 |
| 4 | 68.0 | 200.0 | 4.291 | 12.62 |
| 5 | 90.0 | 320.0 | 5.679 | 20.19 |
| 6 | 182.0 | 450.0 | 11.48 | 28.39 |
| 8 | 367.0 | 820.0 | 23.16 | 51.74 |
| 10 | 540.0 | 1300.0 | 34.07 | 82.03 |
| 12 | 960.0 | 1500.0 | 60.58 | 94.65 |

2.10 Pressure Reducing Valves – Water

.1 Less than 100mm (4"): Bronze body, brass bonnet, composition rubber diaphragm, plated or stainless steel spring, internal strainer.

.2 100mm (4") and over: High tensile cast iron body and bonnet, seat, composition disc and diaphragm, bronze needle control pilot valve with small pressure regulating valve. Flanged body and bonnet.

2.11 Vacuum Breakers – Water

.1 Bronze body, brass trim, composition silicone float disc, full size orifice.

2.12 Relief Valves

.1 Provide ASME rated direct spring loaded type, lever operated nonadjustable factory set discharge pressure as indicated.

2.13 Drain Valves

.1 Bronze compression stop with ¾" hose threaded.

.2 Brass ball valve with ¾" hose thread.

.3 Provide hose thread connection on valve or piping.

.4 Equal to #868C (LEAD FREE), KITZ #68AC (NON LEAD FREE)

2.14 Double Check Valve Assembly - Reduced Pressure Type

.1 Bronze or red brass body, stainless steel springs, composition diaphragm.

.2 Independent acting spring loaded double internal disc valve, three chamber, discharge to atmosphere.

.3 Acceptable Models:

.1 Watts 009 QT
.2 Zurn 975 XL
.3 Febco 825 Y
.4 Combraco 40-200

.4 Non-electronic testing apparatus including gauge, hoses, fittings, accessories, and case. Maximum temperature 104.4°C (220°F), maximum pressure 1034 kPa (150 psi). Equal to Watts TK-9A.

2.15 Strainers

.1 Strainers 50mm (2") and smaller shall be constructed for 250 psig operating pressure at 406 degrees F and shall have a cast iron threaded body and 20 mesh Type 304 stainless steel screen.

.2 Strainers larger than 50mm (2") shall be constructed for 125 psig @ 150 degrees F and shall have a cast iron flanged body and a 3/64" perforated Type 304 stainless steel screen up to 75mm (3") and a 1/8" perforated Type 304 stainless steel screen on 100mm (4") and larger.

.3 Screen free area shall be minimum three times area of inlet pipe. Provide valved drain and hose connection off strainer bottom.

.4 Strainers 50mm (2") and smaller shall have straight thread and gasketed caps and plugged blow-off connections.

.5 Strainers larger than 50mm (2") shall include drain connections complete with ball valve, cap and chain.

.6 Grooved end (where approved): 50mm (2") and larger, 300 PSI (2065 kPa) Y-Type Strainer shall consist of ductile iron body, ASTM A-536, Grade 65-45-12, Type 304 stainless steel perforated metal removable baskets with 1/16" (1,6mm) diameter perforations 2"-3" (DN50-DN75) strainer sizes, 1/8" (3,2mm) diameter perforations 4"- 12" (DN100-DN300) strainer sizes, and 0.156" (4mm) diameter perforations for larger sizes. Victaulic Style 732 and W732.

2.16 Pressure Ratings

.1 Unless otherwise indicated, use valves suitable for minimum 860 kPa (125 psi) and 232°C (450°F).

.2 Use valves for fire protection suitable for 1206 kPa (175 psi).

2.17 Manual Valve Operators

.1 Provide suitable handwheels for gate, globe or angle, radiation and drain valves.

.2 Provide one plug cock wrench for every plug cock valve.

.3 Butterfly Valves: Provide lever lock handle with toothed plate for shutoff service.

.4 Provide valves sized 4" and larger located more than 8 feet from floor in equipment room areas with chain operated sheaves. Extend chains to approximately 60" above floor and hook to clips arranged to clear walking aisles.

**PART 3 - EXECUTION**

3.1 General

.1 All valves shall be located such that the removal of their bonnets is possible.

.2 Install valves with stems upright or horizontal, not inverted.

.3 All flanged valves in horizontal lines with the valve stem in the horizontal position shall be positioned so that the valve stem is inclined one bolt hole above the horizontal position.

.4 Screw pattern valves placed in horizontal lines shall be installed with their valve stems inclined at an angle of a minimum of 30 degrees above the horizontal position.

.5 All valves shall be installed to allow for ease of access, service and reading of devices from the floor.

3.2 Application

.1 Use ball valves for gas service. Plug cocks are not to be used for gas isolation service.

.2 Use ball valves on pressure gauges.

.3 Use plug cocks, globe valves, ball valves, butterfly valves, and metering valves in water systems for throttling service.

3.3 Isolation Valves

.1 Isolation valves are to be ball type valves, pipe size as required, but in no case less than 13mm (½") diameter.

.2 For equipment removal purposes, isolation valves are to be installed with companion screwed unions on piping less than 75mm (3") diameter, or flanged connections on piping 75mm (3") and larger. Grooved mechanical couplings may be used for equipment removal, subject to accessibility, suitability and where approved by specification terms for that piping system or equipment.

.3 Install valves as close as possible to isolated equipment in order to minimize the amount of water lost during maintenance, replacement or drain down operations.

.4 Isolation drain valves are to be provided with combination air inlet fitting as required to relieve vacuum during draining operations.

.5 Install gate valves or ball valves where approved for shutoff and isolating service, or to isolate equipment, parts of systems or vertical risers.

.6 Provide drain valves at main shutoff valves, low points of piping and equipment.

3.4 Control Valves

.1 Control valves to be supplied by the Controls Contractor and turned over to the HVAC Contractor for installation.

.2 Install valves to allow proper access and clearance and so actuators are in horizontal position visible from the floor. All valves shall be installed so actuators are in horizontal position.

.3 Provide a union at all connections to each control valve.

3.5 Circuit Balancing Valves (CBV)

.1 The Contractor shall size and install balancing valves according to design flow.

.2 Install CBVs in accordance with manufacturer's instructions.

.3 Use flanged type for 2½" and over in areas where welded pipe is to be used.

.4 Valves shall be installed with flow in the direction of the arrow on the valve body.

.5 Five pipe diameters upstream of the CBV shall be free from any fittings..

.6 Two pipe diameters downstream of the CBV shall be free from any fittings.

.7 Install such that easy and unobstructed access to the valve handwheel and metering port for adjustment and measurement is provided. Handwheel shall be in the horizontal 90 degree position.

.8 Mounting in valve in piping must prevent sediment build-up in metering ports.

.9 Mark up set of as-built drawings indicating balanced flow value and CBV setting.

.10 Label ceiling grid at all CBVs concealed above ceilings.

3.6 Pressure Reducing Valve

.1 Install as per manufacturer's recommendations.

.2 Install in vertical position only.

3.7 Relief Valves

.1 Provide relief valves at pressure tanks, low pressure side of reducing valves, heating convertors, expansion tanks and where indicated.

.2 Pipe relief valve to nearest floor drain.

.3 System relief valve capacity shall equal make up pressure reducing valve capacity. Equipment relief valve capacity shall exceed input rating of connected equipment.

.4 Where one line vents several relief valves, cross sectional area shall equal sum of individual vent areas.

3.8 Drain Valves

.1 Provide ball valves for drains on open systems.

.2 Provide unions downstream of the valve to allow breaking the piping system.

.3 Provide hose thread connection on drain valve and piping.

3.9 Double Check Valve Assembly

.1 Install reduced pressure double check valve assembly to isolate domestic system from hydronic system, where indicated on drawings and as required by code.

.2 Install double check valve assembly at no more than 1.5m (5') above finished floor and to allow a minimum of 1m (40") clearance above the device for connection and operation of testing equipment.

.3 Pipe overflow to drain with air gap.

.4 Provide shutoff valves and unions on both sides of double check valve assembly for testing purposes.

3.10 Strainers

.1 Install on the inlet of all pumps.

.2 Install on the inlet of all coils.

END OF SECTION

## PART 1 - GENERAL

1.1 Quality Assurance

.1 Hydronic water pipe supports shall meet the requirements of ANSI B31.

.2 Natural gas pipe supports shall meet the requirements of CGA B149.1, Gas Installation Code.

.3 Duct hangers shall follow the recommendations of the SMACNA Duct Manuals.

.4 Domestic water pipe supports shall meet the requirements of Ontario Building Code.

1.2 General Requirements

.1 Provide hangers and supports to secure equipment in place, prevent vibration, maintain grade and provide for expansion and contraction.

.2 Install supports of strength and rigidity to suit loading without unduly stressing building. Locate adjacent to equipment to prevent undue stresses in piping and equipment.

.3 Select hangers and supports for the service and in accordance with the manufacturer's recommended maximum loading. Hangers shall have a safety factor of 5 to 1.

.4 Obtain approval prior to drilling for inserts and supports for piping systems.

.5 Obtain approval prior to using percussion type fastenings.

.6 Use of other piping or equipment for hangers and supports is not permitted.

.7 Use of perforated band iron, wire or chain as hangers is not permitted.

1.3 Firestop Sealants and Collars

.1 Standard method of fire tests of firestop system CAN4-S115-M85.

.2 UL Classified and/or FM Systems Approved and tested to the requirements of ASTM E814 (UL1479).

.3 Seals, assemblies and materials for penetration of fire rated surfaces shall be listed by FM and certified by UL or ULC for the service application.

1.4 Submittals

.1 Firestop materials: Submit service limitations, installation instructions, UL certification and FM listing.

.2 Fire rated penetration seals: Submit dimensional data, service limitations, installation instructions, UL certification and FM listing.

## PART 2 - PRODUCTS

2.1 Inserts

.1 Inserts shall be malleable iron case or galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods and lugs for attaching to forms.

.2 Size inserts to suit threaded hanger rods.

2.2 Suspended Mechanical Equipment:

.1 Suspend mechanical equipment from structure with adjustable length steel rods, threaded both ends or continuous threaded, complete with lock nuts on both ends. Provide spreader beams to distribute weight.

.2 Construct supports of structural steel members or steel pipe and fittings. Brace and fasten with flanges bolted to structure.

.3 Provide anchors, bolts and accessories required for mounting and anchoring equipment.

2.3 Pipe Hangers and Supports

.1 **Pipe hangers shall wrap around outside of insulation for all sizes.** Piping shall be provided with insulation flashing of heavy gauge metal to prevent crushing and hanger sized for exterior of insulation.

.2 Hangers:

.1 Pipe Sizes 13mm (½") to 38mm (1½"): Adjustable wrought steel ring, or plated strap.
.2 Pipe Sizes 50mm (2") and over: Adjustable wrought steel clevis.
.3 Hanger Rods: Provide steel hanger rods, threaded both ends or continuous threaded, complete with lock nuts on both ends.
.4 Saddles shall wrap around the outside of the insulation for all piping and be sized accordingly.

.3 Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods, cast iron roll and stand for hot pipe sizes 150mm (6 ") and over.

.4 Wall Support:

.1 Pipe Sizes to 75mm (3"): Cast iron hook, or fabricated bracket of 1"x1"x¼" angle bar.
.2 Pipe Sizes 100mm (4") and over: Welded steel bracket and wrought steel clamp.

.5 Vertical Support:

.1 Steel riser clamp.

.6 Floor Support:

.1 Fabricated stand and pipe clamp or saddle.

2.4 Natural Gas Piping Roof Supports

.1 Gas pipe support systems shall be continuous block channel supports equal to "DURA-BLOK" DB-Series or DB6-Series as supplied by Cooper B-Line, Inc.

.2 Alternate products must meet or exceed the same physical and performance characteristics as per the following:

.1 Density: 0.52 oz/cu in ASTM C642
.2 Durometer Hardness: 67.2A ± 1 ASTM D2240
.3 Tensile Strength: 231 psi minimum ASTM D412

.4 Compression Deformation: 5% at 70psi and 72°F ASTM D395
.5 Brittleness at Low Temp: -50°F ASTM D746
.6 Freeze and thaw when exposed to deicing chemicals: No loss after 50 cycles ASTM C672
.7 Coefficient of Thermal Expansion: 8 x 10-6 in/in/°F (min) ASTM C531
.8 Weathering: 70 hours at 120°F ASTM D573
.9 Hardness retained: 100% (±5%)
.10 Compressive strength: 100% (±5%)
.11 Tensile strength: 100% (±5%)
.12 Elongation retained: 100% (±5%)

.3 Curb base shall be made of 100% recycled rubber and polyurethane prepolymer with a uniform load capacity of 500 pounds per linear foot of support. Each base to have a reflective yellow stripe.

.4 Dimensions: 6-inches wide by 5/6.75 inches tall by 9.6/20.2/30.8/41.4/52.0 inches long to suit pipe size.

.5 Steel frame: Steel, 14ga strut galvanized per ASTMA653 or 12ga strut galvanized per ASTMA653 for bridge series.

.6 Attaching hardware: Zinc-plated threaded rod, nuts and attaching hardware per ASTM B633.

2.5 Duct Hangers and Supports

.1 Hangers:

.1 Concealed - Round Duct: Galvanized steel band iron.
.2 Concealed - Rectangular Duct: Galvanized steel band iron or rolled angle and 9mm rods.
.3 Exposed - Round Duct: continuous galvanized steel band iron secured to single 9mm hanger rod.

.2 Wall Supports: Galvanized steel band iron or fabricated angle brackets.

.3 Vertical Support at Floor: Rolled angle.

.4 Support rectangular ducts 1530mm and less in width or depth with 25mm wide 1.3mm or heavier galvanized bent hangers fastened to the side and bottom of the duct at a spacing of not greater than 2240mm using bolts, rivets, or metal screws.

.5 Support duct over 1530mm in width or depth with 10mm vertical hanger rods, bolted to galvanized steel angles at 610mm intervals.

.6 Support round ducts up to 910mm with 25mm wide, 1.0mm thick single galvanized steel traps and 9mm diameter rods. Support larger ducts with 25mm wide, 1.6mm thick double, horizontally split galvanized steel strap and two (2) 9mm diameter rods. Space support at 3600mm intervals.

.7 Where vertical ducts pass through floors, support with galvanized steel angles riveted and/or bolted to the cut and bearing on the structure.

2.6 Equipment Bases and Curbs

.1 Equipment bases and curbs shall be provided by the General Contractor. The Mechanical Contractor shall coordinate locations and sizes with the General Contractor.

.2 Provide mounting plates to be formed into pads.

**PART 3 – EXECUTION**

3.1 Inserts

.1 Use inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams wherever practicable.

.2 Set inserts in position in advance of concrete work. Provide reinforcement rod in concrete for inserts carrying pipe over 100mm (4") or ducts over 1500mm (60") wide.

.3 Where concrete slabs form finished ceiling, finish inserts flush with slab surface.

.4 Where inserts are omitted, drill through concrete slab from below and provide rod with recessed square steel plate and nut above slab.

.5 Expansion bolt type connections will be approved under certain conditions. Obtain approval from the Consultant. Generally, pipe 50mm (2") or smaller, and ducts less than 600mm x 300mm (24" x 12") will be approved, subject to adequate number of support points.

3.2 Suspended Mechanical Equipment:

.1 Suspend mechanical equipment from structure with adjustable length steel rods. Provide spreader beams to distribute weight.

.2 The threaded rod shall be secured to trusses or to steel angle bars spanning the building trusses. The steel spanning bars are to be provided by this Division.

.3 Construct supports of structural steel members or steel pipe and fittings. Brace and fasten with flanges bolted to structure.

.4 Provide anchor bolts and accessories required for mounting and anchoring equipment.

.5 Provide rigid anchors for ducts and pipes immediately after vibration connections to equipment.

3.3 Pipe Hangers and Support

.1 Fasten hangers and supports to building structure or inserts in concrete construction.

.2 Support horizontal metallic piping as follows:

| Nominal Pipe Size | Distance Between Supports | Hanger Rod Diameter |
|---|---|---|
| 13mm (½") | 1.8m (6') | 9.5mm (3/8") |
| 19 to 38mm (¾" to 1½") | 2.4m (8') | 9.5mm (3/8") |
| 50 to 63mm (2" to 2½") | .0m (10') | 9.5mm (3/8") |
| 63 to 100mm (3" to 4") | 3.6m (12') | 13mm (½") |
| 150 to 300mm (6" to 12") | .3m (14') | 13mm (½") |
| 350 to 450mm (14" to 18") | 5.0m (16') | 25mm (1") |

.3 Install hangers to provide minimum 32mm (1¼") clear space between finished covering and adjacent work.

.4 Place a hanger within 300mm (12") of each horizontal elbow.

.5 Use hangers which are vertically adjustable 38mm (1½") minimum after piping is erected.

.6 Support vertical piping at every floor.

.7 Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

.8 Where practical, support riser piping independently of connected horizontal piping.

.9 Exposed piping, with less than 2.6m (8½ ft) clearance to floors shall be provided with two times the number of hangers normally required. Spacing shall be equal or adjusted for maximum benefit.

.10 Provide copper plated hangers and supports for copper piping or provide nonferrous packing between hanger or support and piping.

.11 Large capacity piping with vibration potential shall not be suspended from any building structure that will allow transfer of vibrations to the occupied spaces.

3.4 Natural Gas Piping Roof Supports

.1 Install in accordance with manufacturer's instructions and recommendations.

.2 If gravel top roof, gravel must be removed around and under pipe support.

.3 Where possible, consult roofing manufacturer for roof membrane compression capacities. If necessary, a compatible sheet of roofing material (rubber pad) may be installed under rooftop support to disperse concentrated loads and add further membrane protection.

.4 Space in conformance with Gas Code and local authorities.

.5 Use properly sized clamps to suit pipe sizes.

3.5 Duct Hangers and Supports

.1 Hanger minimum sizes:

.1 Up to 750mm (30") wide or 330mm (13") diameter: 1¼" x 16 gauge at 3m (10ft) spacing.
.2 750mm (30") to 1200mm (48") wide or up to 450mm (18") diameter: 1½" x 16 gauge at 3m (10ft) spacing.
.3 Over 1200mm (48") wide: 1½" x 16 gauge at 3m (10ft) spacing.

.2 Horizontal duct on wall supports minimum sizes:

.1 Up to 450mm (18") wide: 1½" x 16 gauge or 1" x 1" x 1/8" at 3m (10ft) spacing.
.2 450mm (18") to 1000mm (40") wide: 1½" x 1½" x 2" at 1.8m (6ft) spacing.

.3 Vertical duct on wall supports minimum sizes:

.1 Riveted or screwed to duct:

.1 Up to 1500mm (60") wide: 1½" x 1½" x 3"
.2 Over 1500mm (60") wide: 2" x 1/8"

.4 Vertical duct floor supports minimum sizes:

.1 Riveted or screwed to duct:

.1 Up to 1500mm (60") wide: 1½" x 1½" x 1/8"
.2 Over 1500mm (60") wide: 2" x 2" x 1/8"

3.6 Equipment Bases and Curbs

.1 All equipment shall be mounted on concrete bases, minimum 100mm (4") high.

.2 A curb shall be provided around all piping passing through mechanical room floors, minimum 100mm (4") high.

.3 Equipment bases and curbs shall be provided by the General Contractor. The Mechanical Contractor shall coordinate locations and sizes with the General Contractor.

.4 Provide mounting plates to be formed into pads.

END OF SECTION

## PART 1 - GENERAL

1.1 Scope

.1 Inertia bases.

.2 Vibration isolators.

1.2 Reference Standard

.1 Provide and install mechanical equipment so that Average Noise Criteria curves, as outlined in ASHRAE Guide, are not exceeded.

1.3 Submittals

.1 Provide vibration isolation shop drawings showing isolator locations, load on each isolator, inertia slab dimensions.

1.4 General Requirements

.1 Supply vibration isolation equipment and materials by one supplier. Consider side loading of equipment and inertia bases when calculating maximum loads on isolators.

.2 Ensure equipment is sufficiently rigid for isolator point loading.

.3 All elastomer elements within the restraint shall be bridge bearing neoprene.

1.5 Description

.1 Provide vibration isolation on all motor driven equipment with motors of 0.37 kW and greater power output (as indicated on the motor nameplate) and on piping and ductwork, as specified herein. For equipment less than 0.37 kW, provide neoprene grommets at the support points.

.2 Space isolators under equipment so that the minimum distance between adjacent corner isolators is at least equal to the height of the centre of gravity of the equipment. Include height of centre of gravity on shop drawings. Otherwise, design for increased forces on the supports, and submit design calculations with shop drawings for approval. In particular, chillers shall meet this requirement.

.3 Coordinate with Section 23 33 00 for flexible connections for all ductwork connections to fans or plenums.

.4 For all electrical connections to isolated equipment, provide a minimum 90 degree bend of flexible conduit.

.5 Ensure isolation systems have a vertical natural frequency no higher than one third of the lowest forcing frequency, unless otherwise specified. Use dynamic stiffness for elastomers and do not exceed 60 durometer.

.6 Provide horizontal limit springs on all fans (except vertical discharge) in excess of 1 kPa static pressure, and on hanger supported, horizontally mounted axial fans with more than 333 N thrust due to static pressure.

.7 Isolators and restraining devices which are factory supplied with equipment shall meet the requirements of this section.

.8 Provide concrete inertia bases where specified or required by equipment manufacturers located between all vibrating equipment and the vibration isolation elements. Provide inertia bases on centrifugal fans with static pressure in excess of 875 Pa and/or motor in excess of 40

HP and on base mounted pumps over 10 HP, except slab on grade installations. Refer to structural specifications for concrete work. Concrete work by General Contractor.

.9 Provide concrete inertia bases or structural steel bases for all other motor driven equipment, unless the equipment manufacturer certified direct attachment capabilities.

.10 Coordinate with Division 3 for the provision of housekeeping pads at least 100 mm high under all isolated equipment. Provide at least 175 mm clearance between drilled inserts and edge of housekeeping pads and follow structural consultant's instructions for drilled inserts.

.11 Bolt all equipment to the structure. Do not bridge isolation elements.

.12 For non-isolated equipment (e.g., floor-mounted tanks, heat exchangers, boilers etc.) design anchors and bolts for 2g applied horizontally through the centre of gravity.

.13 For isolated equipment, design anchors, bolts, isolators and bases to withstand without failure or yielding a static load of 2g, minimum, acting through the centre of gravity. For larger isolators, where the 2g requirement cannot be met, provide additional restraint meeting the NBCC requirements.

.14 Where impact forces may be significant, use ductile materials.

1.6 Qualifications/Submittals

.1 All equipment shall be tested in an independent testing laboratory, or certified by a registered professional engineer, to demonstrate that equipment meets the requirements of this section, e.g. static load capability = 2 g, fail safe design, etc. If particular tests are carried out to represent an isolator type, the tests shall be valid for the full load range of the isolator. Submit such tests or certification on request.

.2 Obtain all relevant equipment information and provide shop and placement drawings for all vibration isolation elements and steel bases for review before materials are ordered. Provide attachment to both the equipment and the structure meeting the specified forces involved. Attachment details to the structure to be approved by a Provincially registered professional engineer.

.3 Submit samples of materials required to complete the work of this section for inspection and review if and when requested.

## PART 2 - PRODUCTS

2.1 Isolators

.1 Supply all of the vibration isolation equipment by one approved supplier with the exception of isolators which are factory installed and are standard equipment with the machinery.

.2 All isolators shall be of the following types, supplied by the manufacturers named, or other acceptable manufacturers listed, or approved:

.1 Type 1 - Pad Isolator
Neoprene/steel/neoprene pad isolators, manufactured from "Bridge bearing quality neoprene", as defined by CSA Standard CAN3-S6-M78 Section 11.10. Select Type 1 pads for a 2.5 mm (0.1") static deflection or greater. Bolt down equipment mounted on neoprene pad isolators using neoprene grommets. Design is based on Vibron Vibropad VSV or Mason WMW, Super W.

.2 Type 4 – Hangers
Spring hangers, c/w 6 mm (0.25") thick sound pads sized for 0.5 mm (0.02") minimum deflection, or neoprene hangers. Design is based on Vibron Series VH, approved equal - Mason HD, HS. A neoprene element alone, without a hanger box, is acceptable provided no short circuiting occurs. Hangers shall allow for a minimum of 10° misalignment.

.3 Type 5 - Air Isolator
Rolling lobe air springs with air spring levelling valves. Design based on Vibron MAS with levelling valves.

.3 Select isolators at the supplier's optimum recommended loading, and do not load beyond the limit specified in the manufacturer's literature.

.4 Design springs in accordance with the Society of Automotive Engineers' Handbook Supplement 9 entitled "Manual on Design and Application of Helical and Spiral Springs - SAE - 1975".

.5 Design springs "iso-stiff" (kx/ky = 1.0 to 1.5) with a working deflection between 0.3 and 0.6 of solid deflection.

.6 Provide hot dipped galvanized housings and neoprene coated springs, or other acceptable weather protection, for all isolation equipment located out of doors or in areas where moisture may cause corrosion.

.7 For all electrical connections to isolated equipment, provide a 90 degree bend of flexible conduit for 25 mm conduit and smaller or 90 degree Crouse-Hind EC couplings for larger conduit. Use connections long enough that the conduit will remain intact if the equipment moves laterally 300 mm from the installed position, and flexible enough to transmit less vibration to the structure than is transmitted through the springs.

2.2 Bases

.1 Provide concrete inertia bases a minimum of 1.5 times the weight of the isolated equipment. Generally base thickness shall be 1/12 of the longest dimension of the base, but not less than 150 mm (6"). Include with base a steel channel concrete form with required steel reinforcement (as determined necessary by suppliers' registered professional engineer). Provide additional steel as required by sleeves or inserts to receive equipment anchor bolts. Use height saving brackets in all mounting locations to maintain a 50 mm (2") clearance below the base. Bases are Mason type K or approved equal. Bases to be furnished with built-in motor slide rails, Motor location as specified/scheduled.

.2 Construct structural steel bases sufficiently rigid to keep deflection and misalignment within acceptable limits as determined by the equipment manufacturer. Use height saving brackets in all mounting locations to provide a base clearance of 50 mm (2"). Bases are Mason type WF or approved equal. Bases to be furnished with built-in motor slide rails. Motor location as specified/scheduled.

.3 Construct bases strictly in accordance with the isolation suppliers' drawings.

2.3 Flexible Duct Connectors

.1 Refer to Section 23 3300.

.2 Provide flexible duct connectors of Durodyne with Durolon fabric or approved equal.

2.4 Flexible Pipe Connectors

.1 At the last elbow before piping leaves the mechanical room, and the first elbow entering, provide a bolted flanged 2000 mm long spool piece to facilitate the future installation of silencing equipment.

**PART 3 - PRODUCTS**

3.1 Execution

.1 Execute the work in accordance with the specifications and, where applicable, in accordance with the manufacturer's instructions and only by workmen experienced in this type of work.

.2 For all equipment mounted on vibration isolators, provide a minimum clearance of 50 mm to other structures, piping, equipment, etc.

.3 Isolate all floor or pier mounted equipment on Type 2 isolators, unless otherwise specified.

.4 Isolate all floor or pier mounted equipment on Type 3 isolators, unless otherwise specified. Isolate pumps rotating at more than 1170 RPM on Type 2 isolators. Use the lowest RPM scheduled for two speed equipment in determining isolator deflection.

.5 For equipment mounted on a slab on grade, absorption chillers and in-line pumps, mount on Type 2 isolators, unless otherwise specified. Use Type 1 pads only where approved.

.6 Isolate steam Pressure Reducing Stations (PRV's) and upstream and downstream piping for a distance of 15 m. Install PRV station pipe pedestals on 13 mm thick heat insulating pads, with heat insulating grommets on the hold down bolts and Type 1 pads below. The insulating pad shall be sufficient to maintain Type 1 pad within manufacturer's temperature limits. Submit shop drawing of detail.

.7 Select Type 4 spring hangers for a minimum static deflection of 25 mm for all ceiling hung fans, and air handling units, emergency generator exhaust piping and silencers, steam PRV's and any other vibrating sources.

.8 Provide Type 4 resilient hangers on all piping connected to a vibrating source, if the piping is in excess of 40 mm dia. Provide the hangers for a distance of 6.5 m for a 50 mm pipe and 11.5 m for a 250 mm pipe. Isolate all other pipe for a proportionate distance. Isolate all piping in mechanical rooms. If neoprene hangers are proposed for non-critical spaces, change to spring hangers at no additional cost in the event that the isolation proves inadequate.

.9 Where piping connected to noise generating equipment is routed from the mechanical room through plumbing chases, position piping to avoid contact with the concrete structure, future framing, drywall and other finishes which may radiate noise. Submit proposed details to meet this requirement.

.10 Where the weight of equipment located on type 3 isolators may change significantly due to draining or similar as in cooling towers or chillers, provide limit stops to limit spring extensions.

.11 Provide spring isolators on piping connected to isolated equipment to a minimum as follows: up to 100 mm diameter, first 3 points of support; 125 mm to 200 mm diameter, first 4 points of support; 250 mm diameter and over, first 6 points of support. Static deflection of first point shall be twice deflection of isolated equipment.

.12 Provide spring isolators on all piping in mechanical and boiler rooms.

.13 For in-line pumps 18.6 kW and greater, provide two (2) type 2 isolators under each support foot. Provide Type 6 post-disaster anchors for all base mounted isolated equipment.

.14 Where piping or boiler exhaust stacks, etc., connected to or serving noise generating equipment, is routed from the mechanical room through walls and plumbing chases, position piping, stacks, etc. to avoid contact with the concrete structure, future framing, drywall and other finishes which may radiate noise. Submit proposed details to meet this requirement. <Provide 6.5 bar controls compressed air to Type 5 isolators.

.15 Where a pump intake pipe or similar pipe configuration requires a pedestal support, construct inertia or steel base large enough to accommodate pedestal. Provide flexible pipe connections for all pipe connections to chillers.

.16 Provide resilient elements in pipe anchors, where pipe anchors are specified within 11.5 m of a vibration source. Submit details before installation. Protect neoprene isolator components from overheating. Where piping connects new and existing buildings provide flexibility in piping by elbows, offsets, or 2 flexible pipe connectors 30 pipe dia. apart to isolate one building from another.

3.2 Duct Connections to Isolated Equipment

.1 Provide 75 mm flexible duct connectors and a 40 mm metal to metal gap.

.2 Provide stabilizing springs limiting movement at flexible connections to 25% of fabric width under steady state conditions and 40% at start up.

.3 Flexible duct connections shall be installed so that duct size is not reduced by the deflection of the flexible connector.

3.3 Inspections

.1 The supplier shall provide assistance to the contractor as necessary during the course of installation of isolation equipment. Prior to substantial completion, submit a report listing deficiencies to the specification.

END OF SECTION

## PART 1 – GENERAL

1.1 References

.1 Canadian General Standards Board (CGSB)

.1 CAN/CGSB-1.60-M89, Interior Alkyd Gloss Enamel.
.2 CAN/CGSB-24.3-92, Identification of Piping Systems.

.2 Canadian Standards Association (CSA)

.1 Natural Gas Installation Code CSA B149.1-00

1.2 Product Data

.1 Submit product data in accordance with Division 1

.2 Product data to include paint colour chips, all other products specified in this section.

1.3 Product Literature

.1 Submit product literature in accordance with Division 1.

.2 Product literature to include nameplates, labels, tags, lists of proposed legends.

## PART 2 - PRODUCTS

2.1 Manufacturer's Equipment Nameplates

.1 Metal or plastic lamacoid nameplate mechanically fastened to each piece of equipment by manufacturer.

.2 Lettering and numbers to be raised or recessed.

.3 Information to include, as appropriate:

.1 Equipment: Manufacturer's name, model, size, serial number, capacity.
.2 Motor: voltage, Hz, phase, power factor, duty, frame size.

2.2 System Nameplates

.1 Colours:

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

.2 Construction:

.1 3mm (1/8") thick laminated plastic, matte finish, with square corners, letters accurately aligned and machine engraved into core.

.3 Sizes:

.1 Conform to the following table:

| Size | Dimensions mm (") | No. of Lines mm (") | Height of Letters mm (") |
|---|---|---|---|
| 1 | 10 x 50 (3/8" x 2") | 1 (3/64") | 3 (1/8") |
| 2 | 15 x 75 (1/2" x 3") | 1 (3/64") | 6 (1/4") |
| 3 | 15 x 75 (1/2" x 3") | 2 (5/64") | 3 (1/8") |
| 4 | 20 x 100 (3/4" x 4") | 1 (3/64") | 10 (3/8") |
| 5 | 20 x 100 (3/4" x 4") | 2 (6/64") | 6 (1/4") |
| 6 | 20 x 200 (3/4" x 8") | 1 (3/64") | 10 (3/8") |
| 7 | 25 x 125 (1" x 5") | 1 (3/64") | 15 (1/2") |
| 8 | 25 x 125 (1" x 5") | 2 (5/64") | 10 (3/8") |
| 9 | 32 x 200 (1-1/4" x 8") | 1 (3/64") | 20 (3/4") |

.2 Use maximum of 25 letters/numbers per line.

.4 Locations:

.1 Terminal cabinets, control panels: Use size #5.
.2 Equipment in Mechanical Rooms: Use size #9.
.3 Rooftop equipment: Use size #9.
.4 Equipment above ceiling: Use size #1 riveted to ceiling suspension system.

2.3 Piping Systems Governed By Code

.1 Natural Gas:

.1 Natural gas: To CSA B149.1 and authority having jurisdiction and as indicated elsewhere.
.2 Gas piping shall be painted with 2 coats around complete circumference of piping. Use of bands or markers is not acceptable.
.3 Paint indoor gas piping with **2 coats** of yellow paint.
.4 Paint outdoor gas piping with **2 coats** of weatherproof paint. Colour to match building colour where visible from meter and to be yellow where not visible from meter (i.e. roof).
.5 Yellow colour shall be Benjamin Moore Metal & Wood Alkyd Enamel (K133) Safety Yellow #343.
.6 Provide labels on any gas piping of any pressure over 14" (i.e. 2LB, 5LB, etc.)

2.4 Identification of Piping Systems

.1 Identify contents by background colour marking, pictogram (as necessary), legend; direction of flow by arrows. To CAN/CGSB 24.3 except where specified otherwise.

.2 Legend:

.1 Block capitals to sizes and colours listed in CAN/CGSB-24.3.

.3 Arrows showing direction of flow:

.1 Outside diameter of pipe insulation less than 75 mm (3"): 100 mm (4") long x 50 mm (2") high.
.2 Outside diameter of pipe or insulation 75 mm (3") and greater: 150 mm (6") long x 50 mm (2") high.
.3 Use double-headed arrows where flow is reversible.

.4 Extent of background colour marking:

.1 To full circumference of pipe or insulation.

.2 Length to accommodate pictogram, full length of legend and arrows.

.5 Materials for background colour marking, legend, arrows:

.1 Pipes and tubing 20 mm (3/4") and smaller: Waterproof and heat-resistant pressure sensitive plastic marker tags.

.2 All other pipes: Pressure sensitive vinyl with protective overcoating, waterproof contact adhesive undercoating suitable for ambient of 100% RH and continuous operating temperature of 150°C (300°F) and intermittent temperature of 200°C (395 °F).

.6 Colours and Legends:

.1 Where not listed, obtain direction from Consultant.

.2 Colours for legends, arrows:

| Background colour | Legend | Arrows |
|---|---|---|
| Yellow | White | Black |
| Green | White | Black |
| Red | White | Black |

2.5 Concrete Pads for Mechanical Equipment

.1 The General Contractor shall paint tops and sides of all concrete pads for mechanical equipment with two (2) coats of yellow paint.

2.6 Identification Ductwork Systems

.1 50mm (2") high stenciled letters and directional arrows 150 mm (6") long x 50 mm (2") high.

.2 Colours: Black, or coordinated with base colour to ensure strong contrast.

2.7 Valves, Controllers

.1 Brass tags with 15mm (1/2") stamped identification data filled with black paint.

.2 Include flow diagrams for each system, of approved size, showing charts and schedules with identification of each tagged item, valve type, service, function, normal position, location of tagged item.

.3 Provide coloured adhesive label indication on ceiling grid to locate valves/equipment above. Label description to match device. Size, colour and description to be pre-approved by Consultant.

2.8 Controls Components Identification

.1 Identify all systems, equipment, components, controls, sensors with system nameplates specified in this section.

.2 Inscriptions to include function and (where appropriate) fail-safe position.

.3 Provide yellow adhesive label indication on ceiling grid to locate control devices above. Label description to match device. Size and description to be pre-approved by Consultant.

2.9 Language

.1 Identification to be in English.

**PART 3 - EXECUTION**

3.1 Timing

.1 Provide identification only after all painting specified has been completed.

3.2 Installation

.1 Perform work in accordance with CAN/CGSB-24.3 except as specified otherwise.

.2 Provide ULC and/or CSA registration plates as required by respective agency.

3.3 Namplates

.1 Locations:

.1 In conspicuous location to facilitate easy reading and identification from operating floor.

.2 Standoffs:

.1 Provide for nameplates on hot and/or insulated surfaces.

.3 Protection:

.1 Do not paint, insulate or cover in any way.

3.4 Location of Identification on Piping and Ductwork Systems

.1 On long straight runs in open areas in boiler rooms, equipment rooms, galleries, tunnels not more than 1.7 m (5'-8") intervals and more frequently if required to ensure that at least one is visible from any one viewpoint in operating areas and walking aisles.

.2 Adjacent to each change in direction.

.3 At least once in each small room through which piping or ductwork passes.

.4 On both sides of visual obstruction or where run is difficult to follow.

.5 On both sides of separations such as walls, floors, partitions.

.6 Where system is installed in pipe chases, ceiling spaces, galleries, other confined spaces, at entry and exit points, and at each access opening.

.7 At beginning and end points of each run and at each piece of equipment in run.

.8 At point immediately upstream of major manually operated or automatically controlled valves, dampers, etc. Where this is not possible, place identification as close as possible, preferably on upstream side.

.9 Identification to be easily and accurately readable from usual operating areas and from access points. Position of identification to be approximately at right angles to most convenient line of sight, considering operating positions, lighting conditions, risk of physical damage or injury and reduced visibility over time due to dust and dirt.

3.5 Valves, Controllers

.1 Valves and operating controllers, except at radiation or where in plain sight of equipment they serve: Secure tags with non-ferrous chains or close "S" hooks

.2 Install one copy of flow diagrams, valve schedules mounted in frame behind non-glare glass where directed by Consultant. Provide one copy (reduced in size if required) in each operating and maintenance manual.

.3 Number valves in each system consecutively.

3.6 Mechanical Ceiling Components Identification

.1 Provide lamacoid nameplate or adhesive label indication on ceiling grid to locate component above. Label description to match device.

END OF SECTION

## PART 1 - GENERAL

1.1 Quality Assurance

.1 Test equipment and material where specified required by authorities having jurisdiction to demonstrate its proper and safe operation.

.2 Test procedures shall be in accordance with applicable portions of:

.1 Canadian Gas Association (CGA)
.2 Ontario Building Code
.3 National Fire Protection Association (NFPA)
.4 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
.5 Sheet Metal and Air Conditioning National Association (SMACNA)
.6 American Society of Mechanical Engineers
.7 Ontario Ministry of Health
.8 Local codes and ordinances
.9 Other recognized test codes

.3 Provide additional tests and re-testing as required and requested by the Consultant or Owner.

1.2 Submittals

.1 Obtain certificates of approval and acceptance from authorities having jurisdiction and include in Operating and Maintenance Manuals.

.2 On completion of mechanical installation, provide certification of tests with detailed data as required. Itemize tests as to time performed and personnel responsible. Include a copy of field data in Operating and Maintenance Manuals.

1.3 Liability

.1 During tests, assume responsibility for damages in the event of injury to personnel, building or equipment and bear costs for liability, repairs and restoration.

## PART 2 – PRODUCTS

2.1 All equipment and products necessary to perform tests shall be covered under this Division at no cost to the Owner.

## PART 3 - EXECUTION

3.1 Pressure Tests

.1 Piping, fixtures or equipment shall not be concealed or covered until inspected and approved by the Consultant.

.2 Provide equipment, materials and labour for tests. Use test instruments from approved laboratory or manufacturer and furnish certificate showing degree of accuracy.

.3 Test equipment and material where specified required by authorities having jurisdiction to demonstrate its proper and safe operation.

.4 Provide four (4) days notice to the Consultant before tests.

.5 Carry out hydraulic tests for eight (8) hours and maintain pressure. Where leakage occurs, repair and retest.

.6 Make-Up Water Piping: Test to 1½ times maximum working pressure or 1034 kPa (150 psi) water pressure measured at system low point.

.7 Natural Gas Piping: Conduct a 1 hour test of all gas piping systems up to 11" pressure and a 24 hour chart test at 50 psi of all gas piping systems over 11" pressure. The Contractor shall perform a soap test and electronic test. Arrange and pay for a gas inspection by the local Gas/TSSA Inspector.

.8 Hydronic Piping: Test to 1-1/2 times maximum working pressure or minimum 1034 kPa (150 psi).

.9 Refrigeration Piping: Refer to Section 23 23 00.

.10 Sprinkler Piping: Refer to Section 21 13 13.

.11 Ductwork: Refer to Section 23 31 00 for duct leakage tests.

3.2 Equipment Tests

.1 Perform testing of all equipment as per manufacturer's recommendations and requirements under full operational ranges and submit reports.

.2 Use the services of a qualified Technician and submit report.

3.3 Test Reports

.1 Submit all test reports to Consultant as specified herein within one (1) week of each test completion.

.2 Include a copy of all test reports in the manuals.

END OF SECTION

## PART 1 - GENERAL

1.1 Work Included

.1 Review location of all balancing valves on drawings for air and water systems prior to construction and submit recommendations for additional balancing dampers or balancing valves to perform complete system balancing.

.2 Test, balance and adjust all new air and water systems and equipment and submit reports.

.3 Allow for a minimum of one (1) return visit for any adjustments and/or to work with the Contractor to investigate any issues.

1.2 Scope of Work

.1 Review design drawings and general function of each system including associated equipment, control sequences and operation cycles. Confirm listing of flow and terminal measurements to be performed.

.2 Confirm balancing valve and damper locations are adequate for system balancing. Recommend additional locations to Contractor and Consultant if required to complete system balancing.

.3 Outline procedures for taking test measurements to establish compliance with requirements. Specify type of instrument to be used, method of instrument application and correct factors.

.4 Test, balance and adjust entire air and hydronic water systems upon completion of the work. Use approved report format as approved by the Consultant to record all results. Submit sample to Consultant for approval prior to balancing.

.5 Contact Consultant during or immediately following balancing procedures to discuss any concerns or issues prior to issuing any reports.

.6 Submit one (1) copy of the Balance Report to the Consultant for review.

.7 Make adjustments as directed by the Consultant. Include for a minimum of one (1) return visit for any adjustments and/or to work with the Contractor to investigate any issues.

.8 Revise report and resubmit to the Consultant for review.

.9 Upon acceptance of the report, participate in Commissioning process by the Owner's Third Party Agent. Demonstrate a minimum of 30% of readings and submit on separate test forms. Refer to Commissioning Plan under Appendix 'A'.

1.3 Balance Reports

.1 Use a format acceptable to the Consultant for Reports.

.2 Submit one (1) copy of the report to the Consultant for review within one (1) week from balance completion and prior to inclusion into Maintenance Manuals. Include any comments or concerns from system balancing on report.

.3 Reports shall include equipment data, design data and balance results in metric and imperial units.

.4 Report shall include but not be limited to:

.1 Balancing Company
.2 Balancing Agent who performed the work
.3 Date the balancing was performed
.4 Date of report
.5 Tools and apparatus used for testing including calibration information
.6 System description
.7 Equipment manufacturer, model, arrangement, size, performance, fan size (if applicable), motor size, voltage and amperage
.8 Design and actual air flows (supply air, return air, outside air)
.9 Design and actual water flows
.10 Setting of balancing valves
.11 Design and actual pressure drops (air and water)
.12 Electrical characteristics
.13 Design and actual motor FLA, RPM
.14 Comments or concerns on findings

1.4 Acceptable Balancing Agencies

.1 Any NEBB, CAABC or NBCTA accredited balancing company. Provide a minimum of three (3) quotations for Owner review and approval prior to commencement of work.

**PART 2 - PRODUCTS**

2.1 All equipment and products necessary to perform tests shall be provided and covered by the Balancing Agent.

2.2 Maintenance Manual Materials

.1 Provide copies of the reports to the Contractor for inclusion in the manuals.

**PART 3 – EXECUTION**

3.1 General

.1 Coordinate with system installers to confirm location of all balancing dampers and balancing valves. Balance dampers and valves required in addition to those shown on the drawing must be coordinated prior to installation.

.2 Balance to maximum measured flow deviation from specified values of 10% at terminal device and 5% at equipment.

.3 Mark settings on valves, splitters, dampers and other adjustment devices.

.4 Include any required site investigation and system balancing based on any system deficiencies as noted herein.

.5 Contact Consultant during or immediately following balancing procedures to discuss any concerns or issues prior to issuing any reports.

.6 At final inspection, recheck and prove random selections of data recorded in report at discretion and direction of the Consultant.

.7 Participate in Commissioning by the Owner's Third Party Agent.

3.2 Air System Procedure

.1 Adjust air handling and distribution systems to provide required or design supply and return air quantities.

.2 Make air quantity measurements in ducts by pitot tube traverse of entire cross-sectional area of duct.

.3 Measure air quantities at air inlet and outlet.

.4 Use volume control devices to regulate air quantities only to extent that adjustments do not create objectionable air motion or sound levels. Affect volume control by duct internal devices, such as dampers and splitters.

.5 Vary total system air quantities by adjustment of fan speeds. Vary branch air quantities by damper regulation.

.6 Provide system schematic with required and actual air quantities at each outlet or inlet.

3.3 Water System Procedure – Hydronic Systems

.1 Adjust water systems to provide required or design quantities.

.2 Use calibrated venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.

.3 Adjust systems to provide specified pressure drops and flow through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.

.4 Effect system balance with automatic control valves fully open to heat transfer elements.

.5 Effect adjustment of water distribution systems by means of balancing cocks, valves and fittings. Do not use service or shutoff valves for balancing unless indexed for balance point.

.6 Where pump capacity available is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.

3.4 Reports

.1 Submit written reports for all balancing in a format pre-approved by the Consultant as per Scope of Work above.

.2 Submit one (1) copy of the Balance Report to the Consultant for review.

.3 Make adjustments as directed by the Consultant. Include for a minimum of one (1) return site visit as noted herein.

.4 Revise report and resubmit to the Consultant for review.

.5 Fan Test Reports

.1 Report air flow; air pressure at inlet and discharge; fan speed; motor current; motor voltage; manufacturer; model; fan wheel size.

.2 For fans with power greater than 250 watts, plot design and actual pressure and flow on manufacturer's or drafted fan performance curve.

.6 Pump Test Reports

.1 Report designed water flow; water pressure at inlet and discharge; pump speed; motor current; motor voltage; manufacturer; model; impeller size.

.2 For pumps with power greater than 250 watts, plot design and actual pressure and flow on manufacturer's or drafted pump performance curve.

.7 Upon acceptance of the report, provide copies of final report for maintenance manuals.

3.5 Commissioning

.1 Participate in Commissioning by the Owner's Third Party Agent. Demonstrate a minimum of 30% of readings and submit on separate test forms. Refer to Commissioning Plan under Appendix 'A'.

END OF SECTION

## PART 1 - GENERAL

1.1 Work Included

.1 Duct thermal insulation

.2 Duct acoustic insulation

.3 Recovering

1.2 Quality Assurance

.1 All workers engaged in the application of insulation shall be journeymen, or indentured apprentices working under a journeyman who is on the site.

1.3 Job Conditions

.1 Deliver material to job site in original nonbroken factory packaging, labeled with manufacturer's density and thickness.

.2 Perform work at ambient and equipment temperatures as recommended by the adhesive manufacturer. Make good separation of joints or cracking of insulation due to thermal movement or poor workmanship.

## PART 2 - PRODUCTS

2.1 General

.1 Adhesives, Insulation, Coatings, Sealers and Recovering Jackets shall have composite fire and smoke hazard ratings not exceeding 25 for flame spread and 50 for smoke developed.

.2 Adhesives, coatings and sealers shall be waterproof.

2.2 Thermal Duct Insulation

.1 Insulation shall be pre-covered, preformed insulation complete with foil or kraft all purpose jacket unless otherwise noted.

.2 Use 25mm (1”) thick insulation unless otherwise noted

.3 Exposed Rectangular Ducts: Rigid fibrous glass insulation, "K" value at 0.24 btu/in/sq ft /deg F/hr with factory applied reinforced aluminum foil vapour barrier.

.4 Round Ducts and Concealed Rectangular Ducts: Flexible fibrous glass insulation, "K" value at 0.26 btu/in/sq ft /deg F/hr with factory applied reinforced aluminum foil vapour barrier.

.5 Recovering Jackets (Interior): ULC listed "Thermo Canvas", treated cotton fabric

.6 Acceptable Manufacturers:

.1 Fibreglass Canada
.2 Knauf
.3 Mason

2.3 Thermal Duct Insulation – Exterior to Building

.1 Insulation: 3.0 PCF density, 50mm (2") thick rigid fiberglass insulation board with factory applied fsk facing. Equal to Knauf insulation board with ecose technology.

.2 Jacket: Weatherproof flexible jacket equal to Alumaguard 60.

2.4 Acoustic Duct Insulation

.1 Fiberglass insulation with "K" value at 0.26 btu/in/sq ft /deg F/hr absolute roughness of exposed surface not to exceed 0.033 mm coated to prevent fibre erosion at air velocities up to 400 fpm.

.2 All substrate material to be non-darkened, contrasting colour from liner layer.

.3 Use 25mm (1") thick insulation unless otherwise noted.

**PART 3 - EXECUTION**

3.1 Preparation

.1 Do not install covering before ductwork and equipment has been tested and approved.

.2 Ensure surface is clean and dry prior to installation. Ensure insulation is dry before and during application. Finish with systems at operating conditions.

3.2 Installation - General

.1 In non fire rated surfaces, ensure insulation is continuous through inside walls. Pack around ducts with fireproof self-supporting insulation material properly sealed.

.2 Finish insulation neatly at hangers, supports and other protrusions.

.3 Locate insulation or cover seams in least visible locations.

3.3 Thermal Duct Insulation

.1 Provide insulation on:

.1 All existing supply air ductwork (including rigid and flexible ducts) where being reused and connected to new rooftop units.
.2 All new supply air ductwork, except where internally insulated.
.3 All new exhaust air ductwork within 2.4 meters (8 feet) of insulated surface penetration

.2 Exposed Rectangular Ducts: Secure rigid insulation with 50% coverage of adhesive and 12 gauge galvanized impale anchor tabs on 400mm (16") centres. Seal joints with 100mm (4") wide foil tape.

.3 Round Ducts and Concealed Rectangular Ducts: Adhere flexible insulation to ductwork with adhesive applied in 150mm (6") wide strips on 400mm (16") centres. Provide 16 gauge annealed tie wire, or polypropylene twine, spiral wound or half hitched at 100mm (4") centres for securing duct insulation until adhesive sets. Butt insulation and seal joints and breaks with 100mm (4") foil tape.

3.4 Acoustic Duct Insulation

.1 Apply to interior of:

.1 First 3m (10') of supply AND return ducts on inlet and discharge of RTUs.
.2 First 1.5m (5') of supply AND return ducts on inlet and discharge of Exhaust Fans and remaining air handling equipment.
.3 All ductwork for Gym Stage and Library within Mechanical Room and as indicated on drawings.
.4 Transfer ducts and elbows.
.5 As indicated on drawings.

.2 Secure to ductwork with adhesive using 50% coverage and 12 gauge impale anchor tabs on 400mm (16") centres. Cut off excess fastener length and cover with brush coat of sealer.

.3 Shop fabrication cuts shall be coated with JM's SuperSeal Duct Butter and Edge Treatment products.

.4 Seal all cut and exposed ends.

3.5 Canvas Recovering Jacket

.1 Provide recovering jackets on exposed insulation throughout including but not limited to Mechanical Rooms.

.2 Coat recovering jacket with two coats of waterproof fire retardant coating.

END OF SECTION

## PART 1 - GENERAL

1.1 Work Included

.1 Piping Insulation

.2 Adhesives, Tie wires, Tapes

.3 Recovering

1.2 Quality Assurance

.1 All workers engaged in the application of insulation shall be journeymen, or indentured apprentices working under a journeyman who is on the site. Trades Qualification certificates must be submitted prior to commencing work and must be on site for inspection.

1.3 Job Conditions

.1 Deliver material to job site in original non-broken factory packaging, labeled with manufacturer's density and thickness.

.2 Perform work at ambient and equipment temperatures as recommended by the adhesive manufacturer. Make good separation of joints or cracking of insulation due to thermal movement or poor workmanship.

.3 Protect the insulation from dirt, water, chemical attack and mechanical damage before, during and after installation. Damaged or contaminated insulation should discarded and removed from job site.

1.4 Acceptable Manufacturers:

.1 Fibreglass Canada

.2 Knauf

.3 Mason

.4 Pittsburg Corning

## PART 2 - PRODUCTS

2.1 General

.1 Adhesives, Insulation, Coatings, Sealers and Recovering Jackets shall have composite fire and smoke hazard ratings not exceeding 25 for flame spread and 50 for smoke developed.

.2 Adhesives, coatings and sealers shall be waterproof.

2.2 Materials

.1 Preformed mineral fiber pipe insulation with factory applied all-service vapor-retarder jacket (ASJ) jacket shall have a flame spread rating not greater than 25 and a smoke developed rating not greater than 50 when tested as in accordance with ASTM E84, UL 723 or CAN/ULC S102 (Canada).

.2 Preformed mineral fiber pipe insulation shall have a water vapor sorption of less than 5% by weight as tested in accordance ASTM C 547.

.3 All service jacket (ASJ) shall have a water vapor permeance of 0.02 perms or less as tested in accordance to ASTM E96, procedure "A".

.4 When a vapor mastic is required, a water vapor permeance of 0.02 per ASTM E-96 Procedure B must be achieved.

.5 Heating piping insulation shall be 38mm (1.5") thick for pipe diameters up to and including 32mm (1-1/4") and 50mm (2") thick for pipe diameters 38mm (1-1/2") and larger.

.6 Chilled water piping insulation shall be 25mm (1.0") thick for pipe diameters up to and including 150mm (6") and 38mm (1.5") thick for pipe diameters 200mm (8") and larger.

.7 Hydronic Piping, Exposed Vents: Fine fibrous glass insulation with factory applied vapour barrier jacket, molded to conform to piping, conductivity value at 0.25-0.29 btu/in/sq ft/deg F/hr.

.8 Recovering Jackets, Indoor Exposed Finished Areas (i.e. Mechanical Rooms, Gym,Custodial Rooms, Storage Rooms, etc.): PVC pre-formed.

.9 Protective Jackets, Outdoor piping: minimum 0.4mm (0.016 in.) aluminum jacket for insulation outside diameters. Aluminum jacketing shall conform to ASTM C1729. Secure to piping using SS banding.

## PART 3 - EXECUTION

3.1 Preparation

.1 Do not install covering before piping and equipment has been tested and approved.

.2 Ensure surface is clean and dry prior to installation. Ensure insulation is dry before and during application. Finish with systems at operating conditions.

3.2 Installation

.1 In non fire rated surfaces, ensure insulation is continuous through inside walls. Pack around pipes with fireproof self-supporting insulation material, properly sealed.

.2 Finish insulation neatly at hangers, supports and other protrusions.

.3 Provide recovering jackets on exposed insulation as specified herein.

.4 Coat recovering jacket with two coats of waterproof fire retardant coating.

.5 Do not install and seal vapour proof insulation if ambient air has a high humidity.

.6 **Pipe hangers shall wrap around outside of insulation for all sizes.** Piping shall be provided with insulation flashing of heavy gauge metal to prevent crushing and hanger sized for exterior of insulation.

3.3 Hydronic Piping

.1 Insulate all new hydronic supply and return piping.

.2 Insulate valves, unions, flanges, strainers, flexible connections and expansion joints for all cold water and hybrid water systems. Not required on hot water loop.

.3 Cover elbows, tees and similar fittings with equivalent thickness of insulation material.

.4 The outermost ASJ vapor retarder must have a continuous, unbroken vapor seal. Hangers, supports, anchors, etc., that are secured directly to cold surfaces must be adequately insulated and vapor sealed to prevent condensation.

.5 When a vapor retarder mastic is required, a maximum water vapor permeance of 0.02 per ASTM E-96 Procedure B must be achieved. Follow the mastic manufacturer's recommendations for application to achieve the 0.02 perm rating.

.6 Vapor dams shall be used on all chilled water systems. Vapor dams or vapor seals shall be installed at every fourth section and at the termination of all fittings.

.7 Install PVC (indoor) or metal jacket (outdoors). PVC or metal jackets are installed over factory applied ASJ jacket in order to provide abuse protection, cleanable surface or a specific appearance as required by the space or area of the installation. Overlap PVC jacket at all joints with PVC tape. Install metal jacket with overlap at all joints and secure using SS bands and seal as per manufacturer's instructions. Do not use screws or any fasteners which penetrate the jacket(s).

.8 Do not insulate within radiation enclosures, where applicable.

END OF SECTION

## PART 1 – GENERAL

1.1 Work Included

.1 Commissioning shall be carried out by a Third Party Commissioning Agent obtained by KPRDSB.

.2 The Contractor shall provide assistance throughout the commissioning process as needed.

## PART 2 - PRODUCTS

2.1 All equipment and products necessary to assist with Commissioning shall be covered under this Division at no cost to the Owner.

## PART 3 - EXECUTION

3.1 Commissioning

.1 Provide assistance during complete commissioning process. Refer to Appendix 'A' for Third Party Commissioning Plan.

.2 All equipment and systems shall be started, tested, and reports submitted and accepted prior to commissioning starting.

.3 System tests shall include but not be limited to:

.1 HVAC Systems
.2 Supply and Exhaust Fans
.3 Pumps
.4 Natural Gas Systems
.5 Control Systems
.6 Sound and Vibration Tests
.7 Miscellaneous Systems
.8 Other systems specified within this Division.

.4 The Contractor shall be submit all checklists included with the Commissioning Plan under Appendix 'A'.

.5 The Balancing Agent shall demonstrate a minimum of 30% of TAB readings and record.

3.2 Demonstration and Training

.1 Provide assistance during Demonstration and Training. Refer to Appendix 'A' for Third Party Commissioning Plan.

.2 Complete and accepted maintenance manuals and record drawings shall be submitted and available for use during the Demonstration and Training.

END OF SECTION

## PART 1 - GENERAL

1.1 Summary

.1 Section includes:

.1 Procedures and cleaning solutions for cleaning mechanical piping systems.

1.2 Related Sections

.1 Section 23 05 93 – Testing, Adjusting and Balancing

.2 Section 23 25 13 – Water Treatment

1.3 References

.1 American Society of Testing and Materials International (ASTM)

.1 ASTM E202 – Standard Test Methods for analysis of Ethylene Glycols and Propylene Glycols.

.2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS)

1.4 Submittals

.1 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 22 05 01 and 23 05 01. Include product characteristics, performance criteria, and limitations.

1.5 Quality Assurance

.1 Health and Safety:

.1 Do construction occupational health and safety in accordance with Section 01 – Health and Safety Requirements.

1.6 Delivery, Storage, and Handling

.1 Packing, shipping, handling and unloading.

.1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01.

.2 Waste management and Disposal:

.1 Construction/Demolition Waste Management and Disposal: Separate waste materials for reuse and recycling in accordance with Section 01.

## PART 2 – PRODUCTS

2.1 Cleaning Solutions

.1 Low foaming detergent at all temperatures.

.2 No pH neutralization required.

.3 Designed for use on most metals including aluminum.

.4 Bio-degradable.

.5 Phosphate Free.

.6 Nitrite Free.

**PART 3 – EXECUTION**

3.1 Cleaning Hydronic and Steam Systems

.1 Timing

.1 Systems to be operational, hydrostatically tested and with safety devices functional, before cleaning is carried out.

.2 Cleaning Agency:

.1 Retain qualified water treatment specialist to perform system cleaning.

.3 Install instrumentation such as flow meters, orifice plates, pitot tubes, flow metering valves only after cleaning is certified as complete by water treatment specialist.

.4 Cleaning procedures:

.1 Provide detailed report outlining proposed cleaning procedures at least 4 weeks prior to proposed starting date. Report to include:

.1 Cleaning procedures, flow rates, elapsed time.
.2 Chemicals and concentrations to be used.
.3 Inhibitors and concentrations.
.4 Specific requirements for completion of work.
.5 Special precautions for protecting piping system materials and components.
.6 Complete analysis of water to be used to ensure water will not damage systems or equipment.

.5 Conditions at time of cleaning systems

.1 Systems to be free from construction debris, dirt and other foreign material.
.2 Control valves to be operational, fully open to ensure that terminal units can be cleaned properly.
.3 Strainers to be clean prior to initial fill.
.4 Install temporary filters on pumps not equipped with permanent filters.
.5 Install pressure gauges on strainers to detect plugging.

.6 Report on Completion of Cleaning

.1 When cleaning is completed, submit report, complete with certificate of compliance with specifications of cleaning component supplier.

.7 Hydronic Systems:

.1 Flush system thoroughly with water, back flush pump, strainers, blow down drain valves and risers to removal all loose debris. Remove accumulated sludge in boilers if necessary.
.2 Then add 2% solution of low foaming detergent to the system through a by-pass feeder or another feeding device.
.3 Circulate for 36 hours at 82°C. For chilled systems, circulate at least 48 hours at ambient temperature.
.4 During recirculation, back flush strainers, drain valves and risers at their lowest point once every 8 hours.
.5 Drain cleaning water completely.
.6 Then fill and drain system several times. Circulate 30 minutes every time the system is refilled.
.7 Bleed system at several points until water is clear and non-foaming. Clean pump strainers.
.8 Draw a water sample from the system and sent it out to laboratory for analysis.
.9 If the laboratory report is satisfactory, the system must then be treated with the appropriate formula.

3.2 Start-up of Hydronic Systems

.1 After cleaning is completed and system is filled:

.1 Establish circulation and expansion tank level, set pressure controls.
.2 Ensure air is removed.
.3 Check pumps to be free from air, debris, possibility of cavitation when system is at design temperature.
.4 Dismantle system pumps used for cleaning, inspect, replace work parts, install new gaskets and new set of seals.
.5 Clean out strainers repeatedly until system is clean.
.6 Commission water treatment systems as specified in Section 23 25 13 – HVAC Water Treatment.
.7 Check water level in expansion tank with cold water with circulating pumps OFF and again with pumps ON.
.8 Repeat with water at design temperature.
.9 Check pressurization to ensure proper operation and to prevent water hammer, flashing, cavitation. Eliminate water hammer and other noises.
.10 Bring system up to design temperature and pressure slowly over a 48 hour period.
.11 Perform TAB as specified in Section 23 05 93 – Testing, Adjusting and Balancing (TAB).
.12 Adjust pipe supports, hangers, springs as necessary.
.13 Monitor pipe movement, performance of expansion joints, loops, guides, anchors.
.14 If sliding type expansion joints bind or if bellows type expansion joints flex incorrectly, shut down system, re-align, repeat start-up procedures.
.15 Re-tighten bolts, etc., using torque wrench, to compensate for heat-caused relaxation. Repeat several times during commissioning.
.16 Check operation of drain valves.
.17 Adjust valve stem packings as systems settle down.
.18 Fully open all balancing valves (except those that are factory-set).
.19 Check operation of over-temperature protection devices on circulating pumps.
.20 Adjust alignment of piping at pumps to ensure flexibility, adequacy of pipe movement, absence of noise or vibration transmission.

3.3 Cleaning

.1 Provide in accordance with Division 1.

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

## PART 1 - GENERAL

1.1 Work Included

.1 Conform to Section 23 05 01 – General Mechanical Requirements.

1.2 Description

.2 Provide microprocessor-based Building Automation System (BAS) with electric actuation as indicated on the drawings and as specified.

.3 The BASE BUILDING BAS provider shall carry in their contract the following project scope which shall include, but not be limited to, the following work:

.1 Upgrades to existing electronic building automation system as outlined in the specifications, and drawings and as required to execute the sequence of operations. Integration to new and/or replaced equipment

1.3 Scope

.1 This project scope shall include, but not be limited to, the following work:

.1 Preparation of control shop drawings for review and approval.

.2 Supply and install a network of Direct Digital Control (DDC) panels and field devices.

.3 Supply and install customized graphics software to Building standards, system software, and third party software as specified.

.4 Install, wire and label all DDC control system components.

.5 Calibrate and commission the installed control system.

.6 Provide maintenance manuals and as-built drawings.

.7 Provide customized training for Building operations, maintenance and technical staff.

.8 Provide a one-year on site parts and labour warranty on all components.

1.4 Related Sections

.1 The General Conditions of the Contract, Supplementary Conditions, and General Requirements are part of this specification and shall be used in conjunction with this section as part of the contract documents.

.2 The following sections constitute related work:

.1 Section 23 05 01 - General Mechanical Requirements
.2 Section 23 08 00 – Commissioning

1.5 Approved Systems and Contractors

.1 Use control system hardware that meets the requirements of the existing Reliable Controls system.

.2 The following Controls Contractor shall be used by the Mechanical Contractor to carry out all Electronic Controls work:

.1 Reliable Controls – Setpoint Control.

Contact: Mr. Matthew Jewel, Telephone: 705-745-1600

.3 The following Pneumatic Controls Contractor shall be used by the Mechanical Contractor to carry out all Pneumatic Controls work:

.1 Analysts of Pneumatic Systems Ltd.,
Contact: Dave Strain, Telephone: 1-647-289-2700

1.6 Codes and Standards

.1 Work, materials, and equipment shall comply with the most restrictive of local, provincial, and federal authorities' codes and ordinances or these plans and specifications. As a minimum, the installation shall comply with current editions in effect 30 days prior to receipt of bids of the following codes:

.1 Electric Safety Authority (ESA)
.2 Ontario Building Code (OBC)
.3 ASHRAE/ANSI 135-2001: Data Communication Protocol for Building Automation and Control Systems (BACNET)

Table 1 – Reporting Accuracy

| Measured Variable | Reported Accuracy |
|---|---|
| Space Temperature | ±0.5°C (±1°F) |
| Water Temperature | ±0.5°C (±1°F) |
| Delta-T | ±0.15°C (±0.25°F) |
| Water Flow | ±2% of full scale |
| Water Pressure | ±2% of full scale (see Note 2) |
| Electrical (A, V, W, Power Factor) | ±1% of reading (see Note 3) |

Note 1: 10% - 100% of scale
Note 2: For both absolute and differential pressure
Note 3: Not including utility-supplied meters

Table 2 – Control Stability and Accuracy

| Controlled Variable | Control Accuracy | Range of Medium |
|---|---|---|
| Space Temperature | ±1.0°C (±2.0°F) | |
| Fluid Pressure | ±10 kPa (±1.5 psi)<br>±250 Pa (±1.0 in. w.g.) | MPa (1-150 psi)<br>0-12.5 kPa (0-50 in. w.g.) differential |

1.7 Submittals

.1 Meet requirements of Section 23 05 01 for Shop Drawings, Product Data, and Samples. Provide electronic in PDF format of shop drawings and other submittals on hardware and equipment to be supplied or installed. Begin no work until submittals have been approved for conformity with design intent. Provide electronic drawings in PDF format of each drawing on 11x17" paper. When manufacturer's cutsheets apply to a product series rather than a specific product, clearly indicate applicable data by highlighting or by other means. Clearly reference covered specification and drawing on each submittal. General catalogs shall not be accepted as cutsheets to fulfill submittal requirements. Select and show submittal quantities appropriate to scope of work. Submittal approval does not relieve Contractor of responsibility to supply sufficient quantities to complete work.

.2 Provide submittals within two (2) weeks of contract award on the following:

.1 Direct Digital Control System Hardware

1. Complete bill of materials indicating quantity, manufacturer, model number, and relevant technical data of equipment to be used.
2. Manufacturer's description and technical data such as performance curves, product specifications, and installation and maintenance instructions for items listed below and for relevant items not listed below:

.1 Direct digital controllers (controller panels)
.2 Transducers and transmitters
.3 Sensors (include accuracy data)
.4 Actuators
.5 Valves
.6 Relays and switches
.7 Control panels
.8 Power supplies
.9 Operator interface equipment
.10 Wiring

3. Wiring diagrams and layouts for each control panel. Show termination numbers.
4. Floor plan schematic diagrams indicating field sensor and new or existing controller locations.
5. Riser diagrams showing control network layout, communication protocol, and wire types.

.2 Controlled Systems

1. Schematic diagram of each controlled system. Label control points with point names. Graphically show locations of control elements.
2. Schematic wiring diagram of each controlled system. Label control elements and terminals. Where a control element is also shown on control system schematic, use the same name.
3. Instrumentation list (Bill of Materials) for each controlled system. List each control system element in a table. Show element name, type of device, manufacturer, model number, and product data sheet number.
4. Complete description of control system operation including sequence of operation. Include and reference schematic diagram of controlled system. List I/O points and software points specified on the control schematic and in the sequence of operation. Indicate alarmed and trended points.

.3 Project Record Documents. Submit three copies of record (as-built) documents upon completion of installation for approval prior to final completion. Submittal shall consist of:

.1 As-built versions of submittal shop drawings provided electronically in PDF and hard copy for inclusion into electronic and hard copy maintenance manuals. Hard copy shall be 11x17" paper.
.2 Testing and Commissioning Reports and Checklists. Completed versions of reports, checklists, and trend logs used to meet requirements of Part 3 (Control System Demonstration and Acceptance).
.3 Operation and Maintenance (O&M) Manual. Printed, electronic, or online help documentation of the following:

1. As-built versions of submittal product data.
2. Names, addresses, and telephone numbers of installing contractors and service representatives for equipment and control systems.

3. Operator's manual with procedures for operating control systems: logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing setpoints and variables.
4. Programming manual or set of manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
5. Engineering, installation, and maintenance manual or set of manuals that explains how to design and install new points, panels, and other hardware; how to perform preventive maintenance and calibration; how to debug hardware problems; and how to repair or replace hardware.
6. Documentation of programs created using custom programming language including setpoints, tuning parameters, and object database. Electronic copies of programs shall meet this requirement if control logic, setpoints, tuning parameters, and objects can be viewed using furnished programming tools.
7. Graphic files, programs, and database on magnetic or optical media.
8. List of recommended spare parts with part numbers and suppliers.
9. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
10. Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation or web server software, and graphics software.
11. Licenses, guarantees, and warranty documents for equipment and systems.
12. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.

1.8 Warranty

.1 Warrant labor and materials for specified control system free from defects for a period of 12 months after final acceptance. Control system failures during warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to Owner. Respond during normal business hours within 24 hours of Owner's warranty service request.

.2 Work shall have a single warranty date, even if Owner receives beneficial use due to early system start-up. If specified work is split into multiple contracts or a multi-phase contract, each contract or phase shall have a separate warranty start date and period.

.3 If Engineer determines that equipment and systems operate satisfactorily at the end of final start-up, testing, and commissioning phase, Engineer will certify in writing that control system operation has been tested and accepted in accordance with the terms of this specification. Date of acceptance shall begin warranty period.

.4 Exception: Contractor shall not be required to warrant reused devices except those that have been rebuilt or repaired. Installation labor and materials shall be warranted. Demonstrate operable condition of reused devices at time of Engineer's acceptance.

1.9 Ownership of Proprietary Material

.1 Project-specific software and documentation shall become KPRDSB's property. This includes, but is not limited to:

.1 Graphics
.2 Record drawings
.3 Database
.4 Application programming code
.5 Documentation

**PART 2 – PRODUCTS**

2.1 Materials

.1 Use new products the manufacturer is currently manufacturing and selling for use in new installations.

.2 Do not use this installation as a product test site unless explicitly approved in writing by KPRDSB.

.3 Spare parts shall be available for at least five years after completion of this contract.

2.2 Field Devices

.1 The DDC System shall utilize and integrate the operation of intelligent Building Management and Unitary DDC Controllers (UCs) distributed on the BACnet network.

.2 All electric switch devices shall be selected for the applied load and ULC listed and labeled for the application and environment to which they are applied.

.3 All automatically controlled devices, unless specified otherwise elsewhere, shall be provided with direct-coupled electric actuators sized to operate their appropriate loads with sufficient reserve power to provide smooth modulating action or two-position action and tight close off

.4 Automatic Control Valves

.1 Provide automatic control valves suitable for the specified controlled media of the type and general construction indicated. Where type or general construction is not indicated, provide selection as determined by manufacturer for installation requirements and pressure class, based on controlled media, maximum pressure and temperature rating of piping system, and other pertinent application requirements. Unless otherwise indicated, provide valves which mate and match material of connecting piping. Provide equipment control valves with control valve actuators of required input power type and control signal type that will accurately position the flow control element and provide sufficient force to achieve required leakage specification.

.2 The Controls Contractor shall supply the automatic control valves and actuators. Control valves 2 inches and smaller shall be screwed type, and valves 2-1/2" inches and larger shall be flanged. Valves shall be ANSI-rated to withstand the pressures and temperatures encountered.

.3 Valves (less actuators) shall be turned over to the HVAC Contractor for installation. The Controls Contractor shall install the actuator.

.4 Submit a valve schedule for all valves supplied under this contract. The valve schedule will contain the following information for each valve:

.1 Valve size, connection type, line size, valve manufacturer and model number, valve flow coefficient, design flow, pressure drop across valve, max. close-off pressure, actuator manufacturer and model number, actuator max. torque.

.5 Characterized Control Valves:

.1 Manufactured, brand labeled or distributed by BELIMO.

.2 Control Valves: Factory fabricated of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.

.3 The manufacturer shall warrant all components for a period of 5 years from the date of production, with the first two years unconditional (except as noted).

.4 NPS 2 and Smaller: Nickel-plated forged brass body rated at no less than 400 psi, stainless steel ball and blowout proof stem, female NPT end fittings, with a dual EPDM O-ring packing design, fiberglass reinforced Teflon seats, and a TEFZEL flow characterizing disc.

.5 NPS 2-1/2 and 3: GG25 cast iron body according to ANSI Class 125, standard class B, stainless steel ball and blowout proof stem, flange to match ANSI 125 with a dual EPDM O-ring packing design, PTFE seats, and a stainless steel flow characterizing disc.

.6 Sizing:

.1 Two-Position: Line size or size using a pressure differential of 1psi.
.2 Terminal Units: Pressure drop not to exceed 2 psig.
.3 Major Equipment (AHU): Pressure drop not to exceed 4 psig.

.7 Close-Off Pressure Rating: 100 PSI.

.8 The actuator shall be the same manufacturer as the valve, integrally mounted to the valve at the factory with a single screw on a four-way DIN mounting-base.

.5 Control Valve Actuators

.1 Manufactured, brand labeled or distributed by BELIMO.
.2 Size for torque required for valve close off at 150 percent of total system (head) pressure for two-way valves; and 100 percent of pressure differential across the valve or 100 percent of total system (pump) head differential pressure for three-way valves.
.3 Coupling: Directly couple end mount to stem, shaft, or ISO-style direct-coupled mounting pad.
.4 Mounting: Actuators shall be capable of being mechanically and electrically paralleled to increase torque if required.
.5 Overload Protection: Electronic overload or digital rotation-sensing circuitry without the use of end switches to deactivate the actuator at the end of rotation.
.6 Fail-Safe Operation: Mechanical, spring-return mechanism. Internal chemical storage systems, capacitors, or other internal non-mechanical forms of fail-safe operation are not acceptable.
.7 Power Requirements: Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
.8 Maximum 1 VA at 24-V ac or 1 W at 24-V dc.
.9 Temperature Rating: -22 to +122°F (-30 to +50°C)
.10 Housing: Minimum requirement NEMA type 2 / IP54 mounted in any orientation.
.11 Agency Listing: ISO 9001, cULus, and CSA C22.2 No. 24-93.
.12 The manufacturer shall warrant all components for a period of 5 years from the date of production, with the first two years unconditional.
.13 Valve actuators shall accept a 0-10VDC control voltage for all proportional applications.
.14 Floating point control of valves is not acceptable under any circumstances.

.6 Control Dampers

.1 Control Dampers shall be supplied and installed by the Sheet Metal Contractor.

.7 Control Damper Actuators

.1 Manufactured, brand labeled or distributed by BELIMO.
.2 Size for torque required for damper seal at load conditions.
.3 Coupling: V-bolt dual nut clamp with a V-shaped, toothed cradle.

.4 Mounting: Actuators shall be capable of being mechanically and electrically paralleled to increase torque if required.
.5 Overload Protection: Electronic overload or digital rotation-sensing circuitry without the use of end switches to prevent any damage to the actuator during a stall condition.
.6 Fail-Safe Operation: Mechanical, spring-return mechanism
.7 Power Requirements (Spring Return): 24Vac (unless otherwise indicated), maximum 10 VA at 24-V ac or 8 W at 24-V dc.
.8 Proportional Actuators shall be fully programmable. Control input, position feedback and running time shall be factory or field programmable by use of external computer software Diagnostic feedback shall provide indications of hunting or oscillation, mechanical overload and mechanical travel. Programming shall be through an EEPROM without the use of actuator mounted switches.
.9 Temperature Rating: -22 to +122ºF (-30 to +50ºC)
.10 Housing: Minimum requirement NEMA type 2 / IP54 mounted in any orientation or as required for application.
.11 Agency Listing: ISO 9001, cULus, and CSA C22.2 No. 24-93.
.12 The manufacturer shall warrant all components for a period of 5 years from the date of production, with the first two years unconditional.

.8 Room Sensors/Thermostats

.1 Mount sensors in new control panels at a height of 47'' (1200mm) above finished floor unless otherwise indicated.
.2 10 k ohm thermistors only shall be used and shall have end-to-end accuracy +/- 0.3 degC over the entire operating range.
.3 Provide a guard or cage for all sensors or thermostats mounted in public areas such as stairways, vestibules, lobbies, gymnasiums and pools. On the approval of the Engineer, provide a flush-mounted stainless steel sensor in lieu of guard or cage.

.9 Current Sensor (Analog)

.1 Technical Performance – Output shall be 4-20mA only. End-to-end accuracy +/- 2% of full scale at each range.

.10 Duct Mounted Humidity Sensor

.1 Technical Performance - Operating range from 10% - 90% over 0-60 degC temperature range. End-to-end accuracy of +/- 1% of operating range, with maximum temperature dependence of 0.2% per degC change. 200mm long probe, with enclosure for mounting in duct. 4-20mA output only. Voltage output is not acceptable.

.11 Duct Temperature Sensor

.1 Probe - Technical Performance – 10 k ohm thermistor sensor encapsulated in a 200mm long, 6mm OD copper or stainless stell probe. Operating range 0-60 degrees C. End-to-end accuracy +/- 0.3 degC. Assembly complete with wiring housing and mounting flange.
.2 Averaging - Technical Performance - 10 k ohm thermistor constructed of FT6 plenum rated cable or soft copper tubing, incorporating numerous temperature sensors encapsulated at equal distances along the length of the element. The assembly acts as a single sensor reporting the average temperature form all individual sensors. End-to-end accuracy +/- 0.3 degC. Assembly complete with wiring housing and mounting flange. Mount in a zig-zag manner to provide continuous coverage of the entire duct cross-sectional area.

.12 Outdoor Air Temperature Sensor

.1 Technical Performance, 10 k ohm thermistor -50C to 50C in a weatherproof enclosure, sun shield and mounting bracket. End accuracy of +/- 0.3 degC over the entire operating range.

.13 Pipe Temperature Sensor

.1 Well - Technical Performance - 10k ohm thermistor sensor encapsulated in a 6mm OD, 50mm long probe, with screw fitting for insertion into a standard thermowell. Operating range -10 - +100 degrees C. End-to-end accuracy +/- 0.3 degC over the entire operating range. Comes complete with brass thermowell. Use conductive gel when mounting the sensor in thermowell. No surface mount strap on temperature sensors shall be used to monitor fluid temperature unless approved by the engineer.

.14 Duct Carbon Dioxide (CO2) Sensor

.1 Technical Performance – A stand-alone carbon dioxide (CO2) sensor with one analog output. Operating Temperature: +32°F to +122°F (0°C to +50°C). Relative Humidity (non-condensing): 0 to 95 percent. Power Supply: 24 Vac ±20%, 50/60 Hz (Class 2). Output: Analog: 0-10 Vdc, 0-2000 ppm (fixed). Response Time: 1 min.

.2 Carbon Dioxide Sensor: Operation: Non-dispersive infrared (NDIR). Sampling: Diffusion. Range: 0 to 2000 ppm (fixed). Annual Drift: ±10 ppm (nominal). Accuracy: ±(30 ppm+2%) at normal temperature/pressure.

.15 Relays

.1 Control Relays. Control relays shall be plug-in type, UL listed, and shall have dust cover and LED "energized" indicator. Contact rating, configuration, and coil voltage shall be suitable for application.

.2 Time Delay Relays. Time delay relays shall be solid-state plug-in type, UL listed, and shall have adjustable time delay. Delay shall be adjustable ±100% from setpoint shown. Contact rating, configuration, and coil voltage shall be suitable for application. Provide NEMA 1 enclosure for relays not installed in local control panel.

.16 Current Switches

.1 Current-operated switches shall be self-powered, solid-state with adjustable trip current. Select switches to match application current and DDC system output requirements.

.17 Local Control Panels

.1 Indoor control panels shall be fully enclosed NEMA 1 construction with hinged door key-lock latch and removable sub-panels. A common key shall open each control panel and sub-panel.

.2 Prewire internal and face-mounted device connections with color-coded stranded conductors tie-wrapped or neatly installed in plastic troughs. Field connection terminals shall be UL listed for 600 V service, individually identified per control and interlock drawings, with adequate clearance for field wiring.

.3 Each local panel shall have a control power source power switch (on-off) with overcurrent protection.

2.3 Operator Interface

.1 Operator Functions. Modify the operator interface to allow each authorized operator to execute the following functions as a minimum:

.1 Log In and Log Out. System shall require user name and password to log in to operator interface.

.2 Point-and-click Navigation. Operator interface shall be graphically based and shall allow operators to access graphics for equipment and geographic areas using point-and-click navigation.

.3 View and Adjust Equipment Properties. Operators shall be able to view controlled equipment status and to adjust operating parameters such as setpoints, PID gains, on and off controls, and sensor calibration.

.4 View and Adjust Operating Schedules. Operators shall be able to view scheduled operating hours of each schedulable piece of equipment on a weekly or monthly calendar-based graphical schedule display, to select and adjust each schedule and time period, and to simultaneously schedule related equipment. System shall clearly show exception schedules and holidays on the schedule display.

.5 View and Respond to Alarms. Operators shall be able to view a list of currently active system alarms, to acknowledge each alarm, and to clear (delete) unneeded alarms.

.6 View and Configure Trends. Operators shall be able to view a trend graph of each trended point and to edit graph configuration to display a specific time period or data range. Operator shall be able to create custom trend graphs to display on the same page data from multiple trended points.

.7 View and Configure Reports. Operators shall be able to run preconfigured reports, to view report results, and to customize report configuration to show data of interest.

.8 Manage Control System Hardware. Operators shall be able to view controller status, to restart (reboot) each controller, and to download new control software to each controller.

.9 Manage Operator Access. Typically, only a few operators are authorized to manage operator access. Authorized operators shall be able to view a list of operators with system access and of functions they can perform while logged in. Operators shall be able to add operators, to delete operators, and to edit operator function authorization. Operator shall be able to authorize each operator function separately.

.2 Graphics

.1 Operator interface shall be upgraded graphically and shall include at least one graphic per piece of equipment or occupied zone, graphics for each hot water system, and graphics that summarize conditions on each floor of each building included in this contract. Indicate thermal comfort on floor plan summary graphics using dynamic colors to represent zone temperature relative to zone setpoint.

.2 Graphics shall allow operator to monitor system status, to view a summary of the most important data for each controlled zone or piece of equipment, to use point-and-click navigation between zones or equipment, and to edit setpoints and other specified parameters.

.3 Graphics shall be able to animate by displaying different image files for changed object status.

.4 Indicate areas or equipment in an alarm condition using color or other visual indicator.

.5 Graphics shall be saved in an industry-standard format such as BMP, JPEG, or GIF. Web-based system graphics shall be viewable on browsers compatible with World Wide Web Consortium browser standards. Web graphic format shall require no plug-in (such as HTML and JavaScript) or shall only require widely available no-cost plug-ins (such as Active-X and Macromedia Flash).

.3 Maintain existing configuration, access and security parameters unless otherwise directed by KPRDSB.

2.4 Controllers

.1 Provide Building Controllers, Application Specific Controllers, Actuators, Sensors as required to achieve performance.

2.5 Communication

.1 Each controller shall provide a service communication port for connection to a Portable Operator's Terminal.

.2 BC and ASC operating systems shall manage input and output communication signals to allow distributed controllers to share real and virtual object information and to allow for central monitoring and alarms.

.3 Each BC and ASC shall share data as required with each networked BC and ASC.

.4 Each piece of equipment shall be controlled by a single controller to provide stand-alone control in the event of communication failure. All I/O points specified for a piece of equipment shall be integral to its controller. Provide stable and reliable stand-alone control using default values or other method for values normally read over the network.

2.6 Environment.

.1 Controller hardware shall be suitable for anticipated ambient conditions.

.2 Controllers used outdoors or in wet ambient conditions shall be mounted in waterproof enclosures and shall be rated for operation at -29°C to 60°C (-20°F to 140°F).

.3 Controllers used in conditioned space shall be mounted in dust-protective enclosures and shall be rated for operation at 0°C to 50°C (32°F to 120°F).

2.7 Serviceability

.1 Controllers shall have diagnostic LEDs for power, communication, and processor.

.2 Wires shall be connected to a field-removable modular terminal strip or to a termination card connected by a ribbon cable.

.3 Each BC and ASC shall continually check its processor and memory circuit status and shall generate an alarm on abnormal operation. System shall continuously check controller network and generate alarm for each controller that fails to respond.

.4 Immunity to Power and Noise: Controllers shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m (3 ft).

.5 Transformer: ASC power supply shall be fused or current limiting and shall be rated at a minimum of 125% of ASC power consumption.

2.8 Input and Output Interface

.1 General: Hard-wire input and output points to BCs, ASCs.

.2 Protection: Shorting an input or output point to itself, to another point, or to ground shall cause no controller damage. Input or output point contact with up to 24 V for any duration shall cause no controller damage.

.3 Binary Inputs: Binary inputs shall monitor the on and off signal from a remote device. Binary inputs shall provide a wetting current of at least 12 mA and shall be protected against contact bounce and noise. Binary inputs shall sense dry contact closure without application of power external to the controller.

.4 Pulse Accumulation Inputs: Pulse accumulation inputs shall conform to binary input requirements and shall accumulate up to 10 pulses per second.

.5 Analog Inputs: Analog inputs shall monitor low-voltage (0-10 Vdc), current (4-20 mA), or resistance (thermistor or RTD) signals. Analog inputs shall be compatible with and field configurable to commonly available sensing devices.

.6 Binary Outputs: Binary outputs shall send an on-or-off signal for on and off control. Building Controller binary outputs shall have three-position (on-off-auto) override switches and status lights. Outputs shall be selectable for normally open or normally closed operation.

.7 Analog Output:. Analog outputs shall send a modulating 0-10 Vdc or 4-20 mA signal as required to properly control output devices. Each Building Controller analog output shall have a two-position (auto-manual) switch, a manually adjustable potentiometer, and status lights. Analog outputs shall not drift more than 0.4% of range annually.

.8 Tri-State Outputs: Control three-point floating electronic actuators without feedback with tri-state outputs (two coordinated binary outputs). Tri-State outputs may be used to provide analog output control in zone control and terminal unit control applications such as VAV terminal units, duct-mounted heating coils, and zone dampers.

.9 Common mode noise attenuation of 150 dB or greater at 40-100 Hz

2.9 Wiring And Raceways

.1 General. Provide copper wiring, plenum cable, and raceways as specified in applicable sections.

.2 All control wiring in exposed unfinished areas shall be run in EMT conduit. Final connections shall be liquidtight. All control wiring above t-bar spaces shall be run in EMT conduit or FT6 – where FT6 is used ensure to run neatly, with adequate strapping to ensure no long loose sags but not too taut.

.3 Install communications wire (ASC network) utilizing plenum cable without EMT.

.4 Install room temperature sensor/controller (ASC) wiring in wiremold for surface mounting within classrooms.

.5 Insulated wire shall use copper conductors and shall be UL listed for 90°C (200°F) minimum service.

## PART 3 – EXECUTION

3.1 Examination

.1 Thoroughly examine project plans for control device and equipment locations. Report discrepancies, conflicts, or omissions to KPRDSB and Engineer for resolution before starting rough-in work.

.2 Inspect site to verify that equipment can be installed as shown. Report discrepancies, conflicts, or omissions to Engineer for resolution before starting rough-in work.

.3 Examine drawings and specifications for work of others. Report inadequate headroom or space conditions or other discrepancies to Engineer and obtain written instructions for changes necessary to accommodate Section 23 09 23 work with work of others. Controls Contractor shall perform at his expense necessary changes in specified work caused by failure or neglect to report discrepancies.

3.2 Scope of Work

.1 Controls Contractor shall provide all necessary control valves, temperature sensors, sensor wells, control panels, installation labor, programming, commissioning, graphics generation and training as required for a new, complete and operational controls system.

.2 Provide new temperature controls for new rooftop units including all sensors, and control devices required for a fully operational system. Provide new temperature controls for new variable air volume boxes, wallfins, unit heater and forceflow heaters.

.3 Provide new temperature controls for new domestic hot water heater including all sensors, valves, and control devices required for a fully operational system.

.4 Remove and replace existing pneumatic controls in the areas of work if present– make allowances for the retrofit of any existing pneumatics as required to accomplish this. Remove any redundant pneumatic tubing turn over to the Board as confirmed.

.5 Obtain services of Analysts of Pneumatic Systems Ltd., Dave Strain, Phone: 1-647-289-2700, for demolition of any pneumatic controls.

.6 Report any discrepancies, conflicts, or omissions in regards to the existing control system capabilities to the Engineer for resolution before starting demolition or rough-in work.

.7 Upgrade existing workstation with current operator workstation software and current graphics operator workstation software.

.8 Extend network as required to the new and miscellaneous additional equipment shown.

3.3 Protection

.1 Controls Contractor shall protect against and be liable for damage to work and to material caused by Contractor's work or employees.

.2 Controls Contractor shall be responsible for work and equipment until inspected, tested, and accepted. Protect material not immediately installed. Close open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

3.4 Coordination

.1 Assist in coordinating space conditions to accommodate the work of each trade where work will be installed near or will interfere with work of other trades. If installation without coordination causes interference with work of other trades, Contractor shall correct conditions without extra charge.

.2 Coordinate and schedule work with other work in the same area and with work dependent upon other work to facilitate mutual progress.

3.5 Test and Balance

.1 Provide the Balancing Contractor with a single set of necessary tools to interface to control system for balancing.

.2 Train, Balancing Contractor to use control system interface tools.

.3 Provide a qualified technician to assist with testing and balancing the first 20 terminal units.

.4 The Balancing Contractor shall return tools undamaged and in working condition at completion of testing and balancing.

3.6 Coordination with Other Controls

.1 Integrate with and coordinate controls and control devices furnished or installed by others as follows:

.1 Each supplier of a controls product shall configure, program, start up, and test that product to meet the sequences of operation regardless of where within the contract documents those products are described.
.2 Coordinate and resolve incompatibility issues that arise between control products provided under this section and those provided under other sections or divisions of this specification.
.3 Controls Contractor shall be responsible for integration of control products provided by multiple suppliers regardless of where integration is described within the contract documents.

3.7 General Workmanship

.1 Install equipment, piping, and wiring or raceway horizontally, vertically, and parallel to walls wherever possible.

.2 Provide sufficient slack and flexible connections to allow for piping and equipment vibration isolation.

.3 Install equipment in readily accessible locations as defined by National Electrical Code (NEC) Chapter 1 Article 100 Part A.

.4 Verify wiring integrity to ensure continuity and freedom from shorts and ground faults.

.5 Equipment, installation, and wiring shall comply with industry specifications and standards and local codes for performance, reliability, and compatibility.

3.8 Field Quality Control

.1 Work, materials, and equipment shall comply with rules and regulations of applicable local, provincial, and federal codes and ordinances as identified in Section 22 05 01 and Section 23 05 01.

.2 Continually monitor field installation for code compliance and workmanship quality.

.3 Contractor shall arrange for work inspection by local or state authorities having jurisdiction over the work.

3.9 Existing Equipment

.1 Wiring: Interconnecting control wiring shall be removed and shall become Contractor's property unless specifically noted or shown to be reused.

.2 Local Control Panels: Reuse existing controllers if possible. Remove and deliver any redundant control panels to KPRDSB.

.3 Repair: Unless otherwise directed, Contractor is not responsible for repair or replacement of existing energy equipment and systems, valves, dampers, or actuators. Notify Engineer in writing immediately of existing equipment that requires maintenance.

.4 Indicator Gauges: Ensure operation of and recalibrate for reasonable accuracy or replace existing gauges.

.5 Modify existing starter control circuits if necessary to provide hand-off-auto control of each controlled starter. Furnish new starters or starter control packages as required.

.6 Patch holes and finish to match existing walls.

3.10 Wiring

.1 Control and interlock wiring and installation shall comply with national and local electrical codes, Division 26, and manufacturer's recommendations. Where the requirements of Section 23 09 23 differ from Division 26, Section 23 09 23 shall take precedence.

.2 All control wiring in exposed unfinished areas shall be run in EMT conduit. Final connections shall be liquidtight. All control wiring above t-bar spaces shall be run in EMT conduit or FT6 – where FT6 is used ensure to run neatly, with adequate strapping to ensure no long loose sags but not too taut.

.3 NEC Class 1 (line voltage) wiring shall be UL listed in approved raceway as specified by NEC and Division 26.

.4 Low-voltage wiring shall meet NEC Class 2 requirements. Subfuse low-voltage power circuits as required to meet Class 2 current limit.

.5 NEC Class 2 (current-limited) wires not in raceway but in concealed and accessible locations such as return air plenums shall be UL listed for the intended application.

.6 Install wiring in raceway where subject to mechanical damage and at levels below 3 m (10ft) in mechanical, electrical, or service rooms.

.7 Install Class 1 and Class 2 wiring in separate raceways. Boxes and panels containing high-voltage wiring and equipment shall not be used for low-voltage wiring except for the purpose of interfacing the two through relays and transformers.

.8 Do not install wiring in raceway containing tubing.

.9 Run exposed Class 2 wiring parallel to a surface or perpendicular to it and tie neatly at 3 m (10 ft) intervals.

.10 Use structural members to support or anchor plenum cables without raceway. Do not use ductwork, electrical raceways, piping, or ceiling suspension systems to support or anchor cables.

.11 Secure raceways with raceway clamps fastened to structure and spaced according to code requirements. Raceways and pull boxes shall not be hung on or attached to ductwork, electrical raceways, piping, or ceiling suspension systems.

.12 Size raceway and select wire size and type in accordance with manufacturer's recommendations and NEC requirements.

.13 Include one pull string in each raceway 2.5 cm (1 in.) or larger.

.14 Use color-coded conductors throughout.

.15 Locate control and status relays in designated enclosures only. Do not install control and status relays in packaged equipment control panel enclosures containing Class 1 starters.

.16 Conceal raceways except within mechanical, electrical, or service rooms. Maintain minimum clearance of 15 cm (6 in.) between raceway and high-temperature equipment such as steam pipes or flues.

.17 Adhere to requirements in Division 26 where raceway crosses building expansion joints.

.18 Install insulated bushings on raceway ends and enclosure openings. Seal top ends of vertical raceways.

.19 Terminate control and interlock wiring related to the work of this section. Maintain at the job site updated (as-built) wiring diagrams that identify terminations.

.20 Flexible metal raceways and liquid-tight flexible metal raceways shall not exceed 1 m (3 ft) in length and shall be supported at each end. Do not use flexible metal raceway less than ½ in. electrical trade size. Use liquid-tight flexible metal raceways in areas exposed to moisture including chiller and boiler rooms.

.21 Install raceway rigidly, support adequately, ream at both ends, and leave clean and free of obstructions. Join raceway sections with couplings and according to code. Make terminations in boxes with fittings. Make terminations not in boxes with bushings.

3.11 Communication Wiring

.1 Communication wiring shall be low-voltage Class 2 wiring and shall comply with Article 3.10 (Wiring).

.2 Install communication wiring in separate raceways and enclosures from other Class 2 wiring.

.3 During installation do not exceed maximum cable pulling, tension, or bend radius specified by the cable manufacturer.

.4 Verify entire network's integrity following cable installation using appropriate tests for each cable.

.5 Install lightning arrestor according to manufacturer's recommendations between cable and ground where a cable enters or exits a building.

.6 Each run of communication wiring shall be a continuous length without splices when that length is commercially available. Runs longer than commercially available lengths shall have as few splices as possible using commercially available lengths.

.7 Label communication wiring to indicate origination and destination.

.8 Ground coaxial cable according to NEC regulations article on "Communications Circuits, Cable, and Protector Grounding."

3.12 Installation of Sensors

.1 Install sensors according to manufacturer's recommendations.

.2 Mount sensors rigidly and adequately for operating environment.

.3 Install room temperature sensors on concealed junction boxes properly supported by wall framing.

.4 Air seal wires attached to sensors in their raceways or in the wall to prevent sensor readings from being affected by air transmitted from other areas.

.5 Use averaging sensors in mixing plenums and hot and cold decks. Install averaging sensors in a serpentine manner vertically across duct. Support each bend with a capillary clip.

.6 Install mixing plenum low-limit sensors in a serpentine manner horizontally across duct. Support each bend with a capillary clip. Provide 3 m (1 ft) of sensing element for each 1 $m^2$ (1 $ft^2$) of coil area.

.7 Install pipe-mounted temperature sensors in wells. Install liquid temperature sensors with heat-conducting fluid in thermal wells.

.8 Install outdoor air temperature sensors on north wall at designated location with sun shield.

.9 Smoke detectors, freezestats, high-pressure cut-offs, and other safety switches shall be hard-wired to de-energize equipment as described in the sequence of operation. Switches shall require manual reset. Provide contacts that allow DDC software to monitor safety switch status.

3.13 Actuators

.1 General: Mount actuators and adapters according to manufacturer's recommendations.

.2 Provide necessary mounting hardware and linkages for actuator installation.

.3 Valve Actuators: Connect actuators to valves with adapters approved by actuator manufacturer. Actuator installation shall allow for easy access for servicing and maintenance and shall allow for free rotation of the valve.

3.14 Warning Labels

.1 Affix permanent warning labels to equipment that can be automatically started by the control system.

.2 Labels shall use white lettering (12-point type or larger) on a red background.

.3 Warning labels shall read as follows.

C A U T I O N
This equipment is operating under automatic control and may start or stop at any time without warning. Switch disconnect to "Off" position before servicing.

.4 Affix permanent warning labels to motor starters and control panels that are connected to multiple power sources utilizing separate disconnects.

.5 Labels shall use white lettering (12-point type or larger) on a red background.

.6 Warning labels shall read as follows.

C A U T I O N
This equipment is fed from more than one power source with separate disconnects. Disconnect all power sources before servicing.

3.15 Identification of Hardware and Wiring

.1 Label wiring and cabling, including that within factory-fabricated panels, with control system address or termination number at each end within 5 cm (2 in.) of termination.

.2 Label pneumatic tubing at each end within 5 cm (2 in.) of termination with a descriptive identifier.

.3 Permanently label or code each point of field terminal strips to show instrument or item served.

.4 Label control panels with minimum 1 cm (½ in.) letters on laminated plastic nameplates.

.5 Label each control component with a permanent label. Label plug-in components such that label remains stationary during component replacement.

.6 Label room sensors related to terminal boxes or valves with nameplates.

.7 Manufacturers' nameplates and UL or CSA labels shall be visible and legible after equipment is installed.

.8 Label identifiers shall match record documents

3.16 Programming

.1 Point Naming. Where multiple points with the same name reside in the same controller, each point name may be customized with its associated Program Object number. For example, "Zone Temp 1" for Zone 1, "Zone Temp 2" for Zone 2.

.2 Software Programming. Programming shall provide actions for each possible situation. Graphic- or parameter-based programs shall be documented. Text-based programs shall be modular, structured, and commented to clearly describe each section of the program.

.3 Application Programming. Provide application programming that adheres to sequences of operation. Program documentation or comment statements shall reflect language used in sequences of operation.

.4 System Programming. Provide system programming necessary for system operation.

3.17 Operator Interface

.1 Standard Graphics. Show on each equipment graphic input and output points and relevant calculated points. Point information on graphics shall dynamically update.

.2 Install, initialize, start up, and troubleshoot operator interface software and functions (including operating system software, operator interface database, and third-party software installation and integration required for successful operator interface operation) as described in Section 23 09 23.

3.18 Control System Checkout and Testing

.1 Startup Testing. Complete startup testing to verify operational control system before notifying Owner of system demonstration. Provide Owner with schedule for startup testing. Owner may have representative present during any or all startup testing.

.2 Calibrate and prepare for service each instrument, control, and accessory equipment furnished under Section 23 09 23.

.3 Verify that control wiring is properly connected and free of shorts and ground faults. Verify that terminations are tight.

.4 Enable control systems and verify each input device's calibration. Calibrate each device according to manufacturer's recommendations.

.5 Verify that binary output devices such as relays, solenoid valves, two-position actuators and control valves, and magnetic starters, operate properly and that normal positions are correct.

.6 Verify that analog output devices such as I/Ps and actuators are functional, that start and span are correct, and that direction and normal positions are correct. Check control valves and automatic dampers to ensure proper action and closure. Make necessary adjustments to valve stem and damper blade travel.

.7 Prepare a log documenting startup testing of each input and output device, with technician's initials certifying each device has been tested and calibrated.

.8 Verify that system operates according to sequences of operation. Simulate and observe each operational mode by overriding and varying inputs and schedules. Tune PID loops and each control routine that requires tuning.

.9 Alarms and Interlocks.

1. Check each alarm with an appropriate signal at a value that will trip the alarm.
2. Trip interlocks using field contacts to check logic and to ensure that actuators fail in the proper direction.
3. Test interlock actions by simulating alarm conditions to check initiating value of variable and interlock action.

.10 Submit four (4) copies of the system commissioning report to the Engineer for review and approval.

.11 Record all out-of-season or unverified points in the commissioning report as “uncommissioned”.

.12 The BAS field 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 connected system components should go to their fail-safe state.

3.19 Control System Demonstration and Acceptance

.1 Demonstration. Prior to acceptance, perform the following performance tests to demonstrate system operation and compliance with specification after and in addition to tests specified in Article 3.19 (Control System Checkout and Testing). Provide Engineer with log documenting completion of startup tests.

.2 Engineer will be present to observe and review system demonstration. Notify Engineer at least 10 days before system demonstration begins.

.3 Demonstration shall follow process submitted and approved under Section 23 09 23 Article 1.8 (Submittals). Complete approved checklists and forms for each system as part of system demonstration.

.4 Demonstrate actual field operation of each sequence of operation. Provide at least two persons equipped with two-way communication. Demonstrate calibration and response of any input and output points requested by Engineer. Provide and operate test equipment required to prove proper system operation.

.5 Demonstrate compliance with sequences of operation through each operational mode.

.6 Demonstrate complete operation of operator interface.

.7 Demonstrate each of the following.

1. DDC loop response. Supply graphical trend data output showing each DDC loop's response to a setpoint change representing an actuator position change of at least 25% of full range. Trend sampling rate shall be from 10 seconds to 3 minutes, depending on loop speed. Each sample's trend data shall show setpoint, actuator position, and controlled variable values. Engineer will require further tuning of each loop that displays unreasonably under- or over-damped control.
2. Trend logs for each system. Trend data shall indicate setpoints, operating points, valve positions, and other data as specified in the points list provided with each sequence of operation. Each log shall cover three 48-hour periods and shall have a sample frequency not less than 10 minutes or as specified on its points list. Logs shall be accessible through system's operator interface and shall be retrievable for use in other software programs.
3. Tests that fail to demonstrate proper system operation shall be repeated after Contractor makes necessary repairs or revisions to hardware or software to successfully complete each test.

.8 Acceptance

1. After tests described in this specification are performed to the satisfaction of both Engineer and Owner, Engineer will accept control system as meeting completion requirements. Engineer may exempt tests from completion requirements that cannot be performed due to circumstances beyond Contractor's control. Engineer will provide written statement of each exempted test. Exempted tests shall be performed as part of warranty.
2. System shall not be accepted until completed demonstration forms and checklists are submitted and approved as required in Section 23 09 23 Article 1.8 (Submittals).

3.20 Training

.1 Provide training for a designated staff of Owner's representatives. Training shall be provided via self-paced training, web-based or computer-based training, classroom training, or a combination of training methods.

.2 Training shall enable students to accomplish the following objectives.

1. Proficiently operate system
2. Understand control system architecture and configuration
3. Understand DDC system components
4. Understand system operation, including DDC system control and optimizing routines (algorithms)
5. Operate workstation and peripherals
6. Log on and off system
7. Access graphics, point reports, and logs
8. Adjust and change system setpoints, time schedules, and holiday schedules
9. Recognize common HVAC system malfunctions by observing system graphics, trend graphs, and other system tools
10. Understand system drawings and Operation and Maintenance manual
11. Understand job layout and location of control components
12. Access data from DDC controllers
13. Create, delete, and modify alarms, including configuring alarm reactions
14. Create, delete, and modify point trend logs (graphs) and multi-point trend graphs
15. Configure and run reports

END OF SECTION

## PART 1 - GENERAL

1.1 Welding

.1 Welding materials and labour shall conform to ASME Code and the provincial Regulations.

.2 Use welders fully qualified and licensed by Provincial Authorities.

1.2 Quality Assurance

.1 Gas piping shall meet the requirements of the latest CSA Gas Installation Code.

.2 Water piping shall meet the requirements of the Ontario Building Code and Municipal Codes.

.3 Pipe fittings shall conform to the following standards:

.1 ANSI B36.10, ASTM-197-47 (Materials)
.2 ANSI B16.24, ANSI/ASME B16.15, ANSI B16.8, ANSI/ASME B16.22 (Copper Fittings)
.3 ANSI B16.3 (Malleable Iron Fittings, Threaded)
.4 ANSI B16.9 (Wrought Carbon Steel Fittings, Butt Weld)
.5 ANSI B16.5 (Forged Carbon Steel Flanges, Threaded, Weld Neck or Slip-on)
.6 ANSI B18.2.1 (Carbon Steel Bolts, Hex Head, Course Thread)
.7 ANSI B18.2.2 (Carbon Steel Nuts, Heavy Hex, Course Thread)
.8 ANSI B16.20 (Gaskets)
.9 ANSI B16.39 (Unions)
.10 CSA B242-05 (R2016) (Groove and Shoulder Type Mechanical Pipe Couplings)

1.3 Reference Standards and Codes

.1 Ontario Building Code

.2 ASTM

.3 CSA

.4 CGA

.5 ANSI

.6 NFPA

.7 ULC

.8 Local Codes and Requirements

1.4 Shop Drawings

.1 Submit shop drawings for Expansion Loops.

## PART 2 – PRODUCTS

2.1 Hydronic Piping

.1 Piping up to and including 2": Piping shall be Black Steel Schedule 40 with malleable steel threaded screwed fittings.

.2 Piping 2½" and over: Piping shall be Black Steel Schedule 40 with welded fittings. **Grooved**

**fittings are not acceptable.**

.3 Brass adapters shall be provided at all connections between copper tubing and ferrous piping.

.4 Provide expansion loops in piping systems as indicated on drawings and specified herein.

2.2 Expansion Loops

.1 Provide expansion loops equal to Flex Hose Tri-Flex Loop Model TFL4 (+/-4" axial), which provides a flexible pipe loop that will absorb and compensate multi-plane movements simultaneously as well as reduce piping stress.

.2 Construction to be 3 equal length sections of annular corrugated stainless steel close-pitch hose with stainless steel overbraid that will absorb or compensate for pipe movements in all 6 degrees of freedom (3 coordinate axes, plus rotation about those axes) simultaneously.

.3 The corrugated metal hose, braids, and a stainless steel ring-ferrule/band (material gauge not less than .048") must be integrally seal-welded using a 100% circumferential, full penetration TIG welds. End fittings shall be selected per application. Fittings must be attached using a 100% circumferential TIG weld.

.4 Braided stainless steel Tri-Flex Loops must be suitable for operating temperatures up to 850 degrees F (455 degrees C).

.5 Expansion Loops shall be designed for pressure testing to 1.5 times their maximum rated working pressure and a minimum 4:1 (burst to working) safety factor.

.6 Each braided expansion loop shall be individually leak tested by the manufacturer using air-under-water or hydrostatic pressure.

.7 Expansion Loops shall be prepared for shipment using a cut-to-length metal shipping bar, tacked securely between the elbows of the two parallel legs, to maintain the manufactured length during shipping. Shipping bar must be removed prior to system start-up.

.8 The hanger assembly kit shall be used to support and hang the expansion loop.

.9 The ULC Listed Seismic Wire/Cable assemblies conform to the requirements of the ASCE (American Society of Civil Engineers) guidelines for structural applications of wire rope, in that the cable is pre-stretched and the permanent end fittings maintain the break strength of the cable with a safety factor of two.

.10 The pre-manufactured flexible loop shall be installed as per manufacturer's printed installation instructions. Other manufactured loops that require pipe alignment guides shall use "Spider" type with outer housing ring. Units shall be fabricated from carbon steel. Pipe hangers and/or roller supports shall not be considered acceptable for use as guides.

.11 Expansion loops must have a 5-year full product replacement warranty.

2.3 Condensate Piping

.1 Black Steel Schedule 40 with malleable steel threaded screwed fittings or

.2 Type K or L hard copper complete with cast brass or wrought copper drainage fittings with solder joints or

.3 IPEX XFR.

2.4 Gas Piping

.1 Sizes 50mm (2″) and under: ASTM A53 Schedule 40 seamless wrought steel with standard threaded malleable fittings to ANSI B16.3.

.2 Sizes over 50mm (2″): ASTM A53 Schedule 40 seamless wrought steel with wrought steel butt welding fittings to ANSI B16.9.

.3 Welding materials and labour shall conform to ASME codes and authorities having jurisdiction.

.4 Provide regulators as required and vent as per code.

.5 Gas vents shall not be within 3m (10′) to any natural or mechanical fresh air intakes.

.6 Gas Regulators

.1 Gas regulators shall be complete with internal relief. Where installed indoors, vent to outdoors.
.2 Size using an inlet pressure of 2lb, an outlet pressure of 7″ w.c. and a capacity to suit equipment served.
.3 Acceptable Manufacturers: Sensus as supplied by Ontor, Maxitrol, Fisher.

2.5 Equipment Drains

.1 Galvanized steel schedule 40 with galvanized threaded fittings or
.2 Type K or L hard copper complete with cast brass or wrought copper drainage fittings with solder joints or

2.6 Connections

.1 Unions

.1 Use extra heavy duty pattern unions with ground joints, brass seats and threads to ANSI B1.20.1 for connections 50mm (2″) and under.
.2 Rated for minimum 150 psi.

.2 Flanges

.1 Use standard weight type flanges to ANSI B16.1 with neoprene gaskets for connections 63mm (2½″) and over.
.2 Rated for minimum 125 psi.

.3 Adapters

.1 Brass adapters shall be provided at all connections between copper tubing and ferrous piping.

2.9 Firestop Sealants and Collars

.1 Provide firestop sealants around all pipe penetrations through rated separations.

.2 Provide firestop collars for all combustible pipe penetrations through rated separations (where combustible piping is approved).

.3 Intumescent insert: Flexible, elastomeric strip, two stage expansion, designed to firestop penetrations in fire-rated walls and floors and floor/ceiling assemblies.

.4 Provide a minimum of 15 time free expansion.

.5 Sealants shall not contain water soluble expansion ingredients.

**PART 3 - EXECUTION**

3.1 General

.1 Apply for permit before beginning any work. Have drawings approved for construction by authorities having jurisdiction or local agencies prior to beginning work.

.2 Review all inverts and elevations before beginning any installation.

.3 Pipe fittings for pipe up to and including 2" shall be malleable steel threaded. Pipe fittings for pipe 2½" and over shall be welded (grooved fittings are not acceptable).

.4 Have entire installation inspected, at various stages where required, to ensure approval at completion of project.

.5 Provide clearance for proper installation of insulation and for access to components including but not limited to valves, air vents, drains and unions.

.6 Maintain proper grades on piping for proper drainage and provide valves at all low points.

.7 All exposed piping to run parallel to walls and in a neat and orderly fashion to maintain headroom. Group piping where possible.

.8 Do not run combustible or non-approved pipe through fire separations or return air ceiling plenums. Use approved materials and methods only.

.9 Provide drain valves and air vents at low and high points respectively where required.

.10 All gas piping installations shall comply with CGA code CAN 1-B149, gas safety branch bulletins, local codes and NFPA 96. Provide a CGA approved ball valve where new equipment is to be connected.

.11 Install gas piping in open or ventilated spaces. Pitch lines and provide drip legs for condensation collection points. Where gas piping is run in a concealed space, provide ventilation grilles as required.

.12 Make connections to equipment with unions or flanges. Provide dielectric unions or couplings at all connections between copper tubing and ferrous piping or non-conducting type connections for jointing dissimilar metals.

.13 Install piping to allow for expansion and contraction and to eliminate stress on equipment, piping, or connections.

.14 Provide isolation valves or shutoff valves at all equipment.

.15 Provide cleanouts as indicated on drawings and as required by code. Floor cleanouts are not approved in finished floor areas unless otherwise noted. Ensure adequate clearance to all cleanouts.

.16 Provide sleeves for piping passing through floor slab. Caulk around piping and fill entire space between piping and floor slab with approved fire retardant material to maintain required fire rating where necessary.

.17 Provide fire stop sealant at all pipe penetrations through fire separations.

3.2 Natural Gas Piping

.1 All gas piping installations shall comply with CGA code CAN 1-B149, gas safety branch

bulletins, local codes and NFPA 96. Provide a CGA approved ball valve where new equipment is to be connected.

.2 Coordinate new gas meter with local Utilities. Fill out and submit gas meter application form.

.3 Install gas piping in open or ventilated spaces. Pitch lines and provide drip legs for condensation collection points. Where gas piping is run in a concealed space, provide ventilation grilles as required.

.4 Provide dog house for all gas piping through roof. Refer to details on drawing.

.5 Provide union, valve and drip leg at final connection to all equipment. Drip leg shall be minimum 50mm (2") above any floor or roof level.

.6 Refer to Section 23 05 29 for piping supports and roof block supports.

.7 Gas Regulators

.1 Provide regulators as noted on drawings and as required. Size in accordance with loads and equipment. Where installed indoors, vent to the outdoors.
.2 Gas pressure regulating valve relief pipe is to be extended upward and remote from the gas vent and the fresh air intake, in compliance with current codes. Provide support and bracing as required.

.8 Testing and Inspections

.1 The Contractor shall perform a soap test and electronic test.
.2 Arrange and pay for a gas inspection by the local Gas/TSSA Inspector.

3.3 Steel Pipe Connection

.1 Screw joint steel piping up to and including 38mm (1½"). Screw or weld 50 mm (2") piping. Weld all piping 63mm (2½") and larger, including branch connections. Grooved piping is not acceptable.

.2 Make screwed joints with standard NPT configuration. Use approved nontoxic joint compound or teflon tape.

.3 Use full sized tees or main sized saddle type branch connections for directly connecting branch lines to mains in steel piping. Do not project branch pipes inside the main pipe.

.4 Make reductions in large water pipes with eccentric reducing fittings installed to provide drainage and venting.

3.5 Grades, Routes and Installations

.1 Route piping in orderly manner and maintain proper grades. Install to conserve headroom and interfere as little as possible with use of space.
.2 Run exposed piping parallel to walls. Group piping wherever practical at common elevations.

.3 Install concealed pipes close to the building structure to keep furrings to a minimum.

.4 On closed systems, equip low points with 19mm (¾") drain valves and hose connection.

.5 At high points, provide collecting chambers and high capacity float operated automatic air vents.

3.6 Flashing

.1 Flash all mechanical equipment passes through weather or waterproofed walls and roofs.

3.7 Sleeves

.1 Provide and set sleeves required for piping.

.2 Set sleeves in position in advance of other work. Provide suitable reinforcing around sleeves.

.3 Extend sleeves through potentially wet floors 50mm above finished floor level. Caulk sleeves full depth and provide floor plate.

.4 Where piping passes through floor, ceiling or wall, close off space between pipe and sleeve with noncombustible insulation or approved non-combustible insulation, fire rated as required to match the rating of the penetrated surface. Provide tight fitting metal caps on both sides.

.5 Install chrome plated escutcheons where piping passes through finished surfaces including millwork.

.6 Size large enough to allow for movement due to expansion and to provide for continuous insulation.

3.8 Firestop Sealants and Collars

.1 Clean all concrete, masonry and stone penetrations of all contaminants and impurities, concrete form release agents, water repellents, oils, surface dirt and rust, scale, all old sealants and other surface treatments.

.2 Metal surfaces shall be cleaned by wiping them with an oil- free absorbent cloth saturated with solvent such as xylol or toluol. Do not use alcohols.

.3 Do not apply to polycarbonates or to building materials that bleed oils, plasticizers or solvents, or where sealant is not exposed to atmospheric moisture, or to surfaces which have been or will be painted.

.4 Collars are to be installed with steel fasteners or steel expansion anchors. Low melting temperature anchors of lead, plastic or aluminum are not approved.

.5 Installation only when temperatures are between 4°C (40°F) and 37°C (98°F).

3.9 Identification

.1 Identify all piping with type of service and arrows.

.2 Refer to Section 23 05 53.

3.10 Testing

.1 Test drains for tightness and grade as noted or required by code.

.2 Refer to testing procedures in Section 23 05 92.

3.11 Cleaning and Treatment

.1 Flush, clean and treat piping systems. Refer to Section 23 25 13.

3.12 Glycol

.1 Install glycol into the system and submit report to Consultant.

.2 Required mixture is 60% water and 40% propylene glycol unless otherwise noted.

END OF SECTION

## PART 1 - GENERAL

1.1 Quality Assurance

.1 Comply with Provincial Regulations and have CSA approval.

1.2 Submittals

.1 Provide shop drawings and schedules of manufactured products for review and inclusion in Operating and Maintenance Manuals as per Section 23 05 01.

## PART 2 - PRODUCTS

2.1 Manual Air Vents

.1 Manufactured brass body, soldered or brazed construction, threaded connection. Pressure and temperature rated for service.

.2 3/16" O.D. x 21" copper tube with washer and 1/8" air valve

.3 Acceptable Manufacturers

.1 Equal to Belanger B72-221.

2.2 Automatic Air Vents

.1 Wallfin, Convectors, Radiators:

.1 Float-operated, vertical mounting, brass body & cover and silicone rubber seal. Float shall be constructed of high temperature resistant polyethylene.

.2 Acceptable Manufacturers:

.1 Watts FV-4
.2 Spirax Sarco AE30
.3 Bell & Gossett 97
.4 Armstrong

.2 Pipe Mains & Lines, Mechanical Rooms, Equipment, Coils, Ceilings spaces and all other spaces except noted above:

.1 Self-closing, float-operated, vertical mounting, 1/4" I.P. male connection, designed for pressures up to 150psi, 4-3/8" x 2-1/4", bright brass finish.

.2 Acceptable Manufacturers

.1 Watts
.2 Spirax Sarco
.3 Bell & Gossett
.4 Armstrong

2.3 Air Eliminator

.1 Heavy duty.

.2 Acceptable Manufacturers:

.1 Armstrong 1-AV
.2 Spirax Sarco 13WS
.3 ITT

2.4 Air Separator

.1 Air separator shall have tangential inlet nozzles.

.2 The air separator shall be designed and constructed in accordance with Section VIII, Div 1 of the ASME Boiler and Pressure Vessel Code.

.3 The unit shall be fitted with an NPT vent connection (for connection to a compression tank or an air vent).

.4 An additional NPT tapping shall be provided on the bottom of the air separator to facilitate blow-down.

.5 2″ to 3″ models should be supplied with a cast iron body and NPT system connections, while 4″ to 6″ models should be supplied with a cast iron body and ANSI flanges. 8″ to 24″ models are to be supplied with a fabricated steel body and carbon steel ANSI flanges.

.6 Acceptable Manufacturers:

.1 Armstrong Vortex Model VA
.2 ITT/Bell & Gossett
.3 Spirax Sarco

2.5 Flow Indicators (Water)

.1 Single Double tempered glass window, bronze body, ABS impeller.

.2 Suitable for pressure twice that of working pressure, minimum 125 psig.

.3 Suitable for temperature 200 deg F.

.4 Equal to Ashland Filter-Mate 304SS.

.5 Supplied under Section 23 25 13.

2.6 Sight Glass

.1 Equal to Sarco BS 1400 LG2.

.2 Supplied under Section 23 25 13.

2.7 Strainers

.1 Sizes 50mm (2″) and under: Screwed brass or iron body, Y pattern with 0.8mm stainless steel perforated screen.

.2 Sizes 63mm to 100mm (2½″ to 4)″: Flanged iron body, Y pattern with 1.2mm stainless steel screen.

.3 Screen free area shall be minimum three times area of inlet pipe. Provide valved drain and hose connection off strainer bottom.

.4 Grooved end strainers (where grooved end piping systems are allowed): rated for 300 PSI (2065 kPa) Y-Type Strainer shall consist of ductile iron body, Type 304 stainless steel cylindrical removable baskets with 1/16" (1,6mm) diameter perforations and 41% open area 2"-3" strainer sizes or 1/8" (3,2mm) diameter perforations and 40% open area 4"-12" strainer sizes. Acceptable material: Victaulic Style 732.

**PART 3 - EXECUTION**

3.1 Manual Air Vents

.1 Install coin vents at all perimeter radiation with coin adjuster installed at surface of enclosure.

3.2 Automatic Air Vents

.1 Install size as specified herein and in locations as per drawings, at all system high points and as required for complete air purging.

.2 Where large air quantities can accumulate, provide enlarged air collection standpipe.

.3 Provide ball valve of size to match air vent I.P connection under each air vent. Shut off valve is to allow isolation, removal and service of fitting.

3.3 Air Separator

.1 Provide on suction side of system circulation pump and connect to expansion tank.

.2 Install high and/or away from access routes so as not to interfere with access routes. If they are installed in access routes the bottom of the unit must be minimum 8' above finished floor.

3.4 Strainers

.1 Install as per manufacturer's recommendations and to suit maintenance requirements.
.2 Install on the inlet of all pumps.

END OF SECTION

## PART 1 - GENERAL

1.1 Reference Standards

.1 Ontario Building Code

.2 SMACNA

.3 NFPA 90A – Air Conditioning and Ventilation Systems

.4 ASTM A653

.5 ULC

.6 Local Codes and Requirements

## PART 2 - PRODUCTS

2.1 General

.1 Provide ductwork as recommended and specified in the latest revision of the Sheet Metal and Air Conditioning Contractors National Association incorporated (SMACNA).

2.2 Ductwork

.1 Galvanized steel with G90 designation zinc coating lock forming quality to ASTM A525M.

.2 Rectangular or Square:

.1 Conform to SMACNA standards.

.3 Round:

.1 Factory fabricated, spiral wound, with matching fittings and specials. Longitudinal seam type is not acceptable.
.2 Transverse joints up to 900mm (36″): slip type with tape and sealants.
.3 Transverse joints over 900mm (36″): Ductmate or Exanno Nexas Duct System.

.4 Exposed Ductwork in Finished Areas (i.e. Gymnasiums):
.1 All exposed ductwork in finished areas shall be satin finish (galvannealed) to allow for painting without peeling.
.2 All exposed ductwork in finished areas shall be spiral unless otherwise indicated.
.3 All exposed ductwork in finished areas shall be painted.

2.3 Duct Construction

.1 All supply air ductwork from air handling unit fan discharge to upstream of VAV components or reheat coils shall be constructed to SMACNA 500 Pa (2″ wg) duct construction class. For all other constant volume systems, all supply air ductwork installed in mechanical rooms shall be constructed to SMACNA 500 Pa (2″ wg) duct construction class.

.2 All supply air ductwork downstream of VAV components or reheat coils shall be constructed to SMACNA 250 Pa (1″ wg) duct construction class.

.3 All return air ductwork and all exhaust air ductwork installed in mechanical rooms shall be constructed to SMACNA 500 Pa (2″ wg) duct construction class. All other return air

ductwork and exhaust air ductwork shall be constructed to 250 Pa (1" wg) duct construction class.

.4 Tie rods shall not be used in lieu of external duct reinforcement except where specifically mandated by SMACNA duct construction standards.

.5 Duct tapers to be at 14 degrees maximum (1:4 ratio) for all systems with air velocities less than 1500fpm and 8 degrees (1:7 ratio) for velocities 1500 fpm and greater.

.6 The contractor shall provide a schedule of proposed duct construction, meeting SMACNA standards, to be used on the project. Schedule shall include panel width, gauge, transverse connector, reinforcement, longitudinal seam, sealing class and sealing compound. Submit schedule prior to performing any duct fabrication/installation.

2.4 Fittings

.1 Fabrication: to SMACNA.

.2 Radiused elbows:

.1 Rectangular: standard radius and or short radius with single thickness turning vanes Centreline radius: 1.5 times width of duct.
.2 Round: in exposed areas one-piece smooth radius, 1.5 times diameter.

.3 Mitred elbows, rectangular:

.1 To 400mm (16"): with single thickness turning vanes.
.2 Over 400mm (16"): with double thickness turning vanes.

.4 Branches:

.1 Rectangular main and branch: with 45° entry on branch.
.2 Round main and branch: enter main duct at 45° with conical connection.
.3 Provide volume control damper in branch duct near connection to main duct.
.4 Main duct branches: with splitter damper.

.5 Diffuser connection to main:

.1 High efficiency takeoffs complete with rectangular duct opening and 45° slope body. Takeoffs shall be furnished complete with balancing damper and locking quadrant.
.2 Contractor shall notify Consultant if height of takeoff is required to be reduced to suit ceiling clearances and obtain approval from the same prior to installing or fabricating.

.6 Transitions:

.1 Diverging: 20° maximum included angle.
.2 Converging: 30° maximum included angle.

.7 Offsets:

.1 Full short radiused elbows.

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

2.5 Firestopping

.1 40mm x 40mm x 3mm (1-1/2" x 1-1/2" x 16ga) retaining angles all around duct, on both sides of fire separation.

.2 Firestopping material and installation must not distort duct.

.3 All ductwork passing through partition walls shall be firestopped.

2.6 Fasteners

.1 Fasteners shall be sheet metal screws, rivets, and bolts.

2.7 Flexible Ductwork – Non-Metallic, Insulated

.1 Factory fabricated to CAN/ULC S110 and classified Class 1.

.2 Flame spread rating not to exceed 25. Smoke spread rating not to exceed 50.

.3 Semi-rigid and lightweight air duct, manufactured using a dead soft aluminum strip which is spirally wound and mechanically joined together to form an air tight and leak-proof three ply mechanical seam. Self-supporting and corrosive resistant that provides excellent strength and rigidity.

.4 Provide insulated for all supply air applications unless otherwise noted.

.5 Performance - Uninsulated:

.1 Material: Aluminum
.2 Maximum rated velocity: 5500 fpm
.3 Maximum positive pressure: 2.5 kPa (10 in.wc.)
.4 Maximum negative pressure: 3.0 kPa (12 in.wc.)
.5 Temperature Range : -51C to 315C (-60F to 600F)
.6 Bend Radius : 1.5 times diameter
.7 Available sizes : 50mm to 610mm (2 inches to 24 inches)

.6 Performance – Insulated:

.1 Core material: Aluminum
.2 Thermal Resistance: Available in R4.2, R6, R8
.3 Maximum rated velocity: 4000 fpm
.4 Maximum positive pressure: 3.0 kPa (12 in.wc.)
.5 Maximum negative pressure: 0.25 kPa (1 in.wc.)
.6 Temperature Range : -40C to 121C (-40F to 250F)
.7 Bend Radius : 1.5 times diameter
.8 Available sizes : 100mm to 500mm (4 inches to 20 inches)
.9

.7 Acceptable Manufacturers:

.1 Uninsulated: Flexmaster Triple Lock T/L Aluminum Flexible Ducting
.2 Insulated: Flexmaster Triple Lock T/L Aluminum Thermal Flexible Ducting

2.8 Hangers and Supports

.1 Refer to Section 23 05 29.

2.9 Duct Sealer

.1 Duct Sealer to be ULC classified for surface burning characteristics and be water based.

.2 Duct Sealer shall be Duro-Dyne DWN, grey, water-based for medium and high pressure duct systems, non-flammable (wet state), fire retardant (dry state).

.3 Duct Sealer shall be clear silicone type on all exposed ductwork or duct sealer shall be applied to inside of fittings to ensure clean look.

2.10 Turning Vanes

.1 Turning Vanes shall be of steel construction with prime coat finish and complete with supports and fastenings.

.2 Turning vanes shall have correct airfoil pattern as mandated by SMACNA.

2.11 Instrument Test Ports

.1 Instrument port covers shall be Duro-Dyne IP-1 for bare ducts and IP-2 for insulated ducts.

**PART 3 - EXECUTION**

3.1 Rigid Ductwork

.1 Coordinate with other trades prior to installing ductwork.

.2 All ductwork and fittings shall be installed in accordance with SMACNA and ASHRAE standards.

.3 Duct tapers to be at 14 degrees maximum (1:4 ratio) for all systems with air velocities less than 1500fpm and 8 degrees (1:7 ratio) for velocities 1500 fpm and greater.

.4 Ductwork shall be properly constructed, braced, connected and jointed. Suspend with hangers to SMACNA Standards. Refer to Section 23 05 29.

.5 Do not suspend hangers including wires and rods from the steel roof deck nor from other mechanical or electrical components. Support hangers from structural bearings such as beam, top chords of steel joists or structural concrete slabs. Where structural bearings do not exist, provide angle or channel iron form nearest structural bearings to support hangers.

.6 Use of “S and drive” or equivalent slip joint method, or Ductmate flange joint method is permissible. Fabricate and install in accordance with SMACNA reinforcement standards. Leave smooth finish on edges and interior of duct runs. Install internal ends of slip joints in direction of flow.

.7 Ducts and joints shall be tight and rigid so as not to leak, rattle, or vibrate.

.8 Install ductwork to allow adequate space for normal operation and maintenance of equipment nearby.

.9 Where possible, radiused duct elbows with radiused splitter vanes are preferable over square elbows with turning vanes. Where square duct elbows are necessary, turning vanes to be double thickness airfoil type installed in every slot on the vane rail.

.10 Direct size duct spin-ons are not acceptable. Conical spin-on or square-to-round fittings shall be provided. Where take-off is same size as main, use a 45 degree lead-in fitting.

.11 Where ducts pass through walls, seal around ducts with noncombustible material.

.12 All openings through wall must be sleeved and lined as specified. Openings shall be 50mm (2") larger all around than duct or piping and filled with fireproof Rockwool type insulation complete with fire retardant sealant both sides.

.13 All open ductwork, not being worked on, must be completely covered during construction phase until all sanding, plastering, painting, and finishing is complete.

.14 Inspect and test ductwork prior to any required painting or insulation for air leakage at joints and connections under normal operating conditions. Air leakage tests shall be performed as specified herein.

.15 Paint ductwork visible through registers, grilles and diffusers flat black.

.16 Under no conditions are pipes, rods or wires allowed to penetrate ducts.

.17 Kitchen exhaust duct shall be welded, sloped and with access doors in conformance with NFPA 96.

3.2 Flexible Ductwork

.1 Install in accordance with SMACNA.

.2 Maximum length shall be 1.8m (6'). Minimum 12" (300mm) straight vertical duct run to be provided at all diffusers.

.3 Provide support at centre of flexible duct.

3.3 Duct Sealing

.1 Seal all ductwork with duct sealer as specified herein. Ducts constructed to SMACNA 500Pa (2") duct construction class and under shall be sealed to SMACNA Standard Section 1.6 and 1.7, Class C. Ducts constructed to SMACNA 750Pa (3") duct construction class shall be sealed to SMACNA Standard Section 1.6 and 1.7, Class B. Duct sealer shall be applied behind fittings for all exposed ductwork in finished areas.

.2 The sealer shall be stored at room temperature for at least 24 hours prior to use. Surfaces shall be clean, dry and free from oil, grease, and any other foreign material.

.3 Clean fittings to a depth of four inches with a solvent, exercising safe practices as recommended by the manufacturer.

.4 Stir sealer thoroughly before application.

.5 Use a brush, cartridge guns or spatula to apply the sealer to male section of spiral duct or to both fittings of rectangular duct. Join joints while sealer is wet (within approximately 15 minutes) and secure with sheet metal screws applied as close as possible (1/2" or less). Apply sealer to outside of assembly with a 2" wide band of sealer, thoroughly covering joint head and sheet metal screws. Allow sealer to set (approximately 72 hours) before pressure testing. Do not thin.

.6 The Consultant shall inspect the duct sealing prior to any insulation being installed. Provide minimum four (4) working days' notice.

3.4 Duct Leakage Tests

.1 Test all air systems for leakage in accordance with SMACNA procedures including supply air, return air, outside air and exhaust air. Calibrated orifices shall be used to measure all leakage airflow rates. All ductwork shall be pressure tested at minimum 500 Pa (2"WG). For any system, total leakage at the test pressure shall not exceed 5% of respective fan design air flow rate. For constant volume (CV) systems, test all supply air ductwork from air handler to air terminals including fire dampers but excluding air terminals. For return and exhaust air ducts, blank grilles or open ducts and test duct from fan inlet to most remote inlet including fire dampers, access doors and silencers. Repair all leaks and repeat test. Pressurize with small blower. Test system as a whole, or in parts, provided that all ductwork is accessible for inspection at the time of test.

.2 Tests shall be performed before ducts are insulated or enclosed. Submit notice of all tests in ample time to allow the Consultant or their representative to be present when the tests are conducted. All tests shall be witnessed by the Consultant and the Owner's third party commissioning agent or they shall be repeated.

.3 Any components of the systems which might be damaged during the tests shall be removed before the tests and reinstalled after the tests.

.4 Provide all test holes (including prefabricated insulated capped test hole fittings), dampers, access facilities, etc. as required for air balancing and make any changes required for the final balancing results. Cooperate with the Balancing Contractor to ensure satisfactory completion of his work. Provide test holes prior to application of thermal insulation.

.5 Submit report of air tests to Consultant and include in maintenance manuals.

3.5 Instrument Test Ports

.1 Provide Durodyne IP-1 test ports in all uninsulated duct branches within mechanical rooms. Standard plugs may be used in uninsulated ducts outside of mechanical rooms.

.2 Provide Durodyne IP-2 test ports in all insulated duct branches throughout the building.

.3 Ports shall be supplied and installed by the mechanical contractor prior to installation of external insulation.

.4 With the assistance of the balancing contractor, the contractor will mark the spacing for the instrument ports on the ductwork after installation of the ductwork and notify the commissioning team of the number of ports.

3.6 Painting

.1 All exposed ductwork in finished areas shall be painted by the General Contractor.

3.7 Cleaning (prior to start-up)

.1 Keep ductwork and duct liners clear from dust and debris during construction.

.2 Prior to starting HVAC equipment, inspect and clean all equipment, and ductwork on the inside and outside to ensure that they are completely free from dust and debris.

.3 Install clean filters in all units.

END OF SECTION

## PART 1 - GENERAL

1.1 Reference Standards

.1 Ontario Building Code

.2 ASHRAE

.3 SMACNA

.4 NFPA 90A – Air Conditioning and Ventilation Systems

.5 ULC

.6 CSA

.7 Local Codes and Requirements

1.2 Submittals

.1 Submit shop drawings showing location, ratings, sizes of all fire dampers.

.2 One copy of all stamped reviewed shop drawings plus operation and maintenance data shall be included in the maintenance manual.

## PART 2 - PRODUCTS

2.1 General

.1 All required accessories shall conform to ASHRAE and SMACNA standards and recommendations.

2.2 Fire Dampers

.1 Provide fire dampers in ducts penetrating fire rated walls, floors, or ceiling as indicated on the drawings.

.2 Fire dampers shall be UL STD 555 to 1-1/2 hour fire ratings.

.3 Fire dampers shall be equipped for vertical or horizontal suitable for application.

.4 Frame: 4-7/8", 20 gauge galvanized steel channel.

.5 Blades: 24 gauge galvanized steel blades, curtain type, recessed out of air stream.

.6 Fusible link: 165°F.

.7 Provide duct access doors to service fire dampers for those air transfer openings mounted with ducts.

.8 Acceptable Manufacturers

.1 Ruskin – Series IBD2 Style B
.2 Nailor Industries – 0120 Type B
.3 National Controlled Air (NCA) – FD – 80 Type B
.4 Tamco

2.3 Combination Fire Smoke Dampers

.1 Combination fire/smoke dampers meeting or exceeding the following specifications shall be furnished and installed at locations shown on plans or as described in schedules.

.2 Combination fire smoke dampers shall be triple-V groove blades.

.3 Dampers shall meet the requirements of NFPA90A, 92A and 92B and shall be classified for use for fire resistance ratings of less than 3 hours, in accordance with UL555, and classified as Smoke Dampers in accordance with the latest version of UL555S.

.4 Quality Assurance

.1 Dampers shall be warranted against manufacturing defects for a period of 5 years.
.2 Dampers shall be tested, rated and labeled in accordance with the latest ULC requirements.
.3 Damper pressure drop ratings shall be based on tests and procedures performed in accordance with AMCA 500 and certified by AMCA (if applicable).
.4 Factory Tests: Factory cycle damper and actuator assembly to assure proper operation.

.5 Ratings:

.1 Fire Resistance: 1-1/2 hours in accordance with ULC555.
.2 Smoke Rating: Leakage Class II Smoke Damper in accordance with UL555S. A Class II smoke damper leaks no more than 20 cubic feet per minute (.57 $m^3$/min) at 4 in. wg. (1 kPa) differential pressure.
.3 Elevated Temperature Rating: 165°F.
.4 Air Flow Rating: 2000 fpm.
.5 Differential Pressure Rating: 4 in. wg.

.6 Construction:

.1 Frame: 5 inches x minimum 16 gage (127 x minimum 1.6 mm) roll formed, galvanized steel hat-shaped channel, reinforced at corners. Structurally equivalent to 13 gage (2.3 mm) U-channel type frame.
.2 Blades:

.1 Style: Single skin with 3 longitudinal grooves (flat blades are not acceptable).
.2 Action: Opposed.
.3 Material: Minimum 16 gage (1.6 mm) galvanized steel.
.4 Width: Maximum 6 inches (152 mm).

.3 Bearings: Self-lubricating stainless steel sleeve type, turning in extruded hole in frame.
.4 Seals:

.1 Blade: Inflatable silicone fiberglass material to maintain smoke leakage rating to a minimum of 450°F (232°C) and galvanized steel for flame seal to 1,900°F (1,038°C). Mechanically attached to blade edge (glue-on or grip type seals are not acceptable).
.2 Jamb: Stainless steel, flexible metal compression type.

.5 Linkage: Concealed in frame.
.6 Axles: Minimum ½ inch (13) diameter plated steel, hex-shaped, mechanically attached to blade.
.7 Mounting: Vertical and/or Horizontal.

.8 Temperature Release Device: Heat-Actuated, Quick Detect.

.1 Close (in a controlled manner) and lock damper during test, smoke detection, power failure, or fire conditions through actuator closure spring. At no time shall actuator disengage from damper blades.
.2 Allow damper to be automatically and remotely reset after test or power failure conditions. After exposure to high temperature or fire, inspect damper before reset to ensure proper operation.
.3 Controlled closing and locking of damper in 7 to 15 seconds to allow duct pressure to equalize. Instantaneous closure is not acceptable.

.9 Release Temperature:
.10 Actuator:

.1 Type: Electric 120V, 60 Hz, two-position, fail close.
.2 Mounting: External

.11 Finish: Mill galvanized.

.7 Accessories

.1 Sleeves, sized to suit wall or floor thickness.

.8 Acceptable Manufacturers:

.1 Ruskin - FSD36 or equal
.2 National Controlled Air (NCA) – FSD-3V
.3 Nailor - 1271
.4 Tamco

2.4 Balancing Dampers

.1 Multi-blade damper: Galvanized steel minimum 16 gauge, provide with quadrants or adjustment rods and lock screw.

.2 Single blade damper: Galvanized steel minimum 18 gauge, provide with quadrants and lock screw.

.3 Fabricate splitter dampers of double thickness sheet metal to streamline shape, properly stiffened to avoid vibration. Size on basis of straight air volume proportioning.

.4 Fabricate single blade dampers for duct sizes to maximum 250mm x 750mm (10" x 30").

.5 Fabricate multi-blade dampers of opposed blade pattern with maximum blade sizes 300mm (12") to 1.8m (6'). Assemble centre and edge crimped blades in prime coated or galvanized channel frame with approved type hardware.

.6 Include for the supply and installation of twelve (12) extra balance dampers in installed ductwork pending balance results and comments.

2.4 Turning Vanes

.1 Factory or shop fabricated double thickness to SMACNA standards.

.2 Acceptable Manufacturers:

.1 Duro Dyne
.2 Ductmate

2.5 Automatic Dampers

.1 Damper frames and blades shall not be less than 12 gauge, 0.081" (2.1mm) extruded aluminium. Channel frame to be 4" (101.6mm) deep.

.2 Blades to be single unit, internally reinforced and connected to frame with a 7/16" hexagon rod. Internal hollows to be insulated with 7/8" thick polyurethane foam with T factor of 5.0 per inch. Blades shall be thermally broken. All fresh air intake dampers to be complete with insulated frame and blade.

.3 Blade and frame seals to be extruded synthetic rubber secured in an integral slot within the blade extrusion.

.4 Frame shall be insulated with polystyrene, R factor of 5.0 per inch.

.5 Bearings to be comprised of Celcon inner bearing fixed onto a hexagon rod rotating within a Polycarbonate outer bearing inserted into frame, resulting in no metal to metal contact.

.6 Linkage hardware to be out of air stream and constructed of aluminium and corrosion resistant zinc plated steel, equipped with cup-point trunnion screw for slip-proof grip.

.7 Dampers shall be suitable for operating in temperatures ranging between -40°F (-40°C) and 165°F (731°C).

.8 Leakage shall not exceed 0.6% of the rated air flow at 10" WG differential static pressure across the damper.

.9 This Contractor shall provide all 120-24V transformers as required.

.10 Acceptable Manufacturers:

.1 Tamco 9000
.2 Ruskin
.3 Nailor.

2.6 Damper Actuators

.1 Damper actuators shall be supplied with the unit by the unit manufacturer or by Controls Contractor under Section 23 09 23 as indicated in the equipment schedules, equipment specifications and controls details.

2.7 Access Doors

.1 Provide access doors in ductwork to allow cleaning in the bottom of all duct risers, next to outside air intakes and outlets, at each fire damper and plenum and equipment casings to facilitate maintenance and cleaning of all components.

.2 Construct access doors from double thickness 22 gauge galvanized steel sheets or aluminium in equal strength where required, 25mm apart, with necessary reinforcing inside for rigidity. Fill the 25mm space with glass fibre insulation.

.3 Make doors airtight with a continuous rubber gasket.

.4 Access doors to be square or equal to Nailor Ultra-Low Leakage flat oval.

.5 Access Doors shall have minimum two camlocks for sizes up to 250mm (14"), and four compression latches for sizes up to 600mm (24").

.6 Acceptable Manufacturers

.1 Price
.2 Nailor
.3 Ruskin

2.8 Flexible Connections

.1 Flexible Connections shall be Duro Dyne heavy glass, ULC listed, non-combustible, waterproof fabric, double coated with neoprene and shall be 150 mm minimum width, 0.81mm thick, density of 1.3 kg/$m^2$. Temperature rating shall be -40C (-40F) to +90C (+194F).

.2 Flexible connectors shall be attached to 24 gauge metal strips minimum 75mm (3") wide.

.3 Acceptable Manufacturers:

.1 Duro Dyne
.2 Mercer Rubber Co.

2.9 Test Ports

.1 Test ports shall be equal to Duro Dyne TH-1, IP-2, IP-4 to suit application complete with screw in cap, neoprene gasket, insulating plug, and extensions for insulated ductwork.

.2 Acceptable Manufacturers:

.1 Duro Dyne
.2 Ductmate

**PART 3 - EXECUTION**

3.1 Installation

.1 Provide access doors of adequate size to service, maintain, or inspect within duct stream where required. Locations include but are not limited to automatic dampers, fire dampers, and filters. Coordinate installation with General Contractor.

.2 Install flexible connections where rigid duct connects to equipment that is susceptible to vibration and as indicated on drawings.

.3 Install instrument test ports to allow Pitot tube insertion with cam-action handle.

3.2 Fire Dampers

.1 Confirm rating of devices with ratings of surfaces or separations.

.2 Provide fire dampers at locations shown, where ducts and outlets pass through fire rated components, and where required by authorities having jurisdiction.

.3 Fire dampers shall be complete with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.

.4 Where access door is located below horizontal fire damper, damper shall be equipped with pull tab release.

.5 Provide duct access doors to service fire dampers for those air transfer openings mounted with ducts.

.6 Provide fire stop flaps on air outlets penetrating fire rated membranes or surfaces.

3.3 Combination Fire Smoke Dampers

.1 Inspect areas to receive dampers. Notify the Engineer of conditions that would adversely affect the installation or subsequent utilization of the dampers. Do not proceed with installation until unsatisfactory conditions are corrected.

.2 Install dampers at locations indicated on the drawings and in accordance with manufacturer's ULC approved installation instructions.

.3 Install dampers square and free from racking with blades running horizontally.

.4 Do not compress or stretch damper frame into duct or opening.

.5 Handle damper using sleeve or frame. Do not lift damper using blades, actuator, or jackshaft.

.6 Install bracing for multiple section assemblies to support assembly weight and to hold against system pressure. Install bracing as needed.

3.4 Balancing Dampers

.1 Provide balancing dampers, whether shown or required, at points on supply, return and exhaust systems, where branches are taken from larger ducts, for proper air balancing.

.2 Review balance damper locations with the Balancing Contractor prior to installation. Additional costs to add balance dampers for proper balancing after installation will not be accepted.

.3 Include for the supply and installation of twelve (12) extra balance dampers in the already installed ductwork pending balance results and comments.

3.4 Turning Vanes

.1 Install in conformance with SMACNA standards.

.2 Install in all square elbows and short radius elbows for supply and return air ductwork.

3.5 Automatic Dampers

.1 Install opposed blade automatic control dampers as indicated on drawings.

.2 Opposed Blade Dampers: Use for shut off service, modulating service without companion dampers, throttling services.

.3 Parallel Blade Dampers: Use for mixing or relief service, variable position service with companion dampers.

.4 Coordinate installation of operator and controls with Controls Contractor where applicable.

.5 Damper actuators shall be supplied by Controls Contractor under Section 23 09 23 as indicated in the equipment schedules, equipment specifications and controls details.

3.6 Access Doors

.1 Access doors shall be complete with locking latches.

3.7 Flexible Connections

.1 Provide flexible connections on inlet and outlet duct connections of air handling units or other equipment likely to be affected by, or to cause vibration or noise to be transmitted through ductwork.

.2 Install in accordance with SMACNA.

END OF SECTION

## PART 1 - GENERAL

1.1 Intent of Section

.1 This section covers the supply and installation of silencers as shown and/or specified.

1.2 General

.1 The general conditions and general specifications form an integral part of this specification and must be read in conjunction herewith.

1.3 Codes and Standards

.1 Silencer manufacturer shall operate its own duct-to-reverberant room test facility which provides for airflow in both directions through the test silencer in accordance with ASTM E-477-06a. The facility shall maintain NVLAP accreditation for the E477 test standard.

1.4 Submittals

.1 Provide acoustical system calculations for all duct systems with silencers to demonstrate that the resultant ductborne sound levels of the equipment as measured in the occupied criteria, the guidelines as expressed in Table 34 of Chapter 47, "Sound and Vibration Control" of the 2003 ASHRAE Handbook – HVAC Application, shall be used.

.2 The manufacturer shall supply certified test data for each schedule silencer. The data shall include dynamic insertion loss, generated noise and pressure drop for forward or reverse flow, matching the project's air distribution system requirement. All ratings shall be conducted in the same facility and shall utilize the same silencer.

.3 Test facilities and test reports shall be open to inspection upon request from the Engineer. Silencer performance must have been substantiated by laboratory testing according to ASTM E-477-06a and so certified when submitted for approval. The aero-acoustic laboratory must NVLAP accredited for the ASTM E-477-06a test standard. A copy of the accreditation certificate must be included with the submittals. Data from non-NVLAP accredited test facilities will not be accepted.

.4 Supplier shall be responsible for the overall system pressure loss of the installation based on duct conditions upstream and downstream of the silencer to ensure required airflow is provided. Supplier shall submit detailed pressure drop analysis for the installation and detailed procedure outlining methodology for site measurement of overall system pressure loss for approval prior to manufacture.

.5 **Pressure drop calculations must be supplied with P. Eng stamp at the time of submittal.**

1.5 Manufacturers

.1 Manufacturers of fans whose products are approved in principle, but subject to requirements of drawings and specifications are:

.1 Vibro-Acoustics
.2 Kinetics
.3 VAW Systems

.2 Equivalent fan selections shall not decrease motor power, increase noise level, increase tip speed by more than 10% or increase inlet air velocity by more than 20% from that specified.

**PART 2 - PRODUCTS**

2.1 General Requirements

.1 Silencers shall be of the size, configuration, capacity and acoustic performance as scheduled on the drawings. All silencers shall be factory fabricated and supplied by the same manufacturer.

.2 Silencer inlet and outlet connection dimensions must be equal to the duct sizes shown on the drawings. Duct transitions at silencers are not permitted unless shown on the contract drawings.

.3 Silencers shall be constructed in accordance with ASHRAE and SMACNA standards for the pressure and velocity classification specified for the air distribution system in which it is installed. Material gauges noted in other sections are minimums. Material gauges shall be increased as required for the system pressure and velocity classification. The silencers shall not fail structurally when subjected to a differential air pressure of 8 inches water gauge.

.4 All casing seams and joints shall be lock-formed and sealed or stitch welded and sealed except as noted in Section G below, to provide leakage-resistant construction. Airtight construction shall be achieved by use of a duct-sealing compound supplied and installed by the contractor at the jobsite.

.5 All perforated steel shall be adequately stiffened to insure flatness and form. All spot welds shall be painted.

.6 Fire-Performance Characteristics: Silencer assemblies, including acoustic media fill, Vibar™ film liner, sealants, and acoustical spacer, shall have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested according to ASTM E 84, NFPA 255 or UL 723.

.7 Retain subparagraph below to comply with LEED-NC Prerequisite EQ 1.

.8 Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2007.

2.2 Rectangular Elbow Silencers including models RED: Outer casing shall be ASTM A 653/A 653M, G90 galvanized sheet steel, 18 gauge. All acoustical splitters shall be internally radiused and aerodynamically designed for efficient turning of the air. Half and full splitters are required as necessary to achieve the scheduled insertion loss. All elbow silencers with a turning cross-section dimension greater than 48" shall have at least two half splitters and one full splitter.

2.3 Inner perforated metal liner: ASTM A 653/A 653M, G90 galvanized sheet steel.

.1 Rectangular Silencers: 26 gauge.
.2 Rectangular Elbow Silencers: 22 gauge.
.3 Transitional Silencers: 22 gauge.

2.4 Principal Sound-Absorbing Mechanism:

.1 Dissipative and Film Lined silencers:

.1 Models RED type with acoustic media. Media shall be of acoustic quality, shot-free glass fiber insulation with long, resilient fibers bonded with a thermosetting resin. Glass fiber density and compression shall be as required to insure conformance with laboratory test data. Glass fiber shall be packed with a minimum of 15% compression during silencer assembly. Media shall be resilient such that it will not crumble or break, and conform to irregular surfaces. Media shall not cause or

accelerate corrosion of aluminum or steel. Mineral wool will not be permitted as a substitute for glass fiber.

2.5 HTL Casings: Where indicated on the silencer schedule, silencers shall have high transmission loss (HTL) walls externally applied and completely sealed to the silencer casing by the silencer manufacturer to assure quality controlled transmission loss. The HTL walls shall consist of media, airspace, mass and outer protective metal skin, as required, to obtain the specified room noise criteria. Standard acoustical panels will not be accepted as HTL walls. If requested by the Engineer, breakout noise calculations for each air handling and fan system shall be provided with the silencer submittal to insure compliance with the room noise criteria. Breakout noise calculations shall be based on the sound power levels of the specified equipment.

2.6 Special Construction

.1 Where noted on the silencer schedule, silencers shall have 16 gauge casing, continuously welded.

.2 Where indicated on the silencer schedule, silencers shall have RF filters integral to the silencer. Performance shall be 100 dB at 1 MHz. Pressure drop shall be included in overall silencer pressure drop. RF filter shall be located such that it cannot be bypassed.

.3 Where indicated on the silencer schedule, provide a non-conductive section in the silencer casing at the end of the silencer next to the room wall, and provide a minimum of 10" (254mm) x 10" (254mm) inspection port in the silencer casing next to the wall. These features shall not compromise the composite HTL casing of the silencer.

.4 Where indicated on the silencer schedule, provide security bars running at 6" (150mm) centers both ways inside the silencer casing to prevent ingress through the silencer.

2.7 Accessories

.1 If multiple ratings are required in first subparagraph below, indicate location of each rating on Drawings.

.2 Access Doors: Where indicated on the silencer schedule, silencers shall be supplied with an access door(s) to permit fire damper service. Access doors shall be supplied as an integral part of the silencer by the silencer manufacturer. Where HTL walls are also supplied, the access doors shall not reduce the effectiveness of the HTL walls.

.3 Shipping Protection: Silencers shall be shipped with factory-installed end caps to prevent contamination during shipping.

.4 Airflow Measuring Devices: Where indicated on the silencer schedule, silencers shall have airflow measuring devices factory installed as part of the silencer assembly.

2.8 Source Quality Control: Test according to ASTM E 477-06a.

1. The manufacturer shall test the silencer(s) as indicated in the silencer schedule. The engineer shall be notified of the test date at least two weeks in advance and the test may be witnessed by the engineer. Test shall show compliance with the project criteria and is subject to engineer approval.

2. Test facilities and test reports shall be open to inspection upon request from the Engineer. Silencer performance must have been substantiated by laboratory testing according to ASTM E477-13 and so certified when submitted for approval. The aero-acoustic laboratory must be NVLAP accredited for the ASTM E477-13 test standard. A copy of the accreditation certificate must be included with the submittals. Data from non-NVLAP accredited test facilities will not be accepted.

**PART 3 - EXECUTION**

3.1 Installation

.1 Install silencer according to manufacturer's written installation instructions.

.2 Protect all acoustic media from dirt and moisture during construction.

.3 Ensure duct silencers are installed with airflow arrows in direction of airflow.

.4 After the system has been air balanced the noise control manufacturer shall visit the job and check the sound and vibration levels in those areas requested by the Consultant. Conduct sound tests in areas that do not meet the specified noise levels. Determine the necessary corrective measures.

.5 Sound measurements shall be in accordance with the "American Standard Method for the Physical Measurement of Sound S1.2".

.6 Sound measuring equipment shall be in accordance with ANSI Standards S1.4 or S1.11.

.7 On system start-up the noise control manufacturer shall inspect the complete installation and report in writing any changes necessary to obtain satisfactory operation of isolated equipment.

END OF SECTION

## PART 1 – GENERAL

1.1 Quality Assurance

.1 Conform to AMCA Bulletins regarding construction and testing. Fans shall bear AMCA certified rating seal.

.2 Wheels will be balanced in accordance with AMCA Standard 204-96.

.3 Polyphase, squirrel cage, single speed NEMA/EEMAC Design A or B induction motors, between 1 hp and 200 hp whether in packaged equipment or not, shall comply with the current requirements of the Ontario Hydro Efficiency Standards Regulation, and specifically, CSA C390- 93 Energy Efficiency Test Methods for Three Phase Induction Motors.

1.2 Submittals

.1 Shop Drawings:

.1 Refer to Section 23 05 01 – HVAC General Requirements.
.2 Submit shop drawings to the Consultant for review prior to ordering or installation.
.3 Shop drawings shall include:

.1 Manufacturer and model numbers
.2 Performance data
.3 Fan curves and sound data, with fan and system operating point plotted on curves
.4 Calculations and technical data to support drive selection
.5 Fan details, isolation and details
.6 Cabinet construction, gauge, access doors, fasteners
.7 Maintenance requirements
.8 Conformance to above reference standards

.4 One copy of all stamped reviewed shop drawings shall be included in maintenance manual.

.2 Operation and Maintenance Data:

.1 Provide operation and maintenance literature indicating manufacturer and model of equipment, instructions for operation and maintenance of same, and parts list.
.2 Operation and maintenance data shall be included in the maintenance manual.

1.3 Job Conditions

.1 Do not operate fans for any purpose, temporary or permanent until ductwork is clean, filters in place, bearings lubricated and fan has been run under close supervision

1.4 Acceptable Manufacturers

.1 Manufacturers of exhaust fans whose products are approved in principle, but subject to requirements of drawings and specifications are:

.1 Cook
.2 S&P
.3 Penn
.4 Carnes
.5 Broan
.6 Nutone
.7 Zonex

.2 Alternatives: Equivalent fan selections shall not decrease motor power, increase noise level, increase tip speed by more than 10% or increase inlet air velocity by more than 20% from that specified.

## PART 2 - PRODUCTS

2.1 General

.1 Statically and dynamically balance fans so no objectionable vibration or noise is transmitted to occupied areas of the building.

.2 Provide balanced variable sheaves.

.3 Fans shall be capable of accommodating static pressure variations of +10% with no objectionable operating characteristics.

.4 Unless otherwise noted, include all motors and drive combinations with electrical characteristics as detailed elsewhere.

.5 Fan hubs and sheaves shall be keyed to shafts for fans over ¾ hp. Use of flat ground surface and set screws are not approved.

.6 Select variable and adjustable pitch sheaves unless otherwise specified, so that required rpm is obtained with sheaves set at mid-position, and approximate speed adjustment of 25%.

.7 Rate drive as recommended by manufacturer, but minimum 1.5 times power rating of the motor. Submit calculations and technical data with shop drawings, to support drive selection.

.8 Fans shall bear the AMCA Certified Ratings Seal for both sound and air performance.

2.2 Roof Fans

.1 Housings to be segmented heavy gauge steel panels, screw fastened, gasketed and sealed.

.2 Fan motor and drives supported by welded, heavy roll formed angle frame and mounting plate, vibration isolators, external motor service access door.

.3 Fan drive: Belt drive or direct drive as noted, permanently lubricated thrust roller bearings, forged bearing block, bolted to the frame.

.4 Fan: Corrosion resistant steel fan shaft, keyed to the fan and drive hubs, horizontal backward inclined centrifugal fan, statically and dynamically balanced.

.5 Motor: Continuous duty, drip proof housing, permanently lubricated ball bearings, voltage and phase as specified elsewhere.

.6 Roof curb: New roof curb or adapter curb to suit existing exhaust fan roof curb as noted.

.7 Accessories: Backdraft damper.

2.3 Cabinet Fans

.1 Fans shall be of the centrifugal belt driven in-line type. The fan housing shall be of the square design constructed of heavy gauge galvanized steel and shall include square duct mounting collars.

.2 Cabinet shall be heavy gauge metal with galvanized or baked enamel finish.

.3 Fan construction shall include two removable access panels located perpendicular to the motor mounting panel. The access panels must be of sufficient size to permit easy access to all interior components.

.4 The fan wheel shall be centrifugal backward inclined, constructed of aluminum and shall include a wheel cone carefully matched to the inlet cone for precise running tolerances.

.5 Motors shall be variable speed heavy duty ball bearing type. Motors and drives shall be mounted out of the airstream. Motors shall be readily accessible for maintenance.

.6 Precision ground and polished fan shafts shall be mounted in permanently sealed, lubricated pillow block ball bearings. Bearings shall be selected for a minimum (L50) life in excess of 200,000 hours at maximum catalogued operating speed.

.7 Accessories:

.1 NEMA 1 pre-wired disconnect switch.
.2 Multi-blade, rattle free, backdraft damper with felt lined blade edges.
.3 Time delay off switch where indicated.
.4 Controls as indicated on drawing schedule.

.8 Spare Parts

.1 Supply one (1) complete set of spare belts for all belt driven fans.

2.3 Ceiling Mounted Fans

.1 Ceiling mounted fans shall be low sone type equal to manufacturer and model as per schedule and shall not exceed sone value as indicated.

**PART 3 - EXECUTION**

3.1 General

.1 Install as per manufacturer's instructions.

.2 Install fans as shown, with resilient or spring mountings and fan restraining snubbers and flexible electrical leads. Refer to 23 05 47.

.3 Align shafts, belt drive and motor, adjust belt tension, ensure all set screws are tight, and check motor rotation before start-up.

.4 Protect motors and fans during construction and rotate fans, by hand, every month between delivery and acceptance of building.

.5 Install fans with flexible connections on inlet ductwork and on discharge ductwork in accordance with Section 23 33 00.

.6 Adjust variable pitch fan/motor sheaves during balancing to achieve specified air quantities.

3.2 Roof Fans

.1 Install in conformance with manufacturer's requirements and recommendations.

.2 Install roof curb.

.3 Where inlet or outlet is exposed, provide guard.

.4 Provide belt guards on belt driven fans.

.5 Supply and install sheaves as necessary for final air balancing.

3.2 Cabinet Fans

.1 Install in conformance with manufacturer's requirements and recommendations.

.2 Provide U-Channel, 3/8" rod and vibration isolation for mounting.

.3 Provide guard on any exposed fan inlet or outlet.

.4 Provide belt guards on belt driven fans.

.5 Supply and install sheaves as necessary for final air balancing for belt driven fans.

END OF SECTION

**Part 1 - General**

1.1 Quality Assurance

.1 Air terminal units shall meet the following standards and requirements:

.1 A.S.H.R.A.E.

.2 A.R.I.

.3 N.F.P.A. 90A

.4 U.L.C.

.5 Local Codes and Requirements

.2 Air flow tests and sound levels shall be made in accordance with A.S.H.R.A.E. standards.

.3 Manufacturers shall certify performance and application.

1.2 Submittals

.1 Shop Drawings:

.1 Submit shop drawings to the Consultant for review prior to ordering or installation.

.2 Shop drawings shall include manufacturer, model numbers, performance data, and indicate conformance to above reference standards.

.3 One copy of all stamped reviewed shop drawings shall be included in maintenance manual.

.2 Operation and Maintenance Data:

.1 Provide operation and maintenance literature for all equipment indicating manufacturer and model of equipment, instructions for operation and maintenance of same, and parts list.

.2 Operation and maintenance data shall be included in the maintenance manual.

1.3 Acceptable Manufacturers

.1 Manufacturers of units whose products are approved in principle, but subject to requirements of drawings and specifications are:

.1 Price
.2 Nailor
.3 Metal Aire
.4 Titus
.5 Kreuger

.2 Alternate manufacturers must be pre-approved by the Consultant.

**Part 2 - Products**

2.1 Variable Air Volume Box with Reheat Coil

.1 Furnish and install single duct, variable volume assemblies of the sizes and capacities as shown on the plans.

.2 The assemblies shall be pressure independent and shall reset to any air flow between zero and the maximum cataloged air volume.

.3 At an inlet velocity of 2000 f.p.m., the minimum operating pressure for any unit with attenuator section, sizes four through 16, shall not exceed 0.14 inches w.g.

.4 Performance shall be A.H.R.I. certified.

.5 The air flow sensor shall be of a cross configuration located at the inlet of the assembly. The sensor shall have twelve total pressure sensing ports and a center averaging chamber designed to accurately average the flow across the inlet of the assembly.

.6 Sensor shall provide accuracy within five percent with a 90 degree sheet metal elbow directly at the inlet of the assembly. The air flow sensor shall amplify the sensed air flow signal.

.7 The assembly casing shall be constructed of 22 gauge zinc coated steel, internally lined with ½ inch thick, fiberglass insulation which complies with U.L.-181, A.S.T.M. C 1071 and N.F.P.A.-90A. Any cut edges of fiberglass exposed to the air stream shall be coated with N.F.P.A.-90A approved sealant. The liner shall not contain Pentabrominated diphenyl ether C.A.S.#32534-81-9 and Octabrominated diphenyl ether.

.8 Hot water heating units as scheduled shall include 1, 2, 3 or 4 row coils. Coil capacities shall be as scheduled. A quick opening access panel shall be provided to allow cleaning and inspection of the coil. The coils shall be constructed of 0.500 inch by 0.016 inch copper tube. Fins shall be 0.0045 inch think aluminum sine wave configuration. The coil shall be contained in a 0.030 inch galvanized steel casing.

.9 The coils shall be tested and certified according to AHRI Standard 410. Coil connections can be right hand or left hand as detailed on the drawings. Control valves, automatic air vents and drain vents, if required, shall be supplied and field installed by others.

.10 Provide disconnect switch and N.E.M.A. 1 rated control enclosure for field mounted controls by others.

2.3 Controls

.1 Units shall be capable of accepting field installed controls as supplied by the B.A.S. Controls Contractor.

**Part 3 - Execution**

3.1 Installation

.1 Install as per manufacturer's recommendations.

.2 Install with clearances to allow proper access and service.

.3 Coordinate installation with Controls Contractor for installation of control devices.

.4 Provide access door upstream and downstream of reheat coil where not supplied integral by unit manufacturer.

END OF SECTION

## PART 1 - GENERAL

1.1 Requirements

.1 Air outlets shall meet the following standards and requirements:

.1 ASHRAE
.2 AMCA
.3 Local Codes and Requirements

.2 Air flow tests and sound levels shall be made in accordance with ASHRAE standards.

.3 Manufacturers shall certify performance and application.

1.2 Submittals

.1 Shop Drawings:

.1 Submit shop drawings to the Consultant for review prior to ordering or installation.
.2 Shop drawings shall include manufacturer, model numbers, performance data, and indicate conformance to above reference standards. Louver shop drawings shall include free area, pressure drop and water carry over data.
.3 One copy of all stamped reviewed shop drawings shall be included in maintenance manual.

.2 Operation and Maintenance Data:

.1 Provide operation and maintenance literature for all equipment indicating manufacturer and model of equipment, instructions for operation and maintenance of same, and parts list.
.2 Operation and maintenance data shall be included in the maintenance manual.

## PART 2 – PRODUCTS

2.1 General

.1 Air flow tests and sound levels shall be made in accordance with ASHRAE standards.

.2 Manufacturers shall certify performance and application.

.3 All supply grilles shall be adjustable with double deflection.

2.2 Grilles and Diffusers

.1 Provide grilles, registers and diffusers of the types as shown on the drawings.

.2 Provide vertical throw type as noted based on ceiling heights.

.3 Construction shall be heavy duty, with 14 gauge steel blades and heavy duty steel support bars and frame unless otherwise noted.

.4 Grilles shall be complete with steel volume damper of the opposed blade type for balancing purposes as noted.

.5 Supply diffusers mounted in t-bar shall not contain integral balance dampers. Balance dampers must be installed in branch duct runs to diffusers.

.6 Acceptable Manufacturers:

.1 Price
.2 Nailor
.3 Titus
.4 Metal Aire
.5 Kreuger

2.3 Louvers

.1 Louvers shall be licensed to bear the AMCA seal and certified by the manufacturer for outdoor use.

.2 Louvers shall be sized as noted on drawings and model selected to prevent moisture carry-over (896 fpm for base specified Ventex 2435).

.3 Frame shall be 0.081" (2.06 mm) extruded aluminium, alloy 6063-T5.

.4 Blades shall be 0.081" (2.06 mm) extruded aluminium, alloy 6063-T5, at an angle of 35° on 3.5" (89mm) centres. Louver assembly shall have blades contained within a single frame.

.5 Louver components including heads, jambs, sills and mullions shall be factory assembled.

.6 All materials shall be factory finished after assembly with Polyester Powder Coat, standard mill finish unless otherwise indicated.

.7 Louvers shall be complete with 19 gauge galvanized birdscreen with ½" x ½" openings.

.8 Submit all performance data with shop drawings for free area, pressure drop and water carry over.

.9 Acceptable Manufacturers:

.1 Ventex
.2 Tamco
.3 Price
.4 Ruskin

**PART 3 - EXECUTION**

3.1 Grilles and Diffusers

.1 Confirm location, type of mounting and size of all outlets with site conditions prior to ordering and installing.

.2 Provide flanged connection off ductwork for mounting of grilles.

.3 **Paint inside of ductwork flat black behind supply and return wall grilles.**

.4 Position vertical throw diffusers and deflection of grilles to achieve best air flow in area. Adjust to suit Balancing Contractor and Engineer's requirements.

.5 Provide birdscreen on all open ended return air ducts unless otherwise noted.

3.2 Louvers

.1 Confirm location and size of all louvers with General Contractor prior to ordering and

installing.

.2 Provide 16 gauge galvanized sheet metal sleeve through wall opening where required.

.3 All louvers shall be equipped with birdscreen.

.5 Provide caulking at all louvers using non-shrink Mono caulking to match building colour.

END OF SECTION

## PART 1 - GENERAL

1.1 Quality Assurance

.1 Meet the requirements of CSA, CGA, Provincial and Municipal Codes and be CSA listed.

.2 Cooling capacity, heating capacity and fan performance shall be ARI certified. Complete unit shall be ETL- Canada listed.

.3 Fabricate and label refrigeration system to comply with CSA B52 and ASHRAE 15, "Safety Code for Mechanical Refrigeration."

.4 Energy Efficiency Ratio: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

1.2 Delivery, Storage, and Handling

.1 Unit shall be stored and handled per manufacturer's recommendations.

.2 Lifted by crane requires either shipping top panel or spreader bars.

.3 Unit shall only be stored or positioned in the upright position.

1.3 Submittals

.1 Shop drawings must be submitted and reviewed by the Consultant prior to the contractor ordering or shipping any subject equipment.

.2 Submit certified shop drawings for the following:

.1 Fan curves and sound data
.2 Heating, cooling and air delivery performance data
.3 Filter frame and media details, dimensions and efficiency
.4 Heating and cooling components, materials and accessories
.5 Fan details, isolation and details
.6 Cabinet construction, gauge, access doors, fasteners
.7 Dimensions and weights.
.8 Power wiring diagrams and electrical characteristics.
.9 Control wiring diagrams and interfacing details.
.10 Calculations and technical data to support drive selection.
.11 Maintenance requirements.
.12 Installation and hoisting instructions.

1.4 Warranty

.1 Provide ten (25) year Non-pro-rated parts warranty on heat exchangers.

1.5 Acceptable Manufacturers

.1 AAON

.2 Daikin Rebel

.3 Engineered Air

.4 Other Alternate Manufacturers shall be pre-approved by the Consultant prior to tender close as per Section 23 05 01.

**PART 2 - PRODUCTS**

2.1 General

.1 Units shall be completely factory assembled, piped, wired, tested and shipped in one piece to the job site. Refer to schedules for unit performance.

.2 Units shall be specifically designed for outdoor rooftop application and include a weatherproof cabinet.

.3 The unit shall undergo a complete factory run test prior to shipment. The factory test shall include final balancing of the supply and return fan assemblies, a unit control system operations checkout, test and adjustment of the gas furnace and a final unit inspection.

2.2 Casing

.1 Unit shall be specifically designed for outdoor rooftop application with a fully weatherproof cabinet. Cabinet shall be constructed entirely of G90 galvanized steel with the exterior constructed of 20 gauge or heavier material

.2 Unit shall be designed to reduce air leakage and infiltration through the cabinet. Cabinet leakage shall not exceed 1% of total airflow when tested at 3 times the minimum external static pressure provided in AHRI Standard 210/240.Panel deflection shall not exceed L/240 ratio at 125% of design static pressure, at a maximum 8 inches of positive or negative static pressure, to reduce air leakage. Deflection shall be measured at the midpoint of the panel height and width. Continuous sealing shall be included between panels and between access doors and openings to reduce air leakage. Piping and electrical conduit through cabinet panels shall include sealing to reduce air leakage.

.3 Paint finish shall be capable of withstanding at least 2500 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B 117-95 test procedure. Unit exterior shall be “Grey” in color.

.4 The unit roof shall be sloped or cross-broken to assure drainage.

.5 Access to filters, blower, heating section, cooling section, and other items needing periodic checking or maintenance shall be through hinged, double walled access doors with quarter turn lever handles with ability to lock. Units shall have full-length stainless steel hinges and full perimeter gasketting. Air side service access doors shall have rain break overhangs. Temporary shipping fasteners through doors to be retained and used to secure doors closed.

.6 All openings through the base pan of the unit shall have upturned flanges of at least 1/2” in height around the opening through the base pan.

.7 Cabinet walls, access doors, roof and floors shall be constructed of a 2” thick high performance composite panel with G90 galvanized steel on both sides, a thermal break, and a closed cell polyurethane foam interior core providing a rigid, impact resistant surface. Unit insulation shall be minimum density of 2 pounds/cubic foot and have a minimum R-value of 13.

.8 Unit base shall be insulated.

.9 Each compartment of the unit shall have instrument test ports through the casing accessible from the outside. Test ports shall be sized to allow access to the air stream with a pitot tube or velometer. Provide standard factory supplied neoprene plugs for test ports.

2.3 Fans

.1 Supply fans shall be direct drive plenum type. Power exhaust and ERV exhaust fans shall be direct drive. Fans shall have all aluminum construction

.2 Fans attached to 1760 rpm motors shall be rated for a minimum of 1800 RPM maximum speed. Fans attached to 1170 rpm motors shall be rated for a minimum of 1200 RPM maximum speed.

.3 Fans and motors shall be dynamically balanced. Supply fan assemblies shall be mounted on Rubber in Shear isolators.

.4 Supply and return air connections shall be from the bottom of the unit.

.5 Motors shall be premium efficiency. Motors for use with VFD shall be premium efficiency inverter rated only. Motor bearings shall be ball bearing and shall have external lubrication connections. Ball bearings shall be rated for 200,000 hours.

.6 Direct drive fans shall be complete with VFD drives and shall be factory mounted and wired to the fan motors.

.7 VFD shall accept a 0-10Vdc signal from the BAS.

2.4 Filters

.1 The filter section shall be supplied complete with galvanized steel filter racks as an integral part of the unit. Filters shall slide out from a side access door. The filter section shall be provided with 2" 30% MERV- 8 efficient filters. Specified filter areas are minimum acceptable. Provide one (1) spare set of filters.

.2 Provide magnehelic pressure gauges with clogged filter switch for each filter bank. Magnehelic differential pressure gauges shall be complete with analog display. Clogged filter switch shall have dry contact output signal suitable for tie-in to BAS. Mount gauges in control compartment and provide factory mounted probes. Gauges shall be rated for temperature conditions within control compartment.

2.5 Outside Air

.1 Unit shall include 0-100% economizer consisting of a motor operated outside air damper and return air damper assembly constructed of extruded aluminum, hollow core, airfoil blades with rubber edge seals and aluminum end seals.

.2 Damper blades shall be gear driven and designed to have no more than 15 CFM of leakage per sq. ft. of damper area when subjected to 2 inches w.g. air pressure differential across the damper.

.3 Damper assembly shall be controlled by spring return DDC actuator. Unit shall include outside air opening bird screen, outside air hood with rain lip and barometric relief dampers.

2.6 Gas Heating Section

.1 Unit shall be provided with a High Turndown Modulating Natural Gas Furnace consisting of a stainless steel heat exchanger with multiple concavities, an induced draft blower and an electric pressure switch to lockout the gas valve until the combustion chamber is purged and combustion air flow is established. Furnace shall be equipped with modulating gas valves, adjustable speed combustion blowers, stainless steel tubular heat exchangers, and electronic controller. Combustion blowers and gas valves shall be capable of modulation.

Gas heater shall be capable of capacity turndown ratio as shown on the unit rating sheet and schedules.

.2 Furnace shall include a gas ignition system consisting of an electronic igniter to a pilot system, which will be continuous when the heater is operating, but will shut off the pilot when heating is not required.

.3 Electronic controller includes a factory wired, field installed supply air temperature sensor. Sensor shall be field installed in the supply air ductwork. Supply air temperature setpoint shall be adjustable on the electronic controller within the controls compartment.

.4 Heat trace shall be included on the condensate drain.

.5 Modulating gas burner shall be complete with an integral temperature controller and shall accept a 0-10V DC reset signal from the BAS to reset the supply air temperature from 50°F to 100°F.

.6 Unit shall have gas supply piping entrances in the unit base for through the curb gas piping and in the outside cabinet wall for across the roof gas piping.

2.7 Cooling Coils

.1 Evaporator Coils

.1 Coils shall be designed for use with R-410A refrigerant and constructed of copper tubes with aluminum fins mechanically bonded to the tubes and aluminum end casings. Fin design shall be sine wave rippled.
.2 Coils shall be furnished with factory installed thermostatic expansion valves.
.3 Drain pans shall be stainless steel.

.2 Refrigeration System

.1 Unit shall be factory charged with R-410A refrigerant.
.2 Compressors shall be scroll type with thermal overload protection and carry a 5 year non-prorated warranty, from the date of original equipment shipment from the factory.
.3 Compressors shall be mounted in an isolated service compartment which can be accessed without affecting unit operation. Lockable hinged compressor access doors shall be fabricated of double wall, rigid polyurethane foam injected panels to prevent the transmission of noise outside the cabinet.
.4 Compressors shall be isolated from the base pan with the compressor manufacturer's recommended rubber vibration isolators, to reduce any transmission of noise from the compressors into the building area.
.5 Each refrigeration circuit shall be equipped with automatic reset low pressure and manual reset high pressure refrigerant safety controls, Schrader type service fittings on both the high pressure and low pressure sides and a factory installed replaceable core liquid line filter driers.
.6 Lead circuit shall be a modulating digital scroll compressor to allow capacity control from 10% to 100% based on a 1-5V signal from the BAS system.
.7 Provide compressor blankets.

.3 Condensers – Air-Cooled

.1 Condenser fans shall be a vertical discharge, axial flow, direct drive fans.
.2 Coils shall be designed for use with R-410A refrigerant.
.3 Condenser coils shall be multi-pass and fabricated from aluminum microchannel tubes.
.4 Coils shall be designed for a minimum of 10°F of refrigerant sub-cooling.

.5 Condenser fans shall be variable speed high efficiency electrically commutated or VFD motor driven. Condenser airflow shall continuously modulate based on head pressure and cooling operation shall be allowed down to 35°F with adjustable compressor lockout. Alternatively, condenser fans shall have multiple speeds which are controlled with a fan cycle switch based on head pressure and allow matching condenser airflow with cooling capacity steps.

.6 Low ambient control.

2.8 Damper Actuators

.1 Provide electric actuators of the enclosed reversible gear drive type that can accept modulating control signals as required. Actuators using balance relays or mechanical travel limiting switches are not acceptable.

.2 Provide damper actuators that develop sufficient force to maintain damper rated leakage characteristics. Supply actuator with limit switch for position proving as required in sequence of operation.

2.9 Field Installed DDC Controls by Others

.1 Controls shall be field provided and field installed by others.

.2 Manufacturer shall wire all unit controls to a terminal block for connection by the BAS contractor.

.3 Refer to Controls Schematics on drawings.

2.10 Variable Frequency Drives

.1 Provide fully programmable digital type variable frequency AC drives (VFD) for the control of the fan motor(s). Enclose drives in NEMA 1 enclosures installed within the unit. Provide input line fuses and disconnect switch. VFD enclosure shall be maintained above 0°C for proper operation.

.2 VFD shall be totally digital pulse width modulated (PWM) type utilizing insulated gate bipolar transistors (IGBT's) in the inverter section of the drive. VFD shall accept AC line voltage variation of +10%, -15%.

.3 VFDs shall provide the following protection:

.1 Line over and under voltage protection
.2 Phase loss protection
.3 Phase unbalance protection
.4 Inherent short circuit protection for line to line and line to ground faults
.5 Electronic instantaneous overcurrent protection
.6 Current limit adjustable between 25% and 120%
.7 Internal over temperature protection
.8 Electronic motor stall protection

.4 VFD shall have minimum 97% efficiency at maximum load and speed, minimum line side displacement power factor of 0.96 at all speeds, separately adjustable acceleration and deceleration ramps and separately adjustable minimum and maximum frequency range from 0 to 120 Hz.

.5 VFD shall be capable of starting with the fan already rotating by starting the motor at the speed the fan is operating at and then changing to the speed called for by the unit controller. Provide auto re-start after power interruption.

.6 Provide unit-mounted 32 character display control pads on each drive to monitor and adjust VFD parameters. Provide an additional main control pad in the rooftop control section outside of the airstream for monitoring and adjusting both the supply and return fan VFD.

.7 VFD's shall include remote enable/disable contacts, alarm relay, 4 to 20 mA control signal input and local/remote control.

2.11 Options

.1 Unit shall be provided with a factory installed and wired disconnect. Disconnect to be internal where unit configuration permits.

.2 Unit shall be provided with a 20AMP 115V GFCI receptacle. Receptacle shall be field wired and powered.

.3 Unit shall be provided with phase and brownout protection.

.4 Unit shall be provided with remote safety shutdown contacts.

.5 Units shall be provided with powered exhaust

2.12 Roof Curb

.1 Each unit shall be provided with a prefabricated galvanized steel mounting curb designed and manufactured by the unit manufacturer, for field assembly on the roof decking prior to unit shipment.

.2 The roof curb shall be a perimeter type with complete perimeter support of the air handling section. The curb shall be a minimum of 24 inches high, or as specified on the drawings, and include a nominal 2 x 4-inch wood strip. Curb shall include vertical discharge for supply air and vertical discharge for return air. The curb shall be designed with curb area (except supply air section) as a plenum for return air where required or noted.

.3 The roof curb shall be approved by the National Roofing Contractors Association.

.4 The roof curb shall be designed and sized to allow for all necessary offsets and transitions required to tie the new roof top unit into the existing ductwork below while maintain the required unit clearances. Curb shall include plenum for return air where required or noted.

.5 Unit supplier and contractor shall site verify all curb dimensions prior to submitting shop drawings.

.6 Gasketing shall be provided for field mounting between the unit base and roof curb.

2.13 Startup Service and Warranty

.1 Manufacturer shall furnish a factory trained service technician to perform the unit startup.

.2 Contractor and manufacturer shall provide instruction and demonstration to the owner's personnel on the operation and maintenance of the unit.

.3 The warranty period shall commence at the date of initial startup and shall continue for a period of one (1) year not to exceed eighteen (18) months from shipment. Manufacturer's warranty shall include all parts and labour to install parts.

.4 Perform two (2) separate start-ups and demonstrations for heating and cooling.

2.14 Spare Parts

.1 Supply one (1) complete set of spare belts and filters for all units.

**PART 3 - EXECUTION**

3.1 Installation

.1 Hoist and install units in full accordance to the manufacturer's instructions, generally accepted practice and all applicable codes.

.2 Ensure new structural steel is in place for new units.

.3 Install units flat and level in accordance with manufacturer's installation literature. Install gasketting between unit base rails and curb.

.4 Provide new insulation on the new roof curb side wall. The minimum standard of acceptance will be 32mm (1¼") thick rigid foam insulation with an insulation value of 7.5 deg F/sq.ft./ hr/btu R). Fill inside curb cavity with Roxul insulation. Contractor shall provide a picture of the completed and insulated curb before installation of unit.

.5 Coordinate flashing and counter flashing with Roofing Contractor.

.6 Provide flange gasket material to perfectly seal ducts to rooftop unit. Provide caulking and sealing material to create weather proof fittings.

.7 Contact Consultant for inspection of duct terminations and insulation prior to placing rooftop equipment. All duct flanging, gasketting systems and insulation must be inspected or equipment will be removed for specified inspection.

.8 Install and wire all control accessories and power wiring to the unit. Coordinate with Division 26 for all power wiring 120V and over.

.9 Provide drain pipe complete with trap for the unit. Drain shall terminate beyond roofcurb. Provide extension for adapter curbs as required.

.10 The Contractor shall clean or replace filters prior to turning the building over to the owner.

.11 Temporary shipping fasteners through doors to be retained and used to secure doors closed.

3.2 Start-Up and Demonstration

.1 Perform start-up using a manufacturer's factory trained service technician.

.2 Provide training and demonstration to the owner's personnel on the operation and maintenance of the unit. Factory technician to be present with the Mechanical Contractor.

.3 Perform two (2) separate start-ups and demonstrations for heating and cooling within the applicable seasons to suit the required outdoor air temperature even if outside overall project schedule. In general, cooling start-ups shall be done when outdoor air is greater than 15C and heating start-ups shall be done when outdoor air is less than 15C, however temperatures should be confirmed with equipment manufacturers.

.4 A start-up report shall be submitted to the Engineer, signed and dated by the Technician.

.5 Temporary shipping fasteners through doors to be retained and used to secure doors closed.

3.4 Spare Parts

.1 Turn over one (1) complete set of belts and filters to Owner upon completion of work prior to substantial completion.

END OF SECTION

## PART 1 - GENERAL

1.1 Quality Assurance

.1 Terminal heat transfer units shall be products of manufacturer regularly engaged in production of such units who issues complete catalogue data on such products.

.2 Fans rated in accordance with AMCA.

.3 One year warranty.

1.2 Submittals

.1 Submit certified performance data, water flow, pressure drop, suspension method, weight, fan power, fan performance, electrical characteristics.

.2 Site measurements and final unit lengths for perimeter radiation shall be included with the shop drawings. Shop drawings will not be accepted without this schedule.

1.3 Acceptable Manufacturers

.1 Sigma

.2 Engineered Air

.3 Trane

## PART 2 - PRODUCTS

2.1 Radiant Baseboard Heaters / Wallfin

.1 All heating elements shall be copper/aluminum manufactured with seamless copper tubing mechanically expanded into the diameter of the equally spaced aluminum fins. The element shall be swaged one end.

.2 All partial backplates are to be machine roll formed, pre-painted, 20 gauge steel with formed mounting channel into which the enclosure shall self-locate and secure.

.3 All brackets and hangers are to be die-formed 14 gauge galvannealed steel with channel type construction for rigidity. Brackets are to have pre-formed contour at the top allowing the bracket to interlock with the backplate channel. Brackets are to be self-locating in the vertical (height) position. Provide additional pipe hangers as required.

.4 Enclosures shall be finned-tube, sloped top, 24" high as shown on plans. Material shall be 16 gauge cold rolled steel with baked primer and finished painting. Colour to be confirmed – submit colour chart with shop drawings. Air discharge and/or inlet louvers are to be stamped, "pencil proof." Welded male and female slip joints are to be provided at each end to allow for positive engagement and alignment of adjoining enclosures

2.2 Force Flow Heaters

.1 Provide inverted wall type so air flows in top front and out bottom front.

.2 Cabinet: Heavy 16 gauge furniture steel with removable fronts to provide easy access to motor, blower and heating element. The cabinets shall be rust proofed and finished with a prime coat and finished painting. Colour to be confirmed – submit colour chart with shop drawings. Finish with factory enamel finish.

.3 Coils: 5/8" O.D. seamless copper tubes expanded into aluminum fins to form a permanent mechanical bond.

.4 Blowers: Two (2) double inlet type centrifugal aluminum fans mounted directly on a double ended motor shaft.

.5 Motors: Permanent split capacitor type. Steel shell, die cast aluminum shields, galvanized steel cradle. Resilient mount. Self-aligning sleeve bearings, horizontal mount, class "B" insulation, thermally protected. Windings are "tropical impregnated" for high humidity areas. Thoroughly tested to provide whisper quiet performance with speed variations from high to low.

.6 Filters: Removable type.

.7 Access Door: Provided with camlock fastener for easy access to controls.

.8 Piping: Space provided in cabinet for all piping connections to be made inside the cabinet.

.9 Speed switch: Solid state three speed control with off position.

2.3 Convectors

.1 Heating Elements: Seamless copper tubing mechanically expanded into evenly spaced aluminum fins and cast iron headers, steel side plates and supports, factory air pressure tested at 100 psi under water and means of adjusting pitch of element.

.2 Cabinet: 16 gauge steel front and top, 18 gauge steel back and ends, exposed corners rounded, easily secured removable front panel, adequately braced and reinforced for stiffness with baked primer and finished painting. Colour to be confirmed – submit colour chart with shop drawings

2.4 Unit Heaters

.1 Casing: High quality, heavy gauge, die formed, cold rolled steel with threaded connections for hanger rods.

.2 Finish: Sheet metal chemically degreased, phosphatized and etched. Semi-gloss "grey" paint finish.

.3 Coils: Steel pipe headers, copper tubes, ribbed aluminum plate fins. All coils tested at 200 psig air pressure under water.

.4 Fans: Aluminum blades. Sturdy, balanced, efficient and quiet.

.5 Motors: Totally enclosed, tested, thermally protected, permanently lubricated for a minimum of 20,000 hours.

.6 Motor Mounts: Rugged, corrosion resistant, resiliently mounted.

.7 Air Outlet: Louvre fin diffusers shall have individually adjustable blades for maximum air distribution flexibility.

.8 Controls: Provide required relays for low voltage tie in by BAS.

**PART 3 - EXECUTION**

3.1 Installation

.1 Install all units as per manufacturers recommendations.

.2 Provide each unit with shutoff valve and other accessories as per details on drawings.

.3 Provide each unit with easily accessible automatic air vent at high point. If not easily accessible, extend vent to exterior surface of cabinet for easy servicing.

.4 Confirm mounting type with Architectural Drawings and General Contractor.

3.2 Radiant Baseboard Heaters / Wallfin

.1 Site measure for each section before fabrication and installation to confirm site conditions and ensure a correct fit to all components. Site measurements and final unit lengths shall be included with the shop drawings.

.2 Coordinate mounting detail with units to ensure a flush finish on the top.

.3 Submit detail drawings for review.

.4 Supply and install all piping and piping accessories as shown on the plans and details.

3.3 Unit Heaters

.1 Suspend unit heaters from “speed grip nut” using rod.

END OF SECTION

## PART 1 - GENERAL

1.1 Quality Assurance

.1 Terminal heat transfer units shall be products of manufacturer regularly engaged in production of such units who issues complete catalogue data on such products.

.2 One year warranty.

1.2 Submittals

.1 Submit certified performance data, water flow, pressure drop.

## PART 2 – PRODUCTS

2.1 Reheat Coils

.1 Primary surface of round, seamless copper tubes suitable for 250 PSIG and 300°F working conditions.

.2 Secondary surface shall consist of aluminum plate type fins contoured for maximum heat transfer. Draw full collars from the fins to provide continuous surface cover over the entire tube. Mechanically expand the tubes into the fins. Ensure the fins are continuous across the coil section and ensure no air bypass.

.3 Construct flanged casing of galvanized steel.

.4 Headers of seamless copper tubing complete with steel stub outs with MPT connections and drain and vent fittings.

.5 Do not exceed fin density, tube length, air pressure drop, or water pressure drop scheduled.

.6 Certify coils according to ARI Standard 410.

.7 Select coils ensuring no water carry over.

.8 Circuit coils for drainability without removing plugs from each tube.

.9 Pressure test coils at 125% of design pressure with compressed air under water.

.10 Supply booster coils with flanges for slip and drive fasteners.

.11 Acceptable Manufacturers:

.1 McQuay
.2 Carrier
.3 Trane

## PART 3 - EXECUTION

3.1 Mock-Up

.1 Mock-ups of 3-way and 2-way control valve piping arrangements to be provided for review.

3.2 Installation

.1 Install coils as per manufacturer's requirements and recommendations.

.2 Installation shall ensure reheat coils are readily accessible.

.3 Contractor shall coordinate handing of coil connections.

.4 Provide duct transitions for reheat coils as required.

.5 Provide access door in ductwork both upstream and downstream of reheat coil. Access doors to be minimum 450mm (18") long and as wide as possible. Refer to detail on drawings.

.6 Provide each unit with isolation ball valve, circuit balancing valve, control valve, and all other accessories and components as per details on drawings.

.7 Provide each unit with easily accessible automatic air vent at high point.

END OF SECTION

## PART 1 - GENERAL

1.1 References

.1 UL 508

.2 NEC

1.2 Quality Assurance

.1 To ensure quality and minimize infantile failures at the jobsite, the complete VFD shall be tested by the manufacturer. The VFD shall operate a dynamometer at full load and the load and speed shall be cycled during the test.

.2 All optional features shall be functionally tested at the factory for proper operation.

1.3 Submittals

.1 Shop drawings must be submitted and reviewed by the Consultant prior to the contractor ordering or shipping any subject equipment. Payments will not be processed for equipment not properly documented and reviewed under the terms of submittal.

.2 Submit manufacturer's performance data including dimensional drawings, power circuit diagrams, installation and maintenance manuals, warranty description, VFDs FLA rating, certification agency file numbers and catalog information.

.3 The specification lists the minimum VFD performance requirements for this project. Each supplier shall list any exceptions to the specification. If no departures from the specification are identified, the supplier shall be bound by the specification.

.4 Submit a Harmonic Distortion Analysis for the jobsite location.

.5 Harmonic filtering. The seller shall, with the aid of the buyer's electrical power single line diagram, providing the data required by IEEE-519, perform an analysis to initially demonstrate the supplied equipment will meet the IEEE standards after installation. If, as a result of the analysis, it is determined that additional filter equipment is required to meet the IEEE recommendations, then the cost of such equipment shall be included in the bid. A harmonic analysis shall be submitted with the approval drawings to verify compliance with the latest version of IEEE-519 voltage and current distortion limits as shown in table 10.2 and 10.3 at the point of common coupling (PCC). The PCC shall be defined as the consumer-utility interface or primary side of the main distribution transformer.

1.4 Warranty

.1 The VFD shall be warranted by the manufacturer for a period of 36 months from date of shipment. The warranty shall include parts, labor, travel costs and living expenses incurred by the manufacturer to provide factory authorized on-site service. The warranty shall be provided by the VFD manufacturer.

1.5 Acceptable Manufacturers:

.1 Danfoss/Graham VLT 6000 Series

.2 ABB

**PART 2 - PRODUCTS**

2.1 For pump variable frequency drives, refer to Section 23 21 23. Pump variable frequency drives shall be supplied by pump manufacturer.

2.2 Furnish complete variable frequency drives as specified herein for the fans designated on the drawing schedules to be variable speed. All standard and optional features shall be included within the VFD enclosure, unless otherwise specified. VFD shall be housed in a metal NEMA 1 enclosure, or other NEMA type according to the installation and operating conditions at the job site.

2.3 The VFD shall convert incoming fixed frequency three-phase AC power into a variable frequency and voltage for controlling the speed of three-phase AC motors. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for fan control and to negate the need for motor derating.

2.4 With the motor's rated voltage applied to the VFD input, the VFD shall allow the motor to produce full rated power at rated amps, RMS fundamental volts, and speed without using the motor's service factor. VFDs utilizing sine weighted/coded modulation (with or without 3rd harmonic injection) must provide data verifying that the motors will not be overloaded under operating conditions.

2.5 The VFD shall include input disconnect and main fuses.

2.6 The VFD shall include a full-wave diode bridge rectifier and maintain a fundamental power factor near unity regardless of speed or load.

2.7 The VFD and options shall be tested to ANSI/UL Standard 508. The complete VFD, including all specified options, shall be assembled by the manufacturer, which shall be UL-508 certified for the building and assembly of option panels. Local representative panel shop assembly for option panels is not acceptable. The appropriate UL stickers shall be applied to both the drive and option panel, in the case where these are not contained in one panel. When these drives are to be located in Canada, the CSA or C-UL certifications shall apply. Both drive and option panel shall be manufactured in ISO 9001 certified facilities.

2.8 The VFD shall have DC link reactors on both the positive and negative rails of the DC bus to minimize power line harmonics. VFDs without DC link reactors shall provide a minimum 5% impedance line reactor.

2.9 The VFD's full load amp rating shall meet or exceed NEC Table 430-150. The VFD shall be able to provide full rated output current continuously, 110% of rated current for 60 seconds and 160% of rated current for up to 0.5 second while starting.

2.10 The VFD shall be able to provide full torque at any selected speed up to base speed to allow driving direct drive fans without derating.

2.11 An automatic energy optimization selection feature shall be provided standard in the drive. This feature shall automatically and continually monitor the motor's speed and load and adjust the applied voltage to maximize energy savings and provide a 3% to 10% additional energy savings.

2.12 Input and output power circuit switching can be done without interlocks or damage to the VFD.

2.13 An automatic motor adaptation test algorithm shall measure motor stator resistance and reactance to optimize performance and efficiency. It shall not be necessary to run the motor or decouple the motor from the load to run the test.

2.14 Galvanic and/or optical isolation shall be provided between the drive's power circuitry and control circuitry to ensure operator safety and to protect connected electronic control equipment from damage caused by voltage spikes, current surges, and ground loop currents. Drives not including

isolation on both analog I/O and discrete I/O shall include additional isolation modules.

2.15 VFD shall minimize the audible motor noise through the use of an adjustable carrier frequency. The carrier frequency shall be automatically adjusted optimizing motor and drive efficiencies while reducing motor noise. Drives not incorporating this feature shall have a fixed carrier frequency above 10 kHz without output current derating or reduced motor performance.

2.16 Protective Features

.1 A minimum class 20 $I^2t$ electronic motor overload protection for single motor applications and thermal-mechanical overloads for multiple motor applications shall be provided.

.2 Protection against input transients, loss of AC line phase, short circuit, ground fault, overvoltage, undervoltage, drive overtemperature and motor overtemperature. The VFD shall display all faults in plain English. Codes are not acceptable.

.3 Protect VFD from sustained power or phase loss. The VFD shall provide full rated output with an input voltage as low as 90% of the nominal. The VFD will continue to operate with reduced output with an input voltage as low as 164 volts for 208/230 volt units.

.4 The VFD shall incorporate a motor preheat circuit to keep the motor warm and prevent condensation build up in the stator.

.5 Drive package shall include semi-conductor rated input fuses to protect power components.

.6 To prevent breakdown of the motor winding insulation, the drive shall be designed to comply with IEC Part 34-17. Otherwise the drive manufacturer must ensure that inverter rated motors are supplied.

.7 Drive shall include a “signal loss detection” circuit to sense the loss of the control signal, and shall be programmable to react as desired in such instance.

.8 Drive shall function normally when the keypad is removed while the drive is running and continue to follow remote commands. No warnings or alarms shall be issued.

.9 Drive shall catch a rotating motor operating forward or reverse up to full speed.

.10 VFD shall be rated for 100,000 amp interrupting capacity (AIC).

.11 Drive shall include current sensors on all three output phases to detect and report phase loss to the motor. The VFD will identify which of the output phases is low or lost.

.12 Drive shall continue to operate without faulting until input voltage exceeds 300 volts on 208/230 volt drives.

2.17 Interface Features

.1 Hand/Start, Off/Stop and Auto/Start selector switches shall be provided to start and stop the drive and determine the speed reference.

.2 Provide a 24 V DC output signal to indicate that the drive is in Auto/Remote mode.

.3 Digital manual speed control. Potentiometers are not acceptable.

.4 Lockable, alphanumeric backlit display keypad can be remotely mounted up to 10 feet away using standard 9-pin cable.

.5 All keypads shall be identical and interchangeable.

.6 To setup multiple drives, it shall be possible to upload all setup parameters to the drive's keypad, place that keypad on all other drives in turn and download the setup to each drive.

.7 Display shall be programmable to display in 9 languages including English, Spanish and French.

.8 The display shall have four lines, with 20 characters on three lines and eight large characters on one line.

.9 A red FAULT light, a yellow WARNING light and a green POWER-ON light shall be provided. These indications shall be visible both on the keypad and on the drive when the keypad is removed.

.10 A quick setup menu with factory preset typical HVAC parameters shall be provided on the drive eliminating the need for macros.

.11 The drive shall be fitted with an RS 485 serial communications port and be supplied with Windows® compatible software to display all monitoring, fault, alarm and status signals. The software shall allow parameter changes to be made to the drive settings, as well as storage of each controller's operating and setup parameters, and remote operation of the drive. The same software shall be used throughout the entire product range.

.12 As a minimum, the following points shall be controlled and/or accessible:

- .1 Drive start/stop
- .2 Speed reference
- .3 Fault diagnosis
- .4 Meter points
  - .1 Motor power in kW
  - .2 Motor power in HP
  - .3 Motor kW/hr
  - .4 Motor current
  - .5 Motor voltage
  - .6 Hours run
  - .7 Feedback signal #1
  - .8 Feedback signal #2
  - .9 DC link voltage
  - .10 Thermal load on motor
  - .11 Thermal load on drive
  - .12 Heatsink temperature

.13 Two set-point control interface (PID control) shall be standard in the unit. Drive shall be able to look at two feedback signals, compare with two set-points and make various process control decisions.

.14 The sleep mode shall be functional in both follower mode and PID mode.

.15 Floating point control interface shall be provided to increase/decrease speed in response to switch closures.

.16 Four simultaneous displays shall be available. They shall include frequency or speed, run time, output amps and output power. Drives unable to show these four displays simultaneously shall provide panel meters.

.17 Sleep mode shall be provided to automatically stop the drive when speed drops below set "sleep" level for a specified time. Drive automatically restarts when speed command exceeds set "wake" level.

.18 Run permissive circuit shall be provided to accept a "system ready" signal to assure that the

drive does not start until dampers or other auxiliary equipment are in the proper state for drive operation. The run permissive circuit shall also be capable of sending an output signal as a start command to actuate external equipment before allowing the VFD to start.

.19 An elapsed time meter and kWh meter shall be provided.

.20 The following displays shall be accessible from the control panel in actual units: Reference Signal Value in actual units, Output Frequency in Hz or percent, Output Amps, Motor HP, Motor kW, kWhr, Output Voltage, No Load Warning, DC Bus Voltage, Drive Temperature in degrees, and Motor Speed in engineering units per application (in percent speed, GPM, CFM,...). Drive will read out the selected engineering unit either in a linear, square or cubed relationship to output frequency as appropriate to the unit chosen.

.21 The display shall be programmed to read in inches of water column (in-wg) for an air handler application, pressure per square inch (psi) for a pump application and temperature (°F) for a cooling tower application.

.22 Four meter displays can be shown at once on the display. This allows the actual value of the follower signal to be shown simultaneously with the drive's response to that signal for ease in commissioning.

.23 Drive will sense the loss of load and signal a no load/broken belt warning or fault.

.24 If the temperature of the drive's heat sink rises to 80°C, the drive shall automatically reduce its carrier frequency to reduce the heat sink temperature. If the temperature of the heat sink continues to rise, the drive shall automatically reduce its output frequency to the motor. As the drive's heat sink temperature returns to normal, the drive shall automatically increase the output frequency to the motor and return the carrier frequency to it's normal switching speed.

.25 The VFD shall have temperature controlled cooling fans for quiet operation and minimized losses.

.26 The VFD shall store in memory the last 20 faults and record all operational data.

.27 Eight programmable digital inputs shall be provided for interfacing with the systems control and safety interlock circuitry.

.28 Two programmable relay outputs, one Form C 240 V AC, one Form A 50 V AC, shall be provided for remote indication of drive status.

.29 Two programmable analog inputs shall be provided and shall accept a direct-or-reverse acting signal. Analog reference inputs accepted shall include 0-10 V dc, 0-20 mA and 4-20 mA.

.30 Two programmable 0 to20 mA analog outputs shall be provided for indication of drive status. These outputs shall be programmable for output speed, voltage, frequency, amps and input kW.

.31 Under fire mode conditions the VFD shall automatically default to a preset speed.

2.18 Adjustments

.1 VFD shall have an adjustable carrier frequency in steps of not less than 0.1 kHz to allow tuning of drive to motor.

.2 Sixteen preset speeds shall be provided.

.3 Four acceleration and four deceleration ramps shall be provided. Accel and decel time shall be adjustable over the range from 0 to 3,600 seconds to base speed. The shape of these curves may be automatically contoured to prevent tripping.

.4 Four current limit settings shall be provided.

.5 If the VFD trips on one of the following conditions, the VFD shall be programmable for automatic or manual reset: undervoltage, overvoltage, current limit, inverter overload and motor overload.

.6 The number of restart attempts shall be selectable from 0 through 20 and the time between attempts shall be adjustable from 0 through 600 seconds.

.7 An automatic "on delay" may be selected from 0 to 120 seconds.

2.19 Bypass

.1 Provide a manual 3-contactor bypass consisting of a door interlocked main fused disconnect padlockable in the off position, a built-in motor starter and a four position DRIVE/OFF/LINE/TEST switch controlling three contactors. In the DRIVE position, the motor is operated at an adjustable speed from the drive. In the OFF position, the motor and drive are disconnected. In the LINE position, the motor is operated at full speed from the AC power line and power is disconnected from the drive so that service can be performed. In the TEST position, the motor is operated at full speed from the AC line power. This allows the drive to be given an operational test while continuing to run the motor at full speed in bypass. Customer supplied normally closed dry contact shall be interlocked with the drives safety trip circuitry to stop the motor whether in DRIVE or BYPASS mode in case of an external safety fault.

.2 Service personnel shall be able to defeat the main power disconnect and open the bypass enclosure without disconnecting power This shall be accomplished through the use of a specially designed tool and mechanism while meeting all local and national code requirements for safety.

.3 Smoke purge circuitry shall be interconnected such that an external dry contact can be used in both drive and bypass mode.

2.20 Service Conditions

.1 Ambient temperature, -10 to 40°C (14 to 104°F).

.2 0 to 95% relative humidity, non-condensing.

.3 Elevation to 3,300 feet without derating.

.4 AC line voltage variation, -10 to +10% of nominal with full output.

.5 No side clearance shall be required for cooling of any units. All power and control wiring shall be done from the bottom.

**PART 3 - EXECUTION**

3.1 Start-up Service

.1 The manufacturer shall provide start-up and commissioning of the variable frequency drive and its optional circuits by a factory certified service technician who is experienced in start-up and repair services. The commissioning personnel shall be the same personnel that will

provide the factory service and warranty repairs at the customer's site. Sales personnel and other agents who are not factory certified technicians for VFD field repair shall not be acceptable as commissioning agents. Start-up services shall include checking for verification of proper operation and installation for the VFD, its options and its interface wiring to the building automation system. Start-up shall include customer operator training at the time of the equipment commissioning.

3.2 Examination

.1 Contractor to verify that job site conditions for installation meet factory recommended and code-required conditions for VFD installation prior to start-up, including clearance spacing, temperature, contamination, dust, and moisture of the environment. Separate conduit installation of the motor wiring, power wiring, and control wiring, and installation per the manufacturer's recommendations shall be verified.

.2 The VFD is to be covered and protected from installation dust and contamination until the environment is cleaned and ready for operation. The VFD shall not be operated while the unit is covered.

END OF SECTION

## PART 1 - GENERAL

### 1.1 Instructions to Bidders

.1 The Electrical Supplementary Bid Form must be uploaded to the Bidding System. Electrical Contractors shall identify all sub-contractors they intend to use and must complete all information requested. Contractor shall sign and date the last page and initial and date all other pages.

.2 Should the Electrical Supplementary Bid Form not be submitted then the Contractor shall use Base Bid Manufacturers as listed.

.3 The Stipulated Bid Sum shall be for the base bid manufacturer or supplier equipment only, unless otherwise indicated. Where a choice of this equipment is given, this Contractor shall indicate the supplier or manufacturer they intend to use. Where no choice is indicated, the base bid supplier or equipment shall be used.

.4 Equipment or materials manufactured by firms named in the following listing only shall be deemed equal to the equipment or material specified provided the equipment or material will have capacity, performance, rating, construction, physical dimensions, accessories and features which, in the opinion of the Consultant, are equal to those of the specified equipment or material. The Electrical Contractor shall not indicate equipment, materials or suppliers which are not listed.

.5 Where modification to the work of other trades are not required as a result or part of the alternative offered, include the cost of said modifications in the work.

### 1.2 Electrical Tender Price (Excluding HST)

.1 Having carefully examined all Drawings and Specifications and the Addenda to the Drawings and Specifications, and having carefully examined the sites and all conditions affecting the work, we, the undersigned thereby offer to provide all plant, labour, materials and incidentals required to complete the work for the Total Stipulated Price of:

$ _____

_____
(in writing)

in lawful money of Canada; included in which are all applicable P.S.T., and excise taxes, custom duties, freight, exchange, and all other charges. H.S.T. is not included.

### 1.3 Unit Prices

The unit prices will be used for additions and deletions to the Contract and shall include all material, labour, profit, overhead and taxes for a job completely installed. Credit rate for deletions shall be at 80%.

.1 Luminaires

Supply and installation of the following luminaires. The supply and installation of luminaires shall include the fixtures, flexible conduit, wiring and connection to nearest outlet box containing 120 volt circuit. (Base conduit and wiring on 4500mm length).

.1 Supply and installation of one Luminaire, Type 'A' or equal $ _____

.2 Supply and installation of one Luminaire, Type 'B' or equal $ _____

.3 Supply and installation of one Luminaire, Type 'C' or equal $ _____

.4 Supply and installation of one Luminaire, Type 'S1' or equal $ _____

.5 Supply and installation of one Luminaire, Type 'S2' or equal $ _____

.2 Receptacles

Supply and installation of one duplex receptacle, shall include the receptacle box, cover plate, 5000mm of conduit and wiring, including connection to adjacent receptacle and/or outlet box.

.1 Supply and installation of one duplex receptacle. $ _____

.3 Light Switches

Supply and installation light switch shall include the switch box, cover plate, conduit, wiring and connection to box containing the lighting circuit.

.1 Supply and installation of one 120 volt light switch. $ _____

.2 Supply and installation of one 120 volt light dimmer switch. $ _____

.3 Supply and installation of one 120 volt switch plate sensor. $ _____

.4 Supply and installation of one occupancy sensor. $ _____

.4 Conduit and Cable

Supply and install the following conduit and cables including fastenings, clips, connectors, coupling boxes, etc.as required based on length as shown.

.1 25mm EC/3500mm Length $ _____

.2 2#12-12mm C/3500mm Length $ _____

.3 3#12-12mm C/3500mm Length $ _____

.4 2#10-19mm C/3500mm Length $ _____

.5 3#10-19mm C/3500mm Length $ _____

.6 3#8-19mm C/3500mm Length $ _____

.5 Fire Alarm System

.1 Supply and installation of one fire alarm pull station, including conduits, wiring and connections to the nearest fire alarm pull station. (Base conduit and wiring on 15m length.) $ _____

.2 Supply and installation of one fire alarm horn complete with strobe light including conduit, wiring and connections to nearest fire alarm signaling device. (Base conduit and wiring on 15m length.) $ _____

.3 Supply and installation of one strobe light Including conduit, wiring and connections to nearest fire alarm signaling device. (Base conduit and wiring on 15m length.) $ _____

.3 Supply and installation of one fire alarm horn complete with conduit, wiring and connections to nearest fire alarm signaling device. (Base conduit and wiring on 15m length.) $ _____

.4 Supply and installation of one fire detector complete with conduit, wiring and connections to nearest fire alarm initiating device. (Base conduit and wiring on 15m length.) $ _____

**1.4 Sub-Contractors**

.1 The Contractor shall state below the name of the Fire Alarm and Coordination Study he/she intends to use, which shall not be changed without the consent of the Consultant.

Fire Alarm System _____

Fire Alarm Supplier _____

Communication Contractor _____

Security Contractor _____

**1.5 Electrical Equipment List**

.1 Submit the following list of Base Bid and alternative suppliers in accordance with the bid requirements:

| Spec. Reference Section | Equipment | Base Bid | Acceptable Alternate Manufacturer or Supplier | Indicate Manufacturer or Supplier |
|---|---|---|---|---|
| 26 05 20 | Switches and Receptacles | Hubbell | Legrand<br>Leviton<br>Cooper | |
| 26 05 20 | Dimmer Switches | Leviton | Hubbell<br>Legrand<br>Lutron | |

Contractor Name:_____ Contractor Initial: _____ Date: _____

| | | | | |
|---|---|---|---|---|
| | | | Cooper | |
| 26 05 20 | Disconnect Switches | Eaton | Siemens<br>Schneider Electric | |
| 26 05 20 | Starters and Contactors | Eaton | Allen Bradley<br>Siemens<br>Schneider Electric | |
| 26 05 20 | Occupancy Sensors | Leviton | Hubbell<br>Wattstopper<br>Sensor Switch | |
| 26 24 00 | Service Entrance Board | Eaton | Siemens<br>Schneider Electric | |
| 26 24 00 | Panelboards | Eaton | Siemens<br>Schneider Electric | |
| 26 24 00 | Fuses – Low Voltage | Gould Shawmut | GEC<br>Littlefuse | |
| 26 24 00 | Molded Case Circuit Breakers | Eaton | Siemens<br>Schneider Electric | |
| 26 44 00 | Electric Heaters | Ouellet | Chromolox<br>Dimplex | |
| 26 45 00 | Hand Dryers | Nova | World Dryer | |
| 26 45 00 | Ceiling Fans | Air Pear | N/A | |
| 26 45 00 | Cable Tray | WBT | N/A | |
| 26 51 00 | Luminaires – Strips | Signify (Phillips) | Acuity<br>Visioneering<br>Peerless-Electric | |
| 26 51 00 | Luminaires – Troffers & Gym | Signify (Phillips) | Acuity<br>Visioneering<br>Columbia Lighting<br>Peerless-Electric | |
| 26 51 00 | Luminaires – Site | Signify (Phillips) | LSI<br>Acuity<br>Spaulding Lighting | |
| 26 51 00 | Luminaires – Down Lights | Signify (Phillips) | Acuity<br>Prescolite | |
| 26 52 00 | Emergency Lighting | Lumacell | EmergiLite<br>Beghelli<br>AimLite | |

**1.6 Labour Rates**

.1 The following labour rates shall apply for calculating the cost of credit or extras on Change Notices. The rates shall include any employee benefits. The labour rates do not include overhead and profit.

Superintendent $ _____ /hr

Journeymen _____ /hr

Other _____ /hr

Contractor Name:_____ Contractor Initial: _____ Date: _____

SUBMITTED BY:

I / We certify that I / We have the authority to bind the company:

| | |
|---|---|
| Name of Signing Officer(s) | SIGNATURE |
| Name of Signing Officer(s) | SIGNATURE |
| Telephone Number of Signing Officers | NAME OF COMPANY |
| | ADDRESS OF COMPANY |
| | HST REGISTRATION NUMBER |
| | CORPORATE SEAL |

END OF SECTION

## PART 1 - GENERAL

1.1 General Requirements

.1 The requirements of this section shall apply to all sections in Division 26 – Electrical.

.2 All material, labour, equipment, and services required under this section shall be the full responsibility of the Contractor including any material, labour, equipment, and services provided by their sub-contractors.

.3 Complete and submit the Supplemental Tender Form including list of equipment and materials to be used on this project and forming part of the tender documents.

1.2 Definitions

.1 "Supply" shall mean supply only.

.2 "Install" shall mean install and connect.

.3 "Provide" shall mean supply, install, connect and test.

.4 "Drawings and Specifications" shall mean Contract Documents.

.5 "Authorities" or Authorities having jurisdiction" shall mean all agencies that enforce the applicable laws, ordinances, rules, regulations, or codes of the Place of Work.

.6 "Work" shall mean all equipment, materials, labour, and permits to provide a complete and operational electrical system as detailed in the drawings and specifications.

.7 "Owner" or "KPRDSB" shall mean Kawartha Pine Ridge District School Board.

1.3 Related Work

.1 Division 1 – General

.2 Division 21 – Sprinkler

.3 Division 22 and 23 – Mechanical

.4 Division 26 specifications form a part of the Contract Documents and shall be read, interpreted, and coordinated with all other Divisions. The Instructions to Bidders, General Conditions, General Requirements, Supplementary General Conditions and Amendments and Supplements thereto form a part of this Division and contain items related to the electrical work.

1.4 Intent

.1 The drawings and specifications are not a detailed set of installation instructions. Drawings and specifications are complementary to one another and that which is shown on one is as binding as that which is shown on both.

.2 The Consultant shall be immediately informed of any discrepancies between drawings and specifications leaving in doubt the true intent of the work.

.3 Supply all labour, equipment, and materials necessary to install a complete and operational electrical system described herein and shown on the drawings.

.4 It is the intent of these drawings and specifications to provide for an electrical installation complete and in operating condition. The responsibility for supplying and installing all material necessary to accomplish this, except where specifically noted that such work or materials is not included, shall be part of this section.

.5 Assess and be familiar with existing site conditions prior to pricing and construction and allow for same in tender price.

.6 All work must be done by qualified and certified persons in such line of work. Trade certificates must be available on demand.

.7 All work shall be in accordance with standard industry practice accepted and recognized by the Consultant and the Trade.

.8 The Contractor shall coordinate with and cooperate with all other trades prior to installation. Where work interferes with other trades due to failure to coordinate or cooperate, the work shall be removed and relocated as approved by the Consultant at no extra cost to the Owner.

.9 The Consultant shall have the right to reject any work that does not conform to the Contract Documents and accepted standards of practice including but not limited to performance, quietness of operation, and finish.

.10 Responsibility to determine which Division provides various products and work rests with the Contractor. Additional compensation will not be considered because of differences in interpretation of specifications.

1.5 Codes, Bylaws, Standards, and Regulations

.1 The electrical system shall comply with the latest editions and revisions of applicable codes, bylaws, bulletins, standards, and regulations including but not limited to:

.1 Ontario Building Code
.2 Ontario Electrical Safety Code
.3 Canadian Standards Association
.4 Local Municipal Codes
.5 Local Building Bylaws
.6 Ontario Occupational Health and Safety Act
.7 IEEE

.2 Provide work in accordance with the requirements of all applicable government codes, local by-laws, underwriter's regulations base building standards, contract documents, and all authorities having jurisdiction.

.3 Where discrepancies occur between contract drawings and specifications and above codes and standards referred to herein, the Contractor is to notify the Consultant in writing and obtain clarification prior to proceeding with the work.

.4 Contractors shall not reduce the requirements on the contract drawings and specifications by applying any codes and standards referred to herein.

1.6 Permits and Fees

.1 Apply for, obtain, and pay for all permits, fees, connections, inspections, licenses, certificates or charges necessary including all provincial and federal taxes including HST.

.2 Coordinate all required inspections and give necessary notice to all authorities.

.3 Upon completion of project, provide inspection certificates confirming acceptance by all authorities having jurisdiction.

1.7 Contract Breakdown

.1 After the tenders close, submit a breakdown of the price into scope and trades to the satisfaction of the Consultant based on the sections of the specifications.

.2 Breakdown shall include but not be limited to:

.1 Mobilization and shop drawing submission (minimum $2,000)
.2 Permits and Fees
.3 Panelboards and other miscellaneous distribution equipment
.4 Starters, contactors and control devices
.5 Feeder conduits
.6 Branch conduits
.7 Feeder cables
.8 Branch wiring
.9 Wiring for mechanical equipment
.10 Luminaires and poles (exterior)
.11 Luminaires (interior)
.12 Emergency Luminaires
.13 Fire Alarm System
.14 Voice & Data system rough-in
.15 Public Address (PA) System rough-in
.16 Security and CCTV System rough-in
.17 Close-out Submittals – Manuals & As-builts (minimum $5,000)

.3 Progress claims shall be based on the breakdown. Submit in table format showing contract amount, work complete to date as percentage, previous draw, amount this draw and balance for each line item.

1.8 Shop Drawings

.1 Within thirty (30) days of award, the Contractor shall submit shop drawings of all equipment for the project.

.2 Prior to ordering of products or delivery of any products to job site, submit shop drawings electronically in PDF format to the Consultant for review and comments. Submit sufficiently in advance of construction to allow ample time for review. Size of shop drawings shall be 8.5x11. 11x17 will be acceptable where appropriate for content and scale.

.3 Submittals shall contain but not be limited to details, dimensions, construction, size, arrangement, operating clearances, performance characteristics and capacities of products and parts of the work. Include wiring drawings and schematics showing interconnection with work of other Divisions.

.4 Clearly mark each sheet of printed submittal material, using arrow, underlining or circling, to show particular sizes, dimensions, wiring diagrams, operating clearances, control diagrams, project identification, types, model numbers, ratings, capacities and options actually being proposed. Cross out non applicable material. Note on the submittal specified features such as special tank linings, pump seals, materials or painting.

**.5 Prior to submission to the Consultant, the Contractor shall review all shop drawings. By this review the Contractor represents that he has determined and verified all field measurements, field construction criteria, materials, catalogue numbers and similar data or will do so and that he has checked and coordinated each shop drawing with the requirements of the Work and of the Contract Documents.**

**.6 The Contractor's review of each shop drawing shall be indicated by his approval stamp, date and signature on the front of each page. Drawings will not be considered if not previously checked by the Contractor.**

.7 Review comments from Consultant. If shop drawings are modified, confirm changes before proceeding. If shop drawings are not approved, revise and resubmit changes for approval.

.8 Review of the shop drawings by the Consultant does not relieve the contractor or his supplier of the responsibility to provide the correct and complete equipment, material or installation.

.9 Keep one complete set of shop drawings at job site during construction.

.10 Include stamped reviewed shop drawings in the Maintenance Manuals.

1.9 Product Delivery Schedule

.1 Within two (2) weeks from shop drawing review, a schedule must be submitted by the Contractor showing projected delivery dates of all products to meet required construction schedule.

1.10 Construction Meetings

.1 The Electrical Contractor shall attend all site meetings unless otherwise pre-approved.

.2 Sub-trades shall attend site meetings as requested or as required.

1.11 As-built Drawings

.1 Refer to Section 26 05 02.

.2 Maintain accurate, neat, and clean As-built Drawings on an **on-going basis** during construction to be reviewed periodically by the Consultant during construction.

.3 As-built drawing mark-ups shall be made available at every site meeting or inspection.

.4 As-built drawings shall include but not be limited to final location of all **component locations and conduit runs.**

.5 Prior to Substantial Performance submit a complete set of As-built drawings in PDF format. The Contractor is responsible for providing red-line drawings indicating all As-built conditions.

1.12 ESA Certificates

.1 Furnish an unconditional Certificate of Acceptance from Electrical Safety Authority on completion of work. Arrange for interim and rough-in inspections. Arrange and pay for Occupancy Inspections if required for partial occupancies.

.2 Incorporate a copy of the final ESA Certificate in the operating and maintenance manual.

1.13 Maintenance Manuals

.1 Refer to Section 26 05 02.

.2 Provide the Owner with two (2) **indexed**, hard cover maintenance manuals plus one (1) electronic copy on labeled on memory stick. Manuals shall contain and be tabbed in the following order:

.1 Table of Contents
.2 Contractor's, Manufacturer's and Supplier's Contact Information
.3 Warranty Letter
.4 Colour coding charts for access areas
.5 Final ESA Certificate
.6 Fire Alarm Verification Report, Fire Alarm Certificate and Audibility Results
.7 Emergency Lighting Test Report
.8 ALL stamped approved shop drawings – Include a tab and blank section for any Owner supplied equipment
.9 Maintenance instructions, requirements, and schedule
.10 As-built drawings

.3 Submit one (1) complete copy to the Consultant for review and approval. Revise based on any comments and resubmit all copies and electronic copy to Consultant.

1.14 Testing

.1 The installation shall be free of open circuits and grounds.

.2 On completion, measure insulation resistances and comply with Table 24 of Ontario Electrical Safety Code.

.3 Test all wiring and connections for continuity and grounds before equipment is energized.

.4 Before energizing system, check all connections and set and calibrate all relays and instruments for proper operation, obtain necessary clearances, approval and instructions from utility company.

.5 Carry out all tests and furnish all equipment required to demonstrate safe and proper completion of the work, without cost to the Owner.

.6 Check load balance on all feeders and make necessary adjustments to provide a "balanced" load.

.7 Check voltage drop on all feeders/branch circuits and make necessary adjustments to provide a 2% voltage drop in all feeders and branch circuits and a 4% drop from supply side to point of utilization .

.8 Fully coordinate all testing and commissioning with all trades, the Consultant, and authorities having jurisdiction.

.9 Provide a minimum of forty-eight (48) hours written notice to all parties.

1.15 Demonstration and Training

.1 Demonstrate and train the Owner on proper operation of the Electrical and Auxiliary systems.

.2 Work with and assist Division 21, 22, 23 and 28 during training as required. Allow a minimum of four (4) separate two-hour sessions.

.3 The Contractor shall arrange for all necessary personnel and equipment specialists to be in attendance for purposes of demonstration and training.

.4 Provide instruction by a manufacturer's representatives as required too fully demonstrate the systems.

.5 Demonstration and Training shall include but not be limited to:

.1 Training in the normal, abnormal and emergency operating condition of all systems provided under this Division.
.2 Review of all necessary maintenance procedures of all systems provided under this Division.
.3 Provision of a documented maintenance program covering all systems provided or modified under this contract.
.4 Review of all close-out documentation including complete maintenance manuals and As-built drawings.

.6 Prepare a Training Agenda and Log for signature by all Participants. Submit to Consultant and include in Manuals.

1.16 Substantial Completion and Performance

.1 Substantial completion and performance shall be determined and awarded by the Consultant.

.2 Complete the following to the satisfaction of the Consultant prior to request for substantial performance:

.1 Submit Electrical Safety Authority Certificate
.2 Submit reports as specified herein – fire alarm, emergency lighting
.3 Fire stopping
.4 Communication Test Report
.5 Security/CCTV Test Report
.6 As-built drawings
.7 Demonstration and Training

1.17 Warranty

.1 Provide a one (1) year full parts and labour warranty for the new system from date of substantial completion.

.2 Submit warranty letter on Company letterhead signed by Company representative stating warranty terms including warranty period from date of substantial completion.

**PART 2 - PRODUCTS**

2.1 General

.1 All material used shall be new, free from defects, of quality specified, and installed in accordance with manufacturer's instructions.

.2 Major components shall have nameplates on the exterior of the equipment in a visible location containing manufacturer's name, model number, serial number, performance data, and electrical characteristics.

.3 The same manufacturer shall be used for types of components used in similar applications.

.4 It is the responsibility of the Contractor to store and protect materials supplied by this scope.

.5 Materials must be stored in original containers.

.6 Remove and dispose of all redundant materials and garbage from site.

2.2 Selected Products and Equivalents

.1 Sections within Division 26 list "Acceptable Manufacturers" which must meet characteristics of the specified equipment and products for each section.

.2 Base specified products are specified and/or shown on the drawings, and identified by manufacturer's name, type and catalogue number.

.3 Any alternate manufacturers from base specified products and equipment must equal or exceed the quality, finish and performance of those base specified and/or shown, and not exceed the space requirements allotted on the drawings. Include costs for any associated work to accommodate such substitutions, including the Consultant's time and revisions to the work of other divisions.

.4 If item or material specified is unobtainable, state in Tender proposed substitute and amount added or deducted for its use. Extra monies will not be paid for substitutions after the Contract has been awarded.

.5 If item of size indicated is unobtainable, supply next larger size without additional charge.

2.3 Quality Of Product

.1 All products provided shall be CSA approved, approved by other relevant authorities.

.2 If supplied products are not CSA approved, obtain approval of provincial regulatory authority. Pay all applicable charges levied and make all modifications required for approval.

.3 All products provided shall be new including those not specified and shall be of a quality best suited to the purpose required and their use subject to approval by the Consultant.

2.4 Voltage Ratings

.1 Operating Voltages: to CAN3-C235.

.2 Motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60Hz within normal operating limits established by above standard. Equipment to operate in extreme operating conditions established in above standard without damage to equipment.

2.5 Electric Motors, Equipment and Controls

.1 Refer to Drawings for Contractor's equipment wiring responsibility.

.2 Control wiring and conduit shall be covered under this Division except connections below 50V which are related to control systems specified under Division 23.

2.6 Product Finishes

.1 Shop drawings shall include finishes.

.2 All cabinets, panelboards, switchboards, cable trays, etc. shall be finished in ANSI 61 grey enamel unless otherwise specified.

.3 Apply primer on all items which are to be finished on the job.

.4 Repair dents and touch up all damaged finishes with matching finish, or if required by the Consultant or Owner, completely repaint or replace damaged surface at no extra cost to the Contract.

2.7 Access Doors

.1 Provide access doors/panels as required for access, adjustment, operation, service, and maintenance.

.2 Access doors shall be flush mounted 600mmx600mm (24"x24") for body entry and 300mmx300mm (12"x12") for hand entry. Doors to open 180 degrees, have rounded safety corners, concealed hinges, screwdriver latches and anchor straps.

.4 ACCESS DOORS/COVERS - FLUSH ACCESS DOOR – DRYWALL AREA

.1 **Acudor #DW-5040 Series** flush to surface for drywall, satin coat steel with white baked enamel finish, formed door panel, flanged on four sides, 20 gauge. Galvanized frame with multiple bends and integral taping bead, 26 gauge. Concealed hinge, stainless steel screwdriver operated cam latch.

.5 ACCESS DOORS/COVERS - FLUSH ACCESS DOOR - UNIVERSAL

.1 **Acudor #UF-5000** Universal Access Doors, 14 GA. (1.7mm) steel, baked enamel prime coat, continuous concealed hinge, with positive and self-opening screwdriver operated lock.

.6 Acceptable Manufacturers:

.1 Acudor
.2 Zurn
.3 Nailor Industries
.4 Le Hage

2.8 Floor Mounted Equipment

.1 Mount Switchboards, Motor Control Centres and all other floor mounted electrical equipment on chamfered edge housekeeping pads, minimum of 100 mm (4") high and 150 mm (6") larger than equipment dimensions all around.

2.9 Sleeves

.1 Provide sleeves for all cables passing through masonry, concrete or fire rated assemblies unless run in conduit.

.2 Sleeves shall be EMT conduit complete with bushing.

2.10 Fire Stopping

.1 This Contractor shall work with all other Contractors on the project in providing one common method of fire stopping all penetrations made in the fire rated assemblies.

.2 Approved fire stopping and smoke seal material in all fire separations and fire ratings within annular space between pipes, ducts, insulation and adjacent fire separation and/or fire rating.

.3 Do not use cementious or rigid seals around penetrations for pipe, ductwork, or other mechanical items.

.4 Provide materials and systems capable of maintaining effective barrier against flame, smoke and gases. Ensure continuity and integrity of fire separation.

.5 Comply with the requirements of CAN4-S115-M35, and do not exceed opening sized for which they have been tested.

.6 Systems to have an F or FT rating (as applicable) not less than the fire protection rating required for closures in a fire separation. Provide "fire wrap" blanket around services penetrating fire walls. Extent of blanket must correspond to ULC recommendations.

.7 The fire stopping materials are not to shrink, slump or sag and to be free of asbestos, halogens and volatile solvents.

.8 Firestopping materials are to consist of a component sealant applied with a conventional caulking gun and trowel.

.9 Fire stop materials are to be capable of receiving finish materials in those areas which are exposed and scheduled to receive finishes. Exposed surfaces are to be acceptable to consultant prior to application of finish.

.10 Firestopping shall be inspected and approved by local authority prior to concealment of enclosure.

.11 Install material and components in accordance with ULC certification, manufacturer's instructions and local authority.

.12 Submit product literature and insulation material on fire stopping in shop drawing and product data manual. Maintain copies of these on site for viewing by installers and Consultant.

.13 Acceptable Manufacturers:

.1 Fryesleeve Industries Inc.
.2 General Electric Pensiil Firestop Systems
.3 International Protective Coatings Corp.
.4 Rectorseal Corporation (Metacaulk)
.5 Proset Systems
.6 3M
.7 AD Systems
.8 Hilti

**PART 3 - EXECUTION**

3.1 Site Examination

.1 Examine the site of work and become familiar with all features and characteristics affecting this work before submitting tender.

.2 No additional compensation will be given for extra work due to existing conditions which such examination should have disclosed.

.3 Report to the Consultant any unsatisfactory conditions which may adversely affect the proper completion of this work.

3.2 Interference and Coordination Drawings

.1 Examine the drawings and all divisions of the specifications.

.2 Prepare interference and equipment layout drawings to ensure all components will be properly accommodated within the spaces provided.

.3 Lay out the work and equipment with due regard to architectural, structural and mechanical features, and service requirements.

.4 Submit interference drawings to the Consultant.

.5 Before commencing any work, obtain a ruling from the Consultant if any conflict exists, otherwise no additional compensation will be made for any necessary adjustments.

3.3 Separation of Services

.1 Maintain separation between electrical wiring system and building piping, ductwork, etc. so that wiring system is isolated (except at approved connections to such systems) to prevent galvanic corrosion.

.2 In particular, contact between dissimilar metals, such as copper and aluminum, in damp or wet locations is not permitted.

.3 Do not support wiring from pipes, ductwork, etc. Hangers for suspended ceilings may be used for the support of wiring only when approval is obtained from ceiling installer, and approved clips or hangers are used.

3.4 Workplace Safety

.1 The workplace must be kept safe at all times.

.2 Conform to all ministries of labour, and health and safety regulations at all times.

.3 Use ladders and proper techniques as approved by the ministry of labour to perform all work.

.4 Cover all holes/openings and provide barriers around hazards, etc. to ensure occupants and workers are not at risk.

.5 Where work does not conform to such regulations, stop work immediately and report the situation to the Owner's representative or Consultant or rectify the situation immediately.

.6 Report any hazards or concerns to the Owner's representative immediately.

.7 Conform to the Owner's safety requirements and construction regulations.

3.5 Temporary Requirements

.1 Provide grounded extension cords and temporary lights required for work.

.2 Any specific task lighting required on site is the responsibility of this Division.

3.6 Location Of Luminaires

.1 Locations may have to be revised to suit construction and equipment arrangements and it is expected that such changes will not result in additional cost to the Owner, provided that no additional labour or material is required and installation has not been completed.

3.7 Mounting Heights

.1 Mounting height of equipment is from finished floor to centerline of equipment unless specified or indicated otherwise. Coordinate with block coursing (if applicable).

.2 If mounting height of equipment is not specified or indicated, verify before proceeding with installation.

.3 Install electrical equipment at following heights unless indicated otherwise (measurement to the centre of device unless specified):

.1 Local switches: 900mm (36") - 1100mm (43")
.2 Wall receptacles:

.1 General: 400mm (16")
.2 Above top of continuous baseboard heater: 200mm (8")
.3 Above top of counters or counter splash backs: 100 mm (4")
.4 In mechanical rooms: 1200mm (48")

.3 Panelboards: as required by Code or 1400mm (56")
.4 Voice/Data outlets: At height of adjacent outlet or at 400mm (16")
.5 Voice outlet for phone: 900mm (36") - 1100mm (43")
.6 Fire alarm pull stations: 1200mm (47")
.7 Fire alarm horns: 150mm (6") below ceiling and maximum 2300mm (90") above finished floor (measured to top of device)
.8 Fire alarm visual signal device: entire lens is 2000-2400mm (78"-94")
.9 Fire alarm combination visual and signal devices: Conform to 3.7.3.7 and 3.7.3.8.
.10 Thermostat: 1200mm (47")
.11 Space Sensors: 1400mm (55")
.12 Clocks: 2100mm (84")

3.8 Repairs, Cutting and Restoration

.1 Patch and repair walls, floors, ceilings, and roofs with materials of same quality and appearance as adjacent surfaces unless otherwise shown. Surface finishes shall exactly match finishes of same materials.

.2 Each Section of this Division shall bear expense of cutting, patching, and repairing to install their work and/or replacing of work of other Sections required because of its fault, error, tardiness, or because of damage done by it.

.3 Cutting, patching, repairing, and replacing pavements, sidewalks, roads, and curbs to permit installation of work of this Division is responsibility of Section installing work.

.4 All patching, painting and making good of the existing walls, floors, ceilings, partitions and roof will be at the expense of this Contractor, but performed by the Contractor specializing in the type of work involved unless otherwise noted.

3.9 Painting

.1 Refer to other Divisions for Painting unless otherwise specified herein.

.2 Apply at least one (1) coat of corrosion resistant primer paint to ferrous supports and site fabricated work.

.3 Prime and touch up marred finished paintwork to match original.

.4 Restore to new condition, or replace equipment at discretion of Consultant, finishes which have been damaged too extensively to be merely primed, painted and touched up.

3.10 Concealment

.1 All equipment, components, piping, and conduit shall be concealed in ceiling spaces, bulkheads or walls where possible unless otherwise noted on the drawings or approved by the Owner or Consultant.

.2 Exposed equipment, components, piping, and conduit installed in unfinished areas, shall be installed as high as possible. Run piping and conduit tight to roof deck and down columns.

3.11 Clearances and Accessibility

.1 Install all work for easy access for adjustment, operation, and maintenance.

.2 Maintain clearances for all components as per code and manufacturer's instructions.

.3 Provide access panels of adequate size as required to access components in concealed areas. Do not install access doors in specialty walls or ceilings.

.4 Provide fire rated access doors shall be installed in fire separations and match rating of separation.

3.12 Equipment and System Protection

.1 Protect components and materials from damage in storage and on site before, during, and after installation until final acceptance.

.2 Protect inside and outside of components from dust and debris with appropriate covers that will withstand through the construction.

.3 Where equipment and system components become dirty or damaged, clean and repair to new condition to the satisfaction of the Consultant at the expense of this Contractor.

3.13 Supports

.1 Provide all miscellaneous metals and materials as required for support, hanging, anchoring, and guiding of all components.

.2 All supports must be securely mounted to structures.

3.14 Concrete Pads

.1 Provide 100mm (4") high concrete pads under all floor mounted electrical equipment including but not limited to MCCs, switchboards and transformers. Concrete pad shall extend 100mm (4") beyond footprint of equipment.

.2 Paint top and all sides of pad with two (2) coats of yellow paint.

3.15 Location of Outlets

.1 Do not install outlets back-to-back in wall. Allow minimum 150mm (6") horizontal clearance between boxes.

.2 Change location of outlets at no extra cost or credit, providing distance does not exceed 3m (10') and information is given before installation.

.3 Locate light switches on latch side of doors. Locate disconnect devices in mechanical and elevator machine rooms on latch side of door.

3.16 Fire Stopping

.1 Refer to Part 2 herein.

3.17 Cleaning

.1 In preparation for final acceptance, clean and refurbish all equipment and leave in operating condition.

3.18 Owner Supplied Equipment

.1 Connect to equipment supplied by the Owner and make operable.

3.19 Equipment Identification

.1 Identify electrical equipment with nameplates as follows:

.2 Nameplates:

.1 Lamacoid 3mm (1/8") thick plastic engraving sheet, black face, white core, mechanically attached with self-tapping screws.

Nameplate Sizes

| | | | |
|---|---|---|---|
| Size 1 | 9mm x 50mm (3/8" xx 2") | 1 line | 3mm (1/8") high letters |
| Size 2 | 12mm x 70mm (1/2" x 2-1/2") | 1 line | 5mm (3/16") high letters |
| Size 3 | 12mm x 70mm (1/2" x 2-1/2") | 2 lines | 3mm (1/8") high letters |
| Size 4 | 20mm x 90mm (3/4" x 3-1/2") | 1 line | 9mm (3/8") high letters |
| Size 5 | 20mm x 90mm (3/4" x 3-1/2") | 2 lines | 5mm (3/16") high letters |
| Size 6 | 25mm x 100mm (1" x 4") | 1 line | 12mm (1/2") high letters |
| Size 7 | 25mm x 100mm (1" x 4") | 2 lines | 6mm (1/4") high letters |

.3 Wording on nameplates labels to be approved by Consultant prior to manufacture.

.4 Allow for average of twenty-five (25) letters per nameplate.

.5 Identification to be English.

.6 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.

.7 Nameplates for disconnects, starters and contactors must indicate equipment being controlled and voltage.

.8 Nameplates for transformers must indicate transformer label as indicated and capacity, primary, and secondary voltages.

3.20 Wiring Identification

.1 Identify wiring with permanent indelible identifying markings, either numbered or coloured plastic tapes, on both ends of phase conductors of feeders and branch circuit wiring.

.2 Maintain phase sequence and colour coding throughout.

.3 Colour code: to CSA C22.1.

.4 Use colour coded wires in communication cables, matched throughout system.

3.21 Conduit and Cable Identification

.1 Colour code conduits, boxes and metallic sheathed cables.

.2 Code with plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor, and at 15m (45') intervals.

.3 Colour bands must be 25mm (1") wide.

| | Prime |
|---|---|
| Up to 208V | yellow |
| Voice system | green |
| Data system | orange |
| Security | brown |
| Public address | black |
| Fire alarm | red |

.4 This Contractor must paint all system junction boxes and covers in conformance with the above schedule.

3.22 Wiring Terminations

.1 Lugs, terminals, screws used for termination of wiring to be suitable for either copper or aluminum conductors.

3.23 Warning Signs

.1 Meet requirements of Electrical Safety Authority and Consultant.

.2 Provide porcelain enamel signs, with a minimum size of 175mm x 250mm (7" x 10").

3.24 Load Balance

.1 Measure phase current to panelboards with normal loads (lighting) operating at time of acceptance. Adjust branch circuit connections as required to obtain best balance of current between phases and record changes.

.2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage equipment.

.3 Submit at completion of work, report listing phase and neutral currents on panelboards, dry-core transformers and motor control centres operating under normal load. State hour and date on which each load was measured, and voltage at time of test.

3.25 Field Quality Control

.1 Conduct and pay for following tests:

.1 Power distribution system including phasing, voltage, grounding, and load balancing.
.2 Circuits originating from branch distribution panels.
.3 Lighting and its control.
.4 Motors, heaters and associated control equipment including sequenced operating systems where applicable.
.5 Systems: fire alarm system.

.2 Furnish manufacturer's certificate or letter confirming that entire installation as it pertains to each system has been installed to manufacturer's instructions.

.3 Insulation resistance testing.

.1 Megger circuits, feeders and equipment up to 350 V with a 500 V instrument.
.2 Megger 350-600 V circuits, feeders and equipment with a 1000 V instrument.
.3 Check resistance to ground before energizing.

.4 Carry out tests in presence of Consultant.

.5 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.

.6 Submit test results for Consultant's review.

3.26 Coordination of Protective Devices

.1 Ensure circuit protective devices such as overcurrent trips, relays and fuses are installed to required values and settings as indicated on drawings or as determined from coordination study.

3.27 Field Review and Deficiencies

.1 The Contractor shall notify the Consultant when the job is ready for field review at various stages including rough-in stages.

.2 During the course of construction, the Consultants will monitor construction and provide written reports of work progress, discussions and deficiencies.

.3 The Contractor shall correct all deficiencies within the work period prior to the next review.

.4 The Contractor shall not conceal any work until inspected. Where work was concealed, the Contractor shall remove and replace tiles, coverings or other obstructions to allow proper inspection at the Contractor's expense.

.5 Upon completion of the project the Consultant will do a final review. Upon receiving the final inspection report, the Contractor must correct and sign back the inspection report indicated all deficiencies are completed. A re-inspection will only be done once the Consultant receives this in writing. Where the Consultant performs the re-inspection and the work is not complete, the Contractor is responsible for reimbursing the Consultant for the field review. The fee for additional reviews will be at the Consultant's hourly rates plus mileage and applicable taxes to be paid directly to the Consultant prior to performing the next field review.

END OF SECTION

## PART 1 - GENERAL

1.1 Work Included

.1 Operating and Maintenance Manuals

.2 Assembly of certificates and tests reports

.3 Assembly of shop drawings

.4 Assembly of equipment and systems operating and maintenance instructions

.5 Assembly of identification schedule

.6 As Built Drawings

1.2 Related Work

.1 Division 1

.2 General Electrical Requirements – Section 26 05 01

## PART 2 - PRODUCTS

2.1 Operation and Maintenance Materials

.1 Provide two (2) 8½" x 11", 3 ring type catalogue binders, labeled front and spine, with plastic tab dividers and Table of Contents. Also provide one (1) complete manual in electronic PDF format on labeled memory stick.

.2 Manufacturer's data section is to be indexed and ordered to exactly match the sections of the specifications. Each section of the manufacturer's data section is to include an up to date copy of the equipment schedule for that section. The schedule is to be revised to suit all addenda, change orders and field changes, as well as manufacturers and model numbers matching the equipment supplied.

.3 Assemble or develop complete and correct documentation for the operation and preventative maintenance of equipment and systems provided.

.4 Assemble or develop copies of all certified shop drawings and material required to complete the documentation. This generally includes but is not limited to the following:

.1 Table of Contents
.2 Contractor's, Manufacturer's and Supplier's Contact Information
.3 Warranty Letter
.4 Colour coding charts for access areas
.5 Final ESA Certificate
.6 Fire Alarm Verification Report, Fire Alarm Certificate and Audibility Results
.7 Emergency Lighting Test Report
.8 ALL stamped approved shop drawings – Include a tab and blank section for any Owner supplied equipment
.9 Maintenance instructions, requirements, and schedule
.10 As Built drawings

2.2 As Built Drawings

.1 As Built drawings shall be kept up to date on an ongoing basis during construction for periodic review by the Consultant. As Built drawings shall always be kept in the same location on site known to the Consultant.

.2 Contractors shall certify that final reproducible As Built drawings to be correct by notation and signature on the drawings.

.3 As Built drawings shall precisely identify the configuration, size and location of all systems and equipment installed under this Division.

.4 As Built drawings must be submitted in AutoCAD as specified herein.

2.3 Test Reports

.1 Include a copy of all test reports for inclusion in Operating and Maintenance Manuals.

2.4 Demonstration and Training Reports

.1 Refer to Section 26 05 01 – General Electrical Requirements

.2 Include a copy of all Training literature in the Operating and Maintenance Manuals.

.3 Include a copy of the signed and dated Training Log.

**PART 3 - EXECUTION**

3.1 General

.1 Substantial Performance will not be granted until the hard copies and electronic copy of the complete manual have been submitted by the Contractor and reviewed and accepted by the Consultant.

.2 Submit a draft copy of the manual to the Consultant for review prior to final submission of all copies.

.3 Provide two (2) final hard copies and one (1) electronic copy in PDF format to the Consultant for final acceptance.

3.2 As Built Drawings

.1 Prior to Substantial Performance submit a complete set of As Built drawings in PDF format. The Contractor is responsible for providing red-line drawings indicating all As Built conditions. Make any changes as requested by the Consultant after review.

.2 Substantial performance will not be granted until the As Built drawings have been submitted to the Consultant.

END OF SECTION

## PART 1 - GENERAL

1.1 General

.1 The following specification represents the minimum standard required for installation of basic electrical components.

1.2 Work Included

.1 Refer to Section 26 05 01.

.2 Work to be done under this Section includes labour, materials, and equipment required to install, test and operate Electrical and Communication Systems.

.3 Removal of all redundant wiring and conduit including where specifically requested by the Owner.

1.3 Codes and Standards

.1 Ontario Electrical Safety Code – Current Edition.

.2 CSA

.3 ULC

.4 American Electronic/Telecommunication Industry Association

.5 Commercial Building for Telecommunications Pathways and Spaces

.6 Local Telephone Company requirements

.7 Local Codes and Requirements

1.4 Submittals

.1 Shop Drawings:

.1 Submit shop drawings to the Consultant for review prior to ordering or installation.
.2 Shop drawings shall include manufacturer, model numbers, electrical data, wiring diagrams, and indicate conformance to above reference standards.
.3 Contractor is responsible for reviewing and stamping all shop drawings to ensure equipment is as per specifications and match site conditions. Shop drawings will not be reviewed without contractor stamp indicating review.
.4 One copy of all stamped reviewed shop drawings shall be included in maintenance manual.

.2 Operation and Maintenance Data:

.1 Provide operation and maintenance literature for all equipment indicating manufacturer and model of equipment, instructions for operation and maintenance of same, and parts list.
.2 Operation and maintenance data shall be included in the maintenance manual.

1.5 Standard of Materials

.1 Materials and equipment are specifically described and named in this Specification in order to establish a standard of material and workmanship.

.2 Materials required for performance of work shall be new and the best of their respective kinds and of uniform pattern throughout work.

.3 Equipment items shall be standard products of approved manufacture. Identical units of equipment shall be of same manufacture.

.4 Chemical and physical properties of materials and design performance characteristics and methods of construction and installation of items of equipment, specified herein, shall be in accordance with latest issue of applicable Standards or Authorities when such are either mentioned herein, or have jurisdiction over such materials or items of equipment.

.5 Materials shall bear approval labels as required by Code and/or Inspection Authorities.

.6 Install materials in strict accordance with manufacturer's recommendations.

.7 Include items of material and equipment not specifically noted on Drawings or mentioned in Specification but which are necessary to make a complete and operating installation.

.8 Remove materials, condemned as not approved for use, from job site and deliver and install suitable approved materials in their place.

.9 Where a specific manufacturer is noted herein, other manufacturers may be considered where approved by the owner.

## PART 2 - PRODUCTS

2.1 General

.1 Provide all equipment as per the following description to complete the entire works as shown on drawings and as indicated in the specifications to provide a complete and operational system.

.2 Coordinate with other trades to provide the components required to make all systems operational – see mechanical schedules for details of equipment provided to make sure the works are complete.

2.2 Outlet Boxes

.1 Outlet boxes shall conform to C.S.A. Standard C22.2 No. 18-1972.

.2 Ceiling boxes shall be 103 mm octagon or square, complete with fittings, where required to support fixtures.

.3 Switch and receptacle boxes shall be:

.1 103 mm square with plaster ring, where flush mounted in plaster walls.
.2 No. 1104, where flush mounted in wood or drywall, with stud fasteners as required.
.3 Masonry boxes in masonry walls.

.4 Where boxes are surface mounted in unfinished areas they shall be FS conduits.

.5 Standard outlet boxes shall be manufactured from code gauge galvanized steel.

.6 Provide a suitable outlet box for each light, switch, receptacle or other outlet, approved for the particular area it is to be installed.

.7 Boxes shall be of a size suitable for the number and size of conductors and the space requirements for the wiring device.

2.3 Conduit Accessories, Condulets and Fittings

.1 Conduit accessories, condulets and fittings shall conform to C.S.A. Standard C22.2 No. 18-1972.

.2 Rigid conduit bushings shall be as manufactured by:

.1 Thomas & Betts Ltd. – Series 5031
.2 Efcor of Canada Ltd. – Series 720B
.3 Commander / Iberville

.3 EMT Connectors shall be steel set screw type as manufactured by:

.1 Thomas & Betts Ltd. – Steel City TC 121E Series
.2 Efcor of Canada Ltd. – Series 720B
.3 Commander / Iberville

.4 Ground Bushing shall be as manufactured by:

.1 Thomas & Betts – Blackjack or 1220 Series
.2 Efcor of Canada Ltd.
.3 Commander / Iberville

.5 Flexible conduit connectors shall be as manufactured by:

.1 Thomas & Betts Ltd. – Series 3110
.2 Efcor of Canada Ltd. – Series 1001B
.3 Commander / Iberville

.6 Conduit fittings shall be as manufactured by:

.1 Crouse-Hinds of Canada Ltd.
.2 Kondu Mfg. Co. Limited
.3 Thomas & Betts Ltd.
.4 Killark of Canada
.5 Efcor of Canada Ltd.
.6 Commander / Iberville

.7 Steel conduit shall be as manufactured by:

.1 Conduits National Co. Ltd.
.2 MBF Industries

.8 Aluminum conduits shall be as manufactured by:

.1 Alcan Canada Products Ltd.

.9 Terminate rigid conduit entering boxes or enclosures with nylon insulated steel threaded bushings.

.1 Thomas & Betts – 8125 Series

.10 Terminate EMT entering boxes or enclosures with nylon insulated steel threaded bushings.

.11 Terminate flexible conduit entering boxes or enclosures with nylon insulated steel connectors.

.1 Thomas & Betts – 5332 Series

.12 Install wall entrance seals where conduits pass through exterior walls below grade.

.13 Provide expansion coupling in conduit runs at building expansion joints and in long runs subject to thermal expansion, all in accordance with manufacturer recommendations.

.14 All cabling shall be run in EMT conduit unless otherwise approved.

.15 BX cable is acceptable for short drops to light fixtures to a **MAXIMUM LENGTH OF 1500 mm**. Any installations exceeding 1500 mm **WILL BE REMOVED AND REPLACED AT THE CONTRACTORS EXPENSE**. All installations of BX cable shall be complete with anti-short bushings at all stripped ends as per OEC #12-608(1)(a). Connectors for BX cable shall be Crouse Hinds #L16ST.

.16 Rigid PVC (unplasticized) conduit shall be CSA approved according to CSA Standard C22.2 No. 136.

.17 Pull Cords/Strings

.1 Nylon twine

2.4 Conductors, Wires and Cables

.1 Wiring installed in conduit, unless otherwise noted, shall be copper 600 volt RW75XLPE, RWU75XLPE or T-75 nylon jacket as per the requirements on the plans. It is the responsibility of the contractor to verify all equipment termination temperature and adjust wire size/rating to suit.

.2 Lighting and power wiring shall be copper, minimum No. 12 gauge. Size wires for 2% maximum voltage drop to farthest outlet on a maximum 80% loaded circuit.

.3 Conductors shall be colour coded. Conductors No. 10 gauge and smaller shall have colour impregnated into insulation at time of manufacture. Conductors size No. 8 gauge and larger may be colour coded with adhesive colour coding tape but only black insulated conductors shall be employed in this case, except for neutrals which shall be white wherever possible.

.4 Colour Coding shall be as follows:

.1 Phase "A" – Red
.2 Phase "B" – Black
.3 Phase "C" – Blue
.4 Control – Orange
.5 Ground – Green
.6 Neutral – White

.5 Wire shall be as manufactured by:

.1 Nexans
.2 Industrial Wire and Cable (1970) Ltd.
.3 Southwire Canada
.4 Prysmian Cables & Systems Ltd (formerly Pirelli Cables Ltd.)

.6 Neatly train circuit wiring in cabinets, panels, pull boxes and junction boxes and hold with nylon cable ties.

.7 Splice wire, up to and including No. 6 gauge, with nylon insulated expandable spring type connectors.

.1 Thomas & Betts – Marr Max Series

.8 Splice large conductors using compression type connections insulated with heat shrink sleeves.

.1 Thomas & Betts – 5400 Series lugs and heat shrink type #s series

.9 Where colour coding tape is utilized, it shall be applied for a minimum of 2" at terminations, junction and pull boxes and condulet fittings. Do not paint conductors under any condition. Colour coding shall also apply to bussing in panels and, switchgear, disconnects, and metering cabinets.

2.5 Junction Boxes and Pull Boxes

.1 Junction and pull boxes must conform to CSA C22.2 No. 40 (latest edition).

.2 Welded steel construction with screw-on flat covers for surface mounting.

.3 Covers with 25 mm (1") minimum extension all around, for flush-mounted pull and junction boxes.

2.6 Switches

.1 Local switches shall be 15A or 20A, single pole, double pole, three-way, four-way, keyed, or motor rated complete with pilot light. Switches to be silent, A.C. type and C.S.A. listed, specification grade. Provide switches rated to suit system voltage.

.2 Manually operated general purpose with the following features:

.1 Terminal holes approved for No. 10 AWG wire.
.2 Silver alloy contacts
.3 Urea or melamine molding for parts subject to carbon tracking
.4 Suitable for back and side wiring
.5 Toggle style

.3 Toggle operated fully rated for tungsten filament and LED lamps

.4 Up to 80% of rated capacity of motor loads.

.5 Switches and receptacles shall be of the same manufacturer throughout except where a specified item is not made by that manufacturer.

.6 Provide white colour (to be confirmed at shop drawing review).

.7 Catalogue numbers listed below have been used to indicate quality standards.

| | | |
|---|---|---|
| .1 | Single Pole | Hubbell 1221/18221 Series |
| .2 | Double Pole | Hubbell 1222/18222 Series |
| .3 | Three-Way | Hubbell 1223/18223 Series |
| .4 | Four-Way | Hubbell 1224/18224 Series |
| .5 | Keyed | Hubbell HBL1221L + 2 matching keys Hubbell HBL1209 |
| .6 | Motor rated | Hubbell HBL1221PL c/w pilot light (min 20A) |

.8 Acceptable Manufacturers:

.1 Hubbell of Canada Ltd.
.2 Leviton
.3 Legrand

2.7 Dimmer Control

.1 Dimmers to be provided with following features:

.1 Rating of 20A 120V
.2 Wattage to suit load as indicated. Minimum wattage to be 1000W.
.3 Linear slide control.
.4 Dimmer must be rated for LED control and provide full range control from zero to full intensity.
.5 On/Off switch
.6 Mountable in a single gang or multi-ganged box as required.
.7 Cover plate to match other wiring devices

2.8 Occupancy Sensors

.1 Ceiling mounted sensors shall be Dual Technology capable of detecting presence in the control area by detecting doppler shifts in transmitted ultrasound and passive infrared heat changes.

.2 Wall mounted sensors shall be Single Technology capable of detecting presence in the control area by detecting passive infrared heat changes

.3 Ceiling sensors shall use patent pending ultrasonic diffusion technology that spreads coverage to a wider area.

.4 Ceiling sensors shall utilize Dual Sensing Verification Principle for coordination between ultrasonic and PIR technologies. Detection verification of both technologies must occur in order to activate lighting systems. Upon verification, detection by either shall hold lighting on.

.5 Ceiling sensors shall have a retrigger feature in which detection by either technology shall retrigger the lighting system on within 5 seconds of being switched off.

.6 Ceiling sensors shall be ceiling mounted with a flat, unobtrusive appearance and provide 360° coverage.

.7 Ultrasonic sensing shall be volumetric in coverage with a frequency of 40 KHz. It shall utilize Advanced Signal Processing that automatically adjusts the detection threshold dynamically to compensate for changing levels of activity and airflow throughout controlled space.

.8 To avoid false ON activations and to provide immunity to RFI and EMI, Detection Signature Analysis shall be used to examine the frequency, duration, and amplitude of a signal, to respond only to those signals caused by human motion.

.9 The PIR technology shall utilize a temperature compensated, dual element sensor and a multi-element Fresnel lens. The lens shall be Poly IR4 material to offer superior performance in the infrared wavelengths and filter short wavelength IR, such as those emitted by the sun and other visible light sources. The lens shall have grooves facing in to avoid dust and residue build up which affects IR reception.

.10 Sensors shall have a time delay that is adjusted automatically (with the SmartSet setting) or shall have a fixed time delay of 5 to 30 minutes, set by DIP switch.

.11 Sensors shall feature a walk-through mode, where lights turn off 3 minutes after the area is initially occupied if no motion is detected after the first 30 seconds.

.12 Ceiling sensors shall have a built-in light level sensor that works from 10 to 300 foot candles.

.13 Sensors shall have a manual on function that is facilitated by installing a momentary switch.

.14 Sensors shall have eight occupancy logic options that give the ability to customize control to meet application needs.

.15 The sensors shall feature terminal style wiring, which makes installation easier.

.16 Sensors shall have an additional single-pole, double throw isolated relay with normally open, normally closed and common outputs. The isolated relay is for use with HVAC control, data logging, and other control options.

.17 Each sensing technology shall have an LED indicator that remains active at all times in order to verify detection within the area to be controlled. The LED can be disabled for applications that require less sensor visibility.

.18 To ensure quality and reliability, sensor shall be manufactured by an ISO 9002 certified

manufacturing facility and shall have a defect rate of less than 1/3 of 1%.

.19 Sensors shall have standard 5 year warranty and shall be UL and CUL listed.

.20 Sensorworx is an acceptable alternate for occupancy sensor lighting control.

2.9 Receptacles

.1 Receptacles shall conform to CSA 22.2 No. 42 (latest edition).

.2 Receptacles shall be specification grade of amperage and voltage indicated on the drawings.

.3 Manually operated general purpose with the following features:

.1 Terminal holes approved for No. 10 AWG wire.
.2 Break-off links for use as split receptacles
.3 Urea or melamine molding for parts subject to carbon tracking
.4 Suitable for back and side wiring (eight back wired entrances, four side wiring screws)
.5 Triple wipe contacts and riveted grounding contacts
.6 Tamper resistant

.4 Switches and receptacles shall be of the same manufacturer throughout except where a specified item is not made by that manufacturer.

.5 Provide white colour (to be confirmed at shop drawing review).

.6 Receptacles shall be as listed below:

.1 15 ampere, 120V, single phase grounded duplex tamper resistant receptacle shall be NEMA-U-ground type CSA Configuration 5-15R.
.2 20 ampere, 120V, single phase grounded duplex tamper resistant receptacle shall be NEMA-U-ground type CSA Configuration 5-20RA.
.3 15 ampere, 120V, weatherproof receptacles shall be equal to those above but complete with gasketed cast plate and hinged covers.

.7 Other types of receptacles shall be provided as shown on Drawings.

.8 Catalogue numbers listed below have been used to indicate quality standards.

| | | |
|---|---|---|
| .1 | Standard Duplex | Hubbell BR15WHITR |
| .2 | T-Slot | Hubbell BR20WHITR |
| .3 | Controlled | Hubbell BR15C2GNTR |
| .4 | Controlled T-Slot | Hubbell BR20C2GNTR |
| .5 | GFI | Hubbell GFTRST15W |
| .6 | GFI T-Slot | Hubbell GFTRST20W |
| .7 | USB Duplex | Hubbell USB15C5W |
| .8 | USB Only | Hubbell USB4W |
| .9 | Twist Lock | Hubbell HBL23XX |
| .10 | Dryer | Hubbell HBL9430A |
| .11 | Range | Hubbell HBL9450A |

.9 Acceptable Manufacturers:

.1 Hubbell
.2 Legrand
.3 Leviton
.4 Cooper

2.10 Cover Plates

.1 Switch, receptacle, telephone and other plates shall be stainless steel 18-8 chrome metal alloy, Type 302, non-metallic in finished areas and pressed steel in unfinished areas. Finish brush marks shall be run in a vertical direction.

.2 Cover plates shall be of the same manufacturer throughout.

.3 Cover plates shall be as manufactured by:

.1 Leviton
.2 Hubbell
.3 Legrand

2.11 Destratification Fans and Controls (General Purpose Room)

.1 Air Pear Thermal Equalizer by AIRIUS.

.2 Eye hook / eyebolt for free hanging.

.3 6 foot cord for direct power connection (plug-in is not acceptable).

.4 The Supplier or Electrical Contractor shall supply wire guards for fans.

.5 The Supplier or Electrical Contractor shall supply a speed controller to suit the supplied fan. Speed controller to be able to control two fans. Provide stainless steel cover plate.

2.12 Disconnect Switches

.1 Fused or Un-fused disconnect or safety switches shall be Type "A", quick-make, quick-break construction with provision for padlocking switches in either "ON" or "OFF" position.

.2 Switches throughout job shall be of same manufacture.

.3 Fused switches shall have fuse clips designed for Class "J" fuses and designed to reject standard N.E.C. fuses.

.4 Switches shall be as manufactured by:

.1 Eaton
.2 Siemens
.3 Schneider Electric

.5 Provide fused or un-fused safety or disconnect switches as shown and as required by Code.

.6 Disconnects feeding elevator controllers must be equipped with two auxiliary contacts approved by the elevator supplier.

2.13 Motor Starters

.1 Starts shall conform to CSA C22.2 No. 14 (latest edition) and EEMAC E14-1.

.2 Manual motor starters shall be/have:

.1 Used for motors ½ hp or less
.2 Equal to Allen Bradley type 600 and 609
.3 Toggle operated
.4 Locking
.5 Plug-in heaters sized to suit the full load current of the motors installed
.6 Red neon pilot light

.3 Magnetic motor starters shall be/have:

.1 Used for motors over ½ hp
.2 Equal to Allen Bradley IEC type
.3 Contactor solenoid operated, rapid action type
.4 Motor overload protective device in each phase, manually reset from outside enclosure
.5 Hand/off/auto push button selector switches
.6 Indicating lights: standard duty, 1 red pilot light for "stop" or "off" and 1 green light for "start" or "on".
.7 1-N/O and 1-N/C spare auxiliary contacts
.8 24V auxiliary contacts
.9 Wiring and schematic diagram inside starter enclosure in visible location

.4 Combination starters shall be/have:

.1 Used where fused switch and magnetic starter are in same location
.2 Equal to Allen Bradley IEC
.3 Include fused disconnect switch with operating lever on outside of enclosure to control disconnect
.4 Locking in "OFF" position
.5 Independent locking of enclosure door
.6 Provision for preventing switching to "ON" position while enclosure door is opened.
.7 Magnetic starter features as per above.

.5 Provide control transformers and auxiliary contacts as required for control connections.

.6 Provide push to test lights throughout.

.7 Half size and IEC starters will not be accepted.

.8 Acceptable Manufacturers:

.1 Allen Bradley
.2 Eaton
.4 Siemens
.5 Schneider Electric

2.14 Control Transformers

.1 Control transformers shall conform to CSA C22.2 No. 66 (latest edition).

.2 Auto-transformers shall conform to CSA C22.2 No. 47 (latest edition).

.3 Single phase, dry type, control transformer with primary voltage as indicated and secondary voltage to suit remote control device, complete with secondary fuse, installed in with starter as indicated.

.4 Size control transformer for control circuit load plus 20% spare capacity.

2.15 Contactors

.1 Contactors shall conform to CSA C22.2 No. 14 (latest edition).

.2 Electrically held and controlled by pilot devices as indicated and rated for type of load controlled. (Mechanically held style for exterior lighting control).
.3 Complete with 2 normally open and 2 normally closed auxiliary contacts unless indicated otherwise.

.4 Mount in CSA Enclosure 1 unless otherwise indicated.

.5 Include following options in cover:

.1 Red indicating lamp.
.2 Hand – Off – Auto selector switch.

.6 24V Control transformer: mounted in contactor enclosure.

.7 Acceptable Manufacturers:

.1 Allen-Bradley
.2 Eaton
.3 Siemens
.4 Schneider Electric

2.16 Control Relays

.1 Control relays shall be equal to Allen Bradley type P, electrically held. Confirm coil voltages for relays controlling mechanical equipment with controls contractor.

2.17 Hangers and Supports

.1 Provide and correctly locate all hangers and inserts required for the installation of all work under this Contract.

.2 Hangers for electrical conduit shall be galvanized after fabrication.

.3 Conduit hangers shall be as manufactured by:

.1 Burndy Canada Ltd.
.2 Canadian Strut Products Ltd.
.3 E. Myatt & Co. Ltd.
.4 Steel City Electric Co.
.5 Pilgrim
.6 Thomas & Betts
.7 B-line

.4 Do not use perforated strapping (grappler bars).

2.18 Finishes and Painting

.1 All factory supplied equipment shall have finish coating factory applied whether finish be painted, galvanized or other, as required and as specified.

.2 Repair dents and touch up all damaged finishes with matching finish, or if required by the Consultant or Owner, completely repaint or replace damaged surface at no extra cost to the Contract.

**PART 3 - EXECUTION**

3.1 General

.1 All wiring to meet Ontario Electrical Safety Code and local authorities.

.2 All power, interlock and control wiring over 50V, and disconnects shall be supplied and installed by the Electrical Contractor. Coordinate with Division 22 and 23.

.3 Division 22 and 23 shall install all control and low voltage interlock wiring less 50V or less for mechanical equipment unless specified.

.4 All outdoor wiring to be run in liquidtight. All indoor wiring to be run in conduit. Last 1.5m

(5') at final connection to equipment shall be run in flexible conduit only (not liquidtight).

.5 Where wire size is not indicated, ampacity must match or exceed rating of protective device.

.6 Panels are specified as sequence bussed and all branch circuit wiring from these panels shall be such that where a common neutral is used for two or three circuits, these circuits shall be fed from adjacent breakers, so that single-pole breakers may be replaced with 2 or 3 pole breakers should this be required in the future. All circuits shall be balanced. All neutrals shall be sized to meet the requirements of Section 4-018 of the Ontario Electrical Safety code and in no case smaller than 12 AWG.

.7 Feeders, sub-feeders, circuit wiring and ancillary items shall be colour coded for phase identification. Neutral conductors shall be full capacity with white covering and be continuous throughout the system without fuses, switches or breakers of any kind.

.8 Install wiring continuously within raceways, splices will be permitted only at outlets and junction boxes. Sufficient slack wire shall be left at these points to permit proper connection of fixtures, devices, equipment, etc.

.9 Any exposed conduits or cables shall be run parallel to or at right angles to building lines and in a neat manner. Conduits shall be thoroughly reamed and each threaded termination shall be provided with two lock nuts. Running threads for rigid conduit will not be accepted.

.10 Internal raceways in the building

.1 Securely cap or plug all openings in conduit and ducts during the execution of the Work to prevent dust and debris from entering the openings.
.2 At completion of the installation, the service entry ducts and the conduit system in the building shall be fished to clear all blocks.

.11 Outlet and pull boxes shall be cleaned out and the system left free from water and moisture.

.12 Provide all conduit, wire, fittings, disconnect switches, line voltage, starters, disconnects, controls and auxiliary materials as previously defined to wire into service all 3 phase motors, single phase motors and equipment included in other Sections unless specified otherwise.

.13 Install pull boxes in conduit run where required to facilitate the pulling in of cable and locate in inconspicuous accessible spaces.

.14 Provide flexible connections to mechanical equipment for vibration isolation. Connections to equipment roof mounted or in other damp or wet locations shall be liquid tight.

.15 Conduits and cables shall not be attached to mechanical units for support.

.16 All devices in General Purpose rooms (Gym), Mechanical and/or Electrical rooms and all exterior mounted devices shall have wire guards for protection from mechanical damage. Provide wire guards elsewhere as noted on drawings.

3.2 Wiring Methods

.1 Install wiring in conduit unless otherwise specified.

.2 Flexible conduit and armoured cable will be accepted for a maximum length of 1500 mm for final connection to lighting fixtures. Do not connect from fixture to fixture.

.3 Use thin wall conduit (EMT), up to and including 53 mm conduit size, for branch circuit and feeder wiring in ceilings, furred spaces, concrete block walls, hollow walls and partitions. Use rigid galvanized steel conduit for wiring in poured concrete, where exposed, and for conduit 65 mm or larger. Use rigid PVC conduit for wiring in slabs on grade and wiring below grade.

.4 Aluminum conduit may be used, in lieu of rigid steel conduit, in clean and dry locations, but shall not be used in poured concrete, or for signal and intercommunication systems wiring.

.5 Conduit manufacturer's touch-up enamel shall be used to repair all scratches and gouges on epoxy-coated conduit.

3.3 Outlet Boxes

.1 Where 103 mm square outlet boxes are installed in exposed concrete or cinder block finished areas, blocks will be cut under Masonry Division as instructed under this Section. Opening shall be cut to provide a close fit to boxes and covers so that edges of openings are not visible after installation of plates. Mortar shall not be used to patch up openings that are cut too large or to patch ragged edges.

.2 Ceiling boxes shall be 103 mm octagon or square, complete with fittings, where required to support fixtures.

.3 Provide a suitable outlet box for each light, switch, receptacle or other outlet, approved for the particular area it is to be installed.

.4 Support outlet boxes independently of conduit and cable.

.5 Locate outlet boxes, mounted in hung ceiling space, so they do not obstruct or interfere with the removal of lay-in ceiling tiles.

.6 Offset outlet boxes, shown back to back in partitions, horizontally a min. 150mm to minimize noise transmission between adjacent rooms.

.7 Use gang boxes at locations where more than one device, of the same system only, is to be mounted. Each system shall utilize separate boxes.

.8 Use tile wall covers where 103 mm square outlet boxes are installed in exposed concrete or cinder block in finished areas.

.9 Flush mount boxes, panels, cabinets and electrical devices, which are installed in finished areas, shall be provided with suitable flush trims and doors or covers, unless specifically noted otherwise.

.10 Provide pre-formed polyethylene vapour barriers for all boxes located in walls with internal vapour barriers.

3.5 Conduit Accessories, Condulets and Fittings

.1 Terminate rigid conduit entering boxes or enclosures with nylon insulated steel threaded bushings.

.1 Thomas & Betts – 8125 Series

.2 Terminate EMT entering boxes or enclosures with nylon insulated steel threaded bushings.

.3 Terminate flexible conduit entering boxes or enclosures with nylon insulated steel connectors.

.1 Thomas & Betts – 5332 Series

.4 Install wall entrance seals where conduits pass through exterior walls below grade.

.5 Provide expansion coupling in conduit runs at building expansion joints and in long runs subject to thermal expansion, all in accordance with manufacturer recommendations.

3.6 Conductors, Wires and Cables

.1 Conductors shall be colour coded. Conductors No. 10 gauge and smaller shall have colour impregnated into insulation at time of manufacture. Conductors size No. 8 gauge and larger may be colour coded with adhesive colour coding tape but only black insulated conductors shall be employed in this case, except for neutrals which shall be white wherever possible.

.2 Colour Coding shall be as follows:

.1 Phase "A" – Red
.2 Phase "B" – Black
.3 Phase "C" – Blue
.4 Control – Orange
.5 Ground – Green
.6 Neutral – White

.3 Neatly train circuit wiring in cabinets, panels, pull boxes and junction boxes and hold with nylon cable ties.

.4 Splice wire, up to and including No. 6 gauge, with nylon insulated expandable spring type connectors.

.1 Thomas & Betts – Marr Max Series

.5 Splice large conductors using compression type connections insulated with heat shrink sleeves.

.1 Thomas & Betts – 5400 Series lugs and heat shrink type #s series

.6 Where colour coding tape is utilized, it shall be applied for a minimum of 2" at terminations, junction and pull boxes and condulet fittings. Do not paint conductors under any condition. Colour coding shall also apply to bussing in panels and, switchgear, disconnects, and metering cabinets.

3.7 Junction Boxes and Pull Boxes

.1 Install pull boxes in inconspicuous but accessible locations. Provide access doors in all drywall areas.

.2 Install junction boxes and pull boxes so as not to exceed 30m (100') of conduit run between pull boxes and in conformance with the Electrical Safety Authority.

.3 Provide equipment identification in conformance with Section 260501.

.4 Label all junction boxes with panel and circuit number.

3.8 Switches

.1 Install single throw switches with handle in the "up" position when switch is closed.

.2 Install switches in gang type outlet box when more than one switch is required in one location.

.3 Confirm colour prior to ordering.

.4 Refer to Section 26 05 01 for mounting heights.

3.9 Receptacle

.1 Mount receptacles so long dimension is in the vertical.

.2 Exact locations shall be verified to suit furniture layout.

.3 Connect receptacle grounding terminal to the outlet box with a copper wire.

.4 Install receptacles in gang type outlet box when more than one switch is required in one location.

.5 Where split receptacle has one portion switched mount vertically and switch upper portion.

.6 Weatherproof receptacles shall be equal to 20A GFI and mounted in weatherproof enclosure complete. Enclosure shall be equivalent to Hubbell RW58300.

.7 Confirm colour prior to ordering.

.8 Refer to Section 26 05 01 for mounting heights.

3.10 Cover Plates

.1 Do not install plates until final painting of room or area is completed. Remove protective covering.

3.11 Destratification Fans and Controls

.1 Ensure fans and controls are installed in conformance with manufacturer recommendations.

.2 Suspend/free hang ceiling fans from roof structure from eye hook / eyebolt on fan. Use minimum ¼ carabineer. Provide chain for back-up support.

.3 Provide junction box for power connection directly above the fan and run flexible conduit to fan.

.4 Fans shall be mounted level with surrounding structure to ensure air flow is not impeded.

.5 Electrical Contractor shall supply and install switch or speed controller to suit fan.

.6 Install wire guards to be level. Fasten wireguards to structure NOT roof deck. Provide intermediate unistrut supports to suit.

.7 Demonstrate fan operation at the time of final inspection.

3.12 Hangers and Supports

.1 Provide and correctly locate all hangers and inserts required for the installation of all work under this Contract.

.2 Support outlet boxes, junction boxes, conduit and all electrical equipment independently with hangers and fastenings to building structural members.

.3 Hangers in general shall be supported from inserts in concrete construction or from building structure using beam clamps for steel structures. Provide all additional angle or channel steel members required between beams for support of conduits, cables, luminaires, etc.

.4 Use coach screws, lag screws or wood screws as appropriate in any wood construction.

.5 Feeders, conduits and power ducts running vertically in a building shall be supported at each floor and between each floor if necessary.

3.13 Mounting Heights

.1 Refer to Section 26 05 01.

3.14 Conduit Sleeves and Curbs

.1 Provide conduit sleeves of galvanized steel for conduit and cable runs passing through concrete walls, beams, slabs and floor. Include for all power, communications and control wiring. All conduit sleeves shall be de-burred and have plastic bushings installed to protect wiring.

.2 Extend galvanized conduit sleeves for conduit rising through slabs 4" minimum above finished floors. Provide sleeves, passing through floors having a waterproof membrane, with an integral flashing clamp.

3.15 Hand Dryers

.1 Install and connect hand dryers in conformance with manufacturer's recommendations.

.2 Provide GFI breaker for circuit feeding hand dryer.

.3 Hand dyers are to be mounted at a height to suit age of expected users. Unless otherwise noted confirm height with Architectural drawings prior to rough in.

.4 Once installed this Contractor is to caulk the joint between dryer and wall surface with a bead of white silicone. Coordinate installation with General Contractor.

3.16 Supports and Bases

.1 Mount Switchboards, Motor Control Centres and all other floor mounted electrical equipment on chamfered edge housekeeping pads, minimum of 100 mm (4") high and 150 mm (6") larger than equipment dimensions all around.

.2 Supply and erect special structural work required for installation of electrical equipment. Provide anchor bolts and other fastenings unless noted otherwise. Mount equipment required to be suspended above floor level, where details are not shown, on a frame or platform bracketed from the wall or suspended from the ceiling. Carry supports to either the ceiling or the floor, or both as required, at locations where, because wall thickness is inadequate, it is not permitted to use such brackets.

.3 Switches or other electrical equipment shall be complete with suitable bases or mounting brackets.

4. Provide channel or other metal supports where necessary, to adequately support lighting fixtures. Do not use wood unless wood forms part of the building structure.

5. Support hangers, in general, from inserts in concrete construction or from building structural steel beams, using beam clamps. Provide additional angle or channel steel members, required between beams for supporting conduits and cables.

6. Provide any additional supports required from existing concrete construction for any piping or equipment, by drilling same and installing expansion bolt cinch anchors.

7. Do not use explosive drive pins in any section of work without obtaining prior approval.

3.17 Finishes and Painting

.1 Primary and final painting for work, other than items specified as factory primed or finished, shall be performed by trades specializing in this type of work.

.2 Repair and finish factory finished equipment, damaged or scratched during installation, in an approved manner.

.3 Leave bare metal surfaces ready for painting by removing dirt, rust, grease or millscale to Consultant's approval.

.4 All structural steel including hangers, brackets, supports and other ferrous metals shall be shop or factory prime painted wherever practicable. Wherever structural steel including hangers, brackets, supports, and other ferrous metals cannot be shop or factory prime painted, wire brush to remove all traces of rust, clean of all traces of dirt, oil, and grease, and apply one coat of an approved rust inhibiting primer in accordance with CGSB-GB-40d and leave ready to receive finish paint.

3.18 Electrical Connections for Mechanical Equipment

.1 Provide all required electrical connections to apparatus provided and/or supplied by Division 21, 22 and 23, the Owner and as part of the work of other Divisions of the Specifications.

.2 All power and control wiring over 50V and disconnects shall be installed by the Electrical Contractor.

.3 All control and low voltage wiring 50V and under shall be installed by the Mechanical Contractor and/or Controls Contractor. Coordinate all low voltage wiring with the Mechanical Contractor.

.4 All connections to roof mounted mechanical equipment shall be installed through a gooseneck style pitch pocket equal to Thaler Metal MEF-2A/2A1/2A2. Pitch pocket supplied and installed by Electrical Contractor. Coordinate installation with General Contractor and/or Roofing Contractor.

3.19 Motors and Starters

.1 Division 26 shall supply and install all starters unless otherwise indicated.

.2 Coordinate with Division 22 and 23 as required.

.3 Install line voltage disconnect switches at each motor not within the required distance from its starter to meet code requirements.

.4 All motors shall be wired and connected under this Division. The drawings do not necessarily show the exact location of wiring to motors and it shall be the responsibility of this Division to fully coordinate this work with Division 22 and 23.

.5 Temperature Controls: Be responsible for the “line" side power connections to all control apparatus where detailed or required to make the system operational.

3.20 Equipment Identification

.1 Refer to Section 26 05 01.

3.21 Testing

.1 Make tests of equipment and wiring at times requested.

.2 Tests shall include meggered insulation values, voltage and current readings to determine balance of panels and feeders under full load, and operation of each piece of equipment for correct operation.

.3 Supply meters, materials and personnel as required to carry out these tests.

.4 Test electrical work to standards and function of Specification and applicable codes in an approved manner. Replace defective equipment and wiring with new material and leave entire system in complete first class operating condition.

.5 Before energizing system, check all connections and set and calibrate all relays and instruments for proper operation, obtain necessary clearances, approval and instructions from utility company.

.6 Connect single phase loads so that there is the least possible unbalance of the supply phases.

.7 Submit all test results in report format.

END OF SECTION

## PART 1 - GENERAL

1.1 Shop Drawings

.1 Submit shop drawings for each system in Conformance with Section 26 05 01.

1.2 Product/Maintenance Data

.1 Submit product/maintenance data for each system for inclusion in maintenance manual conforming to Section 26 05 01.

1.3 Scope

.1 The scope of this Section will include the following systems.

.1 Cable management system
.2 Telephone system rough-in
.3 Communications rough-in
.4 Fire Assembly

## PART 2 - PRODUCTS

2.1 Cable Management System

.1 Supply and install new cable management system throughout corridor.

.2 The system shall be a continuous, rigid, welded steel wire mesh cable management system with the following features:

.1 Permits continuous ventilation of cable and maximum dissipation of heat.
.2 Continuous safety edge T-welded wire lip.
.3 Welded at all intersections.
.4 Straight sections 4"x 12" (100 mm x 300 mm) in configurations noted on the drawings.
.5 Constructed of carbon steel wire, ASTM A 510, grade 1008. Wire welded, bent, and surface treated after manufacture.
.6 Post fabrication finish of electro-plated zinc galvanizing: ASTM B 633, Type III, SC-1.
.7 Fittings: Field fabrication in accordance with manufacturer's instructions from straight sections.

.3 The support system shall be threaded rods as per manufacturer recommendations for specified system

.4 The necessary hardware, including splice connectors and support components furnished by manufacturer.

.5 The product shall be WBT tray. #WBT4x8 complete with support brackets and hangers at intervals as recommended by the manufacturer.

.6 The manufacturer shall be: WBT or approved equal.

2.2 Telephone System Rough-In

.1 Provide a #6 insulated green ground conductor from main service ground to telephone equipment backboard located on drawings.

.2 Concealed empty conduit with pull strings and junction boxes maximum 50' spacing. Conduit shall terminate above cable management system in corridor.

.3 Outlets where noted shall be single gang flush mounted in wall.

.4 Recess empty conduit

.5 Outlets if unwired are to be provided with blank cover plates

2.4 Communications Rough-In

.1 Concealed empty conduit with pull strings and junction boxes maximum 50' spacing. Conduit shall terminate above cable management system in corridor.

.2 Outlets where noted shall be single gang flush mounted in wall.

.3 Recess empty conduit

.4 Outlets if unwired are to be provided with blank cover plates.

2.4 Fire Assembly

.1 Provide fire rated assembly for communication cables entering any data rooms as noted on drawings.

.2 Fire Assembly shall be Specified Technologies Inc. model #EZDP433GK.

**PART 3 – EXECUTION**

3.1 Cable Management System

.1 Install cable management system at locations indicated on the drawings or if not shown, throughout entire corridor and in accordance with manufacturer's instructions.

.2 Support system every 2.4 m (8'-0") unless system is used within a telecommunication room. In that situation support every 1.5 m (5'-0").

.3 Cute wires in accordance with manufacturer's instructions.

.4 Cut wires with side action bolt cutters to ensure integrity of galvanic protective layer. Cut using side action bolt cutters.

.5 Cut each wire with 1 clean cut to eliminate grinding or touch-up.

.6 Install cable management system using hardware, splice connectors, support components, and accessories furnished by manufacturer.

.7 Suspend from structure or intermediate unistrut channel spanning across the corridor where access to structure is not available due to the concentration of mechanical ductwork and/or piping.

.8 Ground cable tray with continuous ground per O.E.S.C. and manufacturer instructions. Test to ensure minimum 5 ohms resistance.

.9 Locate cable management system minimum 9" EMI source including but not limited to fluorescent lights, transformers, motors, and power cables.

.10 Coordinate installation with communications contractor prior to ordering final system to ensure communication requirements are met.

3.2 Telephone System Rough-In

.1 Provide fire rated plywood backboard as noted complete with ground connection to main service ground.

.2 A 21 mm (¾") conduit as to be installed from elevator machine room to service backboard.

3.5 Communications Rough-In

.1 Outlets are to be installed complete with 21 mm (¾") conduit to ceiling space or nearest zone conduit (if applicable).

.2 Provide insulated bushings on all conduits terminated in ceiling space.

END OF SECTION

## PART 1 - GENERAL

1.1 Codes and Standards

.1 Ontario Electrical Safety Code-Current Edition

.2 CSA

.3 ULC

.4 Local Codes and Requirements

1.2 Submittals

.1 Shop Drawings:

.1 Submit shop drawings to the Consultant for review prior to ordering or installation.
.2 Shop drawings shall include manufacturer, model numbers, electrical data, wiring diagrams, and indicate conformance to above reference standards.
.3 One copy of all stamped approved shop drawings shall be included in maintenance manual.

.2 Operation and Maintenance Data:

.1 Provide operation and maintenance literature for all equipment indicating manufacturer and model of equipment, instructions for operation and maintenance of same, and parts list.
.2 Operation and maintenance data shall be included in the maintenance manual.

## PART 2 – PRODUCTS

2.1 Lighting and Receptacle Panels

.1 Panel boards shall be as manufactured by Eatons complete with circuit breakers and labeled with a CSA short circuit rating. Panel board and circuit breaker short circuit rating shall be as indicated on panel schedules. Provide copper bus sized in accordance with the contract drawings and CSA standards.

.2 Electrical characteristics, main sizes, quantities of breakers and quantity of branch circuits shall be as indicated on the drawings.

.3 Where noted on the drawings, panel boards serving isolated ground circuits shall be complete with a separate ground bar isolated from the panel board box by an insulating plate. Connect this ground bar directly to the main building ground using AWG #6 copper minimum or larger as required by table 16 of the Ontario Electrical safety Code (unless otherwise noted).

.4 Panel boards shall be supplied with doors, concealed hinges, chromed locks and hardware. All locks shall be keyed alike. Doors shall be fitted with plastic covered panel directory, with circuits and areas served typed in. Doors shall be provided with spring latches and semi flush cylinder locks and catch assemblies. Provide two (2) keys per panel board.

.5 All panel boards to have sprinkler proof enclosures.

.6 Branch Breakers: Shall be of the heavy duty, bolt-on type, single, two or three pole as shown on the drawings and of the ampere ratings indicated. They shall be thermal magnetic, non interchangeable, moulded, case type with toggle mechanism, and be designed for use as switches. Two and three pole breakers shall be common trip type with single handle. Handle ties will not be permitted. Each breaker to be quick-make, quick break type. Shall be approved for use with CU/AL cables.

.7 Breakers 200 Amps and above shall have adjustable long delay pickup/time, adjustable short delay pickup/time and adjustable instantaneous pickup.

.8 Provide lock-on devices for fire alarm, stairway, exit and night light circuits.

.9 Ground fault circuit interrupters where required shall be C.S.A Class A with 5 mA tripping level and shall have push-to-test button on front.

.10 Provide ground bus in each panel.

.11 Door and trim finish: grey enamel.

.12 Panel board depth is not to exceed 146mm.

.13 Cover plates shall be provided for all the blank spaces in the distribution section.

.14 Provide a nametag on the exterior of the enclosure. Nametag to indicate interrupting rating, voltage, service description, etc.

.15 Provide sequential phase bussing with odd numbered breakers on the left and even numbered on the right complete with each breaker identified by permanent marker identification as to circuit number and place.

.16 Main breaker, where required, to be mounted top or bottom of the panel to suit cable entry. When mounted vertically, down position shall trip the breaker.

.17 Branch circuit panel boards (250 AMP or smaller) must be equal to Eatons POW-R-Line-C PRL-1 or PRL-2 or approved alternate.

.18 Branch circuit panel boards shall be complete with transient voltage surge suppression filtering system integral to the panel tub and must be equal to Eatons #CPSBXCH208YSD or approved alternate.

.19 Power distribution circuit breaker panel boards (400 AMP or larger) must be equal to Eatons POW-R-Line-C PRL-4a with bottom side entry wire way or approved alternate.

.20 Acceptable Manufacturers:

.1 Eaton
.2 Schneider
.3 Siemens

2.6 Fuses

.1 Fuses: Shall be RK5 or HRC-I, Class J or L unless otherwise specified. Fuses in combination starters shall be HRC time delay type where specified.

.2 Motor fuses shall be sized according to the Drawings for the specified motor and starting cycle.

.3 Fuses shall be as manufactured by Buss, Gould, Little Fuse or approved equal.

.4 Provide three spare fuses of each type and size installed for maintenance.

**PART 3 – EXECUTION**

3.1 Installation

.1 Ensure all distribution equipment is installed with the associated clearances required by the Ontario Electric Safety Code.

3.2 Grounding

.1 Make all required ground connections from water meter and gas piping to main electrical service ground. Ground conductors shall be minimum #2/0 copper wire connected with approved fittings.

.2 Conduit systems shall not be used for grounding. Provide separate ground conductors in all raceways. Bond the ground wire to all boxes and luminaries.

.3 Install grounding connections to typical equipment included in but not necessarily limited to the following list. Service equipment transformers, switchgear, duct systems, frames of motors, motor control centres, starters control panels, building steel work, distribution panels, outdoor lighting.

.4 Test the resistance of the grounding system. Add additional ground wires and ground rods if required as directed by the Engineers and retest. Repeat this process until ground resistance is 2 ohms or less. Conduct all tests using Megger Null Balance or Megger Universal ground resistance test equipment.

.5 Test and log all ground connections at panels, switchboards and ground buses prior to and after the computer is put into operation. Trace and isolate all equipment causing current in ground wires to exceed one ampere. Replace such equipment if furnished as part of this contract.

.6 Test all receptacles for proper connections with a neon lamp type polarity tester. Check that ground resistance is less than 0.2 ohms with an Edgecumbe Peebles Ltd., ground loop impedance tester.

3.3 Electrical Connections for Mechanical Equipment

.1 Provide all required electrical connections to apparatus provided and/or supplied by Division 21, 22 and 23, the Owner and as part of the work of other Divisions of the Specifications.

.2 All power and control wiring over 50V and disconnects shall be installed by the Electrical Contractor.

.3 All control and low voltage wiring 50V and under shall be installed by the Mechanical Contractor or Controls Contractor. Coordinate all low voltage wiring with same.

END OF SECTION

## PART 1 - GENERAL

1.1 Codes and Standards

.1 Ontario Electrical Safety Code – Current Edition

.2 CSA

.3 ULC

.4 Local Codes and Requirements

1.2 Submittals

.1 Submit shop drawings to the Consultant for review prior to ordering or installation.

.2 Shop drawings shall include manufacturer, model numbers, electrical data, wiring diagrams, and indicate conformance to above reference standards.

## PART 2 - PRODUCTS

2.1 Fixtures

.1 Luminaires including fixtures and lamps shall conform to the light fixture schedule.

.2 Manufacturer:

.1 Acceptable Manufacturers:

1. Refer to luminaire schedule on drawing for acceptable and alternate manufacturers.

.2 Alternate manufacturers must provide equal fixtures to the satisfaction of the Engineer. Any alternates that do not satisfy the specifications or the Engineer will be rejected.

.3 Alternate fixtures must be on approved DLC list if base spec fixtures is on approved list for applicable energy benefits.

.4 Where alternates alter functional or visual design, or change the space requirements or mounting details, all such information shall be clearly presented to the Consultant for consideration and any costs associated with same shall be the responsibility of the Contractor.

.5 Once shop drawings are approved, no substitutions will be considered except for special circumstances such as delivery. Delivery reasons shall only be considered if at no fault to the Contractor. Contractor's failure to order fixtures within the schedule will not be acceptable.

.3 Similar luminaires shall be products of same manufacturer.

.4 Luminaires shall be completely factory assembled and delivered in cartons or in palletized form.

.5 All fixtures shall be recessed type in acoustic tile or drywall ceilings unless otherwise indicated. Provide drywall trim frame for recessed drywall applications.

.6 Troffers in ceiling shall be equipped with adjustable mounting brackets.

.7 All fixtures shall be provided with ballasts suitable for the fixture type and application. All ballasts shall CSA approved and ULC listed and comply with CSA standard C22.2 No. 74. Ballasts shall be suitable for 120 volt application as noted.

.8 Protective wire guards shall be provided for all fixtures where indicated on the drawings and where subject to damage.

2.2 Lenses

.1 In general, lenses shall be K12 distribution acrylic 0.125" (32mm) thick, shall have a recessed prismatic pattern of 3/16" (5mm) square based female cones running 45 degrees to the parallel and perpendicular axis to the panel. Provide vandal lenses where specified.

.2 Panel shall be made of ultraviolet inhibited injection moulded clear virgin acrylic.

.3 Panels shall be strain free and uniform in production. There shall be no fade-outs or streaks to detract from job performance.

.4 Lenses shall be low brightness, sparkling crystal panel that provides maximum efficiency and good brightness control in the direct glare zone.

2.3 Solid State Drivers

.1 Drivers shall be UL/CSA approved for application required and meet all applicable CEC, NEMA and ANSI Standards.

.2 Driver to provide full-range dimming, 0-10V, where indicated.

.3 Drivers shall comply with NEMA limits governing electromagnetic and radio frequency interference and shall not interfere with operation of other normal electrical equipment.

.4 Driver shall meet ANSI Spec C62.41 and IEEE standards regarding all applicable transient protection.

.5 Frequency of operation shall be 20 kHz or greater.

.6 Driver shall have an 'A' sound rating.

.7 Total harmonic distortions shall be less than 10%. Meet ANSI C82.77.

.8 Drivers shall have a power factor of 0.85 minimum.

.9 Driver warranty shall be minimum five (5) years.

2.4 LEDs

.1 Shall conform to ANSI C78.377 (latest edition)

.2 LEDs shall be 4500K unless otherwise noted. Verify colour of LEDs before ordering.

.3 LEDs shall provide a minimum 80 CRI unless otherwise noted.

.4 LED life shall be minimum 50,000 hours. LEDs shall be rated for L70 life span.

.5 Warranty shall be minimum 5 years.

2.5 Down lights

.1 Shallow construction

.2 Damp location rated for exterior mounting where noted

.3 Exterior down lights to come with adjustable trim/lamp

.4 Lamp to be LED

.5 Colour temperature to be 3500k

## PART 3 – EXECUTION

3.1 General

.1 Luminaires shall be stored in a dry and protected area. Confirm acceptable storage area prior to luminaire being delivered to site.

.2 Lenses for fixtures shall be stored on site and installed separately from the fixtures at a time to be directed by the Consultant.

3.2 Installation of Lighting Fixtures

.1 Provide all lighting fixtures and lamps as shown on the drawings and schedules.

.2 Include for assembly, and mounting of all fixtures, complete with all wiring, connections, fittings, hangers, aligners, box covers and accessories which may be required for any fixture to provide a complete, safe, fully operational assembly.

.3 Install fixtures in accordance with applicable reflected ceiling plans and/or as directed by the Consultant.

.4 In Equipment Rooms, shafts and similar secondary areas, install fixtures after the mechanical and other major work is roughed-in and adjust fixture locations as required at no cost to the Owner. Fixtures in these areas shall be installed at the same height unless otherwise directed.

.5 At the discretion of the Consultant, site test and demonstrate the operation of special application fixtures and adjust their locations within a reasonable distance to obtain the effects desired. Assist in the aligning and positioning of all adjustable fixtures, and ensure that fixtures with adjustable lamp holders are properly positioned to correspond with the lamps specified.

.6 Thoroughly review all ceiling types, construction details and mounting arrangements before placing fixture orders and ensure that all mounting assemblies, frames, rings and similar features are included for and match the required installation.

.7 Mount luminaires perfectly level and plumb. Luminaires shall fit tightly to ceiling without showing a space or light leak between frame and ceiling. Re-install improperly installed fixtures at no expense to the Owner.

.8 All fixtures and fixture assemblies shall be properly secured and supported. Support fixtures independent of the ceiling construction complete with all fasteners, framing and hangers as required. Do not secure fixtures to mechanical ductwork or other vibration producing apparatus.

.9 Where fixtures are suspended from the structure they shall utilize self aligning box covers with an additional ground wire from the outlet through the hanger for continuity of ground.

.10 Carefully co-ordinate the fixture installation with the work of other trades ensuring that the necessary depths and mounting spaces are provided. Do not alter fixture locations unless approved by the Consultant.

.11 All lamps shall be new and intact when the project is complete, and ready for acceptance. Replace lamps used for testing fixture assemblies at the discretion of the Consultant. Include a full lamp listing in the Operating and Maintenance Instructions.

.12 Provide safety chains on all surface mounted, T-bar mounted or suspended light fixtures. Luminaires shall have two chains, each supporting two corners of the luminaire (all four corners supported). Chain shall be #10 tensile jack chain, bright inc coated, with a strength of 400 lbs (180 kg). Attachments shall be made using a No. 10 "S" hook. Caddy fasteners may be used where applicable. "S" hooks must be closed after installation.

.13 Industrial luminaires, where suspended, shall have ½" (12mm) conduit hangers and ARB cylinder ball aligners. Length and location shall clear equipment, ducts and pipes. Metal strut (Flexibar or equal) may be used for mounting of luminaires in mechanical areas or electrical rooms.

END OF SECTION

## PART 1 - GENERAL

1.1 Codes and Standards

.1 Ontario Electrical Safety Code – Current Edition

.2 CSA Z32

.3 ULC

.4 Local Codes and Requirements

1.2 Submittals

.1 Shop Drawings:

.1 Submit shop drawings to the Consultant for review prior to ordering or installation.
.2 Shop drawings shall include manufacturer, model numbers, electrical data, wiring diagrams, and indicate conformance to above reference standards.
.3 One copy of all stamped reviewed shop drawings shall be included in maintenance manual.

.2 Operation and Maintenance Data:

.1 Provide operation and maintenance literature for all equipment indicating manufacturer and model of equipment, instructions for operation and maintenance of same, and parts list.
.2 Operation and maintenance data shall be included in the maintenance manual.

1.3 Acceptable Manufacturers

.1 EmergiLite

.2 Lumacell

.3 Beghelli

.4 AimLite

.5 Stanpro

## PART 2 – PRODUCTS

2.1 Battery Units

.1 New batteries shall be 12 volt D.C. and shall be designed to supply all units and all connected remote heads for a period of one half hour to an end voltage of 91%. The fully automatic charger shall regulate the charging current according to battery need and provide full recharge in 12 hours or less after full discharge.

.2 Battery units shall be complete with long life lead batteries, 10-year warranty and type integral heads as indicated on the drawings. Capacities shall be as noted on the drawings. Provide white finish.

.3 Battery units shall provide the required operating time for all connected lights and signs under emergency conditions in conformance with the OBC.

.4 Battery Units shall have line cord kit.

2.2 Remote Emergency Lights

.1 Lamp head and stem shall be injection molded, impact resistant, flame retardant thermoplastic, factory white.

.2 Lamp type to be LED. Provide wattage as indicated on drawings.

.3 The lens shall be inverse concave design and fully adjustable for aisle or area distribution during installation without the need to energize the lamp.

.4 Visual identification of distribution shall be provided through position of adjustment pins.

.5 Fixture shall be supplied with a canopy for installation on any four inch octagon box.

.6 Housing shall be so designed to allow for lamp replacement if required.

.7 Provide protective cages over lights in gymnasiums and other areas where they would susceptible to damage.

2.3 Pictorgram (Exit) Signs

.1 Exit signs shall be C.S.A.-22.2 Number 141-10 approved.

.2 Exit signs shall have white running man on green background complete with directional arrow where required and noted.

.3 Exit signs shall operate with universal A.C. input voltage as per site conditions at less than 1.5 watts and universal two-wire D.C. input voltage from 6 volts D.C. to 24 volts D.C. at less than 1.5 watts for single and double face signs.

.4 The exit sign shall be suitable for wall, end or ceiling mount.

.5 The faceplates shall be constructed of robust clear poly carbonate panel with multiple legend plates provided for field selectable directional routing.

.6 The frame shall be of a one-piece steel construction painted factory white.

.7 The light source shall be light emitting diodes (L.E.D.). The L.E.D. lamps shall provide illumination in normal and emergency operation and shall be mounted inside the exit housing, no on the face.

.8 An L.E.D. sensitive diffuser shall be mounted behind the legend to provide the letters with even illumination.

.9 The exit sign in a self-powered configuration shall stay illuminated during emergency operation for at least two hours upon A.C. failure.

.10 Provide protective cages over lights in areas where they would susceptible to damage.

**PART 3 – EXECUTION**

3.1 General

.1 Installation of system equipment shall be in accordance with Canadian Electrical Code and Ontario Building Code.

3.2 Battery Units

.1 Provide 120V receptacle for each battery unit mounted adjacent and at height of battery unit.

3.3 Emergency Lights

.1 Provide emergency lighting on battery back-up as indicated on the drawings.

.2 Emergency lighting is required to provide an average level of illumination of not less than 10 lux at floor level and a minimum level of 1 lux.

.3 Emergency Lights shall be mounted as noted on drawings. Where wall mounting is shown, mount 2.45m (8') above finished floor to the underside of the fixture. Where the ceiling height does not permit this mounting height, the minimum acceptable height is 2.13m (7)'.

.4 Provide protective cages over lights in gymnasiums and other areas where they would susceptible to damage.

.5 Provide an additional 10 single head remotes and 5 double head remotes to be installed after light level tests at the discretion of the Consultant and/or Building Inspector. Installation of spare devices shall be based on lowest wattage lamp indicated on drawings and include labour and material based on 5000mm of conduit and wire.

2.4 Pictorgram (Exit) Signs

.1 Every Exit Sign shall be visible from the exit approach. Provide suitable arrows or chevrons indicating direction of egress as required.

.2 Exit signs shall be illuminated continuously.

.3 Exit lights shall be mounted 2.45m (8') above finished floor to the underside of the fixture. Where the ceiling height does not permit this mounting height the minimum acceptable height is 2.13m (7)'.

.4 Exit lights at doors shall be mounted above the door where space permits otherwise it can be mounted directly adjacent to it but ensuring it is visible from the exit approach.

.5 Provide protective cages over lights in gymnasiums and other areas where they would susceptible to damage.

.6 Provide an additional 5 exit signs to be installed at the discretion of the Consultant and/or Building Inspector. Installation of spare devices shall include remobilization if required and labour and material based on 5000mm of conduit and wire.

3.4 Installation

.1 Include all necessary conduits, wiring and lamps for a complete operating system.

.2 Panel breakers feeding emergency lighting and exit lights shall be complete with circuit breaker lock-off device.

.3 Wiring to remote heads and exit light DC sockets shall be sized for a maximum voltage drop of 5%. In no case shall wiring be less than #10 AWG. Provide separate circuits for all exit lighting using separate raceways from non-emergency wiring.

3.5 Verification

.1 Following completion of the exit and emergency lighting installation, conduct tests of each system component and confirm battery operation life under emergency conditions.

.2 Conduct light level tests in upgraded areas upon completion of emergency lighting system installation.

.3 Upon completion of the tests, issue to the Consultant and Building Inspector a report for each test. Reports shall include:

.1 As-built location of each component
.2 Confirmation that it will remain operational for minimum required time in conformance with OBC
.3 Light level readings
.4 Technician's name and signature that performed the tests
.5 Owner Representative's name and signature that witnessed the tests.

.4 Verify all emergency lighting systems in area of work to the Consultant and Building Inspector as requested by them.

END OF SECTION

## PART 1 - GENERAL

1.1 Shop Drawings

.1 Submit electronic set of shop drawings to the electrical contractor for submission to the consultant for review.

.2 Submit shop drawings of materials and equipment to be supplied on the project. Submission shall include manufacturer, dimensions, appearance and specifications.

.3 Submit shop drawings for jacks, copper cable, faceplates, patch panels, ranks, cable managers, patch cords, etcetera.

1.2 Product/Maintenance Data

.1 Submit product/maintenance data for each system for inclusion in maintenance manual conforming to Section 26 05 02.

1.3 Scope

.1 The scope of this Section will include the following system.

.1 Voice/data network installations.

## PART 2 - PRODUCTS

2.1 Voice/Data Network Installations

.1 The scope of work for this system shall be as follows:

.1 This work includes Category 6 voice and data cabling.

.2 Copper services between the communication rooms and a voice outlet shall consist of the one plenum rated Category 6 compliant four-paired unshielded twisted pair cable, and one plenum rated Category 6 compliant four-paired unshielded twisted pair cables for a data outlet.

.3 Horizontal data cables shall be terminated in Cat. 6 jacks at the workstation end and in Cat. 6 path panels at the communications closet end.

.4 Patch panels shall be mounted in racks(s) and/or cabinets as specified.

.5 Horizontal voice cables shall be terminated in Cat. 6 jacks at the workstation end and in BIX1A4 punch down blocks in the main telecommunication room. Punch down blocks shall be mounted in BIX10A complete with designation strips and labels.

.6 A cable management system has been provided in the corridors for all voice and data cables. Outlets boxes and conduits have been provided at each outlet location. Conduits extend from the outlet box to the corridor and terminate adjacent to the cable management system.

.7 Additional conduits have been provided to complement the cable management system. Refer to the floor plans.

.8 Supply and install a complete voice and data structured cabling system ad outlined in the tender drawings and specifications.

.9 The installation of patch cords at the work station end shall be by this contractor. The length of the patch cords shall be as follows: 50% 4ft. long and 50% 6ft. long.

.10 The local area network system must be “protocol neutral” and provide users access into a variety of resources from any location within the building. An Ethernet backbone shall be utilized for the system with intelligent switching HUBS coordinating and managing data flow. The wiring configuration is based on a “physical star” topology in which cabling runs emanate in a radial pattern form the telecom rooms in which the intelligent switching equipment is located.

.11 The Contractor shall provide cabling from main Hub Room to each location shown on drawings for future wireless access points. Contractor shall coil 6.1 meters (20 feet) of cable in ceiling space at location to allow for relocation as required by Owner's I.T. personnel. Indentify each cable in main Hub Room.

.12 All work performed must conform to the latest version of the applicable codes, standards and regulations of authorities having jurisdiction.

| | | |
|---|---|---|
| .1 | A.N.S.I./T.I.A./E.I.A.-568-B | Telecommunications Cabling Standard |
| .2 | A.N.S.I./T.I.A./E.I.A.- 569 | Pathway and Space |
| .3 | I.S.O.-11801 | Generic Cabling for Customer Premises |
| .4 | B.I.C.S.I. | Telecommunications Distribution Methods Manuals |
| .5 | C.S.A. T530 | Commercial Building Standard for Telecommunication .6 Pathways and Spaces (ANSI/T.I.A./E.I.A.-569-A) |
| .6 | C.S.A. T528 | Administration Standards for the Telecommunications Pathway and Spaces. (ANSI/T.I.A./E.I.A.-606) |
| .7 | C.S.A. T527 | Commercial Building Grounding and Bonding Requirements for Telecommunications. (ANSI/T.I.A./E.I.A.-607) |
| .8 | C.S.A. C22.1 | Canadian Electric Code Part 1 - Ontario Electrical Safety Code |
| .9 | C.S.A. C22.2 No. 214 | Communications Cables. |
| .10 | C.S.A. C22.2 No. 232-M | Fibre Optic Cables. |
| .11 | O.B.C. | Ontario Building Code |

.2 The Owner has standardized on Panduit for the Structured Cabling System. No alternative will be accepted, except where noted. Bidders must identify alternate products with their bids, including Manufacturer part numbers. No alternates will be considered unless they are clearly identified in the tender submission.

.3 The successful bidder will be responsible for complete storage, handling, delivery and installation of all materials.

.4 The Telecommunications Contractor will be responsible for cleanup related to his/her scope of work. The Contractor will be excepted to remove all debris related to his work on a daily basis. Failure to comply will expose the Contractor to back-charges from the General Contractor or the Owner for clean-up on the Contractor's behalf.

.5 The Contractor will have only tradesmen who are fully qualified and experienced in the installation of a certified communications cabling system and wireless network systems.

.6 The successful Contractor will be required to submit the following documents, prior to being awarded the contract:

.1 Current training and certification status by the specified manufacturer of the Cabling System.

.2 Proof of R.C.D.D. on staff. Registration information must be submitted with the shop drawings.

.3 Experience in construction projects for related projects.

.4 Experience in construction projects working for General Contractors.

.5 Experience on troubleshooting and problem solving in data communication networks.

.7 At least one member of the Contractor's project team must hold a current R.C.D.D. accreditation. The R.C.D.D. will be responsible for quality control and certification of the project.

.8 A Project Manager and Foreman will be assigned to the project within 3 working days of contract award. These personnel will not be removed from the project without the prior consent of the Board's Representative.

.9 The Contractor must comply with all job-site union requirements for the duration of the project.

.10 The contractor will not subcontract any portion of the work, unless authorized in wiring by the Board's Representative.

.11 The Contractor must comply with all requirements of the Occupational Health and Safety Act, without exception.

.12 Outlets where noted shall be single gang flush mounted in wall or surface raceways.

.13 Outlets if unwired are to be provided with blank coverplates to suit related sections of this specification.

.14 A single manufacturer shall manufacture the specified cable and channel components. The manufacturer shall warrant the cable, channel components, and applications for a period as specified in the Warranty section.

.15 Category 6 Cable

.1 Cable shall be 4 pair, 24 A.W.G. solid bare annealed copper conductors.

.2 The jacket shall be printed with TRU-Mark™ 1000 feet to 0 feet marking system, C.M.P. (F.T.-.6) rated with blue outer sheath for data and white outer sheath for voice.

.3 Shall be suitable for use indoor, riser or plenum, and horizontal applications.

.4 Category marking shall be printed every one foot.

.5 Shall be independently verified to comply with T.I.A./E.I.A. 568-B.2 or T.I.A./E.I.A. 568-A-5.

.6 Shall be packaged in a way protecting the cable.

.7 Cable shall be A.N.S.I./T.I.A./E.I.A.-568-B-.2 and I.S.O./I.E.C. 11801 category 6 compliant.

.8 Attenuation shall be measured in accordance with T.I.A./E.I.A. 568B.2 and shall be maximum of 22.0 d.B. at 100 M.Hz.

.9 Cable shall be exhibit positive P.S.A.C.R. above 200 M.Hz.

.10 Cable shall be tested & characterized to 350 MHz.

.11 Cable shall be U.L. LISTED.

.12 An I.S.O. 9002 Certified Manufacturer shall make the Cable.

.13 Cable shall exhibit the following transmission characteristics:

| Frequency M.Hz. | NEXT dB | ELFEXT dB | Attenuation (d.B.) | Return Loss (d.B.) |
|---|---|---|---|---|
| 1.0 | 70 | 64 | 2.0 | 20.0 |
| 4.0 | 61 | 52 | 4.1 | 23.0 |
| 10.0 | 55 | 44 | 6.5 | 25.0 |
| 16.0 | 52 | 40 | 8.2 | 25.0 |
| 20.0 | 50 | 38 | 9.3 | 25.0 |
| 31.25 | 47 | 34 | 11.7 | 23.6 |
| 62.5 | 43 | 28 | 17.0 | 21.5 |
| 100.0 | 40 | 24 | 22.0 | 20.1 |

.14 The "Structured Cabling Plan" is an end to end solution which includes the data communication outlet and patch cord at the workstation and the patch panel, patch cords and racks at the HUB room.

.15 Approved Manufacturers:

Panduit Cat. # PUP6X04BU-U (DATA)

Panduit Cat. # PUP6X0WH-U (DATA)

.16 Faceplates

.1 Faceplates shall be U.L. Listed C.S.A. Certified

.2 Faceplates shall be constructed of stainless steel.

.3 Faceplates shall be 2.75 inches Wide by 4.5 inches High (69.8 millimeters by 114.3 millimeters) for single gang and 4.5 inches by 4.5 inches (114.3 by 114.3 millimeters) double gang.

.4 Faceplates shall be available to mount one, two, three, four, or six jacks in a single gang, and six or nine jacks in double gang configuration.

.5 Two and three-port faceplates shall be available with thermal ink transfer stenciled port indications for voice and data or voice.

.6 Faceplates shall provide for T.I.A./E.I.A. 606 compliant station labeling.

.7 All horizontal data cable installed in surface raceway shall be terminated with jacks as specified following in a 3-port "DECO adapter" plate on the raceway outlet location. Provide plate to match selected raceway colour and provide blanks in ports not used. Surface faceplates on top of the raceway will not be permitted.

.8 Approved Manufacturers:

.1 Panduit Cat. # C.F.P. Series

.17 Category 6 Modular Jack (Horizontal Cabling)

.1 Jacks shall be 8-position un-keyed.

.2 Each jack shall be individually constructed unit and shall snap mount in an industry standard manufacturer's opening (.760 inches by 580 inches).

.3 Jack housings shall be high impact 94 V.0. rated thermoplastic.

.4 Jacks shall have an operating temperature range of minus 10 degrees Celsius (14 degrees Fahrenheit) to 60 degrees Celsius (140 degrees Fahrenheit).

.5 Modular jack contacts shall accept a minimum of 2500 plug insertions without degradation of electrical or mechanical performance.

.6 Contacts shall maintain a minimum vertical deflection force of 110 grams.

.7 Modular jack contacts shall be formed flat for increases surface contact with mated plugs. These contacts shall be arranged on the PC board in 2 staggered arrays of 4 maximize contact spacing and minimize crosstalk.

.8 Modular jack contacts shall be constructed of Beryllium copper for maximum spring force and resilience.

.9 Contact Plating shall be a minimum of 50 micro inches of gold in the contact area over 50 micro-inches of nickel.

.10 Jack termination shall be industry standard insulation displacement contact, integral to the jack housing, laid out in 2 arrays of 4 contacts, positioned at angles to minimize the bending of terminated cables.

.11 Jacks shall utilize a paired punch down sequence. Cable pairs shall be maintained up to the I.D.C., terminating all conductors adjacent to its pair mate to better maintain pair characteristics designed by the cable manufacturer.

.12 Insulation displacement contacts shall utilize tin lead plated (60 percent tin per 40 percent lead) phosphor bronze.

.13 Jacks shall terminate 22-26 A.W.G. standard or solid conductors.

.14 Jacks shall terminate insulated conductors with outside diameters up to .050 inches.

.15 Jacks shall be compatible with single conductor impact termination tools (if applicable).

.16 Jacks shall include grey translucent wire retention stuffer caps to hold terminated wires in place while allowing conductors to be viewed in the I.D.C. housing. Stuffer caps may also be used for wire termination with parallel jaw pliers.

.17 Jacks shall be compatible with E.I.A./T.I.A. 606 color code labeling and accept snap on icons for identification or designation of applications.

.18 Jacks shall be designed for 100 Ohm U.T.P. cable termination.

.19 Jacks shall be U.L. VERIFIED for T.I.A./E.I.A. Component compliant Category 6e electrical performance.

.20 Jacks shall be U.L. LISTED 1863 and C.S.A. certified.

.21 Jacks shall be manufactured by an I.S.O. 9002 Registered Manufacturer.

.22 Jacks shall exhibit values, which exceed the following in a Channel Performance (ga) based on worst case in a 4-connector model verified at TEL Laboratories.

| Frequency<br>M.H.z. | ATTEN<br>d.B. | PSNEXT<br>d.B. | NEXT<br>d.B. | ELFEXT<br>d.B. | PSELFEXT<br>d.B. | Return Loss<br>d.B. |
|---|---|---|---|---|---|---|
| 10 | 6 | 55.6 | 57.7 | 45.5 | 43.6 | 28.7 |
| 62.5 | 15 | 41.8 | 44.8 | 33.1 | 29.4 | 20.7 |
| 100 | 18.3 | 37 | 40.3 | 27 | 25.4 | 18.5 |
| 155 | 23.7 | 33.9 | 36.7 | 22.7 | 22 | 16.6 |
| 250 | 31.3 | 30.7 | 33.4 | 21.4 | 17.6 | 16.2 |

.23 Jacks shall exhibit a propagation delay of less than 5 ns.

.24 Jacks shall exhibit a delay skew of less than 1.25 ns.

.25 Approved Manufacturer:

Data: Panduit Cat. #CJ688T3BU

Voice: Panduit Cat. #CJ688T3IW

.18 Category 6 Patch Panels

.1 Panels shall be made of black anodized .090 inch aluminum in 24 and 48-port configurations.

.2 Panels shall accommodate 24 ports for each rack mount space or "U" (1U = 44.5 millimeters [1.75 inches]).

.3 Panels shall be manufactured with a rolled-edge at the top and bottom for stiffness.

.4 Panels shall have modular jacks employing staggered array contracts with a flat "hairpin" design made of Beryllium copper with a minimum 50-mirco-inch gold plating on contact surfaces over 50-100 micro-inch of nickel compliant with F.C.C. part 68.

.5 Panels shall be available in both T568A and T568B wiring schemes.

.6 Panels shall be equipped with a termination made of fire retardant U.L. 940V0 rated thermoplastic and tin lead solder plated I.D.C.

.7 Panel circuit boards shall be fully enclosed front and rear for physical protection.

.8 Panels shall have port identification numbers on both the front and rear of the panels. The port identification numbers on the panel front shall be located so as to minimize obstruction by patch cords.

.9 Panels shall have optional rear cable support bar for strain relief, which shall clip to the rear of the patch panel.

.10 The panel front shall have two raised panel identification label fields to accept ½ foot label inserts.

.11 Panels shall have self-adhesive, clear label holders and white designation labels provided with the panel for each 8 port adapter.

.12 Panels shall provide wiring identification and colour code and maintain a paired punch down sequence that does not required the overlapping of cable pairs.

.13 Panels shall terminate 22-26 A.W.G. solid conductors, maximum insulated conductor outside diameter 0.050 inches.

.14 Panels shall be A.N.S.I./T.I.A./E.I.A.- 568-A- and I.S.O./I.E.C. 11801 Category 6e compliant.

.15 Panels shall be U.L. VERIFIED for T.I.A./E.I.A. Category 6e performance.

.16 Panels shall be U.L. LISTED 1863 and C.S.A. certified.

.17 Panels shall be made by an I.S.O. 9002 Certified Manufacturer.

.18 Panels shall exhibit a Component NEXT loss of at least the following:

| Frequency M.H.z. | NEXT d.B. | FEXT d.B. | Attenuation d.B. |
|---|---|---|---|
| 1.0 | 81.7 | 82.0 | .01 |
| 4.0 | 70.9 | 69.6 | .01 |

| | | | |
|---|---|---|---|
| 8.0 | 68.8 | 64.1 | .01 |
| 10.0 | 67.3 | 62.1 | .01 |
| 16.0 | 63.4 | 58.1 | .02 |
| 20.0 | 61.5 | 56.1 | .02 |
| 25.0 | 59.7 | 54.2 | .03 |
| 31.25 | 57.8 | 52.2 | .03 |
| 62.5 | 51.9 | 45.1 | .05 |
| 100.0 | 47.1 | 68.9 | .09 |

.19 Approved manufacturers:

Panduit 24 PORT Cat. #DP24688WGP

48 PORT Cat. #DP48688WGP

.19 Voice Terminations

.1 All voice cables shall be terminated in the main telecommunication backboard in the Hub Room in BIX1A4 connectors mounted in BIX10A mounts. Supply and install all necessary accessories, designation strips, labels, D-rings, etcetera, for a complete installation.

.20 Patch Cords – U.P.T. (Category6)

.1 Copper patch cords shall be 100% tested to Category 6 A.N.I.S./T.I.A./E.I.A.-568-A-4 specifications.

.2 Cord wiring shall be compatible with T568a and T568B wiring standards.

.3 Patch cords shall have yellow jacket.

.4 Provide in quantities as stated in the scope portion of this specification.

.5 Acceptable manufacturers:

Panduit Cat. # UTPCTGXYL (length as previously specified)

.21 Labels

.1 Labels shall be mechanically printed. Hand written labels are not acceptable.

.2 Supply and install self laminated labels at both ends of each cable. Cables shall be labeled as follows:

"ROOM #/PATCH PANEL LETTER/PORT#"

EXAMPLE: A cable in room 201, patch panel #A, port #12 shall be designated as 201/A/12.

NOTE: Labeling must be confirmed with Owner's Representative.

.3 Supply and install labels at each outlet location. Labels shall be affixed to the faceplate on the space provided by the Manufacturer.

.4 Workstation faceplates shall be designated in an identical duplicate manner as cables.

.5 Patch panel ports shall be identified in simple numeric form.

.6 Patch cords shall be identified at both ends in simple numeric form, not necessarily corresponding to port numbers.

.7 All cable and workstations shall be recorded in a hard copy "CABLE IDENTIFICATION LOG" which is to be handed over to Manager of Computer Services after cable testing and certification is complete.

NOTE: The faceplate identification numbers/tags MUST be added to the electronic versions of the floor plans. BOTH a digital and paper copy of this plan must be submitted. This will be considered part of the AS Built contracts closeout submittals. The electronic version of the floor plan will be provided in an acceptable ACAD format by the Consultant.

.22 Data wiring termination rack:

.1 All racks for this project are to be complete with the following features:

.1 Free standing, floor mounted.

.2 Standard 475 millimeters (19 inches) module compatible.

.3 44u or rack mounting space.

.4 Maximum dimensions: 550 millimeters (22 inches) Wide by 300 millimeters (12 inches) Deep by 2125 millimeters (85 inches) High.

.5 Each rack shall come complete with vertical cable managers installed (one mounted on each side). The vertical cable managers must run the full height of the rack mounting space and provide a minimum of 125 millimeters (5 inches) by 150 millimeters (6 inches) of cable management space on the outside of ganged racks and one 125 millimeters (5 inches) by 188 millimeters (7.5 inches) (minimum) in between each pair of racks. The vertical cable manager must have hinged front doors and back and side cut outs to allow for Patch Cords. It must also have lancets along the back of the cable manager to allow for the fastening of the horizontal cable to the outside of the manager itself.

.6 Each rack shall come complete with a hinged overhead cable manager installed, dimensions 100 millimeters (4 inches) by 150 millimeters (6 inches); both ends of the overhead management are to be completed with end caps.

.7 For all racks the Cabling Contractor is to supply and install horizontal cable managers (compatible with standard 475 millimeters (19 inches) equipment racks). The horizontal cable managers are to be hinged at the front with vertical access to he patch panels above and below. Each horizontal cable manager is to be 2-rack unit (2U) in height. One chimney stack per rack minimum. Supply a total of 1 horizontal cable manager per 48 port patch panel plus 1 additional horizontal cable manager per rack.

.8 Each rack is to come complete with one vertical power bar. Each power bar is to have 10 outlets (minimum) and surge protection. The power cord must be a minimum 1.8 meters (6 feet) in length to reach up to the overhead ceiling where it will plug into a 15 Amp receptacle (supplied by others). The power bars are to be non-switched and have 15 Amp twist lock receptacles, they are to be mounted on the left side of the rack at he back.

.9 In all cases racks and components are to be black.

.10 Approved manufacturers:

RF MOTE Cat. #RFM-1944-RB 19" standing rack complete with

RFM-RVCM - vertical managers

RFM-119 HCT- top mangers

RFM-HCTE - ends caps

RFM-76-PBVT - power strip

RFM-192D-HCM-TD - horizontal manger

Approved equals:

Middle Atlantic

Panduit CMR Series

.23 Grounding and Bonding

.1 The grounding and bonding requirements of this project shall meet C.S.A. T527 and it intender to work in concert with the cabling topology and installed in accordance with C.S.A. T530 (telecommunication pathways and spaces standard).

.2 A copper ground busbar will be established in each telecommunication room provided by the selected Electrical Contractor. Establish a communications ground that is continuous and permanent through all the telecommunication rooms.

.3 Ground all racks, cabinets and pathways to the telecommunication grounding system using green #6 A.W.G. insulated stranded copper ground wire. This grounding is to be provided by the Electrical Contractor.

**PART 3 – EXECUTION**

3.1 Voice/Data Network Installations

.1 Cabling Contractor is to adhere to all Standard, regulations and documents listed following.

.2 All products installed must meet or exceed all local, provincial and federal building, fire, health, safety and electrical codes.

.3 The responsibility of the network sub-contractor is to include but not be limited:

.1 Supply and installation of computer cabling to every outlet as noted on the drawings.

.2 Termination of computer cabling at outlet and distribution panel.

.3 Supply and installation of device faceplates in surface raceways and/or flush outlet boxes.

.4 Supply and installation of fibre optic cable.

.5 Supply and installation of computer network rack and distribution panels required for a complete and operational system. Interface server computer and hubs will be supplied complete by the Owner.

.6 Testing in conformance with noted procedures.

.7 Labeling of outlet faceplates and associated port on distribution panel. An “As Built” floor pan “outlets addresses” must be provided at the completion of the project.

.4 Co-ordinate work with Owner’s Computer Services personnel.

.5 The Owner’s Network Integrator must be present on site to witness and coordinate the required system testing. The cabling contractor and the Network Integrator must together perform a job walk through upon completion of testing, together sign the cabling test report to verify that network cabling is properly installed and performs to acceptable Owner’s Standard.

.6 The Electrical Contractor is to include all costs of the network sub-contactor in his tender. The Electrical Contractor must sub-contract and coordinate all work of the network sub-contractor.

.7 General installation practices shall be as follows:

.1 Supply and install cabling to locations as detained on floor plan(s). The Cabling Contractor shall use the cabling support system (support by others) to distribute the cables throughout the facility. Where the cables leave the cable support system and extend to the termination point they shall use the conduit provided or cable management system. Any horizontal exposed cable must be installed in surface raceways equal to Wiremold Series 500/700.

.2 All Cables and components to be installed and terminated in accordance with C.S.A., A.N.S.I./E.I.A./T.I.A. -568 and its' Amendments as well as UL Guidelines. Particular attention must be given to maintaining the integrity of the pair twists, bend radius and ensuing proper distance is kept from fluorescent light fixtures, electrical cables or any other source of E.M.I.

.3 Ensure A.N.S.I./E.I.A./T.I.A. -568A installation practices are followed. Cables are to be combed and bundled in a neat and organized manner. The Owner's Representative and/or Consultant will determine neatness of the installation. Cables that have not been properly combed and dressed will have to be re-dressed at the Cabling Contractor's expense. The Cabling Contractor shall coordinate with the Communications Consultant prior to termination in any communications room.

.4 The maximum horizontal run length is not to exceed 90 meters (300 feet). If the 90 meters (300 feet) constraint cannot be met, the Cabling Contractor is to notify the Consultant of any cables that exceed 90 meters (300 feet), prior to their installation.

.5 Any deviation from the cable routing, outlet and equipment locations shown on drawings must be approved by the Owner/Consultant and documented on as-built drawings.

.6 Avoid scraping, denting, or otherwise damaging cables, before, during or after installation. The Cabling Contractor without any additional compensation shall replace damaged cables.

.7 Ensure that all cable lengths are sufficient to allow for slack, vertical runs, wastage, connectorization and future moves.

.8 Bush, ream, and remove any sharp projections on all conduits prior to installation of communications cables.

.9 When terminating copper cables remove only enough cable jacket to perform termination, untwist pairs a maximum of 13 millimeters (1/2 inch) for Category 6, Enhanced Category 6 and proposed Category 6 cable.

.8 Faceplates

.1 Jacks and/or connectors shall be terminated to the appropriate cable and inserted in the correct orientation into the faceplate prior to the mounting of the faceplate.

.2 Cable slack shall be stored behind the faceplate in such a way that allows the minimum bend radius of the cable to be maintained as per the following: Fibre Optic Cable, a minimum of 3 feet (1 meter) slack with a minimum bend radius of 1.18 inches (30 millimeters). U.T.P. cable, a minimum of 1 foot slack with a minimum bend radius of 4 times the cable diameter. Care shall be taken when mounting the faceplate to avoid crimping or kinking the cables.

.3 Faceplates shall be securely mounted to a surface mounted housing, a recessed box, or box eliminator bracket.

.4 Faceplates shall be labeled with the appropriate port designations as per the E.I.A./T.I.A. 606 standard.

.9 Category 6 Jacks – U.T.P.

.1 Jacks shall be installed to provide minimal signal impairment by preserving wire pair twists as closely as possible to the point of mechanical termination. The amount of untwisting in a pair as a result of termination to the jack I.D.C. shall be no greater 0.5 inches (13 millimeters).

.2 Jacks shall be installed according to manufacturer's instructions and properly mounted in plates, frames, housings or other appropriate mounting device.

.3 Jacks shall be installed such that cables terminated to the jacks maintain minimum bend radius of at least 4 times the cable diameter into the I.D.C. contacts. Cables shall be terminated on jacks such that there is no tension on the conductors in the termination contacts.

.10 Horizontal Cabling

.1 Cable shall be installed to provide minimal signal impairment by preserving wire pair twists as closely as possible to the point of mechanical termination. The amount of untwisting in a pair as a result of termination shall be no greater than 0.5 inches (13 millimeters).

.2 Shall be installed according to manufacturer's instructions.

.3 Shall be installed such that cables can maintain minimum bend radius of at least 4 times the cable diameter. Cables shall be terminated in cush a way that there is no tension on the conductors in the termination contacts.

.4 Shall be properly labeled on front and back with the cable number and port connections for each port.

.5 Shall be installed in one continuous length unless specified in the contract document.

.6 Adhere to T.I.A. standard requirements regarding pulling tension and allowable lubricants.

.7 The Contractor shall assume the responsibility for any difficulties or damage to the cable during placement.

.8 Contractor shall provide Owner with all installed cable measurements.

.9 Firestop all openings where cable is installed through a fire barrier.

.10 All cables shall have sufficient slack for retermination five times at both ends. Strain relief shall be provided sufficiently to secure cables to terminal panels. All cables are to be neatly tie-wrapped (plenum rated tie wraps) through wiring trays.

.11 All data communication cables shall be separated from sources of electromagnetic radiation in accordance with T.I.A. Standard proposal SP-2072 and the following:

.1 If both data and small power cable (2 k.V.A. power circuits) are installed in grounded, ferrous metal conduit throughout the run, then no separation is required. (i.e. E.M.T. conduit).

.2 C.M.P. (FT-6) rated data cabling with no metallic raceway and power conductors (2 K.V.A. power circuits) in grounded raceway requires 5" (125 millimeters) clearance.

.3 For fluorescent luminaires the required clearance is 12 inches (300 meters).

.4 Clearance increased up to 24 inches (600 millimeters) for power circuits over 5 K.V.A.

.5 For large motor, transformer, power panels, etcetera, the required clearance is 40 inches (1 meter).

.6 Cables must be routed to avoid direct contact with steam piping, hot water piping or other heat sources to avoid thermal degradation.

.12 Testing

.1 The communications Contractor shall perform a full Category 6e test for every data drop installed in order to verify for a 100/1000 megabits per second solution. Testers to be used shall be Microtest Omniscanner or Fluke D.S.P. 4000.

.2 Upon completion of the testing, the Consultant may ask the Contractor to perform random tests of up to 30% of the cables. A penalty of $50.00 will be deducted from the contract amount for each cable that fails the test.

.3 All tests shall be in accordance with A.N.S.I./E.I.A./T.I.A. =568B.1, Section 11, Cabling Transmission Performance and Test Requirements.

.4 Category 6e field test parameters shall be:

.1 Wiremap

.2 Insertion loss

.3 Equal-level far end cross-talk (ELFEXT)

.4 Power sum Equal-level far end cross talk (PSELFEXT)

.5 Propagation Delay

.6 Length

.7 Near end cross talk (NEXT)

.8 Power sum near end cross talk (PSNEXT)

.9 Return loss

.10 Delay skew

.5 Voice cables shall also be tested for continuity, shorts, opens, grounds, correct polarity and length.

.6 Jacks shall be tested as part of the installed horizontal cabling system.

.7 Category 6e Jacks shall be tested as part of the channel for Length, DC continuity, NEXT, PSNEXT, Attenuation, Return Loss, ELFEXT, and PSELFEXT using a level IIe tester for Category 6e channel compliance.

.8 Test patch cords to portable tester must be designed for testing by the manufacturer. Field assembled patch cords are not acceptable. Field testers must use the appropriate jack/tester adapter specified for use with the cabling jack(s) specified within this document.

.9 The nominal velocity of propagation (N.V.P.) must be set specify to each cable manufacturer before testing. Portable tester to be calibrated on a minimum annual basis.

.10 Testing of horizontal cables is to be completed in accordance with the following test criteria. The testing must be completed on the Channel Level. Testing is to be completed from both ends o f the installed cable. Testing of the cabling must confirm to the following Standards: Category 6e: E.I.A./T.I.A. -568-A-5 'Transmission Performance Specifications for 4-Pair 100 Ohm Category 6 E.

.11 Cabling Contractor to produce a test report based on the cable schedules. The report should indicate for each cable, when it was tested successfully and the signature of the technician that performed the test, location, cable

type, cable number and tester make and model. A copy of the test report must be submitted to the Consultants for approval. The entire report must be signed by an authorized person for the Cabling Contractor at the end of the project.

.12 Correct all cable faults. Splicing of any cables will not be permitted, for any reason, unless prior authorization is received in writing from the Consultant.

.13 A "PASS" indication shall be obtained for all link or channel tests when tested using the appropriate level tester for the appropriate category.

.14 Testers shall be correctly set to test the type and manufacturer of the horizontal cable used in the link or channel being tested, including the correct N.V.P.

.15 Link attenuation shall be calculated as: *Link attenuation = cable attenuation + connector insertion loss + splice insertion loss.*

.16 The Owner's Computer Services personnel will conduct a random audit of the newly installed wiring (time frame 9- days from completion) and if the failure rate is greater than 10%, the Contractor will assume the cost of hiring a third party to complete a full audit of all the new network drops.

.13 Test Results

.1 Test results shall be submitted in hard and electronic format. Electronic reports shall be submitted on C.D. format in a Windows based database (Microsoft Excel is acceptable). All electronic reports must be accompanied by a certificate signed by an authorized representative of the company warranting the truth and accuracy of the electronic report. Hard copy of the report is to be submitted triplicate in three individual binders.

.2 The test result documentation shall be submitted to the Electrical Contractor no later than 10 working days following the completion of the installation.

.14 As Built Drawings

.1 This Contractor shall maintain an updated copy of as-built drawings on site at all times.

.2 At the end of the project, the Contractor shall obtain AutoCAD files from the Consultant and update them with the work performed by the Contractor. This Contractor shall provide one (1) electronic copy of updated as-built drawings.

.3 As-built drawings shall be submitted to the Consultant no later than 10 working days following the completion of the installation.

.15 Warranty

.1 The Contractor shall provide a system warranty covering the installed cabling system against defects in workmanship, components, and performance, and follow-up support after project completion for a period of one year.

.2 The Contractor shall warrant the cabling system against defects in workmanship for a period of one year from the date of system acceptance by the Board. The warranty shall cover all labour and materials necessary to correct a failed portion of the system and to demonstrate performance within the original installation specifications after repairs are accomplished. This warranty shall be provided at no cost to the Owner.

.3 The performance warranty shall warrant properly installed 100 M.H.Z. horizontal copper portion of the cabling system. Copper links shall be

warranted against the link performance minimum expected results defined in the T.I.A./E.I.A. 568A, and TSB-67.

.4 The Contractor shall provide a guaranteed twenty four (24) hour response time to any warranty claims.

.5 The Communications Cabling Contractor will be required to provide a 25 year manufacturer's Extended Component Warranty and an Application Assurance Warranty for the entire communications cabling system. Warranty shall be in effect form the date of substantial completion as certified by the Architect.

.6 The Communications Cabling Contractor shall provide certification number within two weeks of award of the project.

.7 The Communications Cabling Contractor shall provide a letter of Certification within two weeks of substantial completion. This document will include the following:

.1 Verification of the performance of the installed system.

.2 Manufacturer's certification number.

.3 Identification of the installation by location and project number.

.8 The system manufacturer shall provide in writing to the Owner that in the event of the demise or failure of the installing certified system installer, the manufacturer shall be responsible for providing another certified system installer/vendor to fulfill the remainder of the warranty conditions.

.9 Contractors must ensure that the selected network cabling components manufacturer and the wiring manufacturer have contractual relationships to ensure that the system warranty is a true "end to end" structured cabling system warranty.

.10 All costs for these warranties must be included in the tender amount.

End of Section

**APPENDIX**

**KPRDSB DIVISION 27 – COMMUNICATIONS**
**VERSION: 2024.1.31**

**In the event that there is a conflict between the preceding Division 27- Communications Section and the following Appendix KPRDSB Division 27 – Communications Section, the following Appendix KPRDSB Division 27 – Communications Section shall take precedence.**

## 27.1 Network and Telephony Cabling

a. Only first class workmanship will be accepted, not only in regards to durability, efficiency and safety, but also in regards to neatness of detail. Present a neat and clean appearance on completion to the satisfaction of the Engineer. Any unsatisfactory workmanship will be replaced at no extra cost.
b. Data cables to be Cat6 with dark blue outer sheath.
c. Phone cables to be Cat6 with dark blue outer sheath.
d. PA speaker cables to be Cat6 with white outer sheath.
e. All cable to be FT6 rated when used in plenum spaces.
f. All data drops to be home-run to nearest appropriate Communications Room.
g. The maximum cable run length is not to exceed 91.4m (300'). If this cannot be met, contractor must consult with Owner to determine a suitable alternative.
h. All products shall be new, of the latest version at time of bid, and brought to the job site in original manufacturer's packaging. Used equipment and damaged material will be rejected.
i. Take care during installation to prevent scratches, dents, chips, etc. Equipment with significant or disfiguring cosmetic flaws will be rejected.
j. In renovations/refreshes, Ethernet TIA cabling standard to be maintained consistently throughout school. For example, if TIA standard "A" is prevalent in the school, continue with "A" standard for all new cabling in the school.
k. All cabling to be run within existing conduit/raceways/cable trays/cable hooks/paths wherever possible.
l. Plenum cables are permitted in accessible ceilings. Provide 'J' hooks in these locations.
m. Fish conduit, clear blockages and outlet and clean out pull boxes at completion of installation. Leave conduit free of water or excess moisture. Install No. 12 gauge galvanized soft iron pull wire, or 3.2 mm (1/8 in) nylon pull cord continuously from outlet to outlet, through conduit and fasten at each box.
n. Install additional steel pull boxes in such a manner that, throughout entire system, there shall be not more than two 90 degree or equivalent bends or more than 30 m (100 feet) in each run, so that wire or cables may be pulled in or withdrawn with reasonable ease. Minimum space requirements in pull boxes having one conduit each in opposite ends of the box, shall be as follows:

| Maximum conduit size | Size of pull boxes in millimetres | | | For each additional conduit size increase width by:- |
|---|---|---|---|---|
| | Width | Length | Depth | |
| 21 mm | 150 mm | 300 mm | 100 mm | 50 mm |
| 27 mm | 200 mm | 400 mm | 150 mm | 75 mm |
| 35 mm | 250 mm | 450 mm | 200 mm | 75 mm |
| 41 mm | 300 mm | 600 mm | 250 mm | 100 mm |
| 53 mm | 350 mm | 750 mm | 300 mm | 125 mm |

o. Firestopping is required in all penetrations to fire rated assemblies according to Code.
p. All data and telephony drops and corresponding cables removed in construction, which are not re-used immediately as part of the project, are to be fully removed and un-terminated from the patch panel to which it connects. This includes full removal of the redundant cable from applicable ceilings/walls/conduits/raceways/cable trays/cable hooks, and the removal of labels

at the patch panel. If pulling the wire all the way out is not feasible, Owner may accept just un-terminating the affected cables from the patch panel and orphaning the cable in the ceiling.

q. BIX (including 'Gigabix') connectors are not acceptable for network cables. If a cable run is too short to reach the required termination point, a new home-run cable must be installed.
r. All existing data and telephony drops are to remain, unless explicitly stated otherwise. If any drops are removed, they must not be orphaned in the ceiling; they must be removed from the BIX panel or patch panel as applicable. For example PA speakers and Wireless Access Points shall re-use existing cabling, unless it is otherwise damaged.
s. Existing PA, phone, and network cables are not to be replaced, if functioning properly.
t. If construction is occurring inside a Communications Closet, contractor must protect the equipment by sealing it off from (i.e. by tarping it off). In cases in which this is not possible, contractor to engage with Owner to arrange for alternative measures.
u. All copper cabling to follow standards as required by TIA 568.0-D, 568.01-D, 568.02-D in each respective scenario.
v. Cabling systems to meet or exceed the specifications of the T1A-568A standards and ISO/IEC IS 11801, if applicable.
w. All cabling to be grounded and bonded as required by TIA 607-D standards.
x. All cabling to be concealed and protected in appropriate cable trays or conduit or raceway, unless otherwise safely and aesthetically hidden in ceiling or wall space.
y. Modular jacks to be Category 6 compliant.
z. Marettes are not to be used with any network or telephony cabling. Bean "B" connectors are acceptable when properly used.

## 27.2 Faceplates

a. Faceplates shall be UL Listed and CSA Certified.
b. Faceplate material and colour to match electrical faceplates.
c. Faceplate sizing to match electrical faceplates.
d. Faceplates shall be available to mount up to six in a single gang, and up to twelve in a double gang configuration.

## 27.3 Backbone Cable

a. Provide fibre optic backbone cables from the main Communications Room to all new or relocated secondary Communications Rooms, each as a dedicated home run.
b. Except where VoIP phone systems are in place, provide 25 pair cat3 backbone cable from the main Communications Room to all new or relocated secondary Communications Rooms, each as a dedicated home run.
c. Provide 12 pair cat3 cable from Phone BIX panel to 12 port patch panel in the Communications Rack, labelled as phone lines. Install in separate U from data patch panels.

## 27.4 Fibre Optic Connectors and Adaptors

a. Fibre Optic connectors shall be LC style multimode.
b. Fibre Optic Adapters shall be LC duplex multimode with ceramic sleeves.
c. All fibre optic cabling to follow standards as dictated by TA 569-E.

## 27.5 Communications Rooms and Patch Panels

a. No Communications Rooms or IT equipment within, are to be moved, added, or removed without explicit approval from Owner.
b. Communications Rooms moved or added must include fibre optic backbone cable to primary Communications Room.
c. Each secondary Communications Closets is to have a dedicated multimode LC fibre connectivity back to the primary Communications Closet
d. In schools with analogue phone systems, a 25 pair cat3 or cat5 or cat6 cable is required between closets.
e. Contractor to supply one floor mounted rack for each Communication Rooms.
f. Communications Rooms to have floor mounted racks, ideally installed 36" from back wall, and minimum of 24" from the back wall, as space allows.
g. Floor mounted racks to be 2-post, 45RU, and 19" module compatible, manufactured in steel (not aluminum). Example is the Panduit model R2P6S.
h. Patch panels to be mounted in 19" rack(s) and/or cabinets.
i. Racks must have 10/32" size screw holes.
j. Racks and patch panels must be black in colour.
k. Patch panel jack modules to be Panduit, such as model CJ688TGBL.
l. Racks to include hinged steal vertical cable management on each side, examples are the Panduit PR2VD06 and WMPV45E.
m. Racks to include to include four horizontal cable management 2U trays required per rack spaced with 1U gap between each tray. Example is the Panduit CMPHH2.
n. Racks much have top 2U must be reserved for patch panels.
o. All Patch panels should meet or exceed industry standards, fit into a 19" rack and be 1RU in height, black in colour, and flat style (not angled). Example of this is the Panduit model CPP24FMWBLY.
p. Panel shall have an adapter tray that accepts 6 six-pack adapter plates with LC multimode adapters. The panel adapter tray shall be removable from the front of the panel by sliding the tray forward. Panel shall have built in patch cable management incorporated into the front of the adapter tray and hold 12-24 fibre connections.
q. Raceway, conduit, J hooks, and other cabling accessories may be of other brands; so long as they can meet the required quality of TIA standards.

## 27.6 Labelling

a. Supply and install labels at each terminated location. Labels shall be affixed to the faceplate on the space provided by the manufacturer.
b. Labels shall be mechanically or digitally printed. Handwritten labels are not acceptable.
c. For Data and Voice cables, labelling at the faceplate (or on keystone for Wireless Access Points) on the client end and the network rack patch panel to be in the format *"ROOM# {dash} COMMUNICATIONS CLOSET LETTER {dash} DROP#".* For example, a cable terminating in Room 101 wired to Communications Room 'A' into patch panel drop 12, is to be labelled as "101-A-12" at both ends.

d. PA cables are to be labelled in the format *"ROOM# {dash} COMMUNICATIONS CLOSET LETTER".* For example, a PA speaker terminating in Room 101 wired to Communications Room 'A' is to be labelled as "101-A" at both ends.
e. BIX panels are to be labelled with corresponding room numbers.
f. PA cabling for speakers in hallways may use "HallA" and "HallB" instead of a room number. For example, Hall1-A for the first chain of speakers going to Hub A, Hall2-A for the second chain.
g. Port numbers within a room should be sequential and maintain sequential numbering across adjacent rooms.

## 27.7 Phone Systems

a. New voice jacks for existing digital (non-VoIP) systems are to be run and patched to main phone system. Confirm this location with Owner, as it is not always in the main Communications Room.
b. New voice jacks for new or existing VoIP phone systems are to be installed as a standard data drop to the nearest appropriate Communications Room.
c. All new voice cabling, whether for Digital or VoIP systems, are to be installed as cat6 with a dark blue outer sheath.
d. For all existing digital (non-VoIP) phone systems, a 25 pair cable must be terminated at the Voice Patch Panel into a 24 port loaded patch panel, with the other end terminated at the BIX1A punch down blocks mounted in BIX10A at phone system.
e. All new phone system installs are to be the 'Avaya IP Office 500v2' VoIP phone system with the following features (part number in brackets):
    I. IP Office R10+ IP Endpoint LIC (383110, minimum 8 per school)
    II. IP Office R10+ 2Channels Lic (383127)
    III. IP Office R11 LIC (396445)
    IV. Power Cord 18AWG (700289770)
    V. Rack Mounting Kit (700429202)
    VI. V2 System SD Card (700479710)
    VII. IP Office 500 Version 2 Control Unit (700501510)
    VIII. IP500 V2 Combo Card ATM4 V2 TAA (700504897)
    IX. J139 IP Phone (700513916, minimum 4 per school)
    X. J179 IP Phone (minimum 3 per school)
f. Contractor to collaborate with Owner to configure new phone systems and moves/adds/changes to existing phone systems.
g. For VoIP systems, Avaya J179 handsets are to be used for Principals, VPs, and secretaries; with Avaya J139 handsets in all other locations.
h. For all Digital (non-VoIP) phone systems, Avaya 9508 digital telephones are to be used for Principals, VPs, and secretaries: with Norstar Cat. #T-7208 handsets for all other locations.
i. For all phone systems (both VoIP and Digital) an 'emergency' phone is to be installed on the wall near the secretary or principal's desk. This is to be connected directly with an RJ11 cable back to dial tone from the provider, bypassing the phone system.

### 27.7.1 Elevator Communications

a. Install phone cable (Cat6 cable with dark blue outer sheath) from elevator room directly to the main phone system.
b. In coordination with Owner, connect elevator call number to an existing line with a line seizure device. This method will guarantee an outgoing connection for the elevator without requiring an additional phone line for the school.
c. Owner's preferred line seizure device is the Viking LSR-1: https://www.vikingelectronics.com/products/lsr-1/
d. Owner requires two pauses before the number to allow the line seizure device time to seize the lines prior to starting to dial.
e. Self-test of elevator communications is to be done only between 6pm and 6am. This prevents phone calls/lines in the school from being interrupted during regular operating hours.
f. Elevator communications self-test to be configured to self-test once each day per TSSA requirements: https://www.tssa.org/en/elevating-devices/resources/Documents/ED-290-20---Elevator-Phones---Various-Technologies.pdf

## 27.8 Wi-Fi & Wireless Access Points (APs)

a. Wherever possible mount APs in middle of room on dropped ceiling.
b. APs are not to be mounted greater than 15ft AFF, whether ceiling or wall mounted. Purpose is to allow for easy maintenance and optimal RF performance.
c. When installing APs in a dropped ceiling, cut discrete hole for the data cable to come through, allowing the ceiling tile to lay flat.
d. Owner's required AP model for most areas (including classrooms) is the Meraki MR36 . High density areas (including but not limited to gymnasiums and auditoriums) require the Meraki MR46. Outdoor Aps require the Meraki MR76 or the Meraki MR86. Substitution of a higher powered or newer model is acceptable with Owner's permission.
e. All Meraki licensing is to applied to the Owner's existing 'KPRDSB' Organization in Meraki dashboard.
f. Contractor to install/reinstall (mount) all APs.
g. Mounting instructions for MR42can be found here: https://documentation.meraki.com/MR/Installation_Guides/MR42_Installation_Guide . Mounting instructions for MR36 are here: https://documentation.meraki.com/MR/MR_Installation_Guides/MR36_Installation_Guide . Refer to the 'Installation Instructions' heading.
h. When mounting APs in T-Rail ceilings, the manufacturer's mounting kit must be used. The mounting kit can be provided by Owner, upon request. Mounting kit specs: https://meraki.cisco.com/product/wi-fi/wireless-accessories/wireless-accessories-mount-kits/wireless-accessories-mount-kits-ap-mount-kits/ma-mnt-clg-1/
i. Data drops for APs to be terminated as a fully contained data jack. An example is the Panduit CBX1WH-A surface mount box (link: https://www.panduit.com/en/products/copper-systems/faceplates-boxes/surface-mount-boxes/cbx1wh-a.html ) with the Panduit CJ688TGBU UTP Jack Module (link: https://www.panduit.com/en/products/copper-systems/connectors/jack-modules/cj688tgbu.html ).

j. APs that are temporarily removed during construction must be re-installed back to their original location, unless otherwise specified by Owner or the plans.
k. APs that are 'existing to be removed' must be safely removed by the contractor and returned to Owner.
l. When APs are being removed (to be reinstalled), APs must be securely stored by contractor and be temporarily labelled (i.e. with masking tape) with room number, and in cases with multiple APs per room to also include coordination N, E, S, W marking.
m. APs must always remain below or mounted on T-Rail ceilings, they must never be left or installed above a T-Rail ceiling. If a new T-Rail ceiling is installed under an existing AP, the AP must be moved to mount onto the new ceiling.
n. For APs that are damaged or not returned, a charge back cost of $1,000 will be applied.
o. For new APs not already existing, contractor must be provided a minimum of 5 business days notice to Owner, allowing Owner to prepare and supply APs to the contractor.

## 27.9 Public Address (PA) System

a. Contractor to collaborate with Owner to configure new PA systems and moves/adds/changes to existing PA systems.
b. All new or moved PA cables must be run back to the main PA system. Confirm this location with Owner, as it is not always in the main Communications Room.
c. Where handsets exist for PA speakers, they must remain or be replaced with new compatible handsets.
d. All new or moved PA cables must be terminated on a 36D BIX or BIX1A or similar modular Jack which must be installed 4'-6" A.F.F. where space permits.
e. All new PA Systems to be Carehawk model 'CH1000-2I-2A-2PG' with the following hardware features (part numbers in brackets): Email Alert Module (EAM), Switch Security Cards as needed (SS16), Administrative Phone (AC1) with PA-AP1 Power Supply, Telephone Communications Card (TC2-KIT), Digital 100 Watt Class D Paging/Power Amplifier 25V with enclosure (DAF100-25) as needed, Attenuator 25V (AT1) as needed.
f. Each 'SS16' to have a dedicated homerun, via cat6 cable, to the main PA system and terminated as a data jack next to the main PA System, then use a patch cable to plug it into the PA System.
g. PA system to include providing and connecting a mixer with the following inputs: XLR mic , 3.5mm input. CD players and FM tuners are not required for PA systems. To be in the main office.
h. Each room to be configured as its own dedicated channel.
i. Each hallway to be configured as a single channel but can be adapted as needed for specific circumstances. All hallways programmed to the hallway zone (Zone 2).
j. Hallways are to have speakers throughout, no more than 10 meters apart.
k. Require Cat6 cable run from main PA system to PA console (microphone or phone). The console is usually located in the main office.
l. Require a shielded 4 wire 18-gauge cable from main PA system to the tuner box. Note the tuner box is usually located in the main office near the secretary.

m. Configuration of PA system to include bells on school's schedule, pre-recorded messages including but not limited to lockdown messaging. If configuration is not able to be completed, contractor must work with Owner to arrange alternative.
n. PA horns to be TOA brand, model SC-630. Horns are not to be used interior.
o. Outdoor horns to be mounted no more than 10ft above ground level.
p. Speakers to be installed on the ceiling T-bars with 25 Volt transformers.
q. Speaker part number with transformer and white square grill: 8229/25/25 link: https://mcbrideloudspeaker.com/images/specs/8LS82219.pdfhttps://mcbrideloudspeaker.com/McBride-8229-25-25-Assembly.html . Speaker on its own is the McBride 8LS822-19 https://mcbrideloudspeaker.com/McBride-8LS822-19.html . Transformer on its own is the McBride MCT25 https://mcbrideloudspeaker.com/McBride-MCT25.html
r. In suspended ceilings, speaker rails must be supported by ceiling rails.
s. Ceiling mounted speakers are not to have call buttons.
t. Speakers in the following spaces to be programmed for emergency paging only: calming / quiet rooms and spaces used primarily by third-party facility partners (i.e. daycares).
u. Gyms and hallways require multiple speakers each, spaced approximately 20' apart.
v. In offices speakers are to be tapped to 0.25 Watt.
w. In all other applications speakers to be tapped to 1 Watt.
x. In shop classes, gyms, and mechanical rooms; a quantity of at least two (upwards of 4) McBride 8LS822-19 speakers are required, spread throughout the room to provide coverage throughout the room, tapped to 1 Watt each.
y. Shops, Gyms, and Auditoriums to have speakers wall mounted approx. 10 to 15 AFF, rather than ceiling mounted.
z. Shop classes to include 1 Carehawk HS100 "Handset Station" connected to the PA speaker.
aa. For new builds and school refreshes, the Carehawk 'Classroom Phone' is to be installed in or on the Control Panel of each classrooms, shop, and meeting space. Call button installation is also required in Control Panel.
bb. All classrooms to have a standard call button (in addition to above Classroom Phone).
cc. All existing handsets are to remain or be replaced with new HS100 handset or Carehawk Classroom Phone.
dd. Main cable from the PA system is to be wired to the handset. A separate cable is to be wired from the handset to the PA speaker in the room.
ee. There must be a white toggle call button installed in every classroom, meeting room, resource room, staff room, and office.
ff. In gyms, install a white toggle call button in a recessed box with cover.
gg. In shops install a white toggle call button as well as a PA handset.
hh. Do not connect to privacy switch in any room.
ii. Service loops are required at all terminated ends.
jj. PA systems to be installed in a clean, well organized, and thoroughly labelled manner. A proper backboard and cable management is required. Example pictured below.
kk. All wires not used on a speaker are to be taped individually or cut and taped so that the wires do not touch metal or each other.
ll. PA wiring should be fed first to the handset/call-button and a separate cable from there to the speaker itself. The white/blue pair is to be terminated to the speaker and not continue down to the call button. The white/orange pair is to be terminated to the call button. Leave service loop.

mm. Marette connectors are not acceptable. B-connectors are standard.

nn. Any spare speaker wires must have the bare ends cut off and taped together with electrical tape to avoid inadvertent contact with other parts or wires.

oo. BIX panels must have reasonable clearance to provide access to maintain.

pp. Final terminations to PA and Phone system may be completed by Owner, when/if consulted in advance.

Figure 1: PA system cabling and termination to BIX panel, with service loops and neat cabling

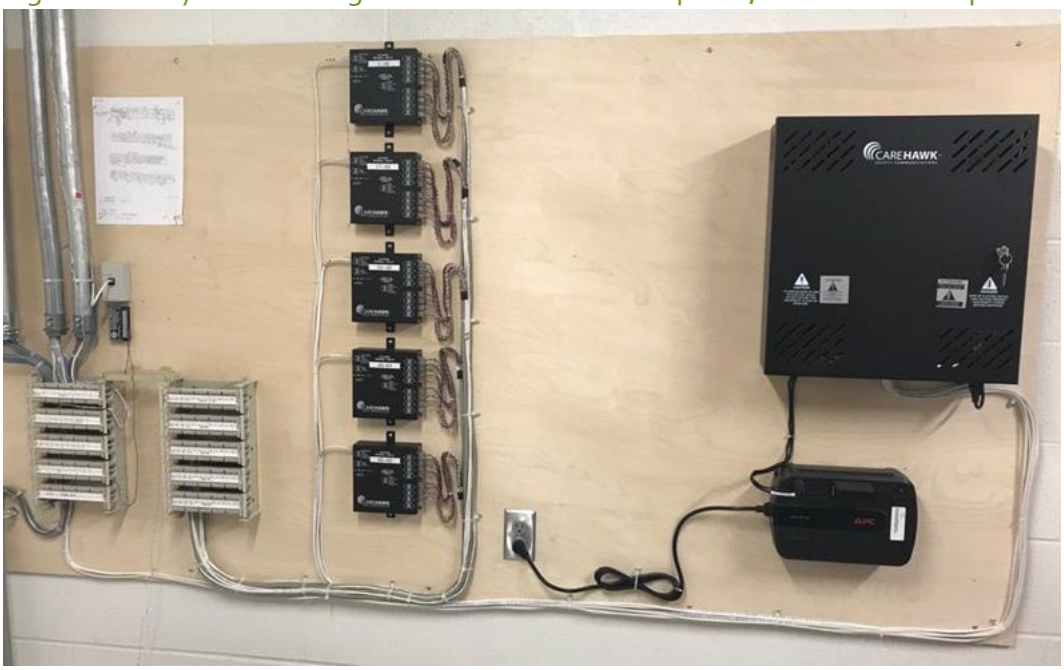
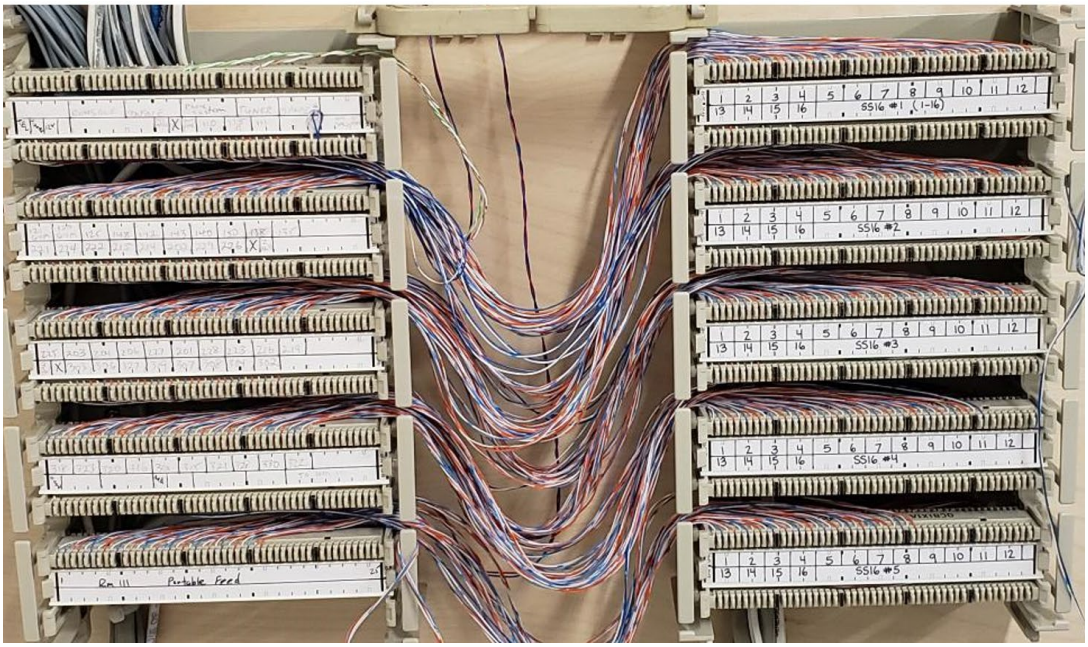



Figure 2: Labelling on BIX panel after cross-connects



## 27.10 Operational Technology

a. For purposes of this document Operational Technology (OT) includes, but is not limited to, Building Automation Systems, Card Access Systems, Irrigation Systems, Security Cameras, and Electronic Signs.
b. All data connections for Operational Technology to be installed under the same standards as all other data cabling, including cat6 cabling and a home run to the nearest Communications Room.
c. OT network connectivity is to be wired (ethernet) only. Wi-Fi connectivity for OT is not permitted. If a vendor would like to request Wi-Fi connectivity for OT, they must formally request it through Owner's ICT department and request an exemption.
d. Network drops and interfaces for all operational technology are to be configured in collaboration with Owner and with an IP address, Subnet Mask, and Default Gateway determined by Owner, to ensure network security requirements are met.

### 27.10.1 Electronic Signs

a. Electronic signs must utilize cloud-based (internet) management consoles.
b. The cloud-based management must be compatible with Chrome and Edge modern browsers and must not require the installation of additional software or plugins.
c. Sign management systems requiring locally installed software are not permitted.
d. Sign management systems requiring layer 2 network access are not permitted.
e. Remainder of Electronic Signs are provided in the appropriate Division.

### 27.10.2 Security Cameras

a. Security cameras must be Verkada brand and licensing applied to Owner's existing Verkada Command account (or purchased through Owner) and installed to the manufacturer's specifications with applicable mounting accessories such as the ACC-MNT-2, ACC-MNT3, ACC-MNT-8, and ACC-MNT-10 as required.
b. Owner's required model for outdoor dome cameras is Verkada CD52-E.
c. Owner's required model for outdoor bullet cameras is Verkada CB62-TE.
d. Owner's required model for standard indoor dome cameras is Verkada CD52.
e. Owner's required model for indoor and outdoor fisheye/360-degree cameras is Verkada CF81-E.

### 27.10.3 Card Access

a. Card Access hardware must be RBH brand utilizing model RBH-UNC-500-422M as the primary panel and RBH-RC-2 for secondary panels as required.
b. Card readers (aka access points) to be the RBH-FR-360N-SWPL.
c. Panels are to be installed in a RBH approved enclosure such as the ENC1.
d. Power for panels is to be supplied through appropriate transformers, connected to a surge protected power bar.
e. Panels to be installed within approved Communications Rooms
f. All hardware to be wired as one Axiom network per building.
g. Configuration of card readers and panels to be done in collaboration with Owner, into Owner's existing Axiom enterprise system.

h. Other door hardware, such as strikes, crash bars, and accessibility operators to be determined in collaboration with other door & entrance specifications in the appropriate Division.

### 27.10.4 Synchronized Clocks

a. Carehawk's synchronized clock system to be utilized with the Master Clock (24ZBMC100) with DC Clock Power Supply (AL600ULPD8).
b. Each room to have Carehawk brand clock, model 14" Analog Secondary Clock (24ZBM14R).
c. This system is to be integrated with and installed in the same room as the CH1000 PA System as specified in section 27.9.e, per manufacturer's recommendations.
d. Configuration and integration of system to be done in collaboration with Owner.

## 27.11 Third-Party Facility Partners

All other standards within this document are to be adhered to in these spaces. Specific additional requirements for these spaces are listed here.

a. The priority for location of third-party IT equipment is to utilize a space within the rented area. If no reasonable space exists for the operator/renter's IT equipment they may, where space allows, place their equipment in Owner's Communication Room. In these cases, the Facility Partner's cabling is to be connected to their own independent data rack, keeping it separate from Owner's equipment, creating both a logical and physically separate entity for the networks.
b. Facility Partner is responsible for supplying and paying for their own internet and telecommunications access and infrastructure.
c. Facility Partner may choose to have their service providers install their modem/demarcation equipment into KPR's Communication Room but must connect to the Facility Partner's own data rack.
d. Facility Partner is responsible for the setup and maintenance of their own network, telecommunications, and other technology infrastructure.
e. Any cabling required for network connectivity, telephone systems, point of sale systems, et al must be specified by Facility Partner.
f. Facility Partner's wireless communications equipment is not to cause interference with Owner's wireless communications. While the Owner may at times collaborate to assist, Facility Partner is responsible for any configuration and costs associated to ensuring this need is met.
g. PA speakers in these spaces to be programmed for emergency paging only.
h. If Facility Partner does not provide specifications for data and telecom infrastructure, the following defaults will be applied: 1x network drop installed in each room, 1x phone drop installed in each room, 1x network drop installed above ceiling in each room.

## 27.12 Testing and Documentation

a. All cables and termination hardware shall be tested for defects in installation and to verify cabling system performance.
b. All call buttons and speakers to be tested individually.

c. As-Builts to include all newly installed or moved telephone systems, PA systems, network closets, and back bone cable runs.

## 27.13 Audio-Visual Equipment

The following guidelines are for standard instructional spaces. Other instructional spaces require explicit coordination and consultation with Owner: low/high overhead spaces, dual screen configurations, and other rooms that are not considered a standard classroom.

a. All A/V equipment to be supplied and installed by owner unless otherwise noted (i.e projection screen).
b. A/V equipment not to be connected to emergency stop, power lockout mechanisms, timers, switches, or advanced controls.

### 27.13.1 Interactive Display [new builds only]

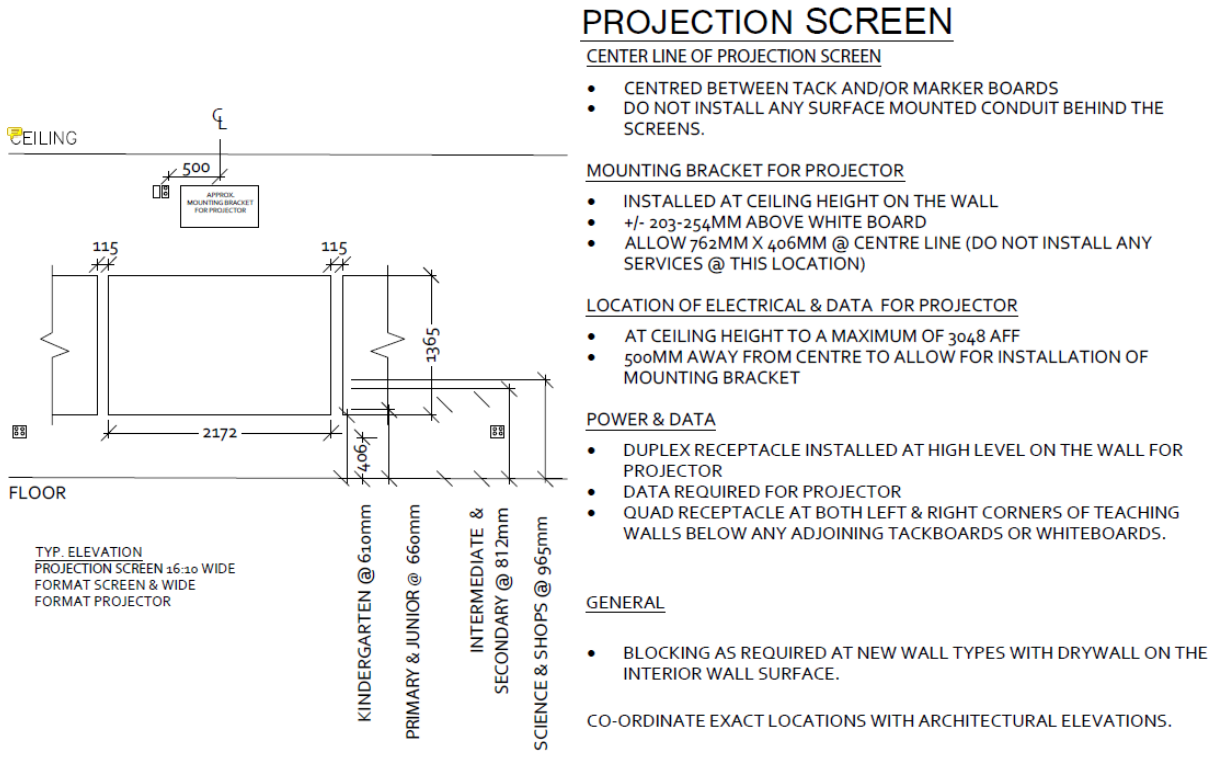
a. Kindergarten classrooms and collaboration spaces to have interactive displays, rather than a projector/projector screen.
b. Interactive displays in kindergarten classrooms to be 75" SMART Board GX075-V2 interactive display with embedded OS, 20 continuous points of touch. To be installed on the SMART Floor Stand Electric, FSE-410.
c. Interactive displays in collaboration spaces to be 65" SMART Board GX065-V2 interactive display with embedded OS, wall mounted.
d. Substitution of a higher powered or newer model is acceptable with Owner's permission.

### 27.13.2 Projectors in Classrooms

a. Projectors to be Epson brand, with the following specifications:
    I. Compatible with Epson Projector Management Software
    II. Minimum 4000 lumens
    III. Laser-interactive
    IV. Support aspect ratio of 16:10
    V. Ethernet network adaptor
    VI. 5-year warranty (as included from manufacturer)
b. An example of a product meeting these specifications is the Epson model 760wi.
c. Substitution of a higher powered or newer model is acceptable with Owner's permission.
d. Projector to be installed above projection screen +/- 203-254mm by Owner.
e. Allow 762mm X 406mm at centre line for projector mounting bracket
f. Do not install any services including surface mounted conduit at this location.
g. Blocking required behind new drywall at location of projector install.
h. Blocking required over existing drywall at location of projector install.
i. Duplex receptacle and data for projector to be installed at high level to a maximum of 3048mm AFF and 500mm from centre of projection screen.
j. Where existing conduit does not exist, cabling for projector and speaker(s) to be surface mounted and run through channel between projection screen and adjoining whiteboard/tack board ending in surface mounted control box.
k. Per below drawing (*Figure 3*) projection screen to be installed at specific height AFF based on room use.

- Kindergarten @ 610mm
- Primary & Junior @ 660mm
- Intermediate & Secondary @ 812mm
- Science and Shops @ 965mm

Figure 3: Projection Screen Installation for Classrooms




## 27.13.3 Projection Screens for Classrooms

Screen specifications to include:

I. projection quality whiteboard compatible with ultra short throw projectors
II. 100-inch diagonal measurement
III. support 16:10 aspect ratio
IV. magnetic
V. dry erase
VI. 5-year warranty (as included from manufacturer)

a. Example of a product meeting these specifications is the DA-Lite Screen 16:10 Wide Format model 25940. Substitution with newer model is acceptable with Owner's permission.
b. Height of whiteboard installation to be confirmed by Owner under the guidelines shown in *Figure 3* below.
c. No services (i.e., surface mounted conduit) are to be installed where whiteboard is to be installed.
d. Whiteboard to be installed on teaching wall between whiteboards/tack boards with a minimum 115mm gap between boards.
e. Grade 1 – 12 Classrooms to have Projector and Whiteboard, rather than an interactive display.

## 27.13.4 Speakers and Amplifiers in Classrooms

a. Classroom Audio Kit to be the TOA brand IR-800 Classroom System #3.
b. Speaker to be installed in T-Rail ceiling in centre of Classroom.
c. Amplifier & microphone to be installed using wall mount bracket, next to projection screen and power receptacle.
d. Substitution of a higher powered or newer model is acceptable with Owner's permission.
e. Exception to these specifications is listed below in27.14.5.

## 27.13.5 Charging Towers/Mobile Technology Storage

a. Charging towers to be included in all elementary instructional spaces.
b. No services, including surface mounted conduit (new or existing), are to be run behind space where charging tower is to be installed.
c. Space of 355mm W must be available on wall for installation and door opening.
d. Require a duplex receptacle within 250mm of the charging tower.
e. Towers to be Powergistics brand, model Flex20 USB.

## 27.13.6 Science and Shop Classrooms

All above standards for classroom technology and infrastructure apply, with the following exceptions;

a. Projection screen to be installed at 965 mm to provide students with clear view of board above science/shop bench.
b. Projector to have conduit at 2" (51mm) from projector location to science/shop bench at side of shelving. The run for this conduit is not to exceed 30' (9144mm). Runs beyond the limit of 30' must be communicated to Owner to determine suitable alternative.
c. Science/shop bench to have duplex receptacle installed inside bench for other Owner purchased peripherals (i.e., amplifier).
d. Shop classrooms to have the TOA IR-800 PLUS Classroom System KIT#2 with speakers equally spaced in the room, (instead of the IR-800 Classroom System KIT#3) with amplifier installed at the bench.

## 27.13.7 Learning Commons

Audio and visual systems for learning commons to utilize the same A/V systems as found Classroom technology standards above, including;

I. Projector
II. Projection screen
III. Two charging towers
IV. Speakers, microphone, and amplifier
V. Interactive display

## 27.13.8 Gymnasium A/V Equipment

Infrastructure for power and conduit for speakers and associated cabling to be supplied and installed by contractor.

Audio and visual systems for gymnasiums & stage to be selected and installed by owner.

- Da-Lite Rear Projection 1 1 Screen
- Epson Projector Epson L630U Laser Projector or equivalent
- Wall Rack
- Rack Storage Drawer
- Rack Lock Kit
- Dual Wireless Handheld Microphones
- Mixer
- Bluetooth Receiver
- Rack Connection plate
- Rack Surge Protector
- Rack Internal Cabling
- Active HDMI
- Speakers
- Speaker cabling