UNIVERSITY OF TORONTO - MISSISSAUGA

Pre-Engineered Building

3265 Principals Road
Mississauga, Ontario

Project Number: 2301

SPECIFICATIONS

Baird Sampson Neuert Architects
November 2024

1 PROJECT INFORMATION

1.01 Project Name and Address

.1 Pre-Engineered Building located at:
University of Toronto Mississauga
3265 Principal's Road
Mississauga, Ontario

2 CONSULTANTS

2.01 The following is a list of Consultants involved in the Work of this Section as noted.

.1 **Architectural (Prime Consultant)**

Baird Sampson Neuert Architects
317 Adelaide Street, West, Suite 1002
Toronto, Ontario, M5V 1P9

Tel No.: 416-363-8877

.2 **Civil Consultant**

MTE Consultants Inc.
970 Lawrence Avenue West, Suite 600
Toronto, Ontario, M6A 3B6

Tel No.: 416-489-7888

.3 **Landscape Consultant**

FRP Inc.
1877 Davenport Road
Toronto, Ontario, M6N 1B9

Tel No.: 416-533-4990

.4 **Mechanical, Electrical, Fire Protection, Telecommunication and Security**

The HIDI Group Inc.
155 Gordon Baker Road
Toronto, Ontario, M2H 3N5

Tel No.: 416-364-2100

.5 **Audio/Visual Consultant**

Smith + Andersen
100 Sheppard Avenue East, Suite 1100
Toronto, Ontario, M2N 6N5

Tel No.: 416-487-8151

END OF SECTION

Division 00 - Procurement and Contracting Requirements

Division 01 - General Requirements

Division 02 - Existing Conditions

Division 03 - Concrete

Division 05 - Metals

Division 06 - Wood, Plastics, and Composites

Division 07 - Thermal and Moisture Protection

Division 08 - Openings

Division 09 - Finishes

Division 10 - Specialties

Division 11 - Equipment

Division 12 - Furnishings

Division 20 - Mechanical Support

Section	Title	Discipline	Page

Refer to Mechanical Consultants Specifications

Division 21 - Fire Suppression

Section	Title	Discipline	Page

Refer to Mechanical Consultants Specifications

Division 22 - Plumbing

Section	Title	Discipline	Page

Refer to Mechanical Consultants Specifications

Division 23 - Heating, Ventilating, and Air Conditioning (HVAC)

Section	Title	Discipline	Page

Refer to Mechanical Consultants Specifications

Division 25 - Integrated Automation

Section	Title	Discipline	Page

Refer to Mechanical Consultants Specifications

Division 26 - Electrical

Section	Title	Discipline	Page

Refer to Electrical Consultants Specifications

Division 27 - Communications

Division 28 - Electronic Safety and Security

Division 31 - Earthwork

Division 32 - Exterior Improvements

Division 33 - Utilities

Appendix (Work provided under Separate Contract, information provided for reference only)

END OF SECTION

1.1 WORK COVERED BY CONTRACT DOCUMENTS

1.1.1 Work of this Contract comprises **providing General contractor services to a stand alone Pre- Engineered Building, approximately 950 GSM**

1.1.2 The Work of this Contract includes furnishing labour, materials, equipment, services, and other related expenses to execute complete construction of facility specified under Contract Documents.

1.1.3 Without limiting generality of foregoing, Contractor shall be responsible for coordination of various parts of the Work so that no part is left in an unfinished or incomplete condition.

1.1.4 Place of the Work is located at:

1.1.4.1 [University of Toronto – Mississauga Campus

3359 Mississauga Rd,

.1 **Mississauga, ON L5L 1C6]**

1.1.5 Contract Type: Project is to be governed by a CCDC 2-2020 contract.

1.1.6 Sustainability Targets: **University's tri-campus energy charter** Refer to Section 01 35 21 for additional requirements.

1.2 COORDINATION WITH OCCUPANTS

1.2.1 Project involves work that is adjacent to structures which are in use or are occupied.

1.2.2 Accordingly, Contractor, without in any way limiting its responsibilities under Contract, shall take all reasonable steps to manage and maintain fire exits, building access and egress, continuity of electric power and all other utilities, suppression of dust and noise, avoidance of conditions likely to propagate mould of any kind and all other steps reasonably necessary to promote and maintain safety and comfort of users and occupants of such structures or adjacent structures.

1.2.3 Adjacent Grounds and Paleomagnetism buildings will be occupied during the course of construction

1.2.4 Before entering existing premises to carry out the Work or to obstruct or take out of use any area of existing premises, or to cause any other interference, request meeting with Consultant and Owner in order to reach agreement as to time and length of time required for interference, possession, obstruction or removal from use of such area or services.

1.3 WORK BY OWNER OR UNDER OTHER CONTRACTS

1.3.1 Ensure full cooperation with Other Contractors to enable smooth execution of such contracts without interference or delay to Work of this Contract. Coordinate Work of this Contract with work under separate contracts.

1.3.2 Immediately report defects, which affect quality and performance of the Work, in writing to Consultant. Commencement of parts of the Work of this Contract, in

existing areas and in areas provided by other contractors, will be deemed to signify Contractor's acknowledgment and acceptance of those parts of the Work.

1.3.3 NIC Work: "NIC" refers to Work not performed or provided under this Contract. "NIC" signifies "Not In this Contract" or "Not a Part of Work by Contractor". NIC Work may be shown on Drawings and in scheduling amount of time and materials necessary for completion of Contract. Work not to be included in the Contract, as noted "NIC" on the Drawings, is by provisions of Contract addressing construction by Owner or Other Contractors.

1.3.4 Generally, the following Work will be performed by Owner or Other Contractors:

1.3.4.1 Permanent keying and hardware cylinders. Note: construction cores and keys are to be supplied by Contractor.

1.3.4.2 Ductless fumehoods will be supplied by UTM

1.3.4.3 Loose furniture procurement and installation

1.3.5 Provide Other Contractors reasonable access and sufficient time to review work of this Contract and to assess its impact on their work.

1.4 PHASING AND WORK SEQUENCE

1.4.1 Phased Construction Schedule: Schedule and construct Work in phases to allow for facilities continued or intermittent use of premises during construction. Do not close portions of facilities until alternate usage is made available via completed Work phases.

1.4.2 Maintain operational life safety systems and public access to exits in occupied areas during all phases of the Work.

1.4.3 Provide Owner with minimum of 10 Working Days' written notice of intention to commence work in a room, or area(s) of existing building(s) so that Owner may vacated or prepare space(s).

1.4.4 Phasing Description:

1.4.4.1 Description of construction phasing and outline of activities is intended to serve only as general guideline. Owner and Consultant may consider alternative proposals by Contractor, to facilitate phased construction using construction means and methods Contractor may wish to employ.

1.4.4.2 Work Phases: Refer to phasing diagrams on Drawings for required phases of Work.

1.4.4.3 Phase: **NA**

.1 Description: **[Phase Description]**

.2 Phase Start: **[Phase Start]**

.3 Phase to be Complete by: **[Phase Complete]**

.4 Constraints: **[Constraints]**

1.4.5 Temporary Work: Provide temporary closures, screens and barriers to separate and protect completed areas of the Work from the areas of the Work still under construction to fullest extent possible and in accordance with the requirements of the authorities having jurisdiction.

1.4.6 Updated Construction Schedule: Before starting Work on each phase, submit updated copy of the Construction schedule. Schedule must indicate sequence, commencement, and completion dates, and, if applicable, move-out and move-in dates for Owner's personnel for all phases of Work.

1.4.7 Coordination with Owner: Contractor must cooperate and coordinate with Owner for moving Owner's equipment into the building when Work is ready for intended use.

1.5 OWNER-SUPPLIED / CONTRACTOR-INSTALLED PRODUCTS

1.5.1 Owner Responsibilities:

1.5.1.1 Order and pay for Owner-supplied Products not already in Owner’s possession.

1.5.1.2 Arrange and pay for delivery of Owner-supplied Products F.O.B. the site, within time frames required by Contractor’s progress schedule. If delivered sooner than required by Contractor’s latest progress schedule submitted to Owner, arrange, and pay for delivery to a temporary storage location and subsequent delivery to the site.

1.5.1.3 Advise Contractor in writing of the value of Owner-supplied Products for Contractor’s insurance purposes.

1.5.1.4 Arrange and pay for delivery to Contractor of reviewed Shop Drawings, Product data, samples, and manufacturer’s installation instructions.

1.5.1.5 Inspect deliveries jointly with Contractor.

1.5.1.6 Submit claims for transportation damage.

1.5.1.7 Arrange for replacement of damaged, defective, or missing items identified at time of delivery.

1.5.1.8 Arrange for manufacturer's field services.

1.5.1.9 Arrange for delivery of manufacturer's warranties to Contractor for inclusion in operation and maintenance manual.

1.5.2 Contractor Responsibilities:

1.5.2.1 Designate in progress schedule, time frames for delivery of Owner-supplied Products to the site and for receipt of related submittals. If the site is not ready to receive delivery of Owner-supplied Products within the time frame indicated in the latest progress schedule submitted to Owner, arrange, and pay for delivery to a temporary storage location and subsequent delivery to the site.

1.5.2.2 Review all required submittals and notify Consultant of any observed discrepancies or anticipated problems.

1.5.2.3 Ensure that course of construction insurance is adequate to cover Owner-supplied Products.

1.5.2.4 Receive and unload Owner-supplied Products at the site.

1.5.2.5 Inspect deliveries jointly with Owner. Record and notify Owner and Consultant of shortages and visibly damaged or defective items.

1.5.2.6 Handle Owner-supplied Products at site, including uncrating and storage. Dispose of waste materials and debris.

1.5.2.7 Take appropriate precautions to protect Owner-supplied Products from loss or damage.

1.5.2.8 Repair or replace items damaged on site.

1.5.2.9 Assemble, install, connect, adjust, and finish Owner-supplied Products as specified.

1.5.2.10 Arrange for inspections required by authorities having jurisdiction as specified.

1.5.2.11 Arrange for or perform testing as specified.

1.5.2.12 Workmanship warranty for installation.

1.5.3 Refer to Technical Specifications for list of Owner-Supplied / Contractor-installed elements.

1.6 SPECIFICATIONS LANGUAGE, STYLE, AND CONVENTIONS

1.6.1 Imperative Mood: Specifications are written in imperative mood and in streamlined form. Imperative language is directed to Contractor, unless stated otherwise.

1.6.1.1 Complete sentences by reading "shall", " Contractor shall", "shall be", and similar phrases by inference. Where a colon (:) is used within sentences and phrases, read the words "shall be" by inference.

1.6.1.2 Fulfill and perform all indicated requirements whether stated imperatively or otherwise.

1.6.1.3 When used in the context of a Product, read the word “provide” to mean “supply and install to result in a complete installation ready for its intended use”.

1.6.2 Specification Structure: Specifications are arranged using a modified CSI/CSC 3-part SectionFormat® structure in 3 broad “Parts”: 1. General, 2. Products and 3. Execution.

1.6.2.1 Installation Requirements: Specifications are not intended as detailed description of installation methods but serve to indicate particular requirements in completing the Work. Where Contract Documents do not Provide sufficient information for complete installation of item, then as supplement, comply with manufacturer's written instructions for quality of Work.

1.6.3 Singular and Gender References: Where items in Contract Documents are referred to in singular, provide as many as required to complete the Work. Words used in one gender only are intended to be inclusive.

1.6.4 Drawings and Schedules: Use for scope and arrangement understanding; refer to them for item locations unless otherwise stated in Specifications.

1.6.5 Text Characteristics: No implied emphasis for text colour or hyperlink features.

1.6.6 Hyperlinks: May lead to external information, not part of Contract Documents unless specifically indicated.

1.6.7 Division 00 and Division 01 Requirements: General provisions of the Contract, including General Conditions and Supplementary Conditions, apply to all

sections of the Specifications. Similarly, requirements of Sections in Division 01 are applicable to the Work of all sections of the Specifications.

1.7 PROJECT COORDINATION AND DIVISION OF WORK

1.7.1 Division of the Work among trades and Subcontractors is solely Contractor's responsibility. Consultant and Owner assume no responsibility to act as an arbiter to establish subcontract limits between Sections or Divisions of the Work.

1.7.2 Scope and Extent Coordination:

1.7.2.1 Analyze Contract Documents to define the extent of the Work. Coordinate scope and extent of work for each trade. Coordinate work of all trades including construction sequence, schedule, and interfacing of all work. Coordinate work of each trade as required for satisfactory and expeditious completion of The Work. Ensure components to be built in are supplied in time with setting Drawings and other related information.

1.7.2.2 Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of The Work. Coordinate construction operations, included in different Sections, which depend on each other for proper installation, connection, and operation.

1.7.2.3 Schedule construction operations in sequence required to obtain the best results, where installation of one part of the Work depends on installation of other components, before or after its own installation. Make adequate provisions to accommodate items scheduled for later installation.

1.7.3 Specifications and Drawings Organization: Organization of Specifications into CSI/CSC MasterFormat® Divisions or into 3-part SectionFormat® is solely for Contractor's convenience. This organization is not intended to determine subcontract limits between Sections or Divisions of the Work.

1.7.3.1 Arrangement of Specifications, Drawings, or schedules, must not affect Contractor's control or responsibility for dividing the Work or establishing each trade's scope of work.

1.7.3.2 Claims for additional compensation due to disputes between trades resulting from Contractor's lack of coordination will not be permitted.

1.8 CONTRACT DOCUMENTS FOR CONTRUCTION PURPOSES

1.8.1 Hard Copies: Owner will supply Contractor with one printed set of CCDC 2 2020 Document

1.8.2 Contractor will be provided with electronic copy of the approved permit documents. Contractor shall print hard copies and made available at construction site at all times

1.8.3 Electronic Documents: Owner will supply Contractor with one complete set of Contract Documents in PDF format prior to commencement of The Work. Contractor is permitted to print hard copies for construction purposes at contractor’s expense.

1.8.4 “IFC” Documents: Contractor acknowledges that Drawings and Specifications labeled as "Issued for Construction" or “IFC” represent Consultant's best effort at incorporating revisions issued during addenda and bidding or negotiation phase. In case of discrepancies, omission, or conflict between “Issued for Construction” documents and Contract Documents, Contractor must promptly notify Consultant.

1.9 ORIGINAL DATA FILES

1.9.1 Files Provided Consultant: Consultant will provide data files in their original format for Contractor's use during construction process and for preparation of as-built drawings.

1.9.2 Fee: One set of original data files will be provided at no cost to Contractor.

1.9.3 Format: Consultant will provide the Contractor with complete set of data files in **[.dwg] [. rvt]** format.

1.9.4 Data Accuracy Disclaimer: Consultant makes no representations as to accuracy or completeness of files as they relate to Contract Drawings.

1.9.4.1 Copy of Contract Documents for the purpose of creating As-Built Drawings and other documentation may not include changes issued as Addenda, Supplemental Instructions, or Change Orders.

1.9.5 Licensing Agreements for Use of Digital Files:

1.9.5.1 Contractor's Data Licensing Agreement: Contractor must execute a data licensing agreement in a form acceptable to both the Owner and Consultant. A copy of Consultant’s typical agreement is provided in Appendix A.

1.9.5.2 Subcontractors and Third Parties' Agreement: Subcontractors and other parties granted access by Contractor to Consultant’s original data files must also execute a data licensing agreement in a form acceptable to both the Owner and Consultant.

1.10 DOCUMENTS AT THE SITE

1.10.1 Maintain following documents at the Place of Work, stored securely, in good order, and available to Owner and Consultant in printed hard copy format and any other format required by municipal building department and Authorities Having Jurisdiction:

1.10.1.1 Approved building permit documents c/w drawings and specifications and other permits from AHJ

1.10.1.2 Current Contract Documents, including Drawings, Specifications, and addenda.

1.10.1.3 Change Orders, Change Directives, and Supplemental Instructions.

1.10.1.4 Reviewed Shop Drawings, Product data and samples.

1.10.1.5 Field test reports and records.

1.10.1.6 Construction progress schedule.

1.10.1.7 Meeting minutes.

1.10.1.8 Manufacturer’s certifications.

1.10.1.9 Permits, inspection certificates, and other documents required by authorities having jurisdiction.

1.10.1.10 Current as-built drawings.

1.10.1.11 Safety Data Sheets (SDS) for all controlled Products.

1.11 CONTRACTOR'S USE OF PREMISES

1.11.1 Comply with Supplementary Condition SC22 (GC3.9). Refer to Section 01 14 00 for additional requirements.

1.12 CLARIFICATIONS TO CONTRACT DOCUMENTS

1.12.1 If clarifications are required in Drawings, Specifications, or other Contract Documents or if there is uncertainty about their meaning or intent, such uncertainties must immediately be reported to Consultant.

1.12.2 Resolving Conflicting Specifications: In cases where Specifications require compliance with multiple requirements that establish different or conflicting quantities or quality levels, Contractor must adhere to most stringent requirement. Where requirements are stated differently, but have apparently equal effects, immediately notify Consultant, and obtain instructions before proceeding.

1.12.3 Resolving Conflicting Reference Standards: If compliance with multiple reference standards is specified and such standards establish different or conflicting requirements for minimum quantities or quality levels, comply with most stringent requirement. Where requirements are stated differently, but have apparently equal effects, immediately notify Consultant, and obtain instructions before proceeding.

1.12.4 Minimum Quantity or Quality Levels: Specified or illustrated quantities or quality levels represent minimum that must be provided or performed. Actual installation may meet minimum specified levels or exceed them within reasonable limits. Numeric values indicated are to be interpreted as minimum or maximum as appropriate. Uncertainties must be referred to the Consultant for clarification.

1.12.5 Comply with Consultant's written instructions or explanations and proceed accordingly. If Changes to the Work are suspected or required, refer to Section 01 26 00, for appropriate procedures to follow.

END OF SECTION

1.1 SUMMARY

1.1.1 Purpose of Section: Section Specifies administrative provisions for assignment of contracts to the Contractor by Owner.

1.2 OVERVIEW OF CONTRACTUAL RELATIONSHIPS

1.2.1 Assignable Contracts: Owner has entered into contracts or negotiated purchase contracts for materials and equipment for the Work.

1.2.2 Assignment Process: Upon award of Contract, assigned contracts will be assigned to Contractor.

1.2.3 Effect of Assignment: Costs for purchasing, receiving, handling, storage (if required), and installation of assigned contracts are to be included in Contract Price, unless specified otherwise.

1.2.4 Contractor's Obligations upon Assignment: Contractor's responsibilities are same as if Contractor had negotiated purchase contracts, including responsibility to renegotiate purchase and to execute final purchasing agreements.

1.3 ASSIGNABLE CONTRACTS / DESIGNATED SUBCONTRACTORS/SUPPLIERS

1.3.1 Contract Name: **Dewar Industrial Services Inc**

1.3.1.1 Description: **Pre- engineered steel components, cladding and foundation**

1.3.1.2 Contact: **Goods and services**

1.3.1.3 UTM will pay Dewar Industrial Services directly

1.3.1.4

END OF SECTION

1.1 CONSTRUCTION ACTIVITIES AND BOUNDARIES

1.1.1 Facility to remain operational: Facility will remain operational during course of The Work. Owner will occupy portion of premises throughout construction period. Cooperate with Owner in scheduling to minimize disruptions to activities and facilitate usage of premises.

1.1.1.1 Assume responsibility for care, custody, and control of portion of existing building made available to Contractor and Make Good damage attributable to construction activities. Restore to condition existing before construction activities began.

1.1.1.2 Use premises for construction activities, storage, and access while accommodating Owner occupancy (whether complete or partial), Work by other contractors, and public usage.

1.1.1.3 Coordinate use of premises under direction of Owner.

1.1.1.4 Perform construction activities in a manner that prioritizes safety and comfort of building occupants. Implement measures to maintain building access, utility continuity, and to suppress dust and noise.

1.1.2 Confine construction activities and materials to area indicated on Drawings and within property lines. Where temporary extension of boundaries is required by Contractor to perform work of this Contract, obtain permission from Owner, and perform such work at no additional cost to Owner.

1.1.2.1 Work on Municipal property must be carried out under regulations of respective municipal and authorities having jurisdiction. Include in Contract Price associated fees, permits, insurance or bonding required.

1.1.2.2 Restrict construction activities in public areas, Owner-occupied areas, and locations designated for off-hours without additional cost to the Owner and return these areas to normal operations as soon as possible.

1.1.2.3 Do not use explosives without written acceptance of the Owner and authorities having jurisdiction.

1.1.2.4 Nut-based abrasive blasting medium, including walnut shells are not permitted.

1.1.2.5 Restrict construction personnel to enclosed construction areas. Arrange work required outside construction areas with Owner’s Representative in advance.

1.1.2.6 Pre-plan work in detail and ensure all materials are available to minimize the time required outside construction area. Schedule appointments with the Owner’s Representative to review areas before starting work.

1.1.2.7 Do not store demolition waste, construction materials, products, or supplies in corridors or occupied areas. Owner is not responsible for loss of items left in areas at the Place of the Work outside of construction areas. Maintain corridors and owner-occupied areas clean and free of dust and debris.

1.1.3 Additional Storage or Work Areas: Obtain and pay for use of additional storage or work areas needed for operations under Contract.

1.2 WORK HOURS

1.2.1 Unless otherwise specified, perform Work during normal regular business hours Monday to Friday, from 8:00 am to 5:00 pm. Where municipal by-laws, facility rules or specifications specify more stringent requirements, comply with such requirements. Incorporate work hour restrictions into construction schedule.

1.2.2 Refer to City of Mississauga Noise Control By-law regarding hours of work allowed in this area.

1.3 DISRUPTIVE OPERATIONS

1.3.1 Coordinate operations that cause significant noise, vibration, dust, or odours with Owner. Inform the Owner's Representative in advance of work likely to affect students, staff, or routine building operations. Secure prior written permission for such activities.

1.3.1.1 Perform work that results in significant noise or odours outside the Work area, vibratory sounds through building assemblies, or work performed by asbestos abatement Subcontractors during off-hours of 7:00 pm and 8:00 am, Monday to Friday, and on weekends.

1.3.1.2 Include in Contract Price for all costs associated with premium time associated with disruptive operations and to maintain services, meet schedule, or quickly restore interrupted services in occupied areas. Claims for additional costs due to failure to consider requirements for disruptive work will not be considered.

1.3.1.3 Confirm with Owner at startup meeting areas that are most sensitive to construction dust, noise, and vibration. Implement measures to control dust, noise, and vibration generated by Work.

.1 Select equipment and tools for minimal noise output.

.2 Use electric compressors in lieu of gasoline types.

1.3.1.4 Apply control measures as necessary to perform the Work and in response to complaints from public, authorities having jurisdiction, Owner, and Consultant.

1.3.1.5 Examples of work transmitting vibratory sounds through building assemblies include, but are not limited to:

.1 Hammer-drilling.

.2 Core-drilling.

.3 Powder-activated concrete nailing.

.4 Demolition.

.5 Saw cutting.

.6 Chipping or hammering of concrete floors and masonry or concrete walls.

.7 Dropping objects on floors.

1.3.1.6 Provide minimum 7 working days advance notice to Owner prior to beginning disruptive operations. Owner reserves the right to request that such activities be performed at specific date and time. Refer to forms listed in Section 01 35 00.

1.4 UTILITY INTERRUPTIONS AND SHUTDOWNS BY CONTRACTOR

1.4.1 Comply with Owner's notification and approval processes for planned utility shutdowns and obtain necessary written permissions. Do not connect or disconnect mechanical and electrical services in occupied areas without Owner's prior approval. Refer to forms listed in Section 01 35 00.

1.4.2 All interruptions require minimum 10 working days advance notice to Owner. Owner reserves the right to request that interruptions are planned outside of normal business or classroom hours, and at no additional cost.

1.4.3 Exercise extreme caution to avoid interrupting essential services in occupied areas without alternate provisions.

1.4.4 Where existing mechanical or electrical services are accidentally uncovered and disrupted, restore such services immediately and provide adequate protection to prevent further disruption until permanent services are restored.

1.4.5 Cover costs associated with restoring disrupted mechanical or electrical services to their original condition and perform restoration at no additional cost to Owner if Owner's Representative and Consultant determine that disruption could have reasonably been foreseen during bidding or was caused by lack of proper care and protection.

1.5 TEMPORARY SHUTDOWN OF CONSTRUCTION ACTIVITIES BY OWNER:

1.5.1 Temporary shutdown of work may be requested by Owner at any time due to emergency or sensitive security reasons.

1.5.2 Do not construe temporary shutdowns as justification for modifying the construction schedule, claiming delay of Work, or requesting additional costs from the Owner.

1.5.3 Include cost of potential temporary shutdowns in Contract. Allow for such temporary shutdowns in project planning and scheduling.

1.6 SECURITY REQUIREMENTS

1.6.1 Ensure security of existing facilities is not diminished by Work of this Contract. Assume total responsibility for security of the areas under construction, except for areas specifically retained by Owner for exclusive use during construction.

1.6.2 Ensure only necessary tools and equipment are brought to each work area where access by the public is possible. Keep constant check on these items and, at end of each work shift, secure all tools and equipment.

1.6.3 Owner may provide a security escort for the Work in locations where it deems necessary.

1.6.4 Owner may issue suitable keys to Contractor, where necessary. Contractor must sign a receipt for issued keys and is responsible for admitting only authorized personnel to accessible areas. Return keys to Owner immediately upon request.

1.6.5 Provide 24/7 CCTV monitoring covering all sides of the project site

1.7 LIFE SAFETY REQUIREMENTS

1.7.1 Comply with applicable requirements of Ontario Fire Code.

1.7.2 Access and Egress for Occupants: Provide and maintain of safe access and egress routes for construction staff and the building occupants. Maintain clear egress routes at all times.

1.7.3 Fire Alarm and Sprinkler Zone Maintenance: Maintain fire alarm zones and sprinkler zones during construction to meet requirements of authorities having jurisdiction.

1.7.4 Determine nature and exact locations of existing fire and smoke sensors prior to the commencement of the Work. Perform Work carefully to avoid triggering sensors.

1.7.5 Costs incurred on account of false fire alarms activated as a result of construction operations without adequate precautions are Contractor's responsibility.

1.7.6 Fire Routes: Maintain fire access routes, including overhead clearances, for use by emergency response vehicles.

1.7.7 Use of Flame and Volatile Substances :

1.7.7.1 Schedule use of flames and volatile substances in advance with Owner and Consultant. Obtain burn permit from Owner as specified in Section 01 35 00.

1.7.7.2 Coordinate with Owner's personnel for required fire safety measures required when using flames or volatile substances.

1.7.7.3 Exercise extreme caution when handling materials, products, or tools that could cause fire or explosion.

1.7.7.4 Handle and store flammable liquids and volatile substances in approved containers. Store and mix paint materials only in approved locations. Place oily waste and rags in approved safety containers and remove daily.

1.8 DRIVEWAYS, WALKWAYS, AND ENTRANCES

1.8.1 Keep driveways, walkways, and entrances clear for Owner and emergency vehicles. Schedule deliveries to minimize disruptions.

1.8.2 Maintain access to existing service and delivery entrance(s) at all times, including ready access for emergency vehicles.

1.8.3 Restriction of Site Access to Non-Construction Personnel: Limit site access strictly to authorized individuals, except for visitors authorized by Contractor. Restrict construction personnel and workers to Place of the Work and necessary access routes to it.

1.8.4 Temporary Vehicular Access and Parking: Refer to Section 01 50 00.

1.9 WORK ON PUBLIC OR MUNICIPAL PROPERTY

1.9.1 Comply with regulations of municipality and authorities having jurisdiction including associated fees, permits, insurance or bonding required.

1.10 ADJACENT PROPERTY AND BUILDINGS

1.10.1 Obtain written approval from Owners of adjacent private and public properties before commencing work that may intrude on such properties.

1.10.2 This applies particularly to underpinning of adjacent buildings and where over-swing of cranes occurs. In these cases, obtain approval in writing from the owners of each building affected.

1.10.3 Receipt of such approvals shall not limit responsibility for property damage or personal injury.

1.10.4 The Paleo Building and Grounds Building will be fully occupied during the course of construction. Care should be taken not to disturb the occupants of these buildings. Access for fire trucks, other emergency vehicles, and/or grounds vehicles should not be obstructed. Trailers and staging should not hinder the use of Principal's Road. Municipal by-law for construction noise regulation should be followed.

1.10.5 Lislehurst Residence access and roadway cannot be impeded at any time due to the residence being occupied

1.10.6 Hoarding to be coordinated to maintain access to Paleo Building and Grounds Building at all times, including a 4m roadway width for fire truck access

1.10.7 Students will be in this area with classrooms in the Paleo Building, all site safety measures should be taken to ensure ongoing student access and safety. Beginning April 2025 construction work will be conducted by other contractors within and outside of the Paleo Building. Coordinate with the UTM Sr. Project Manager. Space separation shall be maintained.

1.10.8 During March 1 - April 20 and July 15 - August 15, there will be nightly roadway closures (8:00pm – 6:00am local time) in this laneway due to protection measures for the Species at Risk: Jefferson Salamanders

1.11 PROHIBITION ON SMOKING AND CONTROLLED SUBSTANCES

1.11.1 The use of tobacco, vaping, alcohol, and controlled substances is prohibited at the Place of the Work and on Owner's property.

1.12 WORKER IDENTIFICATION

1.12.1 Provide identification tags for Contractor personnel working on Project site. Require personnel to use identification tags at all times.

1.13 CONSTRUCTION OF TEMPORARY ACCESS AND EGRESS

1.13.1 Design and maintain temporary access and egress routes, including stairs, runways, ramps or ladders and scaffolding, independent of finished surfaces; comply with safety and regulatory standards of Authorities Having Jurisdiction.

Maintain temporary entrances to building(s) including enclosed hoardings as required.

1.13.2 Bridge excavations with construction to safely support loads that could be imposed and provide personnel to assist in deliveries to building(s) as required.

END OF SECTION

1.1 CASH ALLOWANCES, GENERALLY

1.1.1 Read in conjunction with: CCDC-2, 2020, GC. 4.1 and Supplementary Condition SC30 (GC 4.1).

1.1.2 Function of Cash Allowances:

1.1.2.1 Disbursements from Cash Allowances are intended for Work not shown or described in the Contract Documents. Cash Allowance disbursements must be authorized by Consultant, through Owner, in writing via Supplemental Instruction or cash allowance disbursement authorization.

1.1.3 Provision of Required Documentation:

1.1.3.1 Owner will provide Contractor with necessary documentation for pricing a cash allowance item.

1.1.4 Competitive Pricing Request:

1.1.4.1 Owner may ask Contractor to identify potential Suppliers or Subcontractors and obtain a minimum of three competitive prices for each item.

1.1.5 Disclosure of Price Information:

1.1.5.1 Owner may request Contractor to reveal originals of all bids, quotations, and other price-related information from potential Suppliers or Subcontractors.

1.1.6 Approval and Responsibility:

1.1.6.1 Owner will decide entity which performs each cash allowance item and for what amount. Contractor must obtain Owner's prior written approval via Change Order or Supplementary Instruction before subcontracting or performing work by own forces for work included in a cash allowance.

1.1.7 Scheduling for Ordering:

1.1.7.1 Prepare a schedule jointly with Consultant to ensure for timely authorization of items under cash allowances. Coordinate and process submittals for allowance items similarly to those of other portions of the Work.

1.1.8 Materials Coordination:

1.1.8.1 Coordinate materials and installation for each allowance with related materials to ensure complete integration.

1.1.9 Reallocation of Unexpended Amounts:

1.1.9.1 If actual cost under a cash allowance exceeds cash allowance amount, unexpended amounts from other allowances may be reallocated by Consultant to cover the shortfall.

1.1.9.2 No Additional Overhead and Profit: In case of reallocation, no additional amount for overhead and profit may be added to Contract Price.

1.1.9.3 Compensation for Overall Excess Costs: If actual cost under all cash allowances exceeds total of all allowances, Contractor will be

compensated for substantiated excess costs. Compensation to include an amount for overhead and profit on the excess amounts only. Refer to Section 01 26 00 for administrative procedures related to changes in the Work.

1.2 CASH ALLOWANCES FOR SUPPLY ONLY OF PRODUCTS

1.2.1 Inclusions: Includes cost of Products as invoiced by Supplier, delivery, and applicable taxes, excluding Value Added Taxes.

1.2.2 Exclusions: Does not include costs for unloading, handling, storage on site, installation, other related costs, overheads, and profits. Include such costs in Contract Price and not in cash allowance.

1.3 CASH ALLOWANCES FOR SUPPLY AND INSTALLATION OF PRODUCTS

1.3.1 Inclusions: Includes all costs to provide specified Products, including supply, installation, and related costs, excluding Value Added Taxes.

1.3.2 Exclusions: Does not include Contractor's, Subcontractor's, sub-Subcontractor's overhead and profit, and other related costs. Include such costs in Contract Price and not in cash allowance.

1.4 CASH ALLOWANCES FOR SERVICES

1.4.1 Inclusions: Includes all costs related to the services, excluding Value Added Taxes, and Subcontractor's and sub-Subcontractor's overheads and profits.

1.4.2 Exclusions: Does not include Contractor's overhead and profit, and other related costs. Include such costs in Contract Price and not in cash allowance.

1.5 LIST OF ALLOWANCES

1.5.1 Provide allowances as follows: NA

No.	Description	Amount	Scope*
1		$0.00	SE
2		$0.00	S
3		$0.00	[SE][S&I] [S]

Total of Cash Allowances $0.00

1.5.2 ***LEGEND**

1.5.2.1 SE: Cash Allowance for Services

1.5.2.2 S&I: Cash Allowance for Supply and Installation.

1.5.2.3 S: Cash Allowance for Supply Only of Products.

END OF SECTION

1.1 SUMMARY

1.1.1 Purpose of Section: Section Specifies administrative provisions for substitution requests from Contractor during Bidding and Construction Period.

1.2 DEFINITIONS

1.2.1 Substitution: In this Section “Substitution” means a Product, a manufacturer, or both, not originally specified in Contract Documents by proprietary name but proposed for use by Contractor in place of a Product, a manufacturer, or both, specified by proprietary name.

1.2.2 Substitutions for Cause: Substitution proposed due to altered Project conditions like product unavailability, regulatory changes, or warranty issues.

1.2.3 Substitutions for Convenience: Substitution proposed due to perceived benefits, which may not necessarily be required for fulfill Project requirements.

1.3 RESTRICTIONS ON SUBSTITUTIONS

1.3.1 Adherence to Specifications: Use specified materials and manufacturers unless otherwise stated.

1.3.2 Bidding Period: Where the Bid Documents specify particular Products by proprietary name, Consultant may consider substitutions during bidding period, provided such requests are received, in writing, at least **[10]** calendar before the bid closing time and are in accordance with requirements specified in this Section. If upon review with Owner, a substitution is reviewed without objections, the substitute Product will be named in an addendum. Otherwise, Bidders must consider substitution request rejected.

1.3.3 Substitutions for Convenience: Generally, not permitted.

1.3.4 Substitutions for Cause: Permitted only with Owner’s express approval. Do not order or install Substitutions without Supplemental Instruction or Change Order.

1.3.5 Review Process: Consultant will promptly review a proposed Substitution for Cause, provided submission includes all information specified in this Section under Submission Requirements for Proposed Substitutions.

1.3.6 Acceptance Criteria: Consultant or Owner may accept a Substitution if it can be satisfied that:

1.3.6.1 the proposed substitute Product is the same type as, is capable of performing the same functions as, interfaces with adjacent work the same as, and meets or exceeds the standard of quality, performance and, if applicable, appearance and maintenance considerations, of the specified Product,

1.3.6.2 the proposed substitute manufacturer has capabilities comparable to the specified manufacturer, and

1.3.6.3 the Substitution provides a benefit to Owner.

1.3.7 Invalid Reasons for Substitutions: Delay in ordering specified Product in adequate time to meet construction schedule is not a valid reason for consultant to accept a Substitution.

1.3.8 Documentation of Changes: Accepted Substitutions will be documented through a Supplemental Instruction or Change Order. Refer to Section 01 26 00.

1.3.9 Reversion Restrictions: Do not revert to original specified Product or manufacturer without Consultant's prior written acceptance.

1.4 SUBMISSION REQUIREMENTS FOR PROPOSED SUBSTITUTIONS

1.4.1 Substitution Request Form: Use form appended to this Section for all Substitution requests. Failure to use specified form will result in Consultant rejecting Substitution.

1.4.2 Include with each proposed Substitution the following information:

1.4.2.1 Identification of the Substitution, including product name and manufacturer's name, address, telephone numbers, and web site.

1.4.2.2 Reason(s) for proposing the Substitution.

1.4.2.3 A statement verifying that the Substitution will not affect the Contract Price and Contract Time or, if applicable, the amount and extent of a proposed increase or decrease in Contract Price and Contract Time on account of the Substitution.

1.4.2.4 A statement verifying that the Substitution will not affect the performance or warranty of other parts of the Work.

1.4.2.5 Manufacturer's Product literature for the Substitution, including material descriptions, compliance with applicable codes and reference standards, performance and test data, compatibility with contiguous materials and systems, and environmental considerations.

1.4.2.6 Product samples as applicable.

1.4.2.7 A summarized comparison of the physical properties and performance characteristics of the specified Product and the Substitution, with any significant variations clearly highlighted.

1.4.2.8 Availability of maintenance services and sources of replacement materials and parts for the Substitution, as applicable, including associated costs and time frames.

1.4.2.9 If applicable, estimated life cycle cost savings resulting from the Substitution.

1.4.2.10 Details of other projects and applications where the Substitution has been used.

1.4.2.11 Identification of any consequential changes in the Work to accommodate the Substitution and any consequential effects on the performance of the Work as a whole. A later claim for an increase to the Contract Price or Contract Time for other changes in the Work attributable to the Substitution will not be considered.

END OF SECTION

1.1 PROJECT INFORMATION

Project: _____
From: _____
Date: _____

1.2 PROPOSED SUBSTITUTION

REFERENCE INFORMATION

Specification Section Number and Title: _____

Drawing Reference (if applicable): _____

Page: _____ Article/Paragraph: _____

Specified Product: _____

SUBSTITUTION INFORMATION

Proposed Substitution (Product Name): _____

Product Description: _____

Product History: ☐ New Product ☐ 2-5 years old ☐ 5-10 years old ☐ > 10 years old

Manufacturer: _____

Standard Warranty Offered: _____Extended Warranty Available? ☐ Yes ☐ No

Address: _____

Name of Technical Representative (TR): _____

Technical Representative's Contact

Phone_____Email: _____

Trade Name: _____

Differences between proposed substitution and specified product:

_____

_____

_____

_____

_____

Reason for not providing specified item:

_____

_____

_____

_____

Will proposed substitution affect other parts of Work? ☐ No ☐ Yes; explain_____

_____

_____

_____

Cost Implications of Proposed Substitutions: ☐ None ☐ Savings/Credit; ☐ Extra Costs (explain below)

_____

_____

_____

_____

REFERENCE INSTALLATIONS

List below installations that reference the product installed in projects that are similar in scope and size. Provide at least 3 pertinent reference installations

PROJECT NO.1

Project Title: _____

Project Description: ☐ Commercial ☐Residential ☐Retail ☐Healthcare ☐Other: _____

Date Installed: _____ Location:_____

Reference Contact (if known): Phone: _____ Email:_____

PROJECT NO.2

Project Title: _____

Project Description: ☐Commercial ☐Residential ☐Retail ☐Healthcare ☐Other: _____

Date Installed: _____ Location:_____

Reference Contact (if known): Phone: _____ Email:_____

PROJECT NO.3

Project Title: _____

Project Description: ☐Commercial ☐Residential ☐Retail ☐Healthcare ☐Other: _____

Date Installed: _____ Location:_____

Reference Contact (if known): Phone: _____ Email:_____

SUSTAINABLE INFORMATION
Indicate below sustainable information that apply to this Product.

MANUFACTURING LOCATION

What is the location of the manufacturing plant for this particular product?
_____

ENVIRONMENTAL PRODUCT DECLARATION (EPD)
Does the product have a compliant environmental product declaration (EPD)? ☐ Yes ☐ No

EPD Type: ☐ Industry Wide EPD ☐ Product Specific EPD

Indicate EPD expiry date: _____

MATERIALS AND RESOURCES

Does the product contain wood Products? ☐ Yes ☐ No

If yes, Indicate percentage of FSC Certified wood in product: _____

Indicate wood product low-emitting characteristics:
☐ No Added Urea Formaldehyde (NAUF) ☐ Ultra-low Emitting Formaldehyde (ULEF)

Does the product contain post-consumer or pre-consumer recycled content? ☐ Yes ☐ No

If yes, Indicate percentage of pre-consumer recycled content: _____

If yes, Indicate percentage of post-consumer recycled content: _____
DISCLOSURE AND TRANSPARENCY

Does the product participate in extended producer responsibility program? □ Yes □ No

Does the product have a "Declare" label with ingredient disclosure greater than 1000 ppm? □ Yes □ No

Does the product have a Fully Declare Health Product Declaration? □ Yes □ No

Is this product CDPH Emissions testing compliant? □ Yes □ No

Indicate product VOC content (g/l): _____

SUPPORTING DATA
Attached data includes product description, specifications, drawings, photographs, and performance and test data adequate for evaluation of the request; applicable portions of the data are clearly identified.

Attached data also includes a description of changes to the Contract Documents that the proposed substitution will require for its proper installation

Supporting Data Attached: ☐Drawings ☐ Product Data ☐Samples ☐ Test Reports

FOR INTERNAL USE ONLY

- □ Substitution approved - Make submittals in accordance with Section 01 25 00.
- □ Substitution approved as noted - Make submittals in accordance with Section 01 25 00.
- □ Substitution rejected - Use specified materials.

1.3 DECLARATIONS

1.3.1 I/We the undersigned agree that the Owner reserves the right to accept or reject any or all of the proposed substitution/alternatives and may request that materials specified in the Bidding and Contracting Documents be used.

1.3.2 I/We the undersigned understand that by submitting this Substitution Request, I/We assume full responsibility for ensuring that all requirements are considered.

1.3.3 I/We hereby certify that:

1.3.3.1 Proposed substitution has been fully investigated and determined to be equal or superior in all respects to specified product.

1.3.3.2 Same warranty will be supplied for proposed substitution as for specified product.

1.3.3.3 Same maintenance service and source of replacement parts, as applicable, is available.

1.3.3.4 Proposed substitution will have no adverse effect on other trades and will not affect or delay progress schedule.

1.3.3.5 Proposed substitution does not affect dimensions and functional clearances.

1.3.3.6 Coordination, installation, and changes in the Work as necessary for accepted substitution will be complete in all respects.

SUBMITTED BY: _____

Signature of
Duly Authorized
Signing Officer _____

_____

Position: _____

Firm: _____

Street Address: _____

City, Province, Postal Code _____

Phone: _____

Respectfully submitted this ____ day of _____, 20__ at _____.

END OF FORM

1.1 SUMMARY

1.1.1 Purpose of Section: Section specifies administrative procedures related to modifying Contract by means of Change Orders, Change Directives, and Supplemental Instructions.

1.1.2 Read in conjunction with: CCDC 2-2020, Part 6, Changes in the Work and Supplementary Conditions.

1.2 WAGE SCHEDULE

1.2.1 Comply with Supplementary Condition SC39 (GC6.2)

1.3 SCHEDULE OF EQUIPMENT RATES

1.3.1 Prior to the first application for payment, submit for the Consultant's review a schedule of equipment rates for Construction Equipment owned by Contractor. Specifically, submit schedule of equipment rates for following Construction Equipment:

1.3.1.1 Cranes if applicable.

1.3.1.2 Man hoists if applicable.

1.3.1.3 **[Specify other elements here]**

1.3.2 Equipment rates shall reflect the rates that will be used when:

1.3.2.1 preparing price quotations for Change Orders, and

1.3.2.2 determining the cost of work attributable to Change Directives.

1.3.3 Equipment rates stated in the schedule shall be consistent with local equipment rental market rates and shall not include any additional overhead and profit component.

1.3.4 Obtain the Owner's written acceptance of the schedule of equipment rates before submitting the first Change Order quotation.

1.3.5 Accepted schedule of equipment rates will be used solely for evaluating Change Order quotations and cost of performing work attributable to Change Directives.

1.4 CHANGE ORDERS

1.4.1 Comply with Supplementary Condition SC39 (GC6.2)

1.5 CHANGE DIRECTIVES

1.5.1 Comply with Supplementary Condition SC40 (GC6.3)

1.6 SUPPLEMENTAL INSTRUCTIONS

1.6.1 The Consultant may issue Supplemental Instructions to provide clarifications to the Contract Documents, provide additional information, or make minor variations in the Work not involving adjustment in the Contract Price or Contract Time.

1.6.2 If the Contractor considers a Supplemental Instruction to require an adjustment in Contract Price or Contract Time, the Contractor shall promptly notify the Consultant and the Owner in writing in accordance with requirements of Supplementary Condition SC12.4 (GC 2.2.12).

END OF SECTION

1.1 GENERAL

1.1.1 Interpretation and Modification Authority: Only Consultant has authority to interpret and modify Construction Documents. Owner's Representative may forward RFIs to Consultant as required.

1.1.2 Requests for Information: Submit RFI immediately upon identifying need for further information or clarification of Contract Documents to avoid delays.

1.1.2.1 RFIs from entities other than Contractor will be returned without response.

1.1.2.2 Review RFIs from Subcontractors, vendors, suppliers, or other parties before submitting to Consultant. Consultant may return RFIs for further action if they have not been adequately reviewed by Contractor.

1.1.2.3 Plan submission of RFIs to manage effective flow of information and to avoid sporadic or excessive submissions.

1.1.2.4 Do not use RFIs to request substitutions. Refer to Section 01 25 00 for substitution procedures.

1.1.2.5 Do not use RFIs for submittals, routine communications, correspondence, memos, claims, or information required by other sections of Contract Documents.

1.1.2.6 Do not RFIs to move coordination responsibilities from Contractor to Owner's Representative or Consultant.

1.1.3 Supplemental Instructions: Interpretations of Construction Documents by Consultant will be provided in writing by means of Supplemental Instructions (SIs).

1.1.3.1 SIs do not intend to modify Contract Price. RFIs affecting Contract Time or Contract Price will be subject to Contract modification procedures specified in Section 01 26 00.

1.1.4 Consultant's Action: Allow 10 working days for response to RFIs. Responses may require additional information, in which case response timeline will be restarted.

1.1.5 Non-Binding Interpretations: Responses to questions, interpretations, and modifications are not to be considered binding or effective unless issued as a formal written SI by Consultant.

1.2 RFI PROCEDURES

1.2.1 Submit each RFI to Consultant; address only one subject per RFI.

1.2.2 RFI Content: Each RFI must clearly detail query and include following as a minimum:

1.2.2.1 Project Name

1.2.2.2 Owner Name.

1.2.2.3 Project number (Consultant's and Contractor's).

1.2.2.4 Date

1.2.2.5 Contractor's name.

1.2.2.6 Sequential RFI number

1.2.2.7 Subject.

1.2.2.8 Relevant Specification Sections, drawing references, and field conditions.

1.2.2.9 Proposed resolution and impact on Contract Time or Contract Price.

1.2.2.10 Contractor's signature

1.2.2.11 Additional attachments.

1.2.3 Provide Drawing and Specification references, sketches, technical data, brochures, or other necessary supporting data for the Consultant’s interpretation.

1.2.4 Include a “Proposed Solution” to issue requiring interpretation or clarification.

1.2.5 Update and distribute RFI responses promptly to Subcontractors. Notify Consultant within 5 working days of any disagreements with RFI responses. Beyond this period, RFIs will be considered resolved.

1.2.6 RFI Log: Contractor will maintain a log of RFIs with project details, RFI tracking, and related change documentation.

END OF SECTION

1.1 SUMMARY

1.1.1 Purpose of Section: Section specifies administrative procedures related to progress payments and final payment for The Work.

1.1.2 Read in conjunction with: CCDC 2-2020, Part 5, Payment and Supplementary Conditions.

1.2 SCHEDULE OF VALUES

1.2.1 Initial Submission and Review: Prior to the first application for payment and within timeline specified in Supplementary Condition SC32.4 (5.2.4), submit for Consultant's review initial schedule of values. Modify initial schedule of values as requested by Consultant. Obtain Consultant's and Owner's written acceptance of initial schedule of values prior to first application for payment.

1.2.2 Updated Schedule with Applications for Payment: Together with first and all subsequent applications for payment, submit updated versions of schedule of values to indicate values, to date of application for payment, of work performed and Products delivered to Place of the Work.

1.2.3 Format and Content: Provide the schedule of values in an electronic spreadsheet format based on format provided and content [appended to this Section] [provided in AIA Document G703].

1.2.4 Required Information in Schedule: Provide the schedule of values in an electronic spreadsheet format that provides for inclusion of the following information:

1.2.4.1 Provide multiple line items for amounts in excess of 5% of the Contract Price.

1.2.4.2 Identifying information including title and location of the Work, name of Contractor, number and date of application for payment, and period covered by the application for payment.

1.2.4.3 A work breakdown structure based on Contractor, Subcontractor and sub-Subcontractor work according to each Specification section, and material and labour breakdown. Include separate line items for closeout procedures including closeout submittals, demonstration and training, start-up and testing, and commissioning.

1.2.4.4 Provisions for approved Change Orders, allowances, assignable contracts, and unit price work so that the breakdown amounts indicated in the schedule of values aggregate to the current total Contract Price. Also provide for indicating the estimated value of Change Directives within the schedule of values, separately from the current total Contract Price.

1.2.4.5 For each item in the work breakdown structure, provide as a minimum the following information, under headings as indicated:

.1 Breakdown Amount: A dollar amount, including an appropriate pro rata portion of Contactor's overhead and profit.

.2 Performed to Date: The value of Work performed, and Products delivered to Place of the Work up to the date of the application for payment, stated as a percentage of the Contract Price and in dollars.

.3 Previously Performed: The value of Work performed, and Products delivered to the Place of the Work for which payment has been previously certified, stated in dollars.

.4 Current Period: The value of Work performed, and Products delivered to Place of the Work for which Contractor is currently applying for payment, stated in dollars.

.5 Balance to Complete: The value of Work not yet performed, and Products not yet delivered to Place of the Work, stated in dollars.

1.3 CASH FLOW PROJECTION

1.3.1 Prior to the first application for payment submit, for Consultant's review, a forecast of approximate monthly progress payments for each month of the Contract Time.

1.3.2 Submit revised cash flow forecasts at least monthly. Consultant may also require revised cash flow forecasts when required due to significant changes in rate of progress of the Work or significant changes in the Contract Price.

1.4 WORKERS' COMPENSATION CLEARANCE

1.4.1 Submit proof of workers' compensation clearance (i.e. WSIB) with each application for payment.

1.5 STATUTORY DECLARATIONS

1.5.1 Submit a statutory declaration in the form of CCDC 9A – Statutory Declaration of Progress Payment Distribution by Contractor with each application for payment except the first.

1.6 RELEASE OF HOLDBACK

1.6.1 Comply with Supplementary Condition SC34 (GC5.4)

1.7 "PROPER INVOICE" PROCEDURES

1.7.1 Comply with Supplementary Condition SC32 (GC5.2) and Exhibit "1" (Project-specific requirements for a "Proper Invoice")

1.1 SUMMARY

1.1.1 Purpose of Section: Section specifies administrative procedures related to project management, project coordination and project meetings.

1.1.2 Read in conjunction with: CCDC 2-2020, Part 3, Execution of the Work and Supplementary Conditions.

1.2 CONTRACTOR'S LIST OF PERSONNEL AND SUBCONTRACTORS

1.2.1 Preparation and Submission: Prepare and submit a complete written list of individuals or firms proposed for each portion of the Work complete with Name, address, telephone number, and email address of entity. In addition, submit list of key personnel assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities, list addresses, telephone numbers, and e-mail addresses.

1.2.2 Displaying List: Display copies of list in Project meeting room, temporary field office, and in a prominent location. Maintain list up to date at all times.

1.2.3 Compatibility of Construction Team: Ensure compatibility within Project team, especially between Subcontractors. Owner takes no responsibility for incompatibility (labour and otherwise) among Subcontractors and Suppliers employed on the Project.

1.2.4 Superintendent Appointment: Appoint a senior member of staff as full-time superintendent, with full authority to commit Contractor to methods and construction schedules. Full-time superintendent shall actively participate in administration and maintenance of construction schedule. Do not replace superintendent without Owner’s or Consultant’s approval.

1.3 CONTRACTOR’S ADMINISTRATIVE RESPONSIBILITIES FOR MEETINGS

1.3.1 Unless otherwise indicated, Contractor’s responsibilities for all project meetings except construction start-up meeting are as follows:

1.3.1.1 Schedule and conduct meetings throughout the course of The Work, including those requested at the call of Consultant or Owner, at Project site unless otherwise indicated.

1.3.1.2 Prepare agenda for meetings. Distribute the agenda to all invited attendees.

1.3.1.3 Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Consultant of scheduled meeting dates and times a minimum of 5 working days prior to scheduled meeting dates and times.

1.3.1.4 Provide physical space and make arrangements for meetings.

1.3.1.5 Preside at meetings.

1.3.1.6 Record meeting minutes. Include significant proceedings and decisions. Identify actions by parties.

1.3.1.7 Distribute copies of minutes within 3 working days of meetings and transmit to meeting participants and, affected parties not in attendance.

1.4 CONSTRUCTION START-UP MEETING

1.4.1 After award of Contract, Owner's Representative will request meeting of parties in Contract to discuss and resolve administrative procedures and responsibilities.

1.4.2 Meeting Platform: Meeting will be held virtually using Microsoft Teams or a similar platform. A link will be shared with attendees.

1.4.3 Attendees:

1.4.3.1 Authorized representative of Consultant, Subconsultants, Owner, Contractor, including superintendent, major Subcontractors, major Suppliers, and other concerned parties must be in attendance.

1.4.3.2 Participants at the meeting must be familiar with Project and authorized to conclude matters relating to the Work.

1.4.4 Agenda: Discuss items of significance that could affect progress, including but not limited to the following:

1.4.4.1 Tentative construction schedule and progress schedule.

1.4.4.2 Building permit status.

1.4.4.3 Bonds and insurance certificates.

1.4.4.4 Phasing (if any).

1.4.4.5 Critical work sequencing, and long-lead items.

1.4.4.6 Designation of key personnel and their duties.

1.4.4.7 Lines of communications.

1.4.4.8 Procedures for processing field decisions and contract modifications including, but not limited to proposed changes (contemplated change orders), change orders, procedures, approvals required, mark-up percentages permitted, time extensions, overtime, and other administrative requirements.

1.4.4.9 Procedures for RFIs.

1.4.4.10 Procedures for testing and inspecting.

1.4.4.11 Procedures for processing applications for progress payment including, monthly progress claims, administrative procedures, photographs, and holdbacks.

1.4.4.12 Distribution of the Contract Documents.

1.4.4.13 Submittal procedures, including schedule of submission of shop drawings, samples, colour chips.

1.4.4.14 Preparation of closeout documents including, As-Builts, maintenance manuals, take-over procedures, and warranties.

1.4.4.15 Working hours.

1.4.4.16 Owner's occupancy requirements.

1.4.4.17 Work restrictions for work in occupied buildings such as elevator, washroom, or cafeteria use.

1.4.4.18 Owner's special requirements for Contractors performing work in existing facilities, including path of construction activities (foot, vehicular, carts), interruption of services, no-smoking policies, and similar restrictions.

1.4.4.19 Procedures for disruptions and shutdowns, including bin locations.

1.4.4.20 Parking availability and procedures.

1.4.4.21 Responsibility for temporary facilities and controls including but not limited to, site signage, offices, storage sheds, utilities, hoarding and similar temporary construction.

1.4.4.22 Procedures for moisture and mould control.

1.4.4.23 Construction waste management and recycling.

1.4.4.24 Office, work, and storage areas.

1.4.4.25 Equipment deliveries and priorities.

1.4.4.26 Health and Safety.

1.4.4.27 Security.

1.4.4.28 Progress cleaning and housekeeping procedures.

1.4.4.29 Owner-supplied products, where applicable.

1.4.4.30 Appointment of inspection and testing agencies or firms.

1.4.4.31 Insurances, and transcripts of policies.

1.5 CONSTRUCTION PROGRESS MEETINGS

1.5.1 Schedule regular **bi-weekly** construction progress meetings for the duration of the Work. Prepare meeting agendas, chair meetings, and record and distribute minutes.

1.5.2 Where practical, Owner will arrange for, and provide physical space for meetings. Virtual meetings may be permitted if approved by Owner.

1.5.3 Record significant decisions and identify action items and due dates by attendees or parties they represent in meeting minutes.

1.5.4 Distribute meeting minutes within 3 working days to attendees and affected parties not in attendance.

1.5.5 Ensure Subcontractors attend as and when appropriate to the progress of the Work.

1.5.6 Agenda for each meeting shall include the following, as a minimum:

1.5.6.1 Approval of minutes of previous meeting.

1.5.6.2 Work progress since previous meeting.

1.5.6.3 Field observations, including any problems, difficulties, or concerns.

1.5.6.4 Construction progress schedule.

1.5.6.5 Submittals schedule.

1.5.6.6 Proposed changes in the Work.

1.5.6.7 Requests for information.

1.5.6.8 Site safety issues.

1.5.6.9 Other business.

1.6 OWNER/CONSULTANT/CONTRACTOR (OCC) PROGRESS MEETINGS

1.6.1 Owner/Consultant/Contractor (OCC) Progress meetings will be scheduled to review general project status, financial status, and construction schedule.

1.6.1.1 Frequency: **[bi-weekly][monthly]**, or on a mutually acceptable schedule.

1.6.1.2 Attendees: at least one senior representative of Owner, Consultant and Contractor. Other attendees may be invited on a case-by-case basis.

1.6.1.3 Agenda: As a minimum, prepare to discuss the following:

.1 Review, approval of minutes of previous meeting.

.2 Status of Proposed Changes (Contemplated Change Orders), Change Orders, and Change Directives.

.3 Review of proposed changes for effect on construction schedule.

.4 Problems which impede construction schedule.

.5 Corrective measures and procedures to regain projected schedule.

.6 Revisions to construction schedule.

.7 Status of submittals.

.8 Other business.

1.7 PREINSTALLATION MEETINGS

1.7.1 Conduct a preinstallation meeting at Project site before each construction activity when required by Specifications Sections and when required for coordination with other construction.

1.7.2 Attendees:

1.7.2.1 Invite Subcontractor and representatives of manufacturers and fabricators involved in, or affected, by the work of the trade involved and its coordination or integration with other materials and installations that have preceded or will follow.

1.7.2.2 Invite Consultant, Owner and inspection and testing company's representative who may elect to attend.

1.7.2.3 Where Consultant, Owner or inspection and testing company's representative is required, provide minimum 48 hours notice unless otherwise agreed by parties.

1.7.3 Agenda: Discuss following items as a minimum:

1.7.3.1 Work included.

1.7.3.2 Materials to be used.

1.7.3.3 Storage and handling of materials.

1.7.3.4 Installation procedures.

1.7.3.5 Sequence and quality control.

1.7.3.6 Project staffing.

1.7.3.7 Review of mock-ups.

1.7.3.8 Possible conflicts.

1.7.3.9 Compatibility requirements.

1.7.3.10 Time schedules.

1.7.3.11 Weather limitations.

1.7.3.12 Manufacturer's written instructions.

1.7.3.13 Warranty requirements.

1.7.3.14 Acceptability of substrates.

1.7.3.15 Temporary facilities and controls.

1.7.3.16 Restrictions on areas of work and other matters affecting construction including space and access limitations.

1.7.3.17 Regulations of authorities having jurisdiction.

1.7.3.18 Testing and inspecting requirements.

1.7.3.19 Coordination with other work.

1.7.3.20 Required performance results.

1.7.3.21 Protection of adjacent work.

1.7.3.22 Protection of construction and personnel.

1.7.4 Reporting: Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.

1.7.4.1 Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of The Work and reconvene the conference at earliest feasible date.

END OF SECTION

1.1 SUMMARY

1.1.1 Purpose of Section: Section specifies Contractor's responsibilities for preparation and submission of schedules and other documentation related to tracking construction progress.

1.1.1.1 Schedules inform Owner and Consultant of actual progress versus planned progress and provide assurance that scheduling issues are being proactively identified and addressed in a timely manner, and that planned progress is being maintained as closely as possible.

1.1.2 Read in conjunction with: CCDC 2-2020, Part 3, Execution of the Work.

1.2 CONSTRUCTION SCHEDULE

1.2.1 Format and Content: As specified in Exhibit "2" - Project-specific requirements for the Baseline Schedule and the Construction Schedule.

1.2.1.1 Unless indicated otherwise, float time in schedule is owned by Owner.

1.2.2 Submission: Comply with CCDC 2, 2020, GC. 3.4 and Supplementary Condition SC17(GC 3.4) supplemented as follows:

1.2.2.1 At progress meetings, discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within Contract Time.

1.2.2.2 Discuss construction schedule at progress site meetings and identify activities that are behind schedule and provide measures to regain slippage.

1.2.2.3 Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with minutes of each such meeting.

1.2.2.4 As the Work progresses, indicate completion percentage for each activity.

1.2.2.5 Distribute copies of approved schedule to Consultant, Owner, Other Contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.

1.3 SHORT-TERM / LOOK-AHEAD SCHEDULE

1.3.1 Comply with CCDC 2, 2020, GC. 3.4 and Supplementary Condition SC17(GC 3.4).

1.4 SCHEDULE OF SUBMITTALS

1.4.1 Comply with CCDC 2, 2020, GC. 3.8 and Supplementary Condition SC21(GC 3.8) supplemented as follows:

1.4.1.1 Format and Content:

.1 Prepare a schedule identifying all required Shop Drawings, Product data, and sample submissions, including samples required for testing and those for Owner-supplied Products (if any).

.2 Prepare schedule in electronic format.

.3 Provide a separate line for each required submittal, organized by Specifications section names and numbers, and further broken down by individual Products and systems as required.

.4 For each required submittal, show planned earliest date for return of reviewed submittal by Consultant and latest date for return of reviewed submittal without causing delay.

.5 Allow time in schedule for resubmission of submittals, should resubmission be necessary.

1.4.1.2 Submission:

.1 Submit initial schedule to Consultant within 10 Working Days after Contract award.

.2 Submit schedule via e-mail as .pdf file.

.3 Consultant will review format and content of initial schedule and request necessary changes, if any, within 5 Working Days after receipt.

.4 If changes are required, resubmit finalized schedule within 5 Working Days after return of review copy.

.5 Submit updated submittals schedule monthly to Owner and Consultant.

1.5 RECORDING ACTUAL SITE CONDITIONS ON AS-BUILT DRAWINGS

1.5.1 For the purposes of this Section, the following definitions as defined by the Ontario Association of Architects Practice Tip – PT.14 Version 1.1 apply:

1.5.1.1 As-built drawings: drawings usually prepared by Contractor as it constructs the project and upon which it documents the actual locations of building components and changes to the original contract documents. These, or a copy of same, are typically turned over to the Consultant or Owner at completion of the project.

1.5.1.2 Record drawings: drawings usually prepared by the Consultant when contracted to do so. These are usually a composite of the original drawings, changes known to the Consultant and information taken from the Contractor's as-built drawings.

1.5.2 Clearly label each drawing as "AS-BUILT DRAWING". Record information concurrently with construction progress. Do not conceal Work until required information is recorded.

1.5.3 Accurately and neatly record deviations from Contract Documents, including addenda, Supplemental Instructions and Change Orders, caused by site conditions.

1.5.4 Annotate with coloured felt tip marking pens, maintaining separate colours for each major system, for recording changed information. Digital annotation of as-built data is permitted.

1.5.5 Clearly and legibly mark each item to record the actual construction, including but not limited to:

1.5.5.1 Measured depths of foundation elements in relation to finished first floor datum.

1.5.5.2 Measured horizontal and vertical locations of underground utilities and related components, referenced to permanent surface improvements.

1.5.5.3 Measured locations of pipes, ducts, conduits, outlets, fixtures, access panels, and related components, referenced to visible and accessible features of the construction.

1.5.5.4 Measured locations of interior utilities and related components, referenced to visible and accessible features of the construction.

1.5.5.5 Field changes of dimensions and details.

1.5.5.6 Changes made by Change Orders and Supplemental Instructions.

1.5.5.7 References to Shop Drawings, where Shop Drawings show more detail.

1.5.5.8 Field changes of dimension and detail.

1.5.5.9 Details not shown on original Contract Drawings.

1.5.5.10 Life Safety elements including, but not limited to:

.1 Smoke compartmentalization.

.2 Exit signage.

.3 Fire extinguishers.

.4 Fire alarm devices.

.5 Pull stations.

.6 Sprinkled areas.

1.5.5.11 Refer to Divisions 21, 22, 23 and Division 26 for supplementary requirements.

1.5.6 Maintain manufacturer's certifications, inspection certifications, field test records, required by individual specifications sections.

1.5.7 Store As-Built Drawings and other documentation separately from construction documents in a secure area. Provide appropriate filing cabinets, shelving, or racks for storage. Digital filing of as-built data is permitted, subject to Owner’s approval in writing.

1.5.8 Label As-Built Drawings and other documentation with section numbers that correspond to Table of Contents of Project Manual. Clearly label each document "AS-BUILT" in legible font.

1.5.9 Maintain the As-Built Drawings and other documentation in legible and clean condition, free from damage or deterioration. As-built Drawings and other documentation must not be used for construction purposes.

1.5.10 Keep As-Built Drawings and other documentation readily available for inspection by Consultant.

1.5.11 Refer to Section 01 78 00 for additional requirements.

1.6 PHOTOGRAPHIC DOCUMENTATION

1.6.1 Preconstruction Photographs: Before commencement of the Work, take sufficient photographs of the Place of the Work and surrounding areas, including existing items to remain during construction, from different vantage points, as directed by

Consultant. Submit video recording to supplement photographs to show existing conditions prior to start of The Work.

1.6.2 Concealed Work Photographs: Take photographs of concealed work, such as underground utilities, under slab services, piping, conduits, waterproofing, air barriers or vapour retarders, prior to installing or enclosing such work.

1.6.3 Periodic Construction Photographs: Arrange for periodic digital photography to document and provide a photographic record of the progress of the Work. Take digital progress photographs weekly from date of commencement of The Work until date of Ready-for-Takeover, sufficient to record the state of The Work.

1.6.4 Identify each photograph by project name and date taken. Maintain a key plan with each set to identify photographic locations.

1.6.5 Submission: Submit .jpg format files in standard resolution via e-mail monthly with application for payment.

1.6.5.1 Submit photographs as originally recorded, without alteration, manipulation, editing, or modification.

1.6.5.2 Metadata: Ensure photographs accurately provide date, time, and location data for each picture.

1.6.6 Do not use progress or any other Project photographs for promotional purposes without Owner's written consent.

1.7 [SITE VIDEO MONITORING / CONSTRUCTION WEBCAM

1.7.1 **Provide internet-capable camera and active web site, allowing off-site viewing of Place of the Work 24/7. Submit web site address and security access codes to Owner and Consultant.**

1.7.2 **Basis-of-Design: Multivista or approved equivalent.]**

1.8 DAILY CONSTRUCTION REPORTS

1.8.1 Prepare a daily construction report recording the following information concerning events at Project site:

1.8.1.1 List of subcontractors at Project site.

1.8.1.2 List of separate contractors at Project site.

1.8.1.3 Approximate count of personnel at Project site.

1.8.1.4 High and low temperatures and general weather conditions.

1.8.1.5 Accidents.

1.8.1.6 Meetings and significant decisions.

1.8.1.7 Unusual events.

1.8.1.8 Stoppages, delays, shortages, and losses.

1.8.1.9 Emergency procedures.

1.8.1.10 Orders and requests of authorities having jurisdiction.

1.8.1.11 Change Orders received and implemented.

1.8.1.12 Services connected and disconnected.

1.8.1.13 Equipment or system tests and startups.

1.8.1.14 Other elements as necessary.

1.8.2 Submission: Submit .pdf format files via e-mail **bi-weekly** with date coinciding with progress meeting specified in Section 01 31 00.

END OF SECTION

1.1 SUMMARY

1.1.1 Purpose of Section: Section specifies administrative procedures for preparation and submission of Shop Drawings, Product Data and other documentation related to the Work.

1.1.2 Read in conjunction with: CCDC 2-2020, Part 3, Execution of the Work and Supplementary Conditions.

1.2 ADMINISTRATIVE REQUIREMENTS

1.2.1 Language of Submittals: Provide submittals in English.

1.2.2 Submit specified submittals to Consultant for review. Submit with reasonable promptness and in orderly sequence so as to not cause delay in the Work. Failure to submit in ample time is not considered sufficient reason for an extension of Contract Time or for Product substitutions or other deviations from the Drawings and Specifications.

1.2.3 Where required by authorities having jurisdiction, provide submittals to such authorities for review and approval.

1.2.4 Do not proceed with Work affected by a submittal until review is complete.

1.2.5 Present Shop Drawings, Product data, and samples in SI metric units unless permitted otherwise.

1.2.6 Review submittals, provide verified field measurements where applicable, and affix Contractor's review stamp prior to submission to Consultant. Contractor's review stamp represents that necessary requirements have been determined and verified, and that the submittal has been checked and coordinated with requirements of the Work and Contract Documents.

1.2.7 Verify field measurements and that affected adjacent work is coordinated.

1.2.8 Submittals not meeting specified requirements will be returned with comments.

1.2.9 Do not propose Substitutions or deviations from Contract Documents via Shop Drawing, Product data and sample submittals. Consultant will return such submissions without review. Refer to Section 01 25 00 for Substitution Procedures.

1.3 SUBMITTAL PROCEDURES, GENERALLY

1.3.1 Comply with Supplementary Condition SC21 (GC 3.8)

1.3.2 Schedule of Submittals: Refer to 01 32 00 - Construction Progress Documentation.

1.3.3 Administrative Requirements:

1.3.3.1 Assemble submittals and transmit to Consultant by sending via email. Include PDF transmittal form. Include information in email subject line clearly identifying project name, project no, and submittal scope.

1.3.3.2 Processing Time: Allow time for submittal review, including time for resubmittals, as follows.

.1 Time for review shall commence on Consultant's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.

.2 Processing Time: Allow 10 working days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Consultant will advise Contractor when a submittal being processed must be delayed for coordination.

1.3.3.3 Deviations and Additional Information:

.1 On each submittal, clearly indicate deviations from requirements in the Contract Documents, including minor variations and limitations; include relevant additional information and revisions, other than those requested by Consultant on previous submittals.

.2 Indicate by highlighting on each submittal or noting on attached separate sheet.

.3 Delete information not applicable to project.

.4 Supplement standard information to provide details applicable to project.

.5 Identify options requiring selection by Consultant.

1.3.4 Submittals Format: Submit electronic copies of each submittal unless otherwise indicated. Include the following information in each submittal:

1.3.4.1 Date and revision dates.

1.3.4.2 Project title and number.

1.3.4.3 Location(s) where product is to be installed, as appropriate.

1.3.4.4 Other necessary identification.

1.3.4.5 Remarks.

1.3.4.6 Transmittal letter, containing:

.1 Date.

.2 Project title and number.

.3 Contractor's name and address.

.4 Unique submittal number, including revision identifier. Include Specification Section number with sequential alphanumeric identifier and alphanumeric suffix for resubmittals.

.5 Submittal purpose and description.

.6 Signature of transmitter.

.7 Other pertinent data.

1.3.4.7 Contractor's stamp, signed by Contractor's authorized representative certifying approval of submissions, verification of field measurements and compliance with Contract Documents.

1.3.5 **[Grouped Submittals:**

1.3.5.1 **Group interior submittals together for colour and finish coordination.**

1.3.5.2 Group exterior submittals together for colour and finish coordination.]

1.4 CONTRACTOR'S REVIEW PROCESS AND RESPONSIBILITY

1.4.1 Submit to Consultant and to authorities having jurisdiction (as required), documents listed to be submitted for review. Submit promptly and in orderly sequence to not cause delay in Work.

1.4.2 Do not submit materials that are not identified in Contract Documents, such submissions will be returned without review.

1.4.3 Failure to submit documentation in ample time is not considered sufficient reason for increases to Contract Price or Contract Time. No claims for extension by reason of such default will be allowed.

1.4.4 Final approval of authorities having jurisdiction, where required, shall be obtained prior to submitting Shop Drawings or other documentation to Consultant.

1.4.5 Do not proceed with, or fabricate Work affected by specific submittals until review is complete.

1.4.6 Review submittals prior to submission to Consultant. This review shall represent that necessary requirements have been determined and verified, and that each submittal has been checked and coordinated with requirements of Work and Contract Documents. Submittals not stamped, signed, and dated by the Contractor, and identified as to specific project will be returned without being examined and considered rejected.

1.4.7 Notify Consultant, in writing at time of submission, identifying deviations from requirements of Contract Documents stating reasons for deviations.

1.4.8 Verify field measurements and affected adjacent Work are coordinated. Confirm and coordinate requirements pertaining to fabrication processes, quantities, construction techniques, installation and similar information.

1.4.9 Contractor's responsibility for errors and omissions in submission is not relieved by Consultant's review of submittals.

1.4.10 Contractor's responsibility for deviations in submission from requirements of Contract Documents is not relieved by Consultant's review.

1.4.11 Record each review as well as inspection and testing reports in manner suitable for inclusion in closeout documentation and submission at completion of Project.

1.4.12 Keep one reviewed copy of each submission on site.

1.5 CONSULTANT'S REVIEW AND RESPONSIBILITIES

1.5.1 Consultant's General Review:

1.5.1.1 Consultant will perform general review of The Work for general conformance with Contract Documents, Code and authorities having jurisdiction. Review includes review of Shop Drawings, review of field Work and review of reports produced by various inspection and testing agencies.

1.5.1.2 Review of Contractors' submittals by Consultant is for sole purpose of ascertaining conformance with general concept.

1.5.1.3 This review shall not mean that Consultant approves detail design inherent in submittals, responsibility for which shall remain with Contractor, and such review shall not relieve Contractor of

responsibility for errors or omissions or of responsibility for meeting requirements of Contract Documents.

1.5.1.4 Without restricting generality of foregoing, Contractor is responsible for dimensions to be confirmed and correlated at job site, for information that pertains solely to fabrication processes or to techniques of construction and installation and for co-ordination of Work of sub-trades.

1.5.2 Submittal Review and Actions: Consultant will review each submittal, indicate corrections or revisions required, and return annotated files to Contractor. Consultant will indicate, via markup on each submittal, the appropriate action, as follows:

1.5.2.1 “REVIEWED FOR GENERAL DESIGN” OR “REVIEWED AS NOTED”: Upon review by Consultant, no apparent errors or omissions are discovered by Consultant, or only minor corrections are to be made. Copies will be returned to Contractor and fabrication and installation of Work may proceed.

1.5.2.2 “REVISE AND RESUBMIT”: Make changes as Consultant may require, consistent with Contract Documents. When resubmitting, notify Consultant in writing of revisions other than those requested.

1.5.2.3 “REJECTED”: Shop drawings are rejected. Noted copy will be returned and resubmission of corrected submittals, through same procedure indicated above, must be performed before fabrication and installation of Work proceeds.

1.5.3 Fabrication Guidelines:

1.5.3.1 Do not fabricate any part of the Work until Shop Drawings are reviewed as "REVIEWED FOR GENERAL DESIGN" or "REVIEWED AS NOTED".

1.5.3.2 Do not resubmit Shop Drawings indicated as "REVIEWED FOR GENERAL DESIGN" or "REVIEWED AS NOTED".

1.5.3.3 Resubmit Shop Drawings indicated as "REVISE AND RESUBMIT" with required changes and comments addressed. Insert letter "R" after Shop Drawing number on resubmitted Shop Drawings. Re-date and re-sign resubmitted Shop Drawings. Identify revisions from earlier submissions graphically on revised Shop Drawings.

1.6 PRODUCT DATA

1.6.1 Mark product data sheets to show applicable Products and options. Include the following:

1.6.1.1 Manufacturer's written recommendations, Product Specifications, and installation instructions.

1.6.1.2 Wiring diagrams showing factory-installed wiring.

1.6.1.3 Printed performance curves and operational range diagrams.

1.6.1.4 Testing by recognized testing agency.

1.6.1.5 Compliance with specified standards and requirements.

1.7 SHOP DRAWINGS

1.7.1 Provide Shop Drawings required by Contract Documents. Insert Contractor's review stamp complete with date and signature of Contractor's reviewer.

1.7.2 Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.

1.7.3 Include the following on Shop Drawings as applicable:

1.7.3.1 Project-specific information, drawn accurately to scale.

1.7.3.2 fabrication methods.

1.7.3.3 layout, showing dimensions, including verified field dimensions, and clearances.

1.7.3.4 plans, sections and details.

1.7.3.5 materials thicknesses and finishes.

1.7.3.6 setting, erection and sealing details.

1.7.3.7 methods of securing, fastening and anchoring including field connections.

1.7.3.8 capacities.

1.7.3.9 performance characteristics.

1.7.3.10 standards.

1.7.3.11 operating weight.

1.7.3.12 wiring diagrams.

1.7.3.13 single line and schematic diagrams.

1.7.3.14 relationship to adjacent work.

1.7.3.15 engineer's stamp (as applicable)

1.8 DELEGATED-DESIGN (PROFESSIONNAL ENGINEER'S SHOP DRAWINGS)

1.8.1 It must be understood that Drawings and details provided in Contract Documents are diagrammatic, and are intended to show design concept, aesthetics, interfacing requirements, configuration, and arrangement; they are not intended to identify or completely resolve problems of thermal and structural movements, assembly framing, engineering design, fixings, anchorages and similar fabrication details.

1.8.2 Where Specifications delegate design of a specific element or system to Contractor, Contractor must engage a registered professional engineer as specified in Section 01 40 00 to fully design systems including, sizing of additional supports, anchorages, and bracing as required for safe and secure installation.

1.8.2.1 Professional Engineer's Specific Responsibilities:

.1 Design components requiring structural or other engineering performance.

.2 Determine specific requirements for assemblies, connections, sizes, and joint spacing.

.3 Produce, review, stamp, and sign Shop Drawings.

.4 In addition to Shop Drawings, submit statement for each product and system assigned to Contractor. Clearly state that products and systems comply with performance and design criteria outlined in Contract Documents. Provide list of calculations upon request.

.5 Inspect components during fabrication and erection.

.6 Perform field review and submit field reports within 3 days of site visits.

1.9 SAMPLES

1.9.1 Submit samples for Consultant's review in duplicate, unless otherwise specified in technical Specifications. Label samples as to origin, Project name, and intended use.

1.9.2 Submit Samples for review of kind, colour, pattern, and texture and for a comparison of these characteristics between submittal and actual component as delivered and installed. Include name of manufacturer and Product name on label.

1.9.3 For each sample, exhibit materials and finishes, such as colour (including maximum colour range within each specified colour), sheen, tone, texture, range of blemishes and other markings. Where colour, pattern or texture is criterion, submit full range of samples.

1.9.4 Adjustments made on samples by Consultant are not intended to change Contract Price. If adjustments affect value of Work, state such in writing to Consultant prior to proceeding with Work.

1.9.5 Contractor may be asked to remove and discard Products for which samples have not been reviewed and accepted by Consultant.

1.9.6 Consultant selection from samples is not intended to change the Contract Price or Contract Time. If a selection would affect the Contract Price or Contract Time, notify Consultant in writing prior to proceeding with the Work.

1.9.7 Resubmit samples as required by Consultant to comply with Contract Documents.

1.9.8 Reviewed and accepted samples will establish the standard against which installed Work will be reviewed.

1.9.9 Colours:

1.9.9.1 Where a required colour, pattern or texture has not been specified, submit full range of available Products meeting other specified requirements.

1.9.9.2 Obtain direction on colours and gloss values in advance of need. If requested, submit samples for colour and gloss selection.

1.9.9.3 Follow colour schedule provided by Consultant and use colours and glosses designated.

1.10 MISCELLANEOUS SUBMITTALS

1.10.1 When required by Contract Documents, submit informational and miscellaneous submittals required by Contract Documents (e.g. plans, reports, certifications, results, records, and similar submittals) for Consultant's review.

1.10.2 Test Reports:

1.10.2.1 Submit test reports in accordance with requirements of specification Sections and as requested by Consultant.

1.10.2.2 Reports must be signed by authorized official of testing laboratory and indicate that material, Product or system is identical to material, Product or system to be provided for Project, and has been tested in accordance with specified requirements.

1.10.2.3 Testing must have been within three years of date of Contract award.

1.10.3 Certificates:

1.10.3.1 Submit certificates in accordance with requirements of specification Sections and as requested by Consultant.

1.10.3.2 Statements must be printed on manufacturer's letterhead and signed by responsible officials of manufacturer of product, system or material, and attesting that product, system or material meets specification requirements.

1.10.3.3 Certificates must be project-specific, clearly indicated Project name, and dated after date of Contract award.

1.11 COORDINATION/INTERFERENCE DRAWINGS

1.11.1 For all locations, before commencing installation, prepare coordination/interference drawings showing relationship of items, including, but not limited to, structure, electrical, cable trays, communication system, ductwork, conduits, piping, sprinklers, ceiling supports and framing, communication and specialized equipment located within ceiling and shaft spaces.

1.11.2 Contractor shall lead process of interference Drawings in coordination with mechanical, electrical or other Subcontractors as applicable.

1.11.3 Prepare Drawings indicating relationship of new and existing and/or unforeseen conditions including new construction or construction which existed prior to commencement of work in the area. For construction in existing areas, survey existing conditions. Show existing conditions on interference Drawings and coordinate such conditions with new work. Submit or post coordination/interference drawing files in PDF format in accordance with Shop Drawing requirements specified in this Section.

1.11.3.1 Provide Project-specific information, drawn accurately to a scale large enough to indicate and resolve conflicts. Do not base coordination/interference drawings on standard printed data.

1.11.3.2 Use applicable Drawings as a basis for preparation of coordination/interference drawings. Prepare sections, elevations, and details as needed to describe relationship of various systems and components.

1.11.4 Consultant Review: Consultant will review coordination/interference drawings to confirm that, in general, the Work is being coordinated, but not for the details of the coordination, which are Contractor's responsibility. If Consultant determines that coordination/interference drawings are not being prepared in sufficient scope or detail, or are otherwise deficient, Consultant will so inform Contractor, who shall make suitable modifications and resubmit.

1.11.5 Installation shall proceed in accordance with final approved interference Drawings. Work carried out without final approved interference Drawings, and which does not meet requirements specified in Contract Documents or specified ceiling heights shall be removed, re-coordinated and re-installed at no additional cost to Owner.

1.11.6 Coordination/Interference Drawing Organization: Organize coordination/interference drawings as follows:

1.11.6.1 Floor Plans and Reflected Ceiling Plans: Show architectural and structural elements, and mechanical, plumbing, fire-protection, fire-alarm, and electrical Work. Show locations of visible ceiling-mounted devices relative to acoustical ceiling grid. Supplement plan drawings with section drawings where required to adequately represent the Work.

1.11.6.2 Plenum Space: Indicate sub framing for support of ceiling and wall systems, mechanical and electrical equipment, and related Work. Locate components within plenums to accommodate layout of light fixtures and other components indicated on Drawings. Indicate areas of conflict between light fixtures and other components.

1.11.6.3 Mechanical Rooms: Provide coordination/interference drawings for mechanical rooms, showing plans and elevations of mechanical, plumbing, fire-protection, fire-alarm, and electrical equipment.

1.11.6.4 Structural Penetrations: Indicate penetrations and openings required for all disciplines.

1.11.6.5 Slab Edge and Embedded Items: Indicate slab edge locations and sizes and locations of embedded items for metal fabrications, sleeves, anchor bolts, bearing plates, angles, door floor closers, slab depressions for floor finishes, curbs and housekeeping pads, and similar items.

1.11.6.6 Mechanical and Plumbing Work: Show the following:

.1 Sizes and bottom elevations of ductwork, piping, and conduit runs, including insulation, bracing, flanges, and support systems.

.2 Dimensions of major components, such as dampers, valves, diffusers, access doors, cleanouts and electrical distribution equipment.

.3 Fire-rated enclosures around ductwork.

1.11.6.7 Access Panels:

.1 Before commencing mechanical or electrical work after coordination with respective trades, prepare set of reflected ceiling plans indicating exact locations and sizes of access panels and doors. Prepare Drawings for areas/rooms designated by Consultant.

.2 Submit Drawings to Consultant for review. Allow Consultant to revise layout or quantity of access doors and panels, by relocating related building services a maximum of 2000 mm (6' - 7"), at no additional cost to Owner.

.3 Should a relocation exceed 2000 mm (6' - 7"), Contract Price will be adjusted in accordance with provisions for changes in Contract Documents.

.4 Finish access panels and doors to match adjacent wall and/or ceiling finish unless otherwise specified or indicated.

1.11.6.8 Electrical Work: Show the following:

.1 Runs of vertical and horizontal conduit 32 mm (1-1/4 inches) in diameter and larger.

.2 Light fixture, exit light, emergency battery pack, smoke detector, and other fire-alarm locations.

.3 Panel board, switchboard, switchgear, transformer, busway, generator, and motor-control center locations.

.4 Location of pull boxes and junction boxes, dimensioned from column center lines.

1.11.6.9 Fire-Protection System: Show the following:

.1 Locations of standpipes, mains piping, branch lines, pipe drops, and sprinkler heads.

1.11.7 Mechanical and Electrical Location Drawings: Mechanical and electrical Drawings indicate approximate locations diagrammatically. Prior to installation, request and obtain final locations and arrangement Drawings for mechanical and electrical items.

1.11.7.1 In case of conflicts between locations of mechanical and electrical items, such as switches and fixtures, locations indicated on architectural Drawings shall take precedence.

1.11.7.2 Align and cluster devices and fitments neatly in accordance with specified mounting heights, properly aligned horizontally and vertically.

END OF SECTION

1.1 FACILITITY POLICIES, FORMS AND STANDARDS

1.1.1 Following standards and policies related to The Work are referenced in this Section. For items indicated as Contractor's responsibility within referenced facility policies and standards, and unless the Contract Documents include more stringent requirements, applicable standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.

1.1.1.1 Environmental Health and Safety Forms (https://ehs.utoronto.ca/resources/)

1.1.2 Design Standards relevant to the Work include, but are not limited to:

1.1.2.1 UTM_CommunicationCablingStandards-R3.1_20201112_99pgs – included in the RFT

1.1.3 Forms relevant to the Work include, but are not limited to:

1.1.3.1 Asbestos Management

.1 Acknowledgement of University asbestos program and Ontario regulations

.2 Asbestos awareness training and work experience for contractors (Property Management)

.3 Asbestos awareness training and work experience for contractors (University Planning, Design & Construction)

1.1.3.2 Design and Planning

.1 Basis of design report template and checklist

.2 Building design standard variance request

.3 Design deliverable documentation check sheets

.4 Design standards conformance form

1.1.3.3 Access, Shutdown Requests and Other Facility Forms:

.1 Request for electrical services shutdown

.2 Application for work on live electrical equipment

.3 Request for access to LAN and data equipment rooms

.4 Request for electrical power

.5 Request for high-voltage substation and electrical room access

.6 Building automation systems access and change control forms

.7 Request for fire alarm and sprinkler system activity

.8 Request for investigation of building mechanical services

.9 Request for mechanical rooms and building roofs access (MS Form)

.10 Request for mechanical rooms and building roof access — contractors' acknowledgement form

.11 Request for mechanical services shutdown

.12 Notice of crane or heavy equipment use

.13 Energy management reporting system (EMRS) BACnet compliance test readiness form

.14 Project points list energy management reporting system (EMRS) submittal form

.15 Wiring installation qualification form

.16 Service tunnel regulations

1.1.4 Read and become familiar with facility policies and standards. Be responsible for enforcement of such policies and standards.

1.2 RELEVANT STATUTES AND REGULATIONS

1.2.1 Occupational Health and Safety Act - R.S.O. 1990, C. O.1 (as amended)

1.2.2 Construction Projects - Ontario Regulation 213/91 (as amended)

1.2.3 Asbestos on Construction Projects and in Buildings and Repair Operations - Ontario Regulation 278/05

1.2.4 WHMIS Regulation - Ontario Regulation 860 (as amended)

1.3 CONTRACTOR'S RESPONSIBILITY FOR PROJECT SAFETY

1.3.1 Role of Constructor: Contractor must assume role of "Constructor" as defined under applicable health and safety regulations.

1.3.2 Maintain a safe environment for visitors, staff, students, guests, and Contractors at Owner's facility.

1.3.3 Ensure project safety at all times by providing adequate resources, equipment, training, and documentation.

1.3.4 Promote a culture of safety among all supervisors and workers.

1.3.5 Ensure all workers understand their responsibility to identify, report, and correct unsafe acts and conditions.

1.3.6 Submit site-specific Health and Safety Plan prior to commencement of Work. Health and Safety Plan must include:

1.3.6.1 Results of site-specific safety hazard assessment.

1.3.6.2 Results of safety and health risk or hazard analysis for site tasks and operation

1.3.6.3 Infection prevention and control procedures.

1.3.7 Health and Safety Coordinator: Employ and assign to Work, competent and authorized representative as Health and Safety Coordinator. Health and Safety Coordinator must:

1.3.7.1 Have site-related working experience specific to activities associated with healthcare and infection prevention and control.

1.3.7.2 Have working knowledge of occupational safety and health regulations.

1.3.7.3 Be responsible for completing Contractor's Health and Safety Training Sessions and ensuring that personnel not successfully completing required training are not permitted to enter site to perform Work.

1.3.7.4 Be responsible for implementing, enforcing daily and monitoring site-specific Contractor's Health and Safety Plan.

1.3.7.5 Be on site during execution of Work and report directly to and be under direction of site Superintendent.

1.3.8 Submit duplicate copies of Contractor's authorized representative's work site health and safety inspection reports and other pertinent reports (such as accident reports, recommendations made by authorities having jurisdiction etc.) to Consultant and or authority having jurisdiction.

1.3.9 Consultant's review of Contractor's final Health and Safety plan must not be construed as approval and does not reduce the Contractor's overall responsibility for construction Health and Safety.

1.3.10 Prior to commencement of the Work, carry out preconstruction safety audit to identify hazards and establish protocols, commitment to safety, safety rules, and safety related chain of commands for selective demolition work, sequential project work, and removal of designated hazardous materials.

1.3.11 For sequential projects, preconstruction safety audit shall include reviewing work carried out under previous project which is to be subsumed by the Contract. Design, implement, monitor and maintain a safe work environment throughout Contract in accordance with procedures established during preconstruction safety audit. Attendance at pre-construction safety audit shall be mandatory for Contractor, Subcontractors and major Suppliers.

1.3.12 Provide on-site such equipment and medical facilities as are necessary to furnish first aid to anyone who may be injured in connection with work in accordance with regulations of the Occupational Health and Safety Act (Ontario)

1.3.13 Promptly report in writing to Owner all accidents arising out of or in connection with performance of the Work, whether on or adjacent to site, which caused death, personal injury or property damage, giving full details and statements of witnesses. In addition, in case of death, serious injuries or damages, report accident immediately by telephone or messenger to Owner’s representative

1.3.14 If any claim is made by anyone against the Contractor or any Subcontractor on account of any accident or damage, promptly report facts in writing to Consultant and Owner, giving full details of claim.

1.4 WORKPLACE HAZARDOUS MATERIALS INFORMATION SYSTEM (WHMIS)

1.4.1 Contractor and Subcontractors must be familiar with and comply with WHMIS regulations.

1.4.2 Ensure all controlled products have appropriate labels. Supply appropriate warning labels and conduct training on site.

1.4.3 Before initial delivery, submit Safety Data Sheets (SDS) for all controlled products at Place of the Work.

1.4.4 Maintain log book of hazardous materials, including SDS, delivery dates, quantities, usage, waste records, removal dates, and quantities. Log must be accessible for inspection by Contractor, Owner, Consultants, and site personnel.

1.4.5 Participate in Contractor's Safety Orientation meeting before starting work. Address storage and handling of hazardous materials on site, and and measures to prevent damage or injury from accidental spills.

1.5 CONTRACTOR SAFETY ORIENTATION

1.5.1 [-]

1.6 CONFINED SPACES

1.6.1 [-]

1.7 FALL PROTECTION

1.7.1 [-]

1.8 UNFORSEEN HAZARDS

1.8.1 In case of unforeseen or unusual safety hazards, factors, or conditions during execution of the Work, comply with procedures in place for Employee's Right to Refuse Work in accordance with laws and regulations applicable to jurisdiction of the Place of the Work. Inform Consultant and Owner in writing of situation.

1.9 SPECIAL PROCEDURES - ASBESTOS CONTAINING MATERIALS

1.9.1 Comply with O. Reg. 278/05 "Designated Substance - Asbestos On Construction Projects And In Buildings And Repair Operations" and University of Toronto Asbestos Management Program. In case of conflict, the most stringent requirements apply.

1.9.2 Contractor and Subcontractors must complete the Contractor's Workers Asbestos Awareness Training Program Form for all personnel performing work. Submit copies to the Owner's Representative minimum 48 hours before starting work. Provide and pay for additional Asbestos Awareness Training if required by Owner.

1.9.3 After reviewing Asbestos Management Program, complete Contractor's Acknowledgement of Asbestos Management Program Form. Submit copies at construction start-up meeting.

1.9.4 Unexpected Discovery Of Asbestos, Toxic Or Hazardous Substances And Materials

1.9.4.1 Comply with GC 9.2 and Supplementary Condition SC51 (GC9.2).

1.9.4.2 Clauses below do not apply to hazardous substances and materials that have been clearly identified or can be inferred from Designated Substances Reports appended to [Section 00 30 00] and whose removal must be included in Contract Price.

1.9.4.3 If friable material is unexpectedly discovered, cease work immediately and report to Owner. Await written authorization for remedial work.

1.9.4.4 If disturbed materials are suspected of containing asbestos, immediately suspend work in affected area and report event in writing to the Consultant and Owner.

1.9.4.5 If friable or other potentially hazardous materials are confirmed to be toxic or hazardous, removal of such materials arrangements may become part of the Contract and may be authorized as a Contract modification. Refer to Section 01 26 00.

1.9.4.6 Ensure that removal actions comply with O. Reg. 278/05, “Designated Substance - Asbestos on Construction Projects and in Buildings and Repair Operations.”

1.10 SPECIAL PROCEDURES - MOULD

1.10.1 Reporting of Potential Mould Presence

1.10.1.1 Report potential mould conditions to Owner immediately.

1.10.1.2 Report new and old water damage.

1.10.1.3 New water damage must be reported immediately and addressed within 24 to 48 hours of occurrence.

1.10.1.4 Identify source of water damage and verify for high levels of bio-contaminants (eg. sewage, river water).

1.10.1.5 Strong Odours: Report strong odours consistent with mould immediately.

1.10.1.6 Physical Symptoms:

.1 Report physical symptoms potentially related to mould irritation such as runny nose, eye irritation, skin rash, cough, congestion, fatigue, headache, and asthma aggravation. Note: People with asthma, bronchitis, hay fever or other allergies, or have weakened immune systems are more likely to react to mould.

.2 Refer to Ontario Ministry of Labour - Mould in Workplace Buildings Alert 20: ISSN 1195-5228, Hazard Summary.

1.10.2 Unexpected Discovery of Mould:

1.10.2.1 Comply with GC 9.5 and Supplementary Condition SC53 (GC9.5).

1.10.2.2 Clauses below do not apply to hazardous substances and materials that have been clearly identified or can be inferred from Designated Substances Reports appended to [Section 00 30 00] and whose removal must be included in Contract Price.

1.10.2.3 In event of unexpected discovery of potential mould, stop work immediately and do not disturb potential mould material until it is determined if material contains mould. Immediately report discovery in writing to Owner.

1.10.2.4 If presence of mould is confirmed, arrangements for removal may be authorized as a Contract modification. Refer to Section 01 26 00.

1.10.2.5 If mould is disturbed, suspend work in affected area. Immediately report disturbance in writing to nearest Construction Health and Safety Office, Ministry of Labour, and to Owner.

1.10.2.6 Clean up contamination in accordance with requirements of Construction Health and Safety Branch, Ministry of Labour, and the Owner's Mould Remediation Procedures.

1.10.2.7 Contractor must submit report to Consultant showing that mould has been removed prior to Owner using Place of the Work for intended purpose or obtaining Certificate of Substantial Performance of the Work, whichever date comes first.

1.10.2.8 If Consultant or Owner suspects that mould amplification was caused by Contractor's behaviour or actions, Owner reserves the right to retain a qualified and experienced bio-contamination investigator to determine the source and impact of potential mould amplification on site in accordance with General Conditions and Supplementary Conditions. Investigator will perform sampling, laboratory analysis, and other required assessment steps to determine cause of the mould amplification and submit results to Owner and Contractor for action.

1.10.3 Remediation Procedures:

1.10.3.1 Conform to Owner's Level I, II, III, IVa, and IVb Procedures for Remediation of Fungi in Indoor Environments, prepared by the University's Office of Environmental Health and Safety.

1.10.3.2 Obtain copies of procedures from Owner's Representative.

1.11 MAGNETIC FIELD/RADIO FREQUENCY (RF) FIELD SPECIAL SAFETY WARNINGS AND PRECAUTIONS

1.11.1 The Contractor shall strictly observe and follow the following magnetic field and radio frequency (RF) field special safety warnings and precautions during the performance of the Work of this Contract due to the special nature of the equipment in use by the University in the building area. Failure to comply with the magnetic field and radio frequency (RF) field special safety warnings and precautions specified herein violates the safety standards of the equipment manufacturer's design, manufacture and intended use of the equipment. The Owner assumes no responsibility for the Contractor's failure to comply with the magnetic field and radio frequency (RF) field special safety warnings and precautions specified herein. The Contractor shall pay for all damages caused by the Contractor's and its Subcontractors' failure to comply with the magnetic field and radio frequency (RF) field special safety warnings and precautions specified herein.

1.11.2 The following definitions shall apply to the magnetic field and radio frequency (RF) field special safety warnings and precautions specified herein:

1.11.2.1 Warnings: Warnings are used when failure to observe the instructions or precautions could result in injury or death to humans or animals, or significant property damage.

1.11.2.2 Cautions: Cautions are used when failure to observe the instructions could result in serious damage to the Owner's (University's) equipment or loss of data.

1.11.2.3 Magnetic field and radio frequency (RF) field special safety warnings shall be as follows;

.1 Persons with implanted or attached medical devices such as pacemakers and prosthetic parts must remain outside the 5-Gauss perimeter of the magnet: The magnetic system generates strong magnetic fields that can affect the operation of some cardiac pacemakers or harm implanted or attached devices such as prosthetic parts and metal blood vessel clamps. Pacemaker wearers should also always notify their physician and discuss the health risks of being in proximity to magnetic fields. Wearers of metal prosthetics and implants should consult their physician to determine if a danger exists. A table showing the 5-Gauss stray magnetic field for various magnetic systems is printed on the back of the 5-Gauss Warning Sign (Part No. 87-250303-00).

.2 Keep metal objects outside the 10-Gauss perimeter of the magnet: The strong magnetic field surrounding the magnet attracts objects containing steel, iron, or other ferromagnetic materials which includes ordinary tools, electronic equipment, compressed gas cylinders, steel chairs and steel carts. Unless restrained, such objects can suddenly fly towards the magnet, causing possible personal injury and extensive damage to the probe, Dewar and superconducting solenoid. The greater the mass of the object, the more the magnet attracts the object. Only non-ferromagnetic materials - plastics, aluminum, wood, non-magnetic stainless steel, etc. - should be used in the area around the magnet. If an object is stuck to the magnet surface contact the Owner's Representative and the equipment manufacturer's service for assistance. A table showing the 10-Gauss stray magnetic field for various magnet systems is printed on the back of the 10-Gauss Warning Sign (Part No. 87- 2503020-00).

1.11.2.4 Magnetic field and radio frequency (RF) field special safety precautions shall be as follows;

.1 Keep magnetic media, ATM bank cards and credit cards, and watches outside the 5-Gauss perimeter of the magnet: The strong magnetic field surrounding a superconducting magnet can erase magnetic media such as floppy discs and tapes. The magnetic field can also damage the strip of magnetic media found on credit cards, automatic teller machine (ATM) bank cards, and similar plastic cards. Many wrist and pocket watches are also susceptible to damage from intense magnetism. A table showing the 5-Gauss stray magnetic field for various magnet systems is printed on the back of the 5-Gauss Warning Sign (Part No. 87- 250303-00).

1.11.2.5 Information on the Electric and Magnetic Field Safety Program at the University of Toronto and samples of signs can be found at the following link: https://ehs.utoronto.ca/our-services/radiation-safety/emf-safety-program/

END OF SECTION

1.1 SUMMARY

1.1.1 Purpose of Section: Section specifies minimum quality requirements for the Work.

1.1.2 Read in conjunction with: CCDC 2-2020, Part 3, Execution of the Work.

1.2 REGULATORY REQUIREMENTS

1.2.1 Building Code Information:

1.2.1.1 Project has been designed and must be constructed in accordance with requirements of Ontario Building Code, latest edition including any amendments (The Building Code or “OBC”).

1.2.2 Compliance with Laws: Contract Documents including Drawings, Specifications and other information for the Work are intended to comply with federal, provincial and municipal laws, by-laws, regulations and other requirements of authorities having jurisdiction. Perform Work in accordance with such requirements.

1.2.2.1 Specific design and performance requirements listed in specifications or indicated on Drawings may exceed minimum requirements established by referenced Building Code; these requirements will govern over the minimum requirements listed in Building Code.

1.2.2.2 Where OBC or Contract Documents do not cover a specific requirement, which is covered by the National Building Code of Canada, latest edition (or NBC), conform to requirements of NBC including its related supplements.

1.2.2.3 Where Specifications do not provide sufficient details for a particular item of work indicated on Drawings or Schedules, conform to minimum standards indicated in Building Code, and in the absence of more restrictive requirements comply with specifications, installation methods, and standards of workmanship indicated in OBC, Part 9 "Housing and Small Buildings".

1.3 PERMITS, CERTIFICATES AND TRANSCRIPTS

1.3.1 Required Documentation Prior to Commencement of the Work:

1.3.1.1 Immediately after receiving notification of award of Contract, submit the following:

.1 Workplace Safety & Insurance Certificate status,

.2 transcription of insurances

.3 other certificates and transcripts required by Contract Documents, Consultant or authorities having jurisdiction.

1.3.1.2 Ensure permits, licenses and certificates included under specific Sections are provided as specified. Forward copies of permits to Owner and Consultant before commencing Work.

1.3.2 Building Permit Acquisition and Display:

1.3.2.1 Building permit application and fee payment has been made by Consultant on behalf of Owner.

1.3.2.2 Contractor must print and display building permit and other relevant permits in visible location at Place of the Work.

1.3.3 Contractor's Responsibilities for Other Permits:

1.3.3.1 Except as otherwise noted, Contractor is responsible for applying for, obtaining, and covering fees for other necessary permits, licenses, certificates, inspections, and approvals mandated by Authorities Having Jurisdiction or Contract Documents.

1.4 ABBREVIATIONS AND ACRONYMS

1.4.1 Commonly Assigned Meanings: Words and phrases in these Specifications or in other Contract Documents that are not expressly defined in the General Conditions or Supplementary Conditions of the Contract must be interpreted based on their common meanings within the specific context in which they are used. When interpreting these terms, take into account specialized usage within various trades and professions relevant to the terminology. Refer uncertainties to Consultant.

1.5 REFERENCE STANDARDS

1.5.1 “Reference standards” means consensus standards, trade association standards, guides, and other publications expressly referenced in Contract Documents.

1.5.2 Where an edition or version date is not specified, referenced standards shall be deemed to be the latest edition or revision issued by the publisher at the time of bid closing. However, if a particular edition or revision date of a specified standard is referenced in an applicable code or other regulatory requirement, the regulatory referenced edition or version shall apply.

1.5.3 Reference standards establish minimum requirements. If Contract Documents call for requirements that differ from a referenced standard, the more stringent requirements shall govern.

1.5.4 If compliance with two or more reference standards is specified and the standards establish different or conflicting requirements, comply with the most stringent requirement. Refer uncertainties to Consultant for clarification.

1.5.5 Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.

1.5.6 Copies of Standards: Each entity engaged in construction on Project should be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source.

1.6 MINIMUM QUALIFICATION REQUIREMENTS

1.6.1 Where Specifications use the term “experienced” in the context of qualifications, the following minimum criteria must be applied; individual Specification Sections may specify additional requirements.

1.6.2 Manufacturer Qualifications:

1.6.2.1 Experience: Manufacturer must have a minimum of 10 years' experience in producing systems similar to those specified for the Project.

1.6.2.2 Capabilities: Manufacturer must demonstrate successful in-service performance and have adequate production capacity.

1.6.2.3 Additional Requirements: Must meet qualification, warranty, and technical or factory-authorized service representative requirements.

1.6.3 Fabricator Qualifications:

1.6.3.1 Experience: Fabricator should have at least 10 years' experience in producing products similar to those indicated for the Project.

1.6.3.2 Capabilities: Fabricator must have a record of successful in-service performance and sufficient production capacity.

1.6.4 Welder Qualifications:

1.6.4.1 Certification: Welders must be certified per CSA W47.1 and CSA W59-M, with a minimum certification level of "Division 1" or "Division 2".

1.6.4.2 Operators: Must be qualified per CSA W47.1 for work specified in Contract Documents, with a minimum certification level of "Class O".

1.6.4.3 Inspectors and Supervisors: Must meet CSA W178.1 and CSA W178.2 qualifications and be certified by the Canadian Welding Bureau for "Category (a), Buildings".

1.6.4.4 Documentation: Submit copies of welding certificates to Consultant prior to Work commencement.

1.6.5 Installer Qualifications:

1.6.5.1 Experience: Installer should have at least 5 years' experience in installing systems similar to those specified for the Project and, where applicable, be certified by the manufacturer.

1.6.6 Professional Engineer Qualifications:

1.6.6.1 Credentials: Must be a member in good standing of the Professional Engineers Ontario (PEO) and legally qualified to practice in the jurisdiction where the Project is located.

1.6.6.2 Experience: Not less than 5 years' experience in providing engineering services of similar scope.

1.6.6.3 Insurance: Must carry professional liability insurance of not less than $2,000,000.00. No exceptions.

1.6.6.4 Restrictions: Engineers opting for "Mandatory Disclosure" or "Suggested Disclosure" approaches as permitted by PEO are not eligible to work on this Project.

1.6.7 Surveyor Qualifications:

1.6.7.1 Credentials: Must be a member in good standing of the Association of Ontario Land Surveyors and legally qualified to practice in the jurisdiction where the Project is located.

1.6.7.2 Experience: Not less than 5 years' experience in providing professional land surveying services of similar scope.

1.6.8 Manufacturer's Technical Representative Qualifications:

1.6.8.1 Credentials: Must be an authorized, trained, and manufacturer-approved representative to observe and inspect the installation of products similar to those specified for the Project.

1.6.9 Testing and Inspecting Agency Qualifications:

1.6.9.1 Credentials: Must be an SCC-accredited laboratory or independent agency acceptable to Owner and Consultant with experience and capability to conduct testing and inspection indicated, as documented according to ASTM E329, and with additional qualifications specified in individual sections. Where required by authorities having jurisdiction, testing agency must be acceptable to such authorities.

1.7 QUALITY CONTROL

1.7.1 Contractor’s Quality Control: Quality Control is Contractor’s responsibility. Use qualified personnel trained and experienced in managing and executing quality assurance and quality control procedures as required for the Project.

1.7.2 Contractor-Requested Testing: Testing and inspection requested by Contractor but not required by Contract Documents are Contractor’s responsibility.

1.7.3 Manufacturer's Field Services: Engage factory-authorized service representatives for inspection and observation as specified in Contract Documents or required by manufacturer. Responsibilities include participation in preinstallation meetings, examination of conditions, verification of materials, observation of installation activities, and submission of written reports.

1.7.4 Removal and Replacement of Rejected Work: Promptly remove and replace defective Work rejected by Consultant. Promptly repair damage caused by removals or replacements.

1.7.5 Equipment and Systems: Refer to Divisions 21, 22, 23, and 26 for detailed requirements.

1.8 PERIODIC WORK OBSERVATIONS

1.8.1 Daily Logs: Contractor must assign a supervisor or designated competent individual to compile daily log or diary. Record must cover:

1.8.1.1 Weather conditions.

1.8.1.2 Workforce numbers, including Contractors, Subcontractors, Suppliers, and other personnel present at Work Site.

1.8.1.3 Summary of general project activities.

1.8.1.4 Documentation of extraordinary or emergency incidents.

1.8.1.5 Identification of visitors to Place of the Work who are not regular workforce members.

1.8.2 Manpower and Material Records: Contractor is responsible for keeping detailed records of manpower and material usage for Project. Records must be maintained at Place of the Work.

1.8.3 Availability of Records: Upon Owner’s or Consultant's request, submit records created under this section for inspection and duplication purposes.

1.9 INDEPENDENT INSPECTION AND TESTING AGENCIES

1.9.1 Appointment and Payment: Unless otherwise specified, costs for retaining and paying independent inspection and testing agencies shall be paid **[via cash allowance as specified in Section 01 21 00] [by Owner]**.

1.9.1.1 Inspection and testing agencies will inspect, test, or perform quality control reviews of parts of the Work. The following are specifically excluded from the inspection and testing allowance and must be included in Contract Price:

.1 Inspection and testing mandated by laws, ordinances, rules, regulations, or orders of public authorities.

.2 Inspection and testing conducted solely for Contractor's convenience or own quality control.

.3 Testing, adjustment, and balancing of conveying systems, mechanical and electrical equipment and systems.

.4 Mill tests and certificates of compliance.

.5 Inspections and tests specifically designated as Contractor's responsibility in Divisions 02 – 49 of the Specifications.

1.9.2 Contractor's Responsibility: Employment of inspection and testing agencies by Owner does not relieve Contractor from responsibility to perform the Work in accordance with Contract Documents.

1.9.3 Cooperation with Inspection and Testing Agencies:

1.9.3.1 Allow and arrange for inspection and testing agencies to have access to the Work, including access to off-site manufacturing and fabrication plants.

1.9.3.2 Submit test samples required for testing in accordance with schedule of submittals specified in Section 01 32 00 – Construction Progress Documentation.

1.9.3.3 Provide labour, Construction Equipment and temporary facilities to obtain and handle test samples on site.

1.9.4 Notification for Required Inspection and Testing: For inspection and testing required by Contract Documents or by authorities having jurisdiction, provide Consultant and inspection and testing agencies with timely notification in advance of required inspection and testing.

1.9.5 Reporting:

1.9.5.1 Contractor's Reporting Obligation: For inspection and testing required by Contract Documents or by regulatory requirements, and performed by Contractor retained inspection and testing agencies, submit to Consultant and Owner copies of reports. Submit within three Working Days after completion of inspection and testing.

1.9.5.2 Owner's Reporting Requirements: For inspection and testing performed by Owner retained inspection and testing agencies, copies of inspection and testing agency reports will be provided to Contractor.

1.10 INDEPENDENT INSPECTION AND TESTING

1.10.1 The following items of work may be subject to independent inspection and testing:

1.10.1.1 Division 03 – Concrete

.1 Concrete Construction

1.10.1.2 Division 04 – Masonry

.1 Masonry Construction

1.10.1.3 Division 05 – Metals

.1 Structural Steel

.2 Open-Web Steel Joists

1.10.1.4 Division 07 – Thermal and Moisture Protection

.1 Whole Building Air Barrier Testing

.2 Field Air Leakage Testing – Air Barriers

.3 Field Air Leakage Testing – Curtain Wall

.4 Field Water Leakage Testing – Roofing

.5 Thermography – Roofing

.6 Adhesion – Joint Sealants

.7 Adhesion – Air Barrier Testing

.8 Spray Foam Insulation

.9 Waterproofing Installation

.10 Sprayed Fireproofing

.11 Mastic And Intumescent Coatings

.12 Firestopping And Smoke Seals

1.10.1.5 Division 09 – Finishes

.1 Access Floors

.2 Slab Moisture and Inspection Testing

1.10.1.6 Division 31 – Earthwork

.1 Geotechnical Soils Inspection

.2 Geotechnical Deep Foundation

1.11 MOCK-UPS

1.11.1 General Requirements: Before starting Work specified in technical Specifications, prepare mock-ups for Consultant's review. Obtain Consultant's acceptance before proceeding with corresponding Work.

1.11.2 Size and Location: If mock-up location is not indicated in the Drawings or Specifications, locate where directed by Consultant on site.

1.11.3 Notification: Inform Consultant minimum 5 working days prior to mock-up construction.

1.11.4 Supervision: For mock-up construction, use supervisory personnel and workers who will perform similar tasks on Project.

1.11.5 Aesthetic and Workmanship Range: Demonstrate intended aesthetic effects and quality.

1.11.6 Revisions and Review:

1.11.6.1 Modify mock-up as required until Consultant acceptance is obtained. Address unsatisfactory conditions identified in preliminary review and modify mock-ups as necessary. Allow time in schedule for multiple reviews.

1.11.6.2 Accepted mock-ups establish an acceptable standard for the Work.

1.11.6.3 Acceptance of mock-ups does not imply acceptance of deviations from requirements of Contract Documents, unless such deviations are confirmed in writing by Consultant.

1.11.6.4 Unless otherwise specified in the technical Specifications, accepted mock-ups forming part of the Work may remain as part of the Work.

1.11.7 Protection and Removal:

1.11.7.1 Protect mock-ups from damage until the Work they represent is complete.

1.11.7.2 Remove mock-ups only when the Work they represent is complete or when otherwise directed by Consultant.

1.12 IN-SITU MOCK-UPS

1.12.1 Refer to Technical Specifications.

1.13 BUILDING ENVELOPE MOCK-UPS

1.13.1 Build on-site mock-ups of exterior envelope assemblies, Refer to Section 01 91 19 and Technical Specifications for additional requirements.

1.14 FULL ROOM MOCK-UPS (QUALITY CONTROL REFERENCE ROOM AND AREAS)

1.14.1 Include in Contract Price, cost of construction of a typical interior room or areas complete with finishes and fixtures.

1.14.2 Quality Control Reference Room and Areas serve following purpose:

1.14.2.1 Establish a minimum standard for all other work under this Contract.

1.14.2.2 Resolve misunderstandings and potential future construction, finish, and coordination issues.

1.14.2.3 Accepted Quality Control Reference Room or Area will set standard for workmanship and products for remaining subsequent similar work.

1.14.3 Preparation:

1.14.3.1 At start of interior work, complete one typical room or area as designated by Owner and Consultant.

1.14.4 Scope: Include work from all applicable trades.

1.14.4.1 Provide room complete with finishes, accessories, fitments, appliances, doors and frames, door trim hardware, electrical lighting

fixtures and controls, communication systems and controls, and mechanical equipment and controls.

1.14.4.2 Ensure services are fully energized, operational, cleaned, and ready for use.

1.14.5 Inspection and Acceptance

1.14.5.1 Notify the Consultant in writing when Quality Control Reference Room or Area is ready for inspection.

1.14.5.2 Consultant will review room or area during construction and after completion, and issue a list of deficiencies as necessary.

1.14.5.3 Engage and pay for professional cleaning service to clean area before final inspection. Comply with requirements of Section 01 74 00.

1.14.6 Non-Conforming Work: Parts of the Work not conforming to accepted standard will be rejected.

1.14.7 Maintenance and Use

1.14.7.1 Accepted Quality Control Reference Room or Area may remain as part of the Work.

1.14.7.2 Accepted Quality Control Reference Room or Area must not be used as meeting space for project meetings, pre-installation conferences, or other purposes.

1.14.8 Security: Secure and lock area after final acceptance. Maintain room and area in undisturbed condition throughout project.

1.14.8.1 Unlock room only for confirming workmanship quality or resolving construction and finish issues, then promptly re-lock.

1.14.8.2 Provide 2 additional pass keys to Owner and Consultant.

1.14.9 Refer to relevant specification sections for detailed requirements related to each aspect of the Quality Control Reference Room or Area.

END OF SECTION

1.1 SUMMARY

1.1.1 Purpose of Section: Section specifies responsibilities for temporary facilities and controls for the Work.

1.1.2 Read in conjunction with: CCDC 2-2020, Part 3, Execution of the Work; specifically, GC 3.3.

1.2 SUBMITTALS

1.2.1 Site Utilization and Staging Drawings: Prepare site plan indicating proposed location and dimensions of area to be enclosed and used by Contractor, number of trailers to be used, avenues of ingress/egress to enclosed area and details of enclosure installation. Indicate use of supplemental or other staging area.

1.3 ENGINEERING DESIGN FOR TEMPORARY FACILITIES

1.3.1 Engage and pay for registered professional engineers skilled in relevant disciplines where required by law or Contract Documents, and whenever engineering skill is necessary for safe and satisfactory results.

1.3.2 Submit shop drawings bearing seal and signature of registered professional engineer, detailing temporary structural and other facilities and methods intended for the Work.

1.4 TEMPORARY UTILITIES

1.4.1 Provide temporary utilities as specified and as otherwise necessary to perform the Work expeditiously. Remove temporary utilities after use.

1.5 TEMPORARY WATER

1.5.1 Temporary Water Supply by Contractor: Install water service and distribution piping in sizes and pressures adequate for construction.

1.5.1.1 Use Charges: Pay water service use charges for water used by all entities for construction operations. Install a sub-meter for this purpose at Contractor’s cost.

1.5.1.2

1.6 TEMPORARY ELECTRICAL POWER

1.6.1 Temporary Power by Contractor: Provide electric power service and distribution system of sufficient size, capacity, and power characteristics required for construction operations.

1.6.1.1 Use Charges: Pay electric power service use charges for electricity used by all entities for construction operations. Install a sub-meter for this purpose at Contractor’s cost.

1.6.2 Unless approved by Owner in writing, do not use permanent building lighting systems during construction.

1.7 TEMPORARY HEATING AND VENTILATION

1.7.1 Arrange and pay for temporary heating and ventilation required during construction.

1.7.2 Duct carbon dioxide gas (CO_2) or other noxious or harmful gases from heaters to the exterior of buildings

1.7.3 Vent construction heaters in enclosed spaces to the outside or use flameless type of construction heaters.

1.7.4 Provide temporary heat for the Work as required to:

1.7.4.1 Facilitate progress of Work.

1.7.4.2 Protect the Work against dampness and cold.

1.7.4.3 Prevent moisture condensation on surfaces, freezing, or other damage to finishes or stored Products.

1.7.4.4 Maintain specified minimum ambient temperatures and humidity levels for storage, installation and curing of Products.

1.7.4.5 Maintain the heated parts of the building(s) or temporary enclosures at minimum 10 deg C (50 deg F), or at such temperature specified in Technical Specifications for proper installation of various Products.

1.7.5 Provide temporary ventilation for Work as required to:

1.7.5.1 Prevent accumulations of fumes, exhaust, vapours, gases and other hazardous, noxious, or volatile substances in enclosed spaces, as required to maintain a safe work environment meeting applicable regulatory requirements.

1.7.5.2 Ensure that hazardous, noxious, or volatile substances do not migrate to Owner-occupied spaces.

1.7.5.3 Ventilate temporary sanitary facilities.

1.7.6 Unless approved by Owner in writing, do not use permanent building heating and ventilation systems during construction.

1.8 CONSTRUCTION FACILITIES

1.8.1 Generally: Provide temporary construction facilities as necessary for performance of the Work and in compliance with applicable regulatory requirements.

1.8.1.1 Maintain temporary construction facilities in good condition for the duration of the Work.

1.8.1.2 Remove temporary construction facilities from Place of the Work when no longer required.

1.9 CONSTRUCTION PARKING

1.9.1 Vehicles should be parked in designated parking spaces

1.9.2 Commercial parking permits are available. Additional details are available at:

https://www.utm.utoronto.ca/parking/permits/other-permits

1.9.3 A special permission is required from Owner's Representative for parking equipment in non-designated parking areas.

1.9.4 Comply with University of Toronto "Automobile Parking Regulations." Non-compliance may result in ticketing, towing, or revocation of parking privileges. Owner will not be responsible for parking fines incurred by Contractor, Subcontractors or their employees. Ensure permit is displayed prominently on dash to avoid issuance of parking infraction notice.

1.10 TRAFFIC CONTROL

1.10.1 Do not block public roads, or impede traffic during the course of the Work, unless otherwise permitted. If necessary to temporarily block traffic, Provide and pay for trained personnel acceptable to authorities having jurisdiction to direct traffic as required.

1.10.2 Manage construction traffic by using designated roads and by providing trained flag persons to direct public traffic as appropriate.

1.10.3 When overhead work is in progress, provide and maintain flag persons, temporary traffic signals, barricades, flares, lights and/or lanterns as required to perform the Work and protect the Public as required the authorities having jurisdiction

1.10.4 Do not block streets, walkways or allow their use for parking by construction crew or visitors except with approved specific permission from appropriate authorities and in accordance with stipulated standing regulations and restrictions.

1.10.5 Make and pay for arrangements for temporary use of adjacent properties including roads and walks

1.11 SITE OFFICES

1.11.1 Owner will make space available in the existing facility nearby to accommodate bi-weekly construction meetings

1.11.2 Space is not available in the existing nearby facilities to accommodate contractor's site office

1.11.3 Prefabricated Site Office (Trailer): Provide prefabricated or mobile units with serviceable finishes, temperature controls, and foundations sufficient for normal loading.

1.11.3.1 Ensure office is of sufficient size to accommodate construction personnel needs. Keep office clean and orderly.

.1 Heating and cooling equipment to maintain a uniform indoor temperature of 21 deg C.

.2 Lighting fixtures capable of maintaining average illumination of 215 lux (20 f-c) at desk height.

.3 Provide minimum 4 CSA approved safety helmets and 4 pairs of green label safety boots available for exclusive use of the authorized visitors.

1.12 SANITARY FACILITIES

1.12.1 Provide and maintain temporary sanitary facilities for use by workers in compliance with applicable health and safety legislation, and requirements of authorities having jurisdiction. Provide portable, weatherproof toilets, serviced at least weekly, unless noted otherwise. Keep sanitary facilities clean and fully stocked with the necessary supplies.

1.12.2 Do not use newly installed or constructed permanent washroom facilities during construction.

1.13 TEMPORARY FIRE PROTECTION

1.13.1 Provide and maintain fire protection systems to the satisfaction of relevant authorities, the local fire department, the Consultant, the Owner, and insurance agents.

1.13.2 Access and Identification: Maintain clear access routes to exits, fire line valves, hoses, and portable fire extinguishers. Ensure devices are visibly marked.

1.13.3 Fire Extinguishers: Provide and maintain ULC-labeled fire extinguishers in prominent locations in accordance with requirements of authorities having jurisdiction.

1.13.4 Tarpaulin Use: Only fire-resistant tarpaulins are permitted.

1.13.5 Hot work: Comply with CSA W117.2 and Owner's requirements indicated in Section 01 35 00.

1.13.6 Flammable Materials Storage and Handling:

1.13.6.1 Prohibit bulk storage of flammable liquids on site.

1.13.6.2 Store flammable liquids in approved containers and keep combustibles away from the building.

1.13.6.3 Transport and dispose of flammable materials safely.

1.13.7 Fire Risk Mitigation:

1.13.7.1 Familiarize workers with fire-fighting equipment locations and usage.

1.13.7.2 Suspend work if fire protection deficiencies are found.

1.13.7.3 Wet areas before and after hot work operations where feasible, or use fire-retardant materials where wetting is impractical.

1.13.8 Fire Watch Requirements:

1.13.8.1 Provide continuous fire watch for each of following activities:

.1 open flame activities (e.g. soldering, welding and similar operations).

.2 shutdown of fire detection system.

.3 shutdown of sprinkler system.

.4 any other situation that Consultant may deem appropriate.

1.13.8.2 Equip fire watchers with fire extinguishers and assign them solely to fire watch duties.

1.13.8.3 Fire Reporting Immediately report any fire to the fire department and Consultant, regardless of whether it has been extinguished or not.

1.14 ELEVATORS

1.14.1 Newly Installed Elevators: Do not use newly installed permanent elevators for construction purposes.

1.14.2 Newly Installed Elevators: Permanent elevators may be used by construction personnel and for transporting Products, at Contractor's option. If used during construction:

1.14.2.1 Provide protective coverings for finish surfaces of cars and entrances.

1.14.2.2 Just prior to Ready-for-Takeover, perform required maintenance to ensure elevators are in as near as new condition as possible.

1.14.2.3 Ensure that elevator manufacturer's warranty does not commence until the date of Ready-for-Takeover or, if manufacturer's warranty does commence earlier when elevators are put into use, arrange for necessary extension of manufacturer's warranty or provide equivalent coverage under Contractor's warranty.

1.14.2.4 Owner will permit Contractor to use 1 elevator near work area for transporting tools, persons and small materials that fit in protected cab area, during specified hours and days. Maintain and clean elevators in condition acceptable to the Owner. Coordinate delivery times of small materials with restricted elevator use hours.

1.14.2.5 Coordinate use with Owner. Provide protective coverings, barriers, devices, signs, or other procedures to protect elevator car and entrance doors and frame. Do not load elevators beyond their rated weight capacity.

1.14.2.6 Ensure elevator cab and landing jamb protections are in place and secured at all times. Repair or replace any damages caused to elevator to satisfaction of Owner's Representative and Consultant, and at no additional cost to the Owner.

1.14.2.7 Owner may restrict elevator use if use interferes with building operations. Arrange with Owner's Representative for extended hours or alternate arrangements as necessary. Comply with such arrangements at no additional cost to Owner.

1.15 HOISTING

1.15.1 Provide, operate, and maintain **hoists/ cranes** required for moving of workers, materials and equipment. **Hoists/cranes** to be operated by qualified operators. Submit proof of training upon request.

1.16 TEMPORARY SIGNAGE

1.16.1 Project Identification Signs:

1.16.1.1 Construct Project identification sign from minimum 1800 mm x 3600 mm (6'x12'), including wood frame support and minimum 19 mm (3/4 inch) exterior grade plywood with reinforced resin facing and wood trim at perimeter. Mount on wind-braced wood frame with wood blocking.

1.16.1.2 Consultant will provide drawing of project sign after award of Contract, including required graphics and texts.

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1.16.1.3 Paint sign in colours directed by Owner's Representative and Consultant.

1.16.1.4 Sing must include project name, Owner's name, Consultant's name, Contractor's name, and names of Civil, Structural, Mechanical, and Electrical Consultants, Landscape Architect, Interior Designers and other Consultants as applicable.

1.16.1.5 Cost of project identification sign: to be included in Contract Price.

1.16.1.6 No other signs or advertisements, other than safety, warning, or directional signs, are permitted without Consultant's prior acceptance.

1.16.2 Temporary Safety Signs:

1.16.2.1 Install directional signs as necessary to inform the public and individuals seeking entrance to Project area. Provide safety signs in accordance with requirements of authorities having jurisdiction. Conform to CAN/CSA-Z321.

1.16.2.2 Provide temporary wayfinding, directional, informational, and warning signage and tapes as required for efficient and safe operation of buildings. This includes, but is not limited to, life safety protection and traffic direction for students, visitors, the public, and staff. Additional signage and tapes may be required as directed by the Owner's Representative.

1.16.2.3 Temporary signage and tapes include but are not limited to:

.1 Floor/wall directional arrows: Colour-coded, pressure-sensitive, self-adhesive vinyl arrows and dots by Tenaquip Ltd. or approved equivalent.

.1 Sizes: 121 mm (4-3/4 in) x 150 mm (6 in) for arrows, 75 mm (3 in) diameter for dots. Colours: selected by Owner in consultation with Consultant.

.2 Information directories: Colour-coded, pressure-sensitive, self-adhesive vinyl directories with department names, room numbers, and directional arrows by Tenaquip Ltd. or approved equivalent.

.1 Colours: selected by Owner in consultation with Consultant.

.3 Warning, caution, danger, emergency signage: Pressure-sensitive, self-adhesive vinyl signs by Tenaquip Ltd. or approved equivalent, as required and acceptable to the Owner's Representative and Consultant.

.4 Safety aisle and warning tapes: Colour-coded, pressure-sensitive, self-adhesive vinyl tapes by Tenaquip Ltd. or approved equivalent.

.1 Colours: selected by the Owner in consultation with Consultant.

.5 After removal of temporary signage and tapes, patch, repair, repaint, or replace existing finishes to satisfaction of Owner's Representative and Consultant.

1.17 SITE STORAGE AND LOADING

1.17.1 Owner **will not** make designated storage space available to Contractor at Place of the Work. Do not load or permit to load any part of Work with weight or force that will endanger The Work.

1.17.2 Storage and Fabrication Sheds: Provide sheds sized, furnished, and equipped to accommodate materials and equipment for construction operations. Store combustible materials away from building.

1.18 ACCESSIBILITY REQUIREMENTS

1.18.1 Use commercially reasonable efforts to avoid disrupting access to Owner's facilities for persons with disabilities.

1.18.2 If disruption is unavoidable, promptly notify Owner's Representative and ensure alternative access is available.

1.18.3 Provide public notice of the disruption by posting a sign in a conspicuous place prior to disruption, stating the duration and alternative access means, if any, in accordance with the Accessibility for Ontarians with Disabilities Act (AODA), 2005, Regulation 429/07;

1.18.4 Read, understand, and comply with the University of Toronto's AODA Training for Volunteers & Other Service Providers provided in the Procurement Documents.

1.18.5 Charge brought against Owner due to Contractor's breach of these provisions may entitle Owner to terminate Contract immediately without notice.

1.19 TEMPORARY BARRIERS AND ENCLOSURES

1.19.1 Generally: Provide temporary barriers and enclosures necessary to protect the public and to secure Place of the Work during performance of the Work.

1.19.1.1 Comply with applicable regulatory requirements.

1.19.1.2 Maintain temporary barriers and enclosures in good condition for the duration of the Work.

1.19.1.3 Remove temporary barriers and enclosures from Place of the Work when no longer required.

1.19.2 Site Hoarding: Erect temporary security and safety site hoarding of minimum type and height specified enclosing the entire site.

1.19.2.1 Minimum height: Not less than 2.4 m (8 ft)

1.19.2.2 Material Specifications: Minimum 13 mm (1/2in) thick, exterior-grade plywood, framed with preservative-treated wood posts and rails.

1.19.2.3 Paint public side of hoarding with one coat primer and one coat exterior paint. Maintain public side of hoarding clean and in good repair until removed. Maintain exterior hoarding enclosures in tidy and secure condition. Remove unauthorized signs and posters, if applicable, weekly.

1.19.2.4 Provide lockable access gates for *Construction Equipment* and lockable pedestrian doors as required to facilitate construction access.

1.19.2.5 Erect and maintain pedestrian walkways including roof and side covers, complete with pedestrian signage and electrical lighting.

1.19.3 Scaffolding : Comply with CAN/CSA-S269.2.

1.20 TEMPORARY TREE AND PLANT PROTECTION

1.20.1 Erect sturdy, durable enclosures around existing trees and plants indicated to remain. Place enclosures at perimeter of branch drip line or minimum 1980 mm (6' - 6") from trunk if drip line is less than 1980 mm (6' - 6"). Do not anchor or fasten enclosures to trunks or branches. Comply with requirements of Authorities Having Jurisdiction.

1.20.2 Maintain enclosures throughout construction until final grading and planting has commenced in protected area.

1.20.3 Do not use area inside enclosures for storage or construction operations.

1.21 WEATHER ENCLOSURES

1.21.1 Provide weather tight enclosures to unfinished door and window openings, tops of shafts and other openings in floors and roofs.

1.21.2 Provide weather enclosures to protect floor areas where walls are not finished and to enclose work areas that require temporary heating.

1.21.3 Design weather enclosures to withstand wind pressure and snow loading requirements.

1.22 PROTECTION OF BUILDING FINISHES

1.22.1 Provide necessary temporary barriers and enclosures to protect existing and completed or partially completed finished surfaces from damage during performance of the Work.

1.23 TEMPORARY CONTROLS

1.23.1 Generally: Provide temporary controls as necessary for performance of the Work and in compliance with applicable regulatory requirements.

1.23.1.1 Maintain temporary controls in good condition for the duration of the Work.

1.23.1.2 Remove temporary controls and Construction Equipment used to provide temporary controls from Place of the Work when no longer required.

1.23.2 Dust and Particulate Control:

1.23.2.1 Implement and maintain dust and particulate control measures in accordance with applicable regulatory requirements.

1.23.2.2 Execute Work by methods that minimize dust from construction operations and spreading of dust on site or to adjacent properties.

1.23.2.3 Provide temporary enclosures to prevent extraneous materials resulting from sandblasting or similar operations from contaminating air beyond immediate work area.

1.23.2.4 Cover or wet down dry materials and rubbish to prevent blowing dust and debris. Provide dust control for temporary roads.

1.23.2.5 Use appropriate covers on trucks hauling fine, dusty, or loose materials.

1.23.3 Pollution Control:

1.23.3.1 Take measures to prevent contamination of soil, water, and atmosphere through uncontrolled discharge of noxious or toxic substances and other pollutants, potentially causing environmental damage.

1.23.3.2 Be prepared, by maintaining appropriate materials, equipment, and trained personnel on site, to intercept, clean up, and dispose of spills or releases that may occur. Promptly report spills and releases that may occur to:

.1 authority having jurisdiction,

.2 person causing or having control of pollution source, if known, and

.3 Owner and Consultant.

1.23.3.4 Contact manufacturer of pollutant, if known and applicable, to obtain safety data sheets (SDS) and ascertain hazards involved and precautions and measures required in cleanup or mitigating actions.

1.23.3.5 Take immediate action to contain and mitigate harmful effects of the spill or release.

1.23.4 Pest Control:

1.23.4.1 Implement necessary measures, restraints, procedures, and treatments to prevent and control infestation of insects, rodents, and other pests at the Place of the Work for entire duration of Contract.

1.23.4.2 Pest control measures must comply with the Ontario Building Code (OBC), Municipal By-Laws and Regulations, and requirements of authorities having jurisdiction.

1.24 SECURITY

1.24.1 Provide and pay for responsible security personnel to guard site and contents of site. Security personnel must be present **[after working hours and during holidays.] [24 hours a day, 7 days per week.]**

END OF SECTION

1.1 GENERAL

1.1.1 Provide Products that are not damaged or defective, and suitable for purpose intended, subject to specified requirements. If requested by Consultant, furnish evidence as to type, source and quality of Products provided.

1.1.2 Unless otherwise specified, maintain uniformity of manufacture for like items throughout.

1.1.3 Permanent manufacturer’s markings, labels, trademarks, and nameplates on Products are not acceptable in prominent locations, except where required by regulatory requirements or for operating instructions, or when located in mechanical or electrical rooms.

1.1.4 When conflict occurs between specified technical description and manufacturer's standard model numbers and/or manufacturer's printed description of given model number, technical description specified in Contract Documents shall govern. Have manufacturers make necessary modifications in their manufacturing methods to meet requirements specified.

1.1.5 Where materials or components are not specified, Contractor shall augment materials with those of its choice within applicable Code limitations while maintaining integrity of design and architectural requirements.

1.1.6 Provide Products that are not damaged or defective, and suitable for purpose intended, subject to specified requirements. If requested by Consultant, furnish evidence as to type, source and quality of Products provided.

1.1.7 Defective Products, whenever identified prior to completion of the Work, will be rejected, regardless of previous reviews. Remove and replace defective and/or damaged Products at own expense and be responsible for delays and expenses caused by rejection.

1.1.8 Permanent manufacturer’s markings, labels, trademarks, and nameplates on Products are not acceptable in prominent locations, except where required by regulatory requirements or for operating instructions, or when located in mechanical or electrical rooms.

1.1.9 Ensure products used for temporary facilities shall be sound in structural qualities.

1.1.10 Unless specified in the Contract Documents, ensure there is consistency in product and manufacturer for similar items, materials, equipment, or assemblies. Generally, endeavour to procure primary Products and materials forming part of the same Section from one source and from one manufacturer.

1.1.11 Ensure new materials used to repair damage are compatible with adjacent and existing work.

1.2 PRODUCT OPTIONS

1.2.1 Subject to the provisions of Section 01 25 00 – Substitution Procedures:

1.2.1.1 Wherever a Product or manufacturer is specified by a single proprietary name, provide the named Product only.

1.2.1.2 Wherever more than one Product or manufacturer is specified by proprietary name for a single application, provide any one of the named Products.

1.2.2 Wherever a Product is specified by reference to a standard only, provide any Product that meets or exceeds the specified standard. If requested by Consultant, submit information verifying that the proposed Product meets or exceeds the specified standard.

1.2.3 Wherever a Product is specified by descriptive or performance requirements only, provide any Product that meets or exceeds the specified requirements. If requested by Consultant, submit information verifying that the proposed Product meets or exceeds the specified requirements.

1.3 PRODUCT AVAILABILITY AND DELIVERY TIMES

1.3.1 Promptly upon Contract award and periodically during construction, review and confirm Product availability and delivery times. Order Products in sufficient time to meet the construction progress schedule and the Contract Time.

1.3.2 If a specified Product is no longer available, promptly notify Consultant. Consultant will take action as required.

1.3.3 If delivery delays are foreseeable, for any reason, promptly notify Consultant.

1.3.3.1 If a delivery delay is beyond Contractor's control, Consultant will provide direction.

1.3.3.2 If a delivery delay is caused by something that was or is within Contractor's control, Contractor shall propose actions to maintain the construction progress schedule for Consultant's review and acceptance.

1.4 PRODUCT INGREDIENT DISCLOSURE AND ENVIRONMENTAL TRANSPARENCY

1.4.1 Environmental Product Declarations (EPD): When available, submit Product-specific Type III EPD or industry-wide (generic) EPD conforming to ISO 14025 or other recognized environmental product declaration framework.

1.4.2 Material Ingredient Reporting: When available, submit documentation demonstrating chemical inventory of materials to at least 0.1% (1000ppm) and conforming to one of the following:

1.4.2.1 Health Product Declaration open Standard,

1.4.2.2 Cradle to Cradle v2 Basic level or Cradle to Cradle v3 Bronze level,

1.4.2.3 International Living Future Institute Declare

1.4.2.4 Other approved framework.

1.4.3 When multiple Products are specified, give preference to Products with compliant documentation.

1.5 STORAGE, HANDLING, AND PROTECTION

1.5.1 Store, handle, and protect Products during transportation to Place of the Work and before, during, and after installation in a manner to prevent damage, adulteration, deterioration, and soiling.

1.5.2 Comply with manufacturer's instructions for storage, handling, and protection.

1.5.3 Store packaged or bundled Products in original and undamaged condition with manufacturer's seals and labels intact. Do not remove from packaging or bundling until required in Work.

1.5.4 Comply with the requirements of the workplace hazardous materials information system (WHMIS) regarding use, handling, storage, and disposal of hazardous materials, including requirements for labeling and the provision of material safety data sheets (MSDS).

1.5.5 Store Products subject to damage from weather in weatherproof enclosures.

1.5.6 Store sheet Products on flat, solid, supports and keep clear of ground. Slope to shed moisture.

1.5.7 Remove and replace damaged Products.

1.6 MOULD CONTROL DURING PRODUCT STORAGE AND HANDLING

1.6.1 Conform to GC 9.5 and Supplementary Condition SC51 (GC9.2).

1.6.2 Products, materials, and substances employed in the Work must be free of mould amplification. Do not bring building Products onto site containing toxic moulds. Ensure construction workers are not exposed to amplified moulds. Take every reasonable precaution in circumstances for protection of workers. Be familiar with and implement recommendations outlined in "Mould Guidelines for the Canadian Construction Industry - CCA 82, latest edition".

1.6.3 Exercise continuous quality control and enforce mould control requirements upon Subcontractors and establish proper Product storage and delivery sequence to protect Products from weather and other exposures conducive to mould growth.

1.6.4 Take special care while handling and storing materials, including, but not limited to, particleboard, plywood, cellulose-based materials, wallpaper, ceiling panels, gypsum board, and insulation.

1.6.5 Monitor humidity levels and Provide adequate ventilation in storage areas. Be watchful of moisture conditions in storage areas.

1.6.6 Do not use materials that have been damaged by exposure to moisture and/or showing signs of mould growth.

1.6.7 Products with visible or invisible signs of mould amplification, whether installed or not, will be considered defective and must be removed at Contractor's expense.

1.6.8 Refer to Section 01 35 00 for additional requirements.

1.7 INDOOR AIR QUALITY

1.7.1 Select Products for use in the Work that affect indoor air quality as little as possible. Provide adequate ventilation during installation of finishing materials to avoid deleterious effects on indoor air quality. Specifically, select Products for installation within air-handling and distribution systems to minimize the introduction of pollutants into building's fresh air supply.

1.7.2 Choose odourless Products wherever possible. Where odourless Products are not available, provide additional ventilation during construction period to encourage off-gassing of materials to their minimum levels prior to occupancy of

building. In existing facilities, coordinate installation of products with strong odours with Owner to ensure impact on building occupants is minimized.

1.7.3 Products and materials incorporated in the Work must be as free as possible of VOCs and emissions. Products emitting benzene, mercury, lead, or other known toxic compounds are not permitted.

1.7.4 As far as practical ensure, adhesives, sealants, paints and coatings applied on site and used in the building's interior are tested and determined compliant in accordance with California Department of Public Health (CDPH) Standard Method v1.2–2017, using the applicable exposure scenario.

1.7.5 In addition to emissions criteria specified above, adhesives, sealants, paints and coatings applied on site and used in the building's interior must meet VOC limits established by authorities having jurisdiction and following VOC content limits as follows:

1.7.5.1 All paints and coatings wet-applied on site must meet applicable VOC limits of the California Air Resources Board (CARB) 2007, Suggested Control Measure (SCM) for Architectural Coatings, or the South Coast Air Quality Management District (SCAQMD) Rule 1113.

1.7.5.2 All adhesives and sealants wet-applied on site must meet the applicable chemical content requirements of SCAQMD Rule 1168.

1.7.6 Prioritize emission control for Products known to be high chemical emitters, long term emitters, or those expected to present emissions in high amounts, including office furniture, seating, built-in cabinetry, flooring, ceiling, thermal insulation, paints and coatings, wall coverings, ceiling systems, HVAC duct materials, fireproofing, structural adhesives and sealants, millwork, cove base molding, wall systems, underlayments, and shelving.

1.7.7 Notify Suppliers of such materials of emission control requirements and ensure compliance is obtained from manufacturers. Use only materials that emit the lowest possible levels of particles and chemical vapors as specified in this Section.

1.7.8 Schedule sequence of installation of finishing materials to reduce harm to indoor air quality. Provide necessary ventilation during and after installation of 'wet' Products such as paints, sealants, adhesives and of 'packaged dry' Products.

1.7.9 Isolate substances producing hazardous emissions from circulating air. Locate outside air intakes away from potential sources of contamination.

1.7.10 Install HVAC system filtration media in accordance with Mechanical Specifications. Ensure that the filtration media efficiency meets the specified minimum requirements. If Mechanical Specifications do not specify minimum filtration media efficiency, use filters with Minimum Efficiency Reporting Value (MERV) of 13 or better. If system cannot accommodate MERV 13 due to functional requirements, use highest MERV rating possible acceptable for the system.

1.7.11 Take measures to prevent entry of dust into HVAC system throughout construction phase.

1.7.12 Consider using electrically powered equipment on-site in lieu of gas or propane powered equipment to reduce possibility of carbon monoxide sickness and odours of gas or propane spreading throughout building.

1.7.13 Cooperate with Consultant's monitoring and air sampling of various parts of the new facility during construction and in final months before opening. If necessary, provide additional ventilation in areas designated by the Consultant. During construction phases where materials with high VOCs or odours are used, monitor air quality of the building periodically and implement increased local ventilation measures, such as temporary air handling units, if required.

1.8 PATENTS

1.8.1 Verify existence or exclusivity of patent licenses for Products prior to installation.

END OF SECTION

1.1 SURVEY REQUIREMENTS

1.1.1 Employ a registered Ontario Land Surveyor for all surveying work required to define the limits of the Work. Submit qualifications of the Land Surveyor to the Owner and the Consultant for review and acceptance.

1.1.2 Establish minimum of two permanent benchmarks referenced to municipal benchmarks. Record data in As-Built documentation specified in Section 01 78 00. Correlate geodetic elevations with public utility elevations.

1.1.3 Use high precision instruments to establish lines and levels, and verify site dimensions shown on Drawings.

1.2 SURVEY REFERENCE POINTS

1.2.1 Confirm and establish existing grade elevations and project works prior to commencing the Work. Protect control points and preserve permanent reference points during construction.

1.2.2 Report any lost, destroyed, or relocated reference points to Consultant. Replace damaged or lost control points according to the original survey control.

1.3 SURVEY MONITORING

1.3.1 Monitor and record deflections and creep of suspended slabs and columns at key locations designated by the Owner and Consultant on a bi-weekly basis. Report effects deflections and creep may have on floors and exterior cladding.

1.3.2 Monitor and ensure that completed Work of Contract is within specified tolerances. Indicate promptly to the Owner and Consultant any discrepancies and remedial work required.

1.4 SURVEYING EQUIPMENT

1.4.1 Land Surveyor will review condition of surveying equipment, including but not limited to; checking, maintaining, re-calibrating and repairing all surveying equipment at regular intervals as required obtaining optimum performance from the surveying equipment. Do not use defective or damaged surveying equipment.

1.4.2 Replace defective or damaged surveying equipment with new surveying equipment acceptable to the Consultant. Costs for maintenance, re-calibration, repairs and replacement of surveying equipment shall be paid by the Land Surveyor, at no additional costs to the Owner.

1.5 SURVEYING RECORDS

1.5.1 Maintain a complete, accurate log of all control and survey work as the Work of the Contract progresses, including monthly photographic record.

1.5.2 On completion of foundations, slabs on grade, floor slabs, roof slab and major site improvements, prepare a certified plan of survey showing dimensions, locations, angles and elevations of Work of the Contract.

1.5.3 On completion of slab elevations and deflections survey, prepare a certified plan of survey showing found conditions and changes from previously found conditions.

1.5.4 On request of the Owner and Consultant, submit documentation to verify accuracy of field surveying work.

1.5.5 Submit certificates, drawings, calculations and photographs, stamped and signed by the Land Surveyor and Contractor, certifying that elevations and locations of completed Work of the Contract are in conformance with Contract Documents.

1.5.6 Notify Owner and Consultant, in writing, of discrepancies between Contract Documents and conditions at the Place of the Work.

1.6 EXISTING UTILITIES AND STRUCTURES

1.6.1 Before commencing excavation, drilling or other earthwork, establish or confirm location and extent of all existing underground utilities and structures in work area.

1.6.2 Promptly notify Consultant if underground utilities, structures, or their locations differ from those indicated in Contract Documents or in available project information.

1.6.3 Record locations of maintained, re-routed, and abandoned utility lines.

1.7 SETTING OUT

1.7.1 Before commencing the Work, verify lines, levels and dimensions shown on the Drawings and report all discrepancies in levels or dimensions orally and in writing to the Owner and the Consultant. Be responsible for work done prior to receipt of the Owner’s (University's) decision regarding reported discrepancies.

1.8 VERIFICATION OF EXISTING CONDITIONS

1.8.1 Where work specified in any Section is dependent on the work of another Section or Sections having been properly completed, verify that work is complete and in a condition suitable to receive the subsequent work. Commencement of work of a Section that is dependent on the work of another Section or Sections having been properly completed, means acceptance of the existing conditions.

1.8.2 Verify that ambient conditions are suitable before commencing the work of any Section and will remain suitable for as long as required for proper setting, curing, or drying of Products used.

1.8.3 Ensure that substrate surfaces are clean, dimensionally stable, cured and free of contaminants.

1.8.4 Notify Consultant in writing of unacceptable conditions.

END OF SECTION

1.1 SUMMARY

1.1.1 Except where otherwise specified in technical Specifications or otherwise indicated on Drawings, comply with requirements of this Section.

1.2 MANUFACTURER'S INSTRUCTIONS

1.2.1 Install, erect, or apply Products in strict accordance with manufacturer's instructions.

1.2.2 Notify Consultant, in writing, of conflicts between Contract Documents and manufacturer's instructions where, in Contractor's opinion, conformance with Contract Documents instead of the manufacturer's instructions may be detrimental to the Work or may jeopardize the manufacturer's warranty.

1.2.3 Do not rely on labels or enclosures provided with Products. Obtain written instructions directly from manufacturers.

1.2.4 Provide manufacturer's representatives with access to the Work at all times. Render assistance and facilities for such access so that manufacturer's representatives may properly perform their responsibilities.

1.3 CONCEALMENT

1.3.1 Conceal pipes, ducts, and wiring in floors, walls and ceilings in finished areas:

1.3.1.1 after review by Consultant and authority having jurisdiction, and

1.3.1.2 where locations differ from those shown on Drawings, after recording actual locations on as-built drawings.

1.3.2 Provide incidental furring or other enclosures as required.

1.3.3 Notify Consultant in writing of interferences before installation.

1.4 FASTENINGS - GENERAL

1.4.1 Provide metal fastenings and accessories in same texture, colour and finish as adjacent materials.

1.4.2 Prevent electrolytic action and corrosion between dissimilar metals and materials by using suitable non-metallic strips, washers, sleeves, or other permanent separators to avoid direct contact.

1.4.3 Use non-corrosive fasteners and anchors for securing exterior work and in spaces where high humidity levels are anticipated.

1.4.4 Space anchors within individual load limit or shear capacity and ensure they provide positive permanent anchorage.

1.4.5 Keep exposed fastenings to a minimum, space evenly and install neatly.

1.4.6 Do not use fastenings or fastening methods that may cause spalling or cracking of material to which anchorage is made.

1.5 FASTENINGS - EQUIPMENT

1.5.1 Use fastenings of standard commercial sizes and patterns with material and finish suitable for service.

1.5.2 Bolts shall not project more than one diameter beyond nuts.

1.6 FIRE RATED ASSEMBLIES

1.6.1 When penetrating fire rated walls, ceiling, or floor assemblies, completely seal voids with fire-stopping materials, smoke seals, or both, in full thickness of the construction element as required to maintain the integrity of the fire rated assembly.

1.7 LOCATION OF FIXTURES, OUTLETS AND DEVICES

1.7.1 Consider location of fixtures, outlets, and devices indicated on Drawings as approximate.

1.7.2 Locate fixtures, outlets, and devices to provide minimum interference, maximum usable space, and as required to meet safety, access, maintenance, acoustic, and regulatory, including barrier free, requirements.

1.7.3 Promptly notify Consultant in writing of conflicting installation requirements for fixtures, outlets, and devices. If requested, indicate proposed locations and obtain approval for actual locations.

1.7.4 Tag and mark valves and switches operated by Contractor and Subcontractors with following information:

1.7.4.1 University of Toronto project name/number

1.7.4.2 Contractor’s name

1.7.4.3 Subcontractor’s name

1.7.4.4 Dates and times closed/shut off

1.7.4.5 Dates and times to be opened/turned back on

1.8 PROTECTION OF COMPLETED WORK AND WORK IN PROGRESS

1.8.1 Adequately protect parts of the Work completed and in progress from any kind of damage.

1.8.2 Promptly remove, replace, clean, or repair, as directed by Consultant, work damaged as a result of inadequate protection.

1.8.3 Do not load or permit to be loaded any part of the Work with a weight or force that will endanger the safety or integrity of the Work.

1.9 REMEDIAL WORK

1.9.1 Notify Consultant of, and perform remedial work required to, repair or replace defective or unacceptable work. Ensure that properly qualified workers perform remedial work. Coordinate adjacent affected work as required.

END OF SECTION

1.1 REGULATORY REQUIREMENTS

1.1.1 Comply with applicable regulatory requirements when disposing of waste materials.

1.1.2 Obtain permits from authorities having jurisdiction and pay disposal fees where required for disposal of waste materials and recyclables.

1.2 WASTE MANAGEMENT AUDIT

1.2.1 Prepare and submit to Owner and Consultant, waste audit and reduction plan in compliance with requirements of Ontario Regulation 102/94, Waste Audits and Waste Reduction Workplans, and Ontario Regulation 103/94, Industrial, Commercial and Institutional Source Separation Programs under the Environmental Protection Act of Ontario. For definitions refer to Ontario Regulation 105/94, Definitions.

1.3 GENERAL CLEANING REQUIREMENTS

1.3.1 Provide adequate ventilation during use of volatile or noxious substances. Do not rely on building ventilation systems for this purpose.

1.3.2 Use only cleaning materials recommended by manufacturer of surface to be cleaned, and as recommended by cleaning material manufacturer.

1.3.3 Prevent cross-contamination during the cleaning process.

1.3.4 Notify the Consultant of the need for cleaning caused by Owner or other contractors.

1.4 SNOW REMOVAL

1.4.1 Remove snow from access road, parking areas, site circulation paths and as required to permit access to Work, parking and uninterrupted construction progress.

1.5 PROGRESSIVE CLEANING AND WASTE MANAGEMENT

1.5.1 Maintain the Work in a tidy and safe condition, free from accumulation of waste materials and construction debris.

1.5.2 Provide appropriate, clearly marked, containers for collection of waste materials and recyclables.

1.5.3 Remove waste materials and recyclables from work areas, separate, and deposit in designated containers at end of each Working Day. Collect packaging materials for recycling or reuse. Remove waste materials and recyclables from Place of the Work at least daily.

1.5.4 Clean interior building areas prior to start of finish work and maintain free of dust and other contaminants during finishing operations.

1.5.5 Schedule cleaning operations so that resulting dust, debris and other contaminants will not fall on wet, newly finished surfaces nor contaminate building systems.

1.6 WASTE CONTAINERS AND BINS

1.6.1 Provide closed waste containers and bins for demolition and construction waste disposal specified in this Section.

1.6.2 Provide “closed box” type containers to prevent waste materials from being windblown and contaminating the Owner’s property, adjacent private and Public properties.

1.6.3 Ensure container sizes fit designated locations, as accepted by Owner’s Representative and Consultant.

1.6.4 Place containers at locations acceptable by Owner’s Representative. Owner may require relocation of containers to suit facility operations. Make such arrangements at no additional cost to Owner.

1.6.5 Do not use Owner’s or building’s waste containers for demolition or construction waste.

1.7 FINAL CLEANING

1.7.1 Prior to final cleaning, arrange meeting at Place of the Work to determine acceptable standard of cleaning, ensuring Owner, Consultant, Contractor, and cleaning company are in attendance.

1.7.2 Prior to cleaning, submit to Consultant complete list of cleaning and maintenance instructions for all components of the Work.

1.7.3 Use experienced professional cleaners and appropriate apparatus and cleaning materials for final cleaning; follow manufacturer’s recommendations for surface to be cleaned.

1.7.4 Lock or otherwise restrict access to each room or area after completing final cleaning. Repeat cleaning as necessary on areas re-accessed by Contractor’s workers prior to Owner occupancy.

1.7.5 Remove from the Place of the Work surplus Products, waste materials, recyclables, Temporary Work, and Construction Equipment no longer required. Final cleaning includes, without limitation, requirements specified herein, removal of surplus materials, tools, construction machinery and equipment from site.

1.7.6 Dispose of rubbish and debris and leave the Place of the Work in a clean and tidy condition satisfactory to Consultant.

1.7.7 Clean new and existing components in accordance with manufacturers' recommendations. Remove stains, spots, marks, dust, smudges, and dirt from finished surfaces, electrical and mechanical fixtures, furniture fitments, walls, ceilings, floors, and exteriors.

1.7.8 Clean and maintain various types of flooring in accordance with manufacturers' recommendations:

1.7.8.1 Clean corners and baseboards to remove any marks or dirt. If flooring is new, scrub as needed with appropriate solution to remove protective coatings installed in factory by manufacturer. If the flooring is existing, strip using appropriate chemical solution to remove any existing floor finish coating and base seal coatings.

1.7.8.2 Vacuum, clean, and buff resilient flooring. Do not wax or seal unless specifically recommended in writing by manufacturer.

1.7.8.3 Sweep tile, terrazzo, and stone floors free of debris. Wax, seal, shampoo, or prepare floor finishes, as recommended by manufacturer. Unless indicated otherwise apply two coats of sealer to both new and existing flooring as recommended by manufacturer of the flooring material, ensuring that flooring is completely dry between coats.

1.7.8.4 Clean carpet flooring using a power brush equipped vacuum cleaner and approved stain removal methodology. Lift carpet pile using a rotary pile lifting machine where needed.

1.7.9 Broom clean and wash interior and exterior walks, paved surfaces, concrete floors, steps, and other similar surfaces.

1.7.10 Sweep clean and remove snow and ice from exterior sidewalks, steps, driveways, roads, parking lots, and other paved surfaces.

1.7.11 Use leaf blowers to clean landscaped surfaces, and clean and sweep roofs and clear roof drains.

1.7.12 Clean and polish glass, mirrors, hardware, wall tile, stainless steel, chrome, porcelain enamel, baked enamel, plastic laminate, and other finished surfaces, including mechanical and electrical fixtures. Replace broken, damaged, disfigured, or scratched glass and mirrors.

1.7.13 Clean interior and exterior window glass and frames, walls, ceilings, window coverings, doors, hardware, mechanical and electrical fixtures and equipment, and metals.

1.7.14 Vacuum clean and dust exposed wall, floor, and ceiling surfaces. Clean the following: behind grilles, louvres and screens, and above suspended ceiling tiles. Vacuum clean ducts, fans, blowers, and coils if units were operated without filters during construction.

1.7.15 Remove dust from lighting reflectors, lenses, lamps, bulbs, and other lighting surfaces. Clean mechanical, electrical, and other equipment, and replace filters for mechanical equipment if used during construction.

1.7.16 Remove waste material and debris from crawlspaces and other accessible concealed spaces and Make Good any damage due to the Work outside the Work area, including necessary cleaning.

1.8 WASTE MANAGEMENT AND DISPOSAL

1.8.1 Dispose of waste materials and recyclables at appropriate municipal landfills and recycling facilities in accordance with applicable regulatory requirements.

1.8.2 Do not burn or bury waste materials at Place of the Work.

1.8.3 Do not dispose of volatile and other liquid waste such as mineral spirits, oil, paints and other coating materials, paint thinners, cleaners, and similar materials together with dry waste materials or on the ground, in waterways, or in storm or sanitary sewers. Collect such waste materials in appropriate covered containers, promptly remove from Place of the Work, and dispose of at recycling facilities or as otherwise permitted by applicable regulatory requirements.

1.8.4 Cover or wet down dry waste materials to prevent blowing dust and debris.

END OF SECTION

1.1 COMMISSIONING AUTHORITY (CXA)

1.1.1 Commissioning Authority (CxA) specified in Section 01 91 00 will provide commissioning of Integrated Systems Testing specified in this Section.

1.2 SUMMARY

1.2.1 Purpose of Section: Section details integrated testing of fire protection and life safety systems in accordance with OBC and CAN/ULC S1001 to verify performance and interconnectivity of integrated systems to ensure they function cohesively in emergency situations.

1.2.2 Scope of Section is limited to testing of interconnections between life safety and/or fire protection systems as required by OBC Division B, Subsection “Integrated Fire Protection and Life Safety Systems”. Refer to technical Specification Sections for individual testing and commissioning requirements for systems.

1.3 DEFINITIONS

1.3.1 Integrated Systems Testing: a code requirement specifically for fire protection and life safety systems to verify and document their interconnections and operational performance in accordance with design criteria.

1.3.2 FPLS: Fire Protection and Life Safety.

1.4 PREINSTALLATION MEETINGS

1.4.1 Pre-installation Meetings: Schedule and hold a pre-installation meeting at the Project site at least one week before beginning work on this Section to coordinate activities with related Subcontractors.

1.4.1.1 Required Attendance: Subcontractor performing work of this Section, representatives from manufacturers and fabricators involved in or affected by installation.

1.4.1.2 Notification: Notify Consultant and Owner of scheduled meeting dates in advance; minimum 72-hour notice required.

1.4.1.3 Agenda:

.1 Review progress of related construction activities and preparations for particular activity under consideration.

.2 Make note of required sequencing and coordination with materials and activities that have preceded or will follow.

1.4.1.4 Reporting: Record significant discussions, agreements, and disagreements, including required corrective measures and actions.

1.4.1.5 Distribution: Distribute minutes of the meeting to each party present and to other parties requiring information not more than 72 hours after meeting.

1.5 COORDINATION

1.5.1 Collaborate with Subcontractors responsible for equipment or systems subject to testing under this Section, to ensure comprehensive testing and documentation

of interface and integration between various fire protection and life safety systems provided under those divisions.

1.6 SUBMITTALS

1.6.1 Submittals, generally: in accordance with Section 01 33 00, Submittal Procedures.

1.6.2 Proposed Integrated Testing Plan: Submit detailed test plan prepared by Integrated Testing Coordinator and complying with CAN/ULC S1001, highlighting testing protocols, schedules, and identifying involved parties. As a minimum, integrated testing plan must include:

1.6.2.1 Functional objectives of system integrations

1.6.2.2 Sequence of operations – normal and off-normal

1.6.2.3 Test protocol and procedures.

1.6.2.4 Procedure for notifying building occupants.

1.6.2.5 Alternative measures – notifications and safety protocols for ensuring occupant safety during testing.

1.6.2.6 Phased occupancy requirements, where applicable.

1.6.2.7 Where required, submit testing plan to Authorities Having Jurisdiction for review.

1.6.3 Pre-Testing Confirmation: Submit confirmation from design professionals and installing contractors indicating that systems are installed correctly and functional .

1.6.3.1 Where required, sufficient notification to Authorities Having Jurisdiction to witness integrated systems testing.

1.7 CLOSEOUT SUBMITTALS

1.7.1 Final Integrated Systems Testing Report:

1.7.1.1 Submit documentation providing results of implementation of integrated testing plan final in accordance with section 7 of CAN/ULC-S1001. Report must include:

.1 Integrated testing plan,

.2 Completed initial integration testing forms with test results,

.3 Re-test integration testing forms, if necessary,

.4 Pre-integration testing verification documentation for relevant systems.

1.7.1.2 Distribute copies of the final report as follows:

.1 One copy to each relevant authority having jurisdiction,

.2 One copy to Consultant,

.3 One copy to Owner.

1.8 QUALITY ASSURANCE

1.8.1 Integrated Testing Coordinator: an entity with at least five years' experience installing, erecting, or assembling work similar in material, design, and extent to

that indicated, and whose work has resulted in construction with a track record of successful in-service performance.

1.8.1.1 Integrated Testing Coordinator must be a knowledgeable and experienced individual, firm, corporation, or organization responsible for developing and implementing the integrated testing plan. Where a firm, corporation, or organization is responsible for integrated fire protection and life safety systems testing, a representative of that firm, corporation, or organization shall be designated as the integrated testing coordinator.

1.9 PREPARATION OF INTEGRATED TESTING PLAN

1.9.1 Integrated Testing Coordinator is responsible for following:

1.9.1.1 Develop integrated test plan as described in section 5 of CAN/ULC-S1001.

1.9.1.2 Collaborate with relevant Consultants to obtain necessary design performance criteria for integrating fire protection and life safety systems. This includes, but is not limited to:

.1 building floor plans,

.2 details of control sequences for different systems,

.3 mechanical and electrical riser diagrams, if relevant,

.4 operating and testing instructions from the trade contractors involved,

.5 alternative solutions to prescribed requirements of OBC or standards from the relevant Consultant.

1.9.1.3 Develop integrated testing plan to include, but not be limited to, following:

.1 Objectives for the functionality of system integrations,

.2 Operational sequence for the integrated elements of the fire protection and life safety systems, including:
- .1 Normal operating conditions,
- .2 Fire condition operations,
- .3 Procedures for informing occupants about the testing of integrated systems,

.3 Safety management protocols, including safety guidelines and notifications, to ensure the safety of occupants and workers during system testing,

.4 For phased building testing, include additional procedures for:
- .1 Testing each area of the building at different times for staged occupancy permits,
- .2 Final testing of whole building once phased areas are complete, including scenarios where areas may be occupied concurrently.

.5 Append test procedures for each system-to-system integration as separate sections or as appendix.

.6 Provide workflow diagram in test plan to depict system dependencies, clearly showing sequence and relationships between different systems.

.7 Provide testing schedule with overall construction schedule, marking important dates for potential participation of parties in witnessing tests.

.8 Present initial draft of test plan to Consultant(s) for review. Following feedback and necessary revisions, submit revised draft to Authority Having Jurisdiction.

.9 In case of design changes in fire protection and life safety equipment or systems affecting integration, revise integrated test plan accordingly and submit for Consultant review before implementation.

1.10 TESTING PROCEDURES

1.10.1 Integrated Testing Coordinator is responsible for following:

1.10.1.1 Develop test procedures and test forms in accordance with requirements of section 6 and section 7 of CAN/ULC-S1001 and as specified herein or in technical specifications.

1.10.1.2 Testing must include functional objectives of system integrations and sequence of operations under normal and off normal conditions in accordance with CAN/ULC S1001.

1.10.1.3 Use simulations for tests for non-restorable systems or situations where actual testing could be hazardous.

1.11 EXECUTION

1.11.1 Integrated Testing Coordinator is responsible for following:

1.11.1.1 Execute integrated testing program according to sections 6 and 7 of CAN/ULC-S1001.

1.11.1.2 Prior to starting tests, ensure necessary documentation for installation verification, acceptance testing, notifications, and required inspections by authorities of individual life safety equipment and systems are in place.

1.11.1.3 Notify relevant authorities having jurisdiction about testing schedule and invite them to participate or witness tests.

1.11.1.4 Employ temporary installation measures needed for testing. Maintain log detailing each temporary measure, its installation date, and specific integration test it is meant to support.

1.11.1.5 Planning Phase:

.1 Installing Subcontractors for each integrated system to submit documents detailing integration performance of systems.

.2 Identified deficiencies are to be documented and forwarded to respective installing Subcontractors for resolution.

1.11.1.6 Implementation Phase:

.1 Execute test protocol and procedures as established in planning phase.

.2 Ensure procedure for notifying building occupants is in place, considering alternative measures for occupant safety during testing.

.3 Consider phased occupancy plans and safety of personnel during testing , as applicable.

1.11.1.7 Pre-Testing Requirements: Prior to actual integrated systems testing, complete following pre-testing steps:

.1 Obtain written confirmation from installing Subcontractors that they acceptance testing, and integrity of installation is confirmed.

.2 Secure confirmation from installing contractors regarding correct installation of systems.

.3 Establish and document occupant notification procedures.

.4 Provide sufficient notification to authorities having jurisdiction to witness integrated systems testing, where required.

1.11.1.8 Sequence of Testing Events

.1 Ensure sequence of testing events aligns with integrated testing plan developed during planning phase.

.2 Start with functional testing of individual systems to ensure their independent operability.

.3 Proceed to integrated system tests, where interoperation and collective response of systems to various scenarios is to be verified.

.4 In event of test failure, initiate corrective measures and re-test affected systems until compliance is achieved.

1.12 ADJUSTING

1.12.1 Restore systems to standard operational state after successful integrated testing. If temporary measures were used, remove such measures and update log to record removal date. Include log in final test report.

1.13 DEMONSTRATION AND TRAINING

1.13.1 Train Owner's maintenance personnel to adjust, operate, and maintain life safety systems integration. Demonstration and training must include:

1.13.1.1 Function of integration,

1.13.1.2 Integration method – whether hardwired, network communication, or operating protocols,

1.13.1.3 Type of information – data, commands, monitoring,

1.13.1.4 Temporary measures for future retesting.

1.14 SCHEDULE OF INTEGRATED SYSTEMS TESTING

1.14.1 Applicable portions of the Work subject to testing include, but are not limited to:

1.14.1.1 Division 08 - Openings

.1 Electromagnetic Locking Devices

.2 Door hold-open devices

.3 Automatic Fire Shutters

1.14.1.2 Division 14 - Conveying Equipment

.1 Elevators

.2 Emergency Elevators

1.14.1.3 Division 11 - Equipment

.1 Dust Collection Systems

.2 Spark Arrest Systems.

1.14.1.4 Division 21 - Fire Suppression

.1 Sprinkler Systems

.2 Standpipe Systems

.3 Fire Pumps

.4 Water Supply Control Valves

.5 Freeze Protection Systems

.6 Fixed Fire Suppression Systems

.7 Cooking Equipment Fire Suppression Systems

1.14.1.5 Division 22 - Plumbing

.1 Water Supply

1.14.1.6 Division 23 - Heating, Ventilating, and Air Conditioning (HVAC)

.1 Smoke dampers,

.2 Motorized fire dampers,

.3 Smoke Control Pressurization Systems

.4 Smoke Control Smoke Exhaust Systems

.5 Freeze protection systems (for water-based fire protection piping)

1.14.1.7 Division 25 - Integrated Automation

.1 Building Automation System

1.14.1.8 Division 26 – Electrical

.1 Emergency power distribution systems.

.2 Emergency lighting control systems.

1.14.1.9 Division 27 - Communications

.1 Audio/Visual Control System

1.14.1.10 Division 28 - Electronic Safety and Security

.1 Fire Alarm System (including sequence of operation)

.2 Smoke alarm systems.

.3 Security systems

.4 Notification systems,

.5 Hazardous protection monitoring.

END OF SECTION

1.1 SUMMARY

1.1.1 Purpose of Section: Section specifies administrative procedures for contract closeout.

1.1.2 Read in conjunction with: CCDC 2-2020, Part 12, Owner Takeover and Supplementary Conditions.

1.2 READY-FOR-TAKEOVER

1.2.1 Comply with Supplementary Condition SC58 (GC12.1).

1.3 INSPECTION AND REVIEW BEFORE READY-FOR-TAKEOVER

1.3.1 Contractor's Inspection: Before applying for the Consultant's review to establish Ready-for-Takeover of the Work:

1.3.1.1 Ensure that the specified prerequisites to Ready-for-Takeover of the Work are completed.

1.3.1.2 Conduct an inspection of the Work to identify defective, deficient, or incomplete work.

1.3.1.3 Prepare a comprehensive and detailed list of items to be completed or corrected.

1.3.1.4 Provide an anticipated schedule and costs for items to be completed or corrected.

1.3.2 Consultant's Review: Upon receipt of the Contractor's application for review, together with the Contractor's list of items to be completed or corrected, the Consultant will review the Work. The Consultant will advise the Contractor whether or not the Work is Ready-for-Takeover and will provide the Contractor with a list of items, if any, to be added to the Contractor's list of items to be completed or corrected. Provide the Consultant with a copy of the Contractor's revised list.

1.3.3 Maintain the list of items to be completed or corrected and promptly correct or complete defective, deficient and incomplete work. The Contractor's inspection and Consultant's review procedures specified above shall be repeated until the Work is Ready-for-Takeover and no items remain on the Contractor's list of items to be completed or corrected.

1.3.4 When the Consultant determines that the Work is Ready-for-Takeover, the Consultant will notify the Contractor and the Owner in writing to that effect.

1.4 SUBSTANTIAL PERFORMANCE OF THE WORK

1.4.1 Comply with Supplementary Condition SC34 (GC5.4) and supplemented as follows:

1.4.1.1 The prerequisites to, and the procedures for, attaining substantial performance of the Work, or similar such milestone as provided for in the lien legislation applicable to the Place of the Work, shall be:

.1 independent of those for attaining Ready-for-Takeover of the Work, and

.2 in accordance with the lien legislation applicable to the Place of the Work.

1.4.1.2 Procedures: Comply with requirements of Supplementary Conditions, Construction Act and OAA/OGCA Document 100, latest edition.

1.5 FINAL CLEANING

1.5.1 Read in conjunction with: Section 01 74 00.

1.5.2 Perform final cleaning and waste-removal operations in accordance with local laws and ordinances, as well as Federal and Provincial and local environmental regulations.

1.5.3 Cleaning Personnel: Use experienced workers or professional cleaners for final cleaning tasks.

1.5.4 Cleaning Standards: Each surface or unit must be cleaned to condition expected in an average commercial building cleaning and maintenance program.

1.5.5 Manufacturer's Instructions: Comply with manufacturer's written instructions for cleaning processes.

1.5.6 Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of surface being cleaned. Do not use cleaning agents that are potentially hazardous to health, property, or that could damage finished surfaces.

1.5.6.1 Toxicity: Products must be labeled as 'low-hazard' or 'safer' by an ISO 14024-compliant (Type 1) Ecolabel, or other recognized third-party certification.

1.5.6.2 Compliance with Green Seal GS-37: Generally, use cleaning products that comply with Green Seal GS-37. If GS-37 is not applicable to specified cleaning product, select products that comply with the California Code of Regulations regarding maximum allowable VOC levels.

1.5.6.3 Ingredient Disclosure and Safety: Products must have ingredients disclosed through a Safety Data Sheet (SDS). No ingredients should be present at 100 ppm (0.01%) or above that are classified with GHS codes and hazard statements: H311, H312, H317, H334, H340, H350, H360, H372.

END OF SECTION

1.1 DEFINITIONS

1.1.1 For the purposes of this Section, the following definitions as defined by the Ontario Association of Architects Practice Tip – PT.14 Version 1.1 apply:

1.1.1.1 As-built drawings: drawings usually prepared by Contractor as it constructs the project and upon which it documents the actual locations of building components and changes to the original contract documents. These, or a copy of same, are typically turned over to the Consultant or Owner at completion of the project.

1.1.1.2 Record drawings: drawings usually prepared by the Consultant when contracted to do so. These are usually a composite of the original drawings, changes known to the Consultant and information taken from the Contractor's as-built drawings. Responsibility for preparation of record drawings may be delegated to Contractor if indicated as such in this Section.

1.2 OPERATION AND MAINTENANCE MANUAL

1.2.1 Preparation: Prepare a comprehensive operation and maintenance manual, in the language(s) of the Contract, using personnel qualified and experienced for this task.

1.2.2 Submission Timing: Submit an initial draft of the operation and maintenance manual for Consultant's review. If required by Consultant's review comments, revise manual contents and resubmit for Consultant's review. If required, repeat this process until Consultant accepts the draft manual in writing.

1.2.3 Operation And Maintenance Manual Format:

1.2.3.1 Organize data in the form of an instructional manual.

1.2.3.2 Hard Copies:

.1 Number of Copies: Submit 2 copies of final version to Owner.

.2 Binders: vinyl, hard covered, three D-rings, loose leaf, 216 x 279 mm, with spine and face pockets. When multiple binders are used, correlate data into related consistent groupings. Identify contents of each binder on spine.

.3 Cover: Identify each binder with typed or printed title "Operation and Maintenance Manual for **PEB** and subject matter of contents.

.4 Arrange content by systems or process flow, under Section numbers and sequence of Table of Contents.

.5 Provide Operation and Maintenance Manual in separate binders for each discipline, and generally as follows:
- .1 Architectural.
- .2 Structural
- .3 HVAC Systems and Plumbing.
- .4 Fire Protection Systems.
- .5 Electrical, Communications and IT.

.6 Provide tabbed fly leaf for each separate Product or system, with typed description of Product and major component parts of equipment.

.7 Text: Manufacturer's printed data, or typewritten data.

.8 Drawings: provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.

1.2.3.3 Electronic Copies:

.1 Submission Media: Submit final version to Owner on electronic media acceptable to Owner (i.e. USB media or using a secure cloud storage system).

.2 Format: Provide electronic copy of Operation and Maintenance Manual in PDF format.
- .1 Use electronic files prepared by manufacturer where available. If scanning of paper documents is necessary, configure scanned file for minimum readable file size.
- .2 Bookmarking: Individual documents must be bookmarked based on file names. Name document files to correspond to system, subsystem, and equipment names used on table of contents.
- .3 Group documents for each system and subsystem into bookmarked files.

.3 File Verification: Prior to submission, verify that digital files are not corrupt, retrievable, and can be viewed and opened.

.4 Shop Drawings: Provide electronic copy of Shop Drawings in manual as 1:1 scaled files in .dwg and PDF format.

1.2.4 Operation And Maintenance Manual Contents:

1.2.4.1 General Contents:

.1 Table of contents for each volume.

.2 Introductory information including:
- .1 Date of manual submission.
- .2 Complete contact information for Consultant, subconsultants, other consultants, and Contractor, with names of responsible parties.
- .3 Schedule of Products and systems indexed to content of volume.

.3 For each Product or system, include complete contact information for Subcontractors, Suppliers and manufacturers, including local sources for supplies and replacement parts.

.4 Product Data: mark each sheet to clearly identify specific products, options, and component parts, and data applicable to installation. Delete or strike out inapplicable information. Supplement with additional information as required.

.5 Reviewed Shop Drawings.

.6 Permits, certificates, letters of assurance and other relevant documents issued by or required by authorities having jurisdiction.

.7 Warranties.

.8 Operating and maintenance procedures, incorporating manufacturer's operating and maintenance instructions, in a logical sequence.

.9 Training materials as specified in Section 01 79 00 - Demonstration and Training.

1.2.4.2 Equipment And Systems:

.1 Each Item of Equipment and Each System: include description of unit or system and component parts. Give function, normal operation characteristics, and limiting conditions. Include performance curves, with engineering data and tests, and complete nomenclature and commercial number of replaceable parts.

.2 Panel Board Circuit Directories: provide electrical service characteristics, controls, and communications.

.3 Include installed colour coded wiring diagrams.

.4 Operating Procedures: include start-up, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shut-down, and emergency instructions. Include summer, winter, and any special operating instructions.

.5 Maintenance Requirements: include routine procedures and guide for trouble-shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.

.6 Provide servicing and lubrication schedule, and list of lubricants required.

.7 Include manufacturer's printed operation and maintenance instructions.

.8 Include sequence of operation by controls manufacturer.

.9 Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.

.10 Provide installed control diagrams by controls manufacturer.

.11 Provide Contractor's coordination drawings, with installed colour coded piping diagrams.

.12 Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.

.13 Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.

.14 Include testing and balancing reports.

.15 Include additional content as specified in technical Specifications sections.

1.2.4.3 Products And Finishes:

.1 Include Product data, with catalogue number, options selected, size, composition, and colour and texture designations. Provide information for re-ordering custom manufactured Products.

.2 Instructions for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.

.3 Include an outline of requirements for routine and special inspections and for regular maintenance to ensure that on-going performance of the building envelope will meet the initial building envelope criteria.

.4 Include additional content as specified in technical Specifications sections.

1.2.4.4 Warranties:

.1 Separate each warranty with index tab sheets keyed to Table of Contents listing.

.2 List each warrantor with complete contact information.

.3 Verify that documents are in proper form and contain full information. Ensure that warranties are for the correct duration and are in Owner's name.

.4 Include maintenance bond(s), if any.

1.3 AS-BUILT DRAWINGS

1.3.1 Submit final as-built drawings as specified in Section 01 32 00 – Construction Progress Documentation to Consultant.

1.3.1.1 Hard Copies: None required.

1.3.1.2 Submission Media: Submit electronic copy of As-Built Drawings in PDF and native AutoCAD (.dwg) format on electronic media acceptable to Owner (i.e. USB media or using a secure cloud storage system).

1.4 PROJECT RECORD DRAWINGS

1.4.1 Record Drawings will be prepared by Consultant. Cooperate with Consultant in preparation of record Drawings by providing clarifications on submitted as-built drawings in a timely manner.

1.5 RECORD BUILDING INFORMATION MODEL

1.5.1 **[TBD]**

1.6 SPARE PARTS, MAINTENANCE MATERIALS, AND SPECIAL TOOLS

1.6.1 Supply spare parts, maintenance materials, and special tools in quantities specified in technical Specifications sections.

1.6.2 Ensure spare parts and maintenance materials are new, not damaged nor defective, and of same quality, manufacturer, and batch or production run as installed Products.

1.6.3 Provide tags for special tools identifying their function and associated Product.

1.6.4 Deliver to and store items at location directed by Owner at Place of the Work. Store in original packaging with manufacturer's labels intact and in a manner to prevent damage or deterioration.

1.6.5 Catalogue all items and submit to Consultant an inventory listing organized by Specifications section. Include Consultant reviewed inventory listing in operation and maintenance manual.

1.6.6 [TBD]

END OF SECTION

1.1 EXTENDED WARRANTIES

1.1.1 Provide extended warranties outlined in Technical Specifications. Extended warranties must begin immediately after expiry of contractual one-year warranty and must be co-signed by manufacturers or suppliers. Submission of extended warranties is responsibility of Contractor.

1.1.2 If validity of extended warranties is contingent upon proper maintenance and servicing of specified elements, provide comprehensive maintenance and servicing plan to Owner in Operation and Maintenance Manuals specified in Section 01 78 00.

1.1.3 Extended Warranties are required for the following Products and systems. Refer Technical Specifications for additional details.

1.1.4

Product / System	Section	Length of Extended Warranty (years)

END OF SECTION

1.1 SUMMARY

1.1.1 Demonstrate and provide training to Owner's personnel on operation and maintenance of equipment and systems prior to scheduled date of Ready-for-Takeover.

1.1.2 Owner will provide list of personnel to receive training and will coordinate their attendance at agreed upon times.

1.1.3 Coordinate and schedule demonstration and training provided by Subcontractors and Suppliers.

1.2 COORDINATION

1.2.1 Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations and to ensure availability of Owner's personnel.

1.2.2 Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.

1.2.3 Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operating and maintenance data has been reviewed by Consultant and Owner.

1.2.4 Pre-instruction Meeting: Conduct a meeting at the Project site to review methods and procedures related to demonstration and training including, but not limited to, the following:

1.2.4.1 Inspect and discuss locations and other facilities required for instruction.

1.2.4.2 Review and finalize instruction schedule and verify availability of educational materials, instructors' personnel, audiovisual equipment, and facilities needed to avoid delays.

1.2.4.3 Review required content of instruction.

1.2.4.4 For instruction that must occur outdoors, review forecasted weather conditions and procedures to follow if conditions are unfavorable.

1.3 INSTRUCTION PROGRAM

1.3.1 Develop an instruction program that includes individual training modules for each integrated system operations and for equipment not part of a system, as required by the Owner's training requirements and by individual Specification Sections.

1.3.2 Training Plan:

1.3.2.1 Submit a written training plan, referred to as the Training Plan, to the Owner for review. Training Plan shall cover the following elements.

.1 Equipment and related systems included in training.

.2 Intended audience.

.3 Location of training.

.4 Objectives.

.5 Subjects covered.

.6 Duration of training on each subject.

.7 Instructor for each subject.

.8 Methods (classroom lecture, video, Project site walk-through, actual operational demonstrations, written handouts, etc.).

.9 Instructors and qualifications.

1.3.2.2 Coordinate, schedule, and complete the training related to all equipment specified in the Contract Documents.

1.3.2.3 Owner must acceptable deviations from Contract Document requirements prior to Contractor developing the Training Plan.

1.3.2.4 Conduct classroom-style training session followed by field demonstrations of system operation. When equipment or a system requires both demonstration and training, Contractor may combine the demonstration and training provided that Contractor obtains the Owner's acceptance.

1.3.2.5 Use Operating and Maintenance Manuals as basis for instructing Owner's staff regarding system operation. Review contents of Operating and Maintenance Manuals and review equipment data and performance verification to Owner as part of Owner training.

1.3.2.6 As a minimum, provide training on all systems including, but not limited to, the following (as applicable to the Project):

.1 Architectural Items.

.2 Heating, Ventilating, and Air Conditioning Airside and Waterside Systems.

.3 Building Automation System.

.4 Electrical Systems.

.5 Life Safety Systems (including Fire Alarm, Stairwell Pressurization, Fire Protection, and Smoke Containment, Control, and Response System).

.6 Elevators/Escalators.

.7 Refrigeration Systems.

.8 Lighting Fixtures and Control Systems.

.9 Fire Alarm System.

.10 Communications Systems (including Wired and Wireless Networks, Data, Nurse Call).

.11 Emergency Power and Uninterruptible Power Supply (UPS) Systems.

.12 Security System.

.13 Domestic and Process Water Systems.

.14 Laboratory Gas and Vacuum Systems.

.15 Other major system not identified above.

1.3.2.7 Training to include:

.1 Usage of the printed installation, operation and maintenance instruction material included in the Operating and Maintenance Manuals.

.2 Review of the written operating and maintenance instructions emphasizing safe and proper operating requirements, preventative maintenance, special tools needed and spare parts inventory suggestions. The training shall include start-up, operation in all modes possible, shutdown, seasonal changeover and any emergency procedures.

.3 Discussion of relevant health and safety issues and concerns.

.4 Discussion of warranties and guarantees.

.5 Common troubleshooting problems and solutions.

.6 Explanation of information included in the Operating and Maintenance manuals and the location of all plans and manuals in the facility.

.7 Discussion of any peculiarities of equipment installation or operation.

1.3.3 Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following as applicable to the system, equipment, or component:

1.3.3.1 Basis of System Design, Operational Requirements, and Criteria: Include the following:

.1 System, subsystem, and equipment descriptions.

.2 Performance and design criteria if Contractor is delegated design responsibility.

.3 Operating standards.

.4 Regulatory requirements.

.5 Equipment function.

.6 Operating characteristics.

.7 Limiting conditions.

.8 Performance curves.

1.3.3.2 Documentation: Review the following items in detail:

.1 Emergency manuals.

.2 Operations manuals.

.3 Maintenance manuals.

.4 Project record documents.

.5 Identification systems.

.6 Warranties and bonds.

.7 Maintenance service agreements and similar continuing commitments.

1.3.3.3 Emergencies: Include the following, as applicable:

.1 Instructions on meaning of warnings, trouble indications, and error messages.

.2 Instructions on stopping.

.3 Shutdown instructions for each type of emergency.

.4 Operating instructions for conditions outside of normal operating limits.

.5 Sequences for electric or electronic systems.

.6 Special operating instructions and procedures.

1.3.3.4 Operations: Include the following, as applicable:

.1 Startup procedures.

.2 Equipment or system break-in procedures.

.3 Routine and normal operating instructions.

.4 Regulation and control procedures.

.5 Control sequences.

.6 Safety procedures.

.7 Instructions on stopping.

.8 Normal shutdown instructions.

.9 Operating procedures for emergencies.

.10 Operating procedures for system, subsystem, or equipment failure.

.11 Seasonal and weekend operating instructions.

.12 Required sequences for electric or electronic systems.

.13 Special operating instructions and procedures.

1.3.3.5 Adjustments: Include the following:

.1 Alignments.

.2 Checking adjustments.

.3 Noise and vibration adjustments.

.4 Economy and efficiency adjustments.

1.3.3.6 Troubleshooting: Include the following:

.1 Diagnostic instructions.

.2 Test and inspection procedures.

1.3.3.7 Maintenance: Include the following:

.1 Inspection procedures.

.2 Types of cleaning agents to be used and methods of cleaning.

.3 List of cleaning agents and methods of cleaning detrimental to product.

.4 Procedures for routine cleaning

.5 Procedures for routine and preventive maintenance.

.6 Instruction on use of special tools.

1.3.3.8 Repairs: Include the following:

.1 Diagnosis instructions.

.2 Repair instructions.

.3 Disassembly; component removal, repair, and replacement; and reassembly instructions.

.4 Instructions for identifying parts and components.

.5 Review of spare parts needed for operation and maintenance.

1.3.4 Consultant and Owner will review submittal and advise Contractor of any necessary revisions.

1.3.5 Submit report(s) within 5 Working Days after completion of demonstration and training:

1.3.5.1 identifying time and date of each demonstration and training session,

1.3.5.2 summarizing the demonstration and training performed, and

1.3.5.3 including a list of attendees.

1.3.6 Training video: Submit video record of demonstration and training together with report.

1.4 PREREQUISITES TO DEMONSTRATION AND TRAINING

1.4.1 Testing, adjusting, and balancing has been performed in accordance with Contract Documents.

1.4.2 Equipment and systems are fully operational.

1.4.3 Copy of completed operation and maintenance manual is available for use in demonstration and training.

1.4.4 Conditions for demonstration and training comply with requirements specified in technical Specifications.

1.5 DEMONSTRATION AND TRAINING

1.5.1 Demonstrate start-up, operation, control, adjustment, troubleshooting, servicing, and maintenance of each item of equipment and system.

1.5.2 Review operation and maintenance manual in detail to explain all aspects of operation and maintenance.

1.5.3 Prepare and insert additional information in operation and maintenance manual if required.

1.5.4 As a minimum the following items must be demonstrated:

Equipment / System	Spec Section	Total Hours
Composite Metal Building Panels		1 Hr
Curtain Wall		1 Hr.
Overhead doors and shutters		1 Hr.
Operable Partitions		1 Hr
Window Washing System		1Hr

Equipment / System	Spec Section	Total Hours
Laboratory Equipment		8 Hrs
Fume Hoods & Exhaust Devices		2 Hrs
Roller Window Shades		1 Hr
Controlled Environmental Rooms		4 Hrs
Chillers and System		4 Hrs
Boilers and Heating System and PRV Station		4 Hrs
HVAC Piping Systems		4 Hrs
Air Compressors and Dryers		4 Hrs
Air Handler Units		4 Hrs
Supplementary Supply Fans		2 Hrs
Return Fan/Relief Fan		2 Hrs
Air Terminal Units		2 Hrs
Specialty Exhaust Fans		4 Hrs
Domestic Hot Water Circulating System		2 Hrs
Domestic Water Booster Pumps		2 Hrs
Domestic Water Storage/Break Tank		2 Hrs
Water Softeners		2 Hrs
Pure Water Production Equipment		2 Hrs
Laboratory Compressed Gas Manifolds		4 Hrs
Laboratory Gas and Vacuum System Alarms		2 Hrs
Sump Pumps		2 Hrs
Sewage Ejector		2 Hrs
Fire Pump System		2 Hrs
Dry Pipe Fire Sprinkler Systems		2 Hrs
Fire Protection Water Tank		8 Hrs
Domestic Water Heaters (Natural Gas Fired)		2 Hrs
Laboratory Vacuum & Gas Piping		4 Hrs
Laboratory Vacuum Pump Systems		4 Hrs
High Purity Water System		8 Hrs
Variable Frequency Drives		8 Hrs
Heat Recovery Chiller		8 Hrs
Fuel Oil Piping Systems		16 Hrs
BAS Commissioning		8 Hrs
Lighting Controls		8 Hrs
Emergency Power System		16 Hrs
Uninterruptible Power Supply		8 Hrs
Switchgear		8 Hrs
Generator Paralleling Gear		16 Hrs
600 Volt Generator Paralleling Switchgear		16 Hrs
Automatic Transfer Switches		8 Hrs
Lightning Protection		1 Hr.
Electronic Security - Systems Startup		16 Hrs
Electronic Security		16 Hrs
Fire Alarm & Smoke Detector Systems - Training		20 Hrs / 3-4 Hrs w/ 8Hrs follow up

Equipment / System	Spec Section	Total Hours
Irrigation Systems		1 Hr

END OF SECTION

1 GENERAL

1.01 SUMMARY

.1 Section includes all methods, materials and installation as required to complete the Work of this Section in accordance with the Conditions of the Contract.

.2 Work may include, but is not limited to;
- .1 Removal of pavements.

1.02 REFERENCES

.1 Ontario Regulation 102/94 - Waste Audits and Waste Reduction Work Plans.

1.03 ADMINISTRATIVE REQUIREMENTS

.1 Site Meetings: Convene pre-demolition meeting one week prior to beginning work of this Section in accordance with Section 01 31 19 to:
- .1 Verify project requirements.
- .2 Review existing conditions.
- .3 Co-ordinate with other building subtrades.

.2 Scheduling: Meet project time lines without compromising specified minimum rates of material diversion. Notify Consultant in writing when unforeseen delays occur.

1.04 ACTION SUBMITTALS

.1 Submit action submittals in accordance with Section 01 33 00.

.2 Shop Drawings: Submit Shop Drawings illustrating the following:
- .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.
- .2 Submit for approval drawings, diagrams or details showing sequence of demolition work and supporting structures and underpinning, where required by authorities having jurisdiction.

.3 Waste reduction workplan: Prior to beginning of Work on site, submit detailed Waste Reduction Workplan in accordance Ontario Regulation 102/94 indicating:
- .1 Descriptions of and anticipated quantities in percentages of materials to be salvaged reused, recycled and landfilled.
- .2 Schedule of selective demolition.
- .3 Name and address of waste facilities.

.4 Certificates:
.1 Submit copies of certified receipts from authorized disposal sites and reuse and recycling facilities for material removed from site upon request of Consultant.
.2 Written authorization from Consultant is required to deviate from facilities listed in Waste Reduction Workplan.

1.05 DELIVERY, STORAGE, AND HANDLING

.1 Storage and protection:
.1 Protect existing items designated to remain and items designated for salvage. In event of damage to such items, immediately replace or make repairs to approval of Consultant and at no cost to Consultant.
.2 Remove and store materials to be salvaged, in manner to prevent damage.
.3 Store and protect in accordance with requirements for maximum preservation of material.
.4 Handle salvaged materials as new materials.

1.06 SITE CONDITIONS

.1 Site Environmental Requirements:
.1 Ensure that selective demolition work does not adversely affect adjacent watercourses, groundwater and wildlife, or contribute to excess air and noise pollution.
.2 Do not dispose of waste of volatile materials including but not limited to, mineral spirits, oil, petroleum based lubricants, or toxic cleaning solutions into watercourses, storm or sanitary sewers.
.3 Ensure proper disposal procedures are maintained throughout the project.
.4 Do not pump water containing suspended materials into watercourses, storm or sanitary sewers or onto adjacent properties.
.5 Control disposal or runoff of water containing suspended materials or other harmful substances in accordance with local authorities.
.6 Protect trees, plants and foliage on site and adjacent properties where indicated.

.2 Existing Conditions:
.1 Remove contaminated or hazardous materials as directed by Consultant from site, prior to start of demolition Work, and dispose of at designated disposal facilities in safe manner in accordance with TDGA and other applicable regulatory requirements.

2 PRODUCTS

2.01 EQUIPMENT

.1 Leave machinery running only while in use, except where extreme temperatures prohibit shutting machinery down.

3 EXECUTION

3.01 PREPARATION

.1 Inspect site with Consultant and verify extent and location of items designated for removal, disposal, alternative disposal, recycling, salvage and items to remain.

.2 Locate and protect utilities. Preserve active utilities traversing site in operating condition.

.3 Notify and obtain approval of utility companies before starting demolition.

.4 Disconnect and cap mechanical services:
- .1 Natural Gas Supply Lines: contact utility company to arrange for removal.
- .2 Sewer and Water Lines: remove in accordance with authority having jurisdiction and securely plug to form watertight seal.
- .3 Other Underground Services: remove and dispose of as indicated.

3.02 REMOVAL OF HAZARDOUS WASTES

.1 Remove contaminated or dangerous materials defined by authorities having jurisdiction, relating to environmental protection, from site and dispose of in safe manner to minimize danger at site or during disposal.

3.03 REMOVAL OPERATIONS

.1 Remove items as indicated.

.2 Do not disturb items designated to remain in place.

.3 Removal of pavements, curbs and gutters:
- .1 Square up adjacent surfaces to remain in place by saw cutting or other method approved by Consultant.
- .2 Protect adjacent joints and load transfer devices.
- .3 Protect underlying and adjacent granular materials.

.4 Prevent contamination with base course aggregates, when removing asphalt pavement for subsequent incorporation into hot mix asphalt concrete paving.

.5 Excavate at least 300 mm below pipe invert, when removing pipes under existing or future pavement area.

.6 Stockpile topsoil for final grading and landscaping. Provide erosion control and seeding if not immediately used.

.7 Disposal of Material: Dispose of materials not designated for salvage or reuse on site at authorized facilities approved in Waste Reduction Workplan.

.8 Backfill: Backfill in areas as indicated and in accordance with Section 31 00 00.

3.04 REMOVAL FROM SITE

.1 Remove stockpiled material as directed by Consultant, when it interferes with operations of project.

.2 Remove stockpiles of like materials by alternate disposal option once collection of materials is complete.

.3 Transport material designated for alternate disposal using approved haulers listed in Waste Reduction Workplan and in accordance with applicable regulations. Written authorization from Consultant is required to deviate from haulers listed in Waste Reduction Workplan.

.4 Dispose of materials not designated for alternate disposal in accordance with applicable regulations:
- .1 Disposal Facilities: approved and listed in Waste Reduction Workplan.
- .2 Written authorization from Consultant is required to deviate from disposal facilities listed in Waste Reduction Workplan.

3.05 RESTORATION

.1 Restore areas and existing works outside areas of demolition to match condition of adjacent, undisturbed areas.

.2 Use soil treatments and procedures which are not harmful to health, are not injurious to plants, and do not endanger wildlife, adjacent water courses or ground water.

3.06 CLEANING

.1 Leave Work area clean at end of each day.

.2 Remove debris, trim surfaces and leave work site clean, upon completion of Work.

.3 Use cleaning solutions and procedures which are not harmful to health, are not injurious to plants, and do not endanger wildlife, adjacent water courses or ground water.

.4 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.07 PROTECTION

.1 Repair damage to adjacent materials or property caused by selective site demolition.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 03 30 00 Landscape Cast-in-Place Concrete

.2 Section 32 13 13 Concrete Paving and Edges

1.2 REFERENCE STANDARDS

.1 CSA Group (CSA)

.1 CSA-A23.1-[14] /A23.2-[14] , Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.

.2 CSA S269.1-[16] , Falsework and Formwork.

.3 CAN/CSA-S269.3-[M92(R2003)] , Concrete Formwork.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submittals in accordance with Section 01 33 00- Submittal Procedures.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for proprietary materials used in formwork liners and include product characteristics, performance criteria, physical size, finish, and limitations.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store, and handle materials in accordance with Section with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials off ground, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect formwork from damages.

.3 Replace defective or damaged materials with new.

Part 2 Products

2.1 MATERIALS

.1 Formwork materials:

.1 Use formwork materials to CSA-A23.1/A23.2.

.2 Tubular column forms: round, internally treated with release material.

.1 Spiral pattern not to show in hardened concrete.

.2 Sonotube or equivalent

.3 Form panels:

.1 Plywood: medium density overlay plyform

.4 Form release agent: Proprietary, non volatile material not to stain concrete or impair subsequent application of finishes or coatings to surface of concrete, derived from agricultural sources, non petroleum containing, low VOC and non-toxic.

.5 Falsework materials: to CSA-S269.1.

.6 Light Bollard Base: Dobla 305R as supplied by ArtForms International Inc.

.7 Accessible Signage Base: Dobla 305R as supplied by ArtForms International Inc.

Part 3 Execution

3.1 FABRICATION AND ERECTION

.1 Verify lines, levels, and centres before proceeding with formwork/falsework and ensure dimensions agree with drawings.

.2 Fabricate and erect falsework in accordance with CSA S269.1.

.3 Fabricate and erect formwork in accordance with CAN/CSA-S269.3 to produce finished concrete conforming to shape, dimensions, locations and levels indicated within tolerances required by CSA-A23.1/A23.2.

.4 Align form joints and make watertight.

.1 Keep form joints to minimum.

.5 Use 25 mm chamfer strips on external corners and 25 mm fillets at interior corners, joints, unless specified otherwise.

.6 Form chases, slots, openings, drips, recesses, expansion and control joints as indicated.

.7 Build in anchors, sleeves, and other inserts required to accommodate Work specified in other sections.

.1 Ensure that anchors and inserts will not protrude beyond surfaces designated to receive applied finishes, including painting.

.8 Clean formwork in accordance with CSA-A23.1/A23.2, before placing concrete.

3.2 REMOVAL AND RESHORING

.1 Remove formwork when concrete has reached 70% of its 28 day design strength or minimum period noted above, whichever comes later, and replace immediately with adequate reshoring.

.2 Re-use formwork and falsework subject to requirements of CSA-A23.1/A23.2.

3.3 CLEANING

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 03 10 01 Landscape Concrete Forming and Accessories

.2 Section 32 13 13 Concrete Paving and Edges

1.2 REFERENCE STANDARDS

.1 ASTM International

.1 ASTM C260/C260M-[10a(2016)] , Standard Specification for Air-Entraining Admixtures for Concrete.

.2 ASTM C309-[11] , Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.

.3 ASTM C494/C494M-[16] , Standard Specification for Chemical Admixtures for Concrete.

.4 ASTM C 881/C881M-[15] , Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.

.5 ASTM C1017/C1017M-[13e1] , Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete.

.6 ASTM C C1059/C1059M-[13] , Standard Specification for Latex Agents for Bonding Fresh To Hardened Concrete.

.7 ASTM D412-[16] , Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension.

.8 ASTM D624-[2012] , Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomer.

.9 ASTM D1751-[04(2013)e1] , Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).

.10 ASTM D1752-[04a(2013)] , Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.

.2 Canadian General Standards Board (CGSB)

.1 CAN/CGSB-51.34-[M86] , Vapour Barrier, Polyethylene Sheet for Use in Building Construction.

.3 CSA Group

.1 CSA A23.1/A23.2-[14] , Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.

.2 CSA A283-[06-R2016] , Qualification Code for Concrete Testing Laboratories.

.3 CSA A3000-[13] , Cementitious Materials Compendium (Consists of A3001, A3002, A3003, A3004 and A3005),

1.3 ABBREVIATIONS AND ACRONYMS

.1 Portland Cement: hydraulic cement, blended hydraulic cement (XXb - b denotes blended) and Portland-limestone cement types:

.1 GU, GUb and GUL - General use cement.

.2 MS and MSb - Moderate sulphate-resistant cement.

.3 MH, MHb and MHL - Moderate heat of hydration cement.

.4 HE, HEb and HEL - High early-strength cement.

.5 LH, LHb and LHL - Low heat of hydration cement.

.6 HS and HSb - High sulphate-resistant cement.

.2 Fly ash types:

.1 F - with CaO content maximum 8%.

.2 CI - with CaO content 15 to 20%.

.3 CH - with CaO minimum 20%.

.3 GGBFS - Ground, granulated blast-furnace slag.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00- Submittal Procedures.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for proprietary materials used in Cast-In-Place Concrete and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings: Submit complete reinforcement fabrication and installation shop drawings indicating location, bar size, dowls, lap length, placement and concrete coverage, and dimensions.

.4 Site Quality Control Submittals:

.1 Provide testing and inspection reports for review by Consultant and do not proceed without written approval when deviations from mix design or parameters found.

.2 Concrete pours: provide accurate records of poured concrete items indicating date and location of pour, quality, air temperature and test samples taken as described in PART 3 - FIELD QUALITY CONTROL.

1.5 QUALITY ASSURANCE

.1 Quality Assurance: in accordance with Section 01 45 00- Quality Control.

.2 Provide Consultant, minimum 4 weeks prior to starting concrete work, with valid and recognized certificate from plant delivering concrete.

.1 Provide test data and certification by qualified independent inspection and testing laboratory that materials and mix designs used in concrete mixture meet specified requirements.

.3 Minimum 4 weeks prior to starting concrete work, provide proposed quality control procedures for review by Consultant on following items:

.1 Falsework erection.

.2 Hot weather concrete.

.3 Cold weather concrete.

.4 Curing.

.5 Finishes.

.6 Formwork removal.

.7 Joints.

.4 Quality Control Plan: provide written report to Consultant verifying compliance that concrete in place meets performance requirements of concrete as established in PART 2 - PRODUCTS.

.5 Mock-Ups:

.1 Provide site mock-up for finished concrete indicating forming methods and materials, and procedures proposed to achieve finish as shown on drawings, and to comply with following requirements, using materials indicated for completed work:

.1 Build mock-ups in location and of size as directed by Consultant.

.2 Obtain Consultant's acceptance of mock-ups before starting construction; mock-up used throughout construction period and used as standard of acceptance for subsequent architectural concrete work.

.3 Mock-up may form part of permanent structure when accepted by Consultant; repair or replace unacceptable mock-ups at no additional cost to Owner.

1.6 DELIVERY, STORAGE AND HANDLING

.1 Delivery and Acceptance Requirements:

.2 Concrete hauling time: deliver to site of Work and discharged within 120 minutes maximum after batching.

.1 Modifying maximum time limit without receipt of prior written agreement from laboratory representative and concrete producer as described in CSA A23.1/A23.2. is prohibited.

.2 Concrete delivery: ensure continuous concrete delivery from plant meets CSA A23.1/A23.2.

1.7 SITE CONDITIONS

.1 Placing concrete during rain or weather events that could damage concrete is prohibited.

.2 Protect newly placed concrete from rain or weather events in accordance with CSA A23.1/A23.2.

.3 Cold weather protection:

.1 Maintain protection equipment, in readiness on Site.

.2 Use such equipment when ambient temperature below 5°C, or when temperature may fall below 5°C before concrete cured.

.3 Placing concrete upon or against surface at temperature below 5°C is prohibited.

.4 Hot weather protection:

.1 Protect concrete from direct sunlight when ambient temperature above 27°C.

.2 Prevent forms of getting too hot before concrete placed. Apply accepted methods of cooling not to affect concrete adversely.

.5 Protect from drying.

Part 2 Products

2.1 MATERIALS

.1 Portland Cement: GU to CSA A3001.

.2 Supplementary cementing materials: in accordance with CSA A3001.

.3 Water: to CSA A23.1.

.4 Aggregates: to CSA A23.1/A23.2.

.5 Admixtures:

.1 Air entraining admixture: to ASTM C260.

.1 Sika AER, as distributed by Sika.

.2 Chemical admixture: to ASTM C494. Consultant to approve accelerating or set retarding admixtures during cold and hot weather placing.

.6 Curing compound: to CSA A23.1/A23.2.

.7 Premoulded joint fillers:

.1 Bituminous impregnated fibre board: to ASTM D1751.

.8 Concrete Bonding Agents: Latex to ASTM C1059/C1059M.

.9 Reinforcing Steel:

.1 Flatwork: Refer to Section 32 13 13 Concrete Paving and Edges.

2.2 MIXES

.1 Mix in accordance with CSA A23.1/A23.2.

.1 Ensure materials used in concrete mix have been submitted for testing and meet requirements of CSA A23.1.

.2 Co-ordinate construction methods to suit concrete mix proportions and parameters.

.3 Identify and report immediately to Consultant when concrete mix design and parameters pose anticipated problems or deficiencies related to construction.

.1 Class of exposure: C-2.

.2 Nominal size of course Aggregate: 19mm

.3 Admixture: chemical to ASTM C494/C494M.

.4 Water: to CSA A23.1/A23.2

.5 Air content category: 1 .

.6 Slump: at time and point of discharge max 3 +/- 0.5in.

Part 3 Execution

3.1 PREPARATION

.1 Obtain Consultant's approval before placing concrete.

.1 Provide consultant 24 hours minimum notice prior to placing of concrete.

.2 Place concrete reinforcing accurately and secure in place.

.3 During concreting operations:

.1 Development of cold joints not allowed.

.2 Ensure concrete delivery and handling facilitate placing with minimum of re-handling, and without damage to existing structure or Work.

.4 Pumping of concrete permitted only after approval of equipment and mix.

.5 Disturbing reinforcement and inserts during concrete placement is prohibited.

.6 Prior to placing of concrete obtain Consultant's approval of proposed method for protection of concrete during placing and curing in adverse weather.

.7 Protect previous Work from staining.

.8 Clean and remove stains prior to application for concrete finishes.

.9 Maintain accurate records of poured concrete items to indicate date, location of pour, quality, workability, air content, temperature and test samples taken.

.10 In locations where new concrete dowelled to existing work, drill holes in existing concrete.

.1 Place steel dowels and pack solidly with shrinkage compensating grout to anchor and hold dowels in positions as indicated.

.11 Do not place load upon new concrete until authorized by Consultant.

3.2 INSTALLATION/APPLICATION

.1 Do cast-in-place concrete work to CSA A23.1/A23.2.

.2 Sleeves and inserts:

.1 Do not eliminate or displace reinforcement to accommodate hardware. If inserts cannot be located as specified, obtain written approval of modifications from Consultant before placing of concrete.

.2 Confirm locations and sizes of sleeves and openings shown on drawings.

.3 Set special inserts for strength testing as indicated and as required by non-destructive method of testing concrete.

.3 Anchor bolts:

.1 Set anchor bolts to templates in co-ordination with appropriate trade prior to placing concrete.

.2 Grout anchor bolts in preformed holes or holes drilled after concrete has set only after receipt of written approval from Consultant.

.1 Drilled holes: to manufacturers' recommendations.

.3 Protect anchor bolt holes from water accumulations, snow and ice build-ups.

.4 Set bolts and fill holes with shrinkage compensating grout.

.5 Locate anchor bolts used in connection with expansion shoes, rollers and rockers with due regard to ambient temperature at time of erection.

.4 Grout under base plates using procedures in accordance with manufacturer's recommendations which result in 100 % contact over grouted area.

.5 Finishing and curing:

.1 Finish concrete to CSA A23.1/A23.2.

.2 Use procedures as noted in CSA A23.1/A23.2 to remove excess bleed water. Ensure surface not damaged.

.3 Use curing compounds compatible with applied finish on concrete surfaces.

.4 Rub exposed sharp edges of concrete with carborundum to produce 3 mm minimum radius edges unless otherwise indicated.

.6 Joint fillers:

.1 Furnish filler for each joint in single piece for depth and width required for joint, unless otherwise authorized by Consultant.

.2 When more than one piece required for joint, fasten abutting ends and hold securely to shape by stapling or other positive fastening.

.3 Locate and form expansion joints as indicated.

.4 Install joint filler.

.5 Use 13 mm thick joint filler to separate slabs-on-grade from vertical surfaces and extend joint filler from bottom of slab to within 12mm of finished slab surface unless indicated otherwise.

3.3 SURFACE TOLERANCE

.1 Concrete tolerance to CSA A23.1, 3mm in 3m using straight edge method.

3.4 FIELD QUALITY CONTROL

.1 Site tests: conduct tests as follows and submit report as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.

.1 Concrete pours.

.2 Slump.

.3 Air content.

.4 Compressive strength at 7 and 28 days.

.5 Air and concrete temperature.

.2 Inspection and testing of concrete and concrete materials carried out by testing laboratory to CSA A23.1/A23.2.

.1 Ensure testing laboratory certified to CSA A283.

.3 Non-Destructive Methods for Testing Concrete: to CSA A23.1/A23.2.

.4 Inspection or testing by Consultant not to augment or replace Contractor quality control nor relieve Contractor of contractual responsibility.

3.5 CLEANING

.1 Clean in accordance with Section 01 74 00 - Cleaning.

END OF SECTION

1 GENERAL

1.01 SUMMARY

.1 Section includes all methods, materials and installation as required to complete the Work of this Section in accordance with the Conditions of the Contract.

1.02 REFERENCES

.1 ASTM D523 - Standard Test Method for Specular Gloss.

.2 ASTM D4039 - Standard Test Method for Reflection Haze of High-Gloss Surfaces.

.3 ASTM D5767 - Standard Test Method for Instrumental Measurement of Distinctness-of-Image (DOI) Gloss of Coated Surfaces.

.4 ASTM E1155 - Standard Test Method for Determining FF Floor Flatness and FL Floor Levelness Numbers.

.5 CFCA - Concrete Floor Contractors Association of Canada.

.6 NFSI B101.0 - Walkway Surface Auditing Procedure for the Measurement of Walkway Surface Traction.

.7 NFSI B101.3 - Test Method for Measuring the Wet DCOF of Hard Surface Walkways.

1.03 ADMINISTRATIVE REQUIREMENTS

.1 Site Meetings: Arrange a pre-installation meeting on Site to be attended by Consultant, Contractor, concrete sealer manufacturer's representative, and any other parties directly affecting work of this Section to:
- .1 Review division of responsibilities, floor joint layout and mock-up requirements.
- .2 Examine substrate conditions for compliance with manufacturer's requirements.
- .3 Review methods and procedures related to installation.
- .4 Review all typical and special details as required to complete the work of this section.

1.04 ACTION SUBMITTALS

.1 Submit action submittals in accordance with Section 01 33 00.

.2 Product data:
- .1 Submit manufacturers product data for polished concrete floor sealer including product characteristics, performance criteria, and limitations. Include application instructions for concrete floor treatments.
- .2 Submit preparation, installation and grinding technique information detailing how polished concrete finish is to be achieved.

.3 Samples: Submit 300 mm x 300 mm samples illustrating colour and final concrete finish.

.4 Reports/certificates: Submit the following:
- .1 Proof of current membership in CFCA.
- .2 Proof of manufacturer's acceptance of substrate in writing.

1.05 CLOSEOUT AND MAINTENANCE SUBMITTALS

.1 Submit closeout and maintenance submittals in accordance with Section 01 78 00.

.2 Closeout Product data: Submit manufacturers maintenance and cleaning data for incorporation into operation and maintenance manual including product warranty documentation.

1.06 QUALITY ASSURANCE

.1 Installers: Perform Work of this Section by a company that is a member in good standing of CFCA and has a minimum of five (5) years proven experience in the application of concrete floor sealers of a similar size and nature as approved by material manufacturer.

.2 Mock-ups:
- .1 Construct one (1) mock-up of each level of polished concrete finish in location as directed by Consultant.
- .2 Mock-up shall be 5 m^2 and demonstrate methods, materials, and procedures proposed to achieve polished concrete finishes using materials indicated for completed work.
- .3 Mock-up may form part of the Work if accepted by the Consultant.

1.07 SITE CONDITIONS

.1 Temporary lighting: Minimum 1200 W light source, placed 2.5 m above floor surface, for each 40 sq m of floor being treated.

.2 Electrical power: Provide sufficient electrical power to operate equipment normally used during construction.

.3 Ambient Conditions and relative humidity: Work of this Section shall be performed when air and surface temperatures are above 4 degree C from 48 hours before application to minimum 48 hours after completion of work. Maintain relative humidity no higher than 40% during same period.

.4 Moisture: Ensure concrete substrate is within moisture limits prescribed by flooring manufacturer.

.5 Dust: Limit and control dust generated by grinding and polishing procedures. Properly dispose of collected dry dust.

1.08 WARRANTY

.1 Provide extended warranty for polished concrete in accordance with the General Conditions, except warranty is extended to two (2) years from date Ready-for-Takeover has been attained:
- .1 Warranty to cover defects including shrinkage cracks.
- .2 Warranty shall cover complete replacement of Work, including adjacent work impacted.

2 PRODUCTS

2.01 PERFORMANCE CRITERIA

.1 Design polished concrete floor system to provide a Level 2, Satin (Semi-gloss) finish as defined by CPC and measured with a Image Clarity Metre and Glossmetre calibrated and used in accordance with ASTM D5767 and ASTM D4039.

.2 Design polished concrete floor with static coefficient of friction to NFSI B101.0 and NFSI B101.3 as follows:
- .1 Dry surface: 0.50.
- .2 Wet surface: 0.60.

.3 Provide polished concrete floor with aggregate exposure Class B as defined by CPC.

2.02 MATERIALS

.1 Polished concrete finishing system: Clear, zero Voc concrete polishing system Induroshine System by W.R. Meadows, Retroplate by Advanced Floor Products, or Permashine by Laticrete consisting of the following components:
- .1 Hardener/densifier: Lithium-silicate based material, Liqui-Hard Ultra by W.R. Meadows or approved equal.
- .2 Stain sealer: Hybrid polymer sealer, Bellatrix by W.R. Meadows or approved equal.

.2 Sealant: Two-part, semi-rigid epoxy joint filler
- .1 Euco 700 by Euclid Chemical.
- .2 MasterSeal CR190 by Sika Canada.
- .3 Reziweld-Flex by W.R. Meadows.
- .4 or approved equal.

3 EXECUTION

3.01 EXAMINATION

.1 Examine and verify previously installed Work upon which this Section depends. Report defects or unsatisfactory conditions to Consultant. Commencement of work of this Section means acceptance of existing conditions.

.2 Inspect and verify that concrete has cured a minimum 28 days and does not have curled joints, large cracks, spalling or lippage.

.3 Verify that slab surfaces are ready to receive work and elevations are as indicated on Shop Drawings and as recommended by manufacturer's written instructions.

.4 Ensure concrete floor conforms to FF 40 - FL 30 in accordance with ASTM E1155.

3.02 PREPARATION

.1 Clean and prepare surfaces to receive treatment in accordance with manufacturer's instructions, ensuring that all stains, oil, grease, form release agents, dust and dirt are removed prior to application.

3.03 APPLICATION AND PROCEDURE

.1 Initial Grinding:
- .1 Grind concrete with 80-grit metal bond grinding segment, grind floor surface at rate of 500 ft^2/hr. Vacuum the surface to remove loose particulates.
- .2 Grind floor using 150-grit metal bond grinding segment, grind floor surface at rate of 600 ft^2/hr. Vacuum the surface to remove loose particulates.

.2 Apply concrete hardener/densifier in accordance with manufacturer's written instructions.

.3 Squeegee off excess material and allow surface to dry for 24 hours.

.4 Verify that floor is dry and clear of debris prior to continuation of polishing procedure.

.5 Final Grinding Procedures:

.1 Grind floor using 100-grit resin bond polishing segment, grind floor surface at rate of 600 ft^2/hr. If scratches from the previous grit are still apparent, decrease rate of grinding by 100 ft^2 until scratches are removed. Vacuum surface to remove loose particulates.

.2 Grind floor using 200-grit resin bond polishing segment, grind floor surface at rate of 700 ft^2/hr. If scratches from previous grit are still apparent, decrease rate of grinding by 100 ft^2 until scratches are removed. Vacuum surface to remove loose particulates.

.3 Grind floor using 400-grit resin bond polishing segment, grind floor surface at a rate of 700 ft^2/hr. If scratches from previous grit are still apparent, decrease rate of grinding by 100 ft^2 until scratches are removed. Vacuum surface to remove loose particulates.

.4 Grind floor using 800-grit resin bond polishing segment, grind floor surface at rate of 1000 ft^2/hr. If scratches from previous grit are still apparent, decrease rate of grinding by 100 ft^2 until scratches are removed. Vacuum surface to remove loose particulates.

.6 Clean concrete floor using auto-scrubber with white non-woven pad. Replace pads approximately every 30,000 ft^2.

.7 Allow 24 hours before applying concrete sealer.

.8 Spray apply concrete sealer over surface to rate as recommended by manufacturer.

.9 Pre-wet micro-fiber applicator with concrete sealer prior to use and uniformly spread concrete enhancer creating monolithic, thin, even film, ensuring that product is not allowed to dry before spreading is complete.

.10 Do not over apply concrete sealer. Allow first coat to dry.

.11 Apply second coat at 90° right angle to first coat, allow 24 hours for concrete sealer to dry.

.12 Burnish surface with hogs hair pad at 2000 rpm or substitute diamond pad if necessary.

.13 Seal control joints and joints at junction with vertical surfaces with sealant.

.14 Clean over spray. Clean sealant from adjacent surfaces.

3.04 FIELD QUALITY CONTROL

.1 Polished concrete floor to be tested for conformance with specification.

.2 Specular gloss/reflectance level to be tested in accordance with ASTM D523 at 60 degrees.

.3 Unacceptable areas of completed polished concrete floor system to be reviewed with Consultant and methods to correct established.

3.05 PROTECTION

.1 Protect finished installation in accordance with manufacturer's instructions.

END OF SECTION

1 GENERAL

1.01 SUMMARY

.1 Section includes all methods, materials and installation as required to complete the Work of this Section in accordance with the Conditions of the Contract.

1.02 REFERENCES

.1 CSA A23.1/A23.2 - Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete.

1.03 ADMINISTRATIVE REQUIREMENTS

.1 Site Meetings: Arrange a pre-installation meeting on Site to be attended by Consultant, Contractor, concrete sealer manufacturer's representative, and any other parties directly affecting work of this Section to:
- .1 Review division of responsibilities, floor joint layout and mock-up requirements.
- .2 Examine substrate conditions for compliance with manufacturer's requirements.
- .3 Review methods and procedures related to installation.
- .4 Review all typical and special details as required to complete the work of this section.

1.04 ACTION SUBMITTALS

.1 Submit action submittals in accordance with Section 01 33 00.

.2 Product data: Submit manufacturers product data for concrete floor sealer including product characteristics, performance criteria, and limitations. Include application instructions for concrete floor treatments.

.3 Samples: Submit 300 mm x 300 mm samples illustrating colour and finish of concrete floor sealer.

1.05 QUALITY ASSURANCE

.1 Installers: Perform Work of this Section by a company that has a minimum of five (5) years proven experience in the application of concrete floor sealers of a similar size and nature.

.2 Mock-ups:
- .1 Construct one (1) mock-up of each type of concrete finish in location as directed by Consultant.

.2 Mock-up shall be 300 mm x 300 mm and demonstrate methods, materials, and procedures proposed to achieve concrete finishes using materials indicated for completed work.

.3 Mock-up may form part of the Work if accepted by the Consultant.

1.06 SITE CONDITIONS

.1 Temporary lighting: Minimum 1200 W light source, placed 2.5 m above floor surface, for each 40 sq m of floor being treated.

.2 Electrical power: Provide sufficient electrical power to operate equipment normally used during construction.

.3 Work area: Make work area water tight protected against rain and detrimental weather conditions.

.4 Ambient Conditions and relative humidity: Work of this Section shall be performed when air and surface temperatures are above 10 degree C from 7 days before application to minimum 48 hours after completion of work. Maintain relative humidity no higher than 40% during same period.

.5 Moisture: Ensure concrete substrate is within moisture limits prescribed by flooring manufacturer.

2 PRODUCTS

2.01 PERFORMANCE CRITERIA

.1 Submit written declaration that components used are compatible and will not adversely affect finished flooring products and their installation adhesives.

2.02 MATERIALS

.1 Concrete floor sealer: Clear, zero Voc concrete floor hardener and densifier:
- .1 Cipadeck L by CPD Construction Products.
- .2 Surfhard by Euclid Chemical.
- .3 Sikafloor-3S by Sika.
- .4 Liqui-Hard Ultra by W. R. Meadows.
- .5 Or approved equal.

3 EXECUTION

3.01 EXAMINATION

.1 Examine and verify previously installed Work upon which this Section depends. Report defects or unsatisfactory conditions to Consultant. Commencement of work of this Section means acceptance of existing conditions.

.2 Verify that slab surfaces are ready to receive work and elevations are as indicated on Shop Drawings and as recommended by manufacturer's written instructions.

3.02 APPLICATION

.1 Apply concrete finishing floor hardener in accordance with manufacturer's written instructions.

.2 Seal control joints and joints at junction with vertical surfaces with sealant.

.3 Clean over spray. Clean sealant from adjacent surfaces.

3.03 PROTECTION

.1 Protect finished installation in accordance with manufacturer's instructions.

END OF SECTION

1 GENERAL

1.01 SUMMARY

.1 Section includes all methods, materials and installation as required to complete the Work of this Section in accordance with the Conditions of the Contract.

.2 Work may include, but is not limited to;
- .1 Prefabricated metal stairs.
- .2 Angle lintels.
- .3 Support framing for overhead mounted components.
- .4 Prefabricated ceiling pipe grid.
- .5 Channel frames.
- .6 Bollards.
- .7 Miscellaneous metal fabrications as indicated on drawings.

1.02 REFERENCES

.1 ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

.2 ASTM A123/A123M - Standard Specification for Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products.

.3 ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength.

.4 ASTM F3125/F3125M - Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions.

.5 CSA G40.20-13/G40.21 - General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.

.6 CSA S16 - Design of Steel Structures.

.7 CSA W47.1 - Certification of Companies for Fusion Welding of Steel.

.8 CSA W47.2 - Certification of Companies for Fusion Welding of Aluminum.

.9 CSA W48 - Filler Metals and Allied Materials for Metal Arc Welding.

.10 CSA W59 - Welded Steel Construction (Metal Arc Welding).

.11 NAAMM AMP 555 - Code of Standard Practice for the Architectural Metal Industry.

.12 National Ornamental & Miscellaneous Metals Association (NOMMA).

1.03 ACTION SUBMITTALS

.1 Submit action submittals in accordance with Section 01 33 00.

.2 Product data: Submit manufacturers product data for metal fabrications including product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings: Submit Shop Drawings as follows:
- .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.
- .2 Indicate materials, core thicknesses, finishes, connections, joints, method of anchorage, number of anchors, supports, reinforcement, details, and accessories.
- .3 Stair construction details, sizes of steel sections and thickness of steel sheet.

.4 Samples: Submit 300 mm x 300 mm samples illustrating colours, textures and finishes including, but not limited to:
- .1 Prefabricated metal stair and ladder finish.
- .2 Prefabricated ceiling pipe grid.

.5 Reports and certifications: Submit the following:
- .1 Test Reports: submit certified test reports showing compliance with specified performance characteristics and physical properties.
- .2 Certifications: submit product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

1.04 QUALITY ASSURANCE

.1 Certification of companies: to CSA W47.1 and CSA W47.2 as applicable for fusion welding.

.2 Workmanship: Fabricate work of this Section to meet the required class of workmanship indicated below in accordance with NAAMM AMP 555 (NOMMA), Class 2 as follows:
- .1 Exposed surfaces retain mill marks and moderate irregularities not visible by naked eye at 10 metres. Ensure burrs and sharp edges are filed down or ground off.
- .2 Exposed welds are ground with uniform sized cove.
- .3 Minor distortions are permitted.
- .4 Exposed joints have a maximum gap of 1.5 mm.

2 PRODUCTS

2.01 PERFORMANCE CRITERIA

.1 Design metal fabrications to resist loads and climatic data as indicated, and in accordance with applicable building codes.

.2 Design metal stair, balustrade and landing construction and connections to NBC vertical and horizontal live load requirements.

2.02 MATERIALS - GENERAL

.1 Steel sections and plates: to CSA G40.20/G40.21, Grade 350W, minimum 30% recycled content.

.2 Steel plate: to CSA G40.20/G40.21, Grade 260 W, minimum 30% recycled content.

.3 Steel pipe: to ASTM A53/A53M, standard weight, schedule 40 seamless black.

.4 Steel pipe (bollards): to ASTM A53/A53M standard weight, galvanized finish, minimum 30% recycled content.

.5 Welding materials: to CSA W59.

.6 Welding electrodes: to CSA W48 Series.

.7 Bolts and anchor bolts: to ASTM A307.

.8 High strength bolts: to ASTM F3125/F3125M.

.9 Grout: non-shrink, non-metallic, flowable, 15 MPa at 24 hours.

2.03 FABRICATION

.1 Fabricate work square, true, straight and accurate to required size, with joints closely fitted and properly secured.

.2 Use self-tapping shake-proof screws on items requiring assembly by screws or as indicated.

.3 Where possible, fit and shop assemble work, ready for erection.

.4 Ensure exposed welds are continuous for length of each joint. File or grind exposed welds smooth and flush.

2.04 FINISHES

.1 Galvanizing: hot dipped galvanizing with zinc coating 600 g/m², Coating Grade 85, to ASTM A123/A123M.

.2 Shop coat primer: Refer to Section 09 91 00 for paint system.

.3 Zinc-rich primer:
- .1 Carbozinc 11WB by Carboline.
- .2 Dimetcote 9H by PPG.
- .3 Zinc Clad XL by Sherwin Williams.

2.05 ISOLATION COATING

.1 Isolate aluminum from following components, by means of bituminous paint:
- .1 Dissimilar metals except stainless steel, zinc, or white bronze of small area.
- .2 Concrete, mortar and masonry.
- .3 Wood.

2.06 SHOP PAINTING

.1 Apply one shop coat of primer to metal items, with exception of galvanized or concrete encased items.

.2 Use primer unadulterated, as prepared by manufacturer. Paint on dry surfaces, free from rust, scale, grease. Do not paint when temperature is lower than 7 degrees C.

.3 Clean surfaces to be field welded; do not paint.

2.07 SCHEDULE OF FABRICATIONS

.1 Refer to drawings for metal fabrications items not specifically listed in this Section. Metal fabrications shall include, but not be limited to, the items listed below.

.2 Prefabricated Access Stairs with Railings:
- .1 Ladder: Provide prefabricated mezzanine access stair and roof hatch access stair fabricated from ASTM A36 steel. Provide all required mounting hardware.
- .2 Treads: bar grating treads to NAAMM MBG 533.
- .3 Railings: Construct balusters and handrails from steel pipe.
- .4 Sizing and runs: Refer to Drawings.
- .5 Finish: Manufacturers safety yellow powder coating.
- .6 Basis of Design: Jomy Aluminum, Lapeyre Stair, Skyline Group or approved equal.

.3 Angle Lintels:
- .1 Steel angles: galvanized, sizes indicated for openings. Provide 150 mm minimum bearing at ends.
- .2 Weld or bolt back-to-back angles to profiles as indicated.
- .3 Finish: Shop painted.

.4 Support framing for overhead mounted components:
- .1 Structural channel and angle framing continuously welded and securely anchored to structure above.
- .2 Framing and anchorage as indicated on reviewed Shop Drawings.
- .3 Finish: Prime painted.

.5 Prefabricated Ceiling Pipe Grid:
- .1 Ladder: Provide prefabricated pipe grid system fabricated from 38 mm diameter, Schedule 40 pipe in 1000 mm x 1000 mm pipe spacing. Provide all required hardware and mounting components.
- .2 Design: minimum 40 lbs/linear foot.
- .3 Sizing and layout: Refer to Drawings.
- .4 Basis of Design: IWEISS or approved equal.

.6 Channel Frames:
- .1 Fabricate frames from steel, sizes of channel and opening as indicated.
- .2 Weld channels together to form continuous frame for jambs and head of openings, sizes as indicated.
- .3 Weld steel strap anchors to channel jamb frame.
- .4 Finish: galvanized steel with prime coat painted.

.7 Bollards:
- .1 Fabricate bollards as indicated on drawings and place posts into 1200 mm foundation, project pipes 1200 mm above finished grade
- .2 Size: 150 mm diameter posts with 6 mm thick wall thickness.
- .3 Concrete fill: 20 Mpa concrete with rounded top.
- .4 Finish: Prime coat painted.

.8 Support framing for adult change tables:
- .1 Structural channel and angle framing continuously welded and securely anchored to structure.
- .2 Framing and anchorage as indicated on reviewed Shop Drawings.
- .3 Change tables: Refer to Section 10 28 00.

.9 Miscellaneous brackets and supports for roof screen:
- .1 Provide all miscellaneous brackets, and supports as indicated or required to support Work.
- .2 Metal siding roof screen: Refer to Section 07 46 19.

.10 Miscellaneous brackets, supports and angles:
- .1 Provide all loose steel brackets, supports and angles as indicated or required to support Work.
- .2 Allow for prime paint for interior use and galvanized for exterior use unless indicated otherwise.
- .3 Predrill for countersunk fasteners, expansion anchors and anchor bolts.

3 EXECUTION

3.01 EXAMINATION

.1 Examine and verify previously installed Work upon which this Section depends. Report defects or unsatisfactory conditions to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.02 INSTALLATION

.1 Do welding work in accordance with CSA W59 unless specified otherwise.

.2 Erect metalwork square, plumb, straight, and true, accurately fitted, with tight joints and intersections.

.3 Provide suitable means of anchorage acceptable to Consultant such as dowels, anchor clips, bar anchors, expansion bolts and shields, and toggles.

.4 Exposed fastening devices to match finish and be compatible with material through which they pass.

.5 Supply components for work by other trades in accordance with Shop Drawings and schedule.

.6 Make field connections with bolts to CSA S16 or weld field connections.

.7 Deliver items over for casting into concrete and building into masonry together with setting templates to appropriate location and construction personnel.

.8 Stairs:
- .1 Install in accordance with NAAMM, Metal Stair Manual.
- .2 Install plumb and true in exact locations, using welded connections wherever possible to provide rigid structure. Provide anchor bolts, bolts and plates for connecting stairs to structure.

.9 Touch-up rivets, field welds, bolts and burnt or scratched surfaces with primer after completion.

.10 Touch-up galvanized surfaces with zinc rich primer where burned by field welding.

3.03 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by metal stairs and ladders installation.

END OF SECTION

1 GENERAL

1.01 SUMMARY

.1 Section includes all methods, materials and installation as required to complete the Work of this Section in accordance with the Conditions of the Contract.

.2 Work may include, but is not limited to;
- .1 Millwork supports and framing.
- .2 Metal cage storage doors.
- .3 Stainless steel counters.
- .4 Interior door and window trim.
- .5 Miscellaneous decorative metal fabrications as indicated on drawings.

1.02 REFERENCES

.1 ANSI H35.1/H35.1M - American National Standard Alloy and Temper Designation Systems for Aluminum.

.2 ASTM A123/A123M - Standard Specification for Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products.

.3 ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength.

.4 ASTM A480/A480M - Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.

.5 ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

.6 ASTM B211/B211M - Standard Specification for Aluminum and Aluminum-Alloy Rolled or Cold Finished Bar, Rod, and Wire.

.7 ASTM F3125/F3125M - Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions.

.8 CSA G40.20/G40.21 - General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.

.9 CSA S16 - Design of Steel Structures.

.10 CSA W47.1 - Certification of Companies for Fusion Welding of Steel.

.11 CSA W47.2 - Certification of Companies for Fusion Welding of Aluminum.

.12 CSA W48 - Filler Metals and Allied Materials for Metal Arc Welding.

.13 CSA W59 - Welded Steel Construction (Metal Arc Welding).

.14 NAAMM AMP 555 - Code of Standard Practice for the Architectural Metal Industry.

.15 National Ornamental & Miscellaneous Metals Association (NOMMA).

1.03 ADMINISTRATIVE REQUIREMENTS

.1 Pre-installation meetings: Conduct pre-installation meeting prior to commencing work of this Section to:
- .1 Verify project requirements, including mock-up requirements.
- .2 Verify end finishing requirements.
- .3 Co-ordinate products, installation methods and techniques.

1.04 ACTION SUBMITTALS

.1 Submit action submittals in accordance with Section 01 33 00.

.2 Product data: Submit manufacturers product data for decorative metal fabrications including product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings: Submit Shop Drawings as follows:
- .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.
- .2 Indicate materials, core thicknesses, finishes, connections, joints, method of anchorage, number of anchors, supports, reinforcement, details, and accessories.

.4 Samples: Submit 300 mm x 300 mm samples illustrating colours, textures and finishes including, but not limited to:
- .1 Metal cage storage doors showing corner and frame.

.5 Reports and certifications: Submit the following:
- .1 Test Reports: submit certified test reports showing compliance with specified performance characteristics and physical properties.
- .2 Certifications: submit product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

1.05 QUALITY ASSURANCE

.1 Certification of companies: to CSA W47.1 and CSA W47.2 as applicable for fusion welding.

.2 Workmanship: Fabricate work of this Section to meet the required class of workmanship indicated below in accordance with NAAMM AMP 555 (NOMMA), Class 1 Architectural Metal as follows:
- .1 Exposed surfaces are finished smooth without pitts, mill marks, nicks, burrs, sharp edges, and scratches filled or ground off. Defects should not show when painted, polished, or finished.
- .2 Welds should be concealed where possible. Exposed welds are ground to small radius with uniform sized cove unless otherwise noted.
- .3 Distortions should not be visible to the eye.
- .4 Exposed joints are fitted to a hairline finish.

.3 Perform metal finishing work conforming to NAAMM AMP 500.

2 PRODUCTS

2.01 PERFORMANCE CRITERIA

.1 Design metal fabrications to resist loads and climatic data as indicated, and in accordance with applicable building codes.

2.02 MATERIALS - GENERAL

.1 Steel sections and plates: to CSA G40.20/G40.21, Grade 350W, minimum 30% recycled content.

.2 Aluminum sheet: to ASTM B209 and ANSI H35.1 AA1100 aluminum alloy.

.3 Aluminum extrusions and channels: to ASTM B211 and ANSI H35.1 AA6063 aluminum alloy, T6 temper.

.4 Stainless steel sheet and plate: to ASTM A480/A480M, Type 316.

.5 Expanded metal mesh: 4.6 mm thick carbon steel mesh
- .1 Size and type: ½" No. 16 Standard Raised.
- .2 Design size - short way of diamond (SWD): 12.7 mm.
- .3 Design size - long way of diamond (LWD): 30 mm.
- .4 Opening size: 9.4 mm x 23.8 mm.
- .5 Percent open area: 65%.
- .6 Basis of Design: Item # 460N121648 by McNichols Co., or approved equal.

.6 Welding materials: to CSA W59.

.7 Welding electrodes: to CSA W48 Series.

.8 Bolts and anchor bolts: to ASTM A307.

.9 High strength bolts: to ASTM F3125/F3125M.

.10 Grout: non-shrink, non-metallic, flowable, 15 MPa at 24 hours.

2.03 FABRICATION

.1 Fabricate work square, true, straight and accurate to required size, with joints closely fitted and properly secured.

.2 Use self-tapping shake-proof screws on items requiring assembly by screws or as indicated.

.3 Where possible, fit and shop assemble work, ready for erection.

.4 Ensure exposed welds are continuous for length of each joint. File or grind exposed welds smooth and flush.

2.04 FINISHES

.1 Galvanizing: hot dipped galvanizing with zinc coating 600 g/m², Coating Grade 85, to ASTM A123/A123M.

.2 Shop coat primer: Refer to Section 09 91 00 for paint system.

.3 Zinc-rich primer:
- .1 Carbozinc 11WB by Carboline.
- .2 Dimetcote 9H by PPG.
- .3 Zinc Clad XL by Sherwin Williams.

2.05 ISOLATION COATING

.1 Isolate aluminum from following components, by means of bituminous paint:
- .1 Dissimilar metals except stainless steel, zinc, or white bronze of small area.
- .2 Concrete, mortar and masonry.
- .3 Wood.

2.06 SHOP PAINTING

.1 Apply one shop coat of primer to metal items, with exception of galvanized or concrete encased items.

.2 Use primer unadulterated, as prepared by manufacturer. Paint on dry surfaces, free from rust, scale, grease. Do not paint when temperature is lower than 7 degrees C.

.3 Clean surfaces to be field welded; do not paint.

2.07 STAINLESS STEEL WORK

.1 Take all necessary precautions to safeguard against latent surface discolouration due to disturbance of the natural protective oxide coating of the material or to contamination from other sources.

.2 Workmanship shall be the best standard practice for this type of work. Execute stainless steel work in accordance with the applicable instructions set forth in the Atlas Steels "Technical Handbook of Stainless Steels".

.3 Do all stainless steel fabrication in clean shops, located away from areas where carbon steel is burnt, ground, or cut with abrasive wheels to ensure that carbon steel dust will not be embedded into the stainless steel.

2.08 SCHEDULE OF FABRICATIONS

.1 Refer to drawings for metal fabrications items not specifically listed in this Section. Metal fabrications shall include, but not be limited to, the items listed below.

.2 Millwork supports and framing:
- .1 Provide all supports and framing as indicated or required to support millwork including butcher block counter.
- .2 Allow for prime paint unless indicated otherwise.
- .3 Predrill for countersunk fasteners.

.3 Metal cage storage doors (Drone Storage):
- .1 Fabricate metal cage storage doors of metal mesh with metal angle frame.
- .2 Steel cage doors to be installed on millwork shelving with countersink screws unless otherwise noted. Grind or fill perfectly smooth exposed surfaces of rolled steel shapes.
- .3 Hardware: Heavy duty hinges, integrated folding handle, magnetic latch and cam lock.
- .4 Finish: prime painted.

.4 Stainless steel counter: Provide material to Section 06 20 00.

.5 Door and window trim:
- .1 Fabricate interior door and window trims from 6 mm thick aluminum plate with all edges and corners eased.
- .2 Secure corners with single component bonding adhesive.
- .3 Install trims with colour-matched, flush fasteners in approved manner.

.4 Finish: Dark Grey acrylic finish conforming to AAMA 2603, Duracron or approved equal.

3 EXECUTION

3.01 EXAMINATION

.1 Examine and verify previously installed Work upon which this Section depends. Report defects or unsatisfactory conditions to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.02 INSTALLATION

.1 Do welding work in accordance with CSA W59 unless specified otherwise.

.2 Erect metalwork square, plumb, straight, and true, accurately fitted, with tight joints and intersections.

.3 Provide suitable means of anchorage acceptable to Consultant such as dowels, anchor clips, bar anchors, expansion bolts and shields, and toggles.

.4 Exposed fastening devices to match finish and be compatible with material through which they pass.

.5 Supply components for work by other trades in accordance with Shop Drawings and schedule.

.6 Make field connections with bolts to CSA S16 or weld field connections.

.7 Deliver items over for casting into concrete and building into masonry together with setting templates to appropriate location and construction personnel.

.8 Touch-up rivets, field welds, bolts and burnt or scratched surfaces with primer after completion.

.9 Touch-up galvanized surfaces with zinc rich primer where burned by field welding.

3.03 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by metal stairs and ladders installation.

END OF SECTION

1 GENERAL

1.01 SUMMARY

.1 Section includes all methods, materials and installation as required to complete the Work of this Section in accordance with the Conditions of the Contract.

.2 Work may include, but is not limited to;
- .1 Blocking, furring and miscellaneous framing/supports.
- .2 Electrical mounting boards.

1.02 REFERENCES

.1 ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

.2 ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

.3 ASTM F1667 - Standard Specification for Driven Fasteners: Nails, Spikes, and Staples.

.4 CAN/CSA O80 Series - Wood Preservation.

.5 CSA O121 - Douglas Fir Plywood.

.6 CSA O141 - Softwood Lumber.

.7 CSA O151 - Canadian Softwood Plywood.

.8 CAN/CSA Z809 - Sustainable Forest Management.

.9 National Lumber Grades Authority (NLGA) - Standard Grading Rules for Canadian Lumber.

1.03 ACTION SUBMITTALS

.1 Submit action submittals in accordance with Section 01 33 00.

1.04 QUALITY ASSURANCE

.1 Lumber identification: by grade stamp of an agency certified by Canadian Lumber Standards Accreditation Board.

.2 Plywood identification: by grade mark in accordance with applicable CSA standards.

.3 Plywood, OSB and wood based composite panel construction sheathing identification: by grademark in accordance with applicable CSA standards.

.4 Each board or bundle of fire-retardant treated material to bear ULC label indicating Flame Spread Classification (FSC), and smoke developed.

1.05 DELIVERY, STORAGE, AND HANDLING

.1 Store materials in a dry area. Cover materials with tarpaulins or polyethylene sheets to prevent moisture absorption and impairment of structural and aesthetic properties. Vent to allow air movement. Tie covering to keep in place.

2 PRODUCTS

2.01 MATERIALS

.1 General:
- .1 CAN/CSA Z809, SFI or Forestry Stewardship Council (FSC) certified.
- .2 Lumber dimensions shall conform to dressed sizes specified in CAN/CSA O141 unless otherwise indicated or specified.
- .3 Dimensional references to lumber are to nominal sizes unless actual dimensions are indicated. Such actual dimensions shall be dry size.

.2 Lumber: unless specified otherwise, softwood, S4S, S-DRY Lumber graded and stamped in accordance with following standards:
- .1 CSA O141.
- .2 NLGA Standard Grading Rules for Canadian Lumber.

.3 Furring, blocking, nailing strips, grounds, rough bucks, cants, curbs, fascia backing and sleepers: to NLGA 113d. and 121c., S4S.
- .1 S2S is acceptable for concealed work.
- .2 Board sizes: "Standard" or better grade.
- .3 Dimension sizes: "Standard" light framing or better grade.

.4 Douglas fir plywood: to CSA O121, SEL TF grade, unsanded unless noted otherwise. Urea-formaldehyde free adhesive.

.5 Canadian softwood plywood (CSP): to CSA O151, Class II, sheathing. Urea-formaldehyde free.

.6 Nails, spikes and staples: to ASTM F1667.

.7 Bolts: 12.5 mm diameter unless indicated otherwise, complete with nuts and washers.

.8 Proprietary fasteners: toggle bolts, expansion shields and lag bolts, screws and lead or inorganic fibre plugs, recommended for purpose by manufacturer.

2.02 FINISHES

.1 Galvanizing: to ASTM A123/A123M and ASTM A653/A653M as applicable, use galvanized fasteners for exterior work, interior high humidity areas, pressure-preservative and fire treated lumber.

.2 Stainless steel: use stainless steel Type 304 or 316 alloy for structural components.

2.03 WOOD TREATMENTS

.1 Wood Preservative:
- .1 Wood preservation plants: certified by Canadian Wood Preservation Authority (CWPCA) to Environment Canada Technical Recommendation Document for the Design and Operation of Wood Preservation Facilities.
- .2 Pressure treatment to be waterborne copper-based system conforming to CAN/CSA O80 Series standards, Use Category 3.2.
- .3 Surface-applied wood preservative: waterborne copper-based system as used for shop impregnation or copper napthenate, for use on all cut components.

.2 Fire Retardant:
- .1 Provide fire retardant treated lumber for interior use conforming to CAN/CSA O80 Series, to provide the following characteristics when tested in accordance with CAN/ULC-S102:
  - .1 Flame Spread Classification: Class A.
  - .2 Smoke developed of not more than: 25.

3 EXECUTION

3.01 EXAMINATION

.1 Examine and verify previously installed Work upon which this Section depends. Report defects or unsatisfactory conditions to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.02 PREPARATION

.1 Treat surfaces of material with wood preservative, before installation.

.2 Apply preservative by dipping, or by brush to completely saturate and maintain wet film on surface for minimum 3 minute soak on lumber and one minute soak on plywood.

.3 Re-treat surfaces exposed by cutting, trimming or boring with liberal brush application of preservative before installation.

.4 Treat material as follows:
- .1 Wood cants, fascia backing, curbs, nailers, sleepers on roof deck.
- .2 Wood furring on outside surface of exterior masonry and concrete walls.
- .3 Wood sleepers supporting wood subflooring over concrete slabs in contact with ground or fill.

3.03 INSTALLATION

.1 Lay out work carefully and to accommodate work of others. Cut and fit all components and erect in position indicated by Drawings.

.2 Install rough carpentry to allow for expansion and contraction of materials.

.2 Install furring and blocking as required to space-out and support casework, cabinets, wall and ceiling finishes, facings, fascia, soffit, siding and other work as required.

.3 Align and plumb faces of furring and blocking to tolerance of 1:600.

.4 Install rough bucks, nailers and linings to rough openings as required to provide backing for frames and other work.

.5 Install wood cants, fascia backing, nailers, curbs and other wood supports as required and secure using galvanized steel fasteners.

.6 Install wood backing, dressed, tapered and recessed slightly below top surface of roof insulation for roof hopper.

.7 Install sleepers as indicated.

.8 Use caution when working with particle board. Use dust collectors and high quality respirator masks.

.9 Frame, anchor, fasten, tie and brace members to provide necessary strength and rigidity.

.10 Countersink bolts where necessary to provide clearance for other work.

3.04 SCHEDULE OF ITEMS

.1 Electrical equipment mounting boards:
- .1 Use plywood on 19 x 38 mm furring around spacing, perimeter and at maximum 300 mm intermediate.

.2 Plywood, DFP, G1S grade, square edge, 19 mm thick sanded to Table E.1.
.3 Fire retardant treated to CAN/CSA O80 Series, maximum flame spread 25, maximum smoke developed 25.

3.05 QUALITY CONTROL

.1 Discard wood with defects which will render a piece unable to serve its intended function.

.2 Lumber will be rejected by Consultant for excessive warp, twist, bow, crook, mildew, fungus, or mould, as well as for improper cutting and fitting, whether or not it has been installed.

END OF SECTION

1 GENERAL

1.01 SUMMARY

.1 Section includes all methods, materials and installation as required to complete the Work of this Section in accordance with the Conditions of the Contract.

.2 Work may include, but is not limited to;
- .1 Trims and frames.
- .2 Panelling.
- .3 Handrails.
- .4 Millwork and shelving.
- .5 Counters.
- .6 Benches.

1.02 REFERENCES

.1 ANSI A208.1 - Particleboard.

.2 ANSI A208.2 - Medium Density Fibreboard (MDF) for Interior Applications.

.3 ANSI/HPVA HP-1 - American National Standard for Hardwood and Decorative Plywood.

.4 ASTM C920 - Standard Specification for Elastomeric Joint Sealants.

.5 ASTM F1667 - Standard Specification for Driven Fasteners: Nails, Spikes, and Staples.

.6 Architectural Woodwork Manufacturers Association of Canada (AWMAC) and Woodwork Institute (WI) - NAAWS North American Architectural Woodwork Standards.

.7 ANSI/BHMA A156.9 - Cabinet Hardware.

.8 ANSI/BHMA A156.11 - Cabinet Locks.

.9 CSA O121 - Douglas Fir Plywood.

.10 CSA O141 - Softwood Lumber.

.11 CSA O151 - Canadian Softwood Plywood.

.12 CSA O153 - Poplar Plywood.

.13 CAN/CSA Z809 - Sustainable Forest Management.

.14 ISO 4586 Series - High-Pressure Decorative Laminates (HPL, HPDL), Sheets based on thermsetting resins.

.15 National Lumber Grades Authority (NLGA) - Standard Grading Rules for Canadian Lumber.

.16 NSF/ANSI 51 - Product Certifications for Food and Drinking Water.

.17 CAN/ULC S102 - Surface Burning Characteristics of Building Materials and Assemblies.

.18 CAN/ULC-S104 - Standard Method for Fire Tests of Door Assemblies.

.19 CAN/ULC-S105 - Standard Specification for Fire Door Frames.

1.03 ACTION SUBMITTALS

.1 Submit action submittals in accordance with Section 01 33 00.

.2 Product data: Submit manufacturers product data for finish carpentry including product characteristics, performance criteria, and limitations.

.3 Shop Drawings: Submit Shop Drawings as follows:
- .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.
- .2 Shop Drawings to Indicate details of construction, profiles, jointing, fastening and other related details.
- .3 Indicate materials, thicknesses, finishes and hardware.
- .4 Indicate locations of service outlets in casework, typical and special installation conditions, and connections, attachments, anchorage and location of exposed fastenings.
- .5 Built-in benches with framing and supports.

.4 Samples: Submit 150 mm x 150 mm samples illustrating colours, textures and finishes including, but not limited to:
- .1 Two pieces of each species/type of wood to receive a exposed finish.
- .2 Two samples of laminated plastic for colour selection.
- .3 Two each of laminated plastic joints, edging, and postformed profiles.
- .4 Two pieces of each engineered stone surface colour/finish.
- .5 Two samples of melamine surfaced board, edging and postformed profiles.
- .9 One of each finish carpentry hardware type.

.5 Reports/certificates: Submit the following:
- .1 Test Reports: certified test reports showing compliance with specified performance characteristics and physical properties.

.2 Certificates: product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

1.04 QUALITY ASSURANCE

.1 Manufacturers: Manufacturers to be a member in good standing of AWMAC with 5 years experience of similar complexity and scope. Proof to be submitted upon request.

.2 Lumber identification: by grade stamp of an agency certified by Canadian Lumber Standards Accreditation Board.

.3 Lumber by grade stamp of agency certified by Canadian Lumber Standards Accreditation Board (CLSAB).

.4 Plywood, particleboard, OSB and wood based composite panels to CSA and ANSI standards.

.5 Wood fire rated frames and panels: listed and labelled by an organization accredited by Standards Council of Canada to CAN/ULC-S104 and CAN/ULC-S105.

.6 Mock-ups:
- .1 Construct one (1) mock-up of base cabinet unit, wall cabinet, counter top, benches and each style of shelving unit, complete with hardware and shop applied finishes, and install where directed by Consultant.
- .2 Allow 24 hours for inspection of mock-up by Consultant before proceeding with Work.
- .3 When accepted, mock-up will demonstrate minimum standard for Work.
- .4 Do not proceed with work prior to receipt of written acceptance of mock-up by Consultant.
- .5 Mock-up may form part of the Work if accepted by the Consultant.

1.05 DELIVERY, STORAGE, AND HANDLING

.1 Store materials in a dry area. Cover materials with tarpaulins or polyethylene sheets to prevent moisture absorption and impairment of structural and aesthetic properties. Vent to allow air movement. Tie covering to keep in place.

.2 Protect millwork against dampness and damage during and after delivery.

.3 Store millwork in ventilated areas, protected from extreme changes of temperature or humidity.

.4 Store and protect finish carpentry from nicks, scratches, and blemishes.

.5 Replace defective or damaged materials with new.

2 PRODUCTS

2.01 MATERIALS

.1 General:
- .1 CAN/CSA Z809, SFI or Forestry Stewardship Council (FSC) certified.
- .2 Dimensional references to lumber are to nominal sizes unless actual dimensions are indicated. Such actual dimensions shall be dry size.
- .3 AWMAC/WI North American Architectural Woodwork Standards premium grade, moisture content as specified.
- .4 Perform work in accordance with the definition of First-Class Workmanship as defined in the NAAWS Quality Standards.

.2 Softwood lumber: S4S, S-DRY graded and stamped in accordance with following standards:
- .1 CSA O141.
- .2 NLGA Standard Grading Rules for Canadian Lumber.

.3 Hardwood lumber: moisture content 7 % or less in accordance with National Hardwood Lumber Association (NHLA).

.4 Panel Material: Urea-formaldehyde free:
- .1 Douglas fir plywood (DFP): to CSA O121, standard construction.
- .2 Canadian softwood plywood (CSP): to CSA O151, standard construction.
- .3 Hardwood plywood: to ANSI/HPVA HP-1.
- .4 Poplar plywood (PP): to CSA O153, standard construction.
- .5 Particleboard: to ANSI A208.1.
- .6 Medium density fibreboard (MDF) core: to ANSI A208.2, density 640-800 kg/m³.

.5 Plastic laminate: Decorative surface papers impregnated with melamine resins and pressed over kraft paper core sheets to ISO 4586 series.
- .1 Type: General purpose as follows:
  - .1 Grade: HGS.
  - .2 Size: 1.27 mm thick.
- .2 Colours: To be selected by Consultant.
- .3 Basis of Design manufacturers:
  - .1 Arborite Company.
  - .2 Formica Group.
  - .3 Panolam Surface Systems.
  - .4 Wilsonart Engineered Surfaces.
- .4 Laminated plastic adhesive:
  - .1 General purpose laminate: High solids, low VOC contact adhesive.

.6 Stainless steel laminate:
- .1 Stainless steel sheet: Refer to Section 05 70 00.
- .2 General purpose laminate: High solids, low VOC contact adhesive.

.7 Engineered quartz surface:
- .1 Minimum 20 mm thick homogeneous material consisting of crushed quartz, polyester resins and pigments.
- .2 Flammability: to CAN/ULC S102.
  - .1 Flame spread index: 5.
  - .2 Smoke developed index: 50.
- .3 Adhesive: One component silicone to ASTM C920 as approved by quartz manufacturer.
- .4 Colours: To be selected by Consultant.
- .5 Basis of Design:
  - .1 CaesarStone by CaesarStone Quartz Surfaces.
  - .2 Quartz by Cambria Quartz Surfaces.
  - .3 Silestone by Cosentino.
  - .4 Corian Quartz by DuPont.

.8 Butcher block surface: Solid 38 mm thick surface consisting of kiln dried wood in Maple with lacquered finish. Surface to consist of hardwood strips laminated together with food-safe, water-resistant adhesive.

.9 Bench:
- .1 Leather: Faux leather upholstery. Basis of Design: Foundation, Pattern 1382 by Woeller or approved equal. Provide samples for colour selection by Consultant from manufacturers full colour range.
- .2 Foam padding: Self-extinguishing polyurethane meeting code requirements for flammability, cold-foamed without use of CFC. Average thickness of 95 mm and minimum density of 55 kg/m^3.
- .3 Air release grommets: Stainless steel snap-on type having 12 mm diameter opening.

.10 Nails and staples: to ASTM F1667.

.11 Wood screws: plain, type and size to suit application.

.12 Splines: Type as recommended by fabricator.

.13 Sealant: in accordance with Section 07 92 00.

2.02 FINISHING HARDWARE

.1 Use one manufacturer's product for all similar items.

.2 The following hardware is the minimum quality standard for the work of this Section. Alternatives may be considered provided they are approved by Consultant prior to ordering of products.

.3 Cabinet hardware: to ANSI/BHMA A156.9, as follows:
- .1 Hinges: Full overlay, heavy duty hinge with hinge cup.
  - .1 Finish: Nickel.
  - .2 Basis of Design: Single-joint hinge MB-8310 by Richelieu or approved equal.
- .2 Pulls: 8 mm diameter x 128 mm center to center.
  - .1 Finish: Brushed Nickel.
  - .2 Basis of Design: Contemporary Metal Pull 2288 by Richelieu or approved equal.
- .3 Knobs: Surface mounted knob, 30 mm diameter x 29 mm projection.
  - .1 Finish: Brushed Nickel.
  - .2 Basis of Design: Traditional Metal Knob 8041 by Richelieu or approved equal.
- .4 Catches: magnetic catch, double magnetic aluminum catch by Richelieu or approved equal.
- .5 Shelf supports and standards: Stainless steel shelf support clip with vertical slotted shelf standard in satin finish by Richelieu or approved equal.
  - .1 Finish: Satin.
  - .2 Basis of Design: Stainless Steel Pilaster with Shelf Support for Standard by Richelieu or approved equal.
- .6 Drawer slides: Concealed undermount drawer slides, rated for 45 kg load capacity. Slides to be full extension with soft close.
  - .1 Basis of Design: Eclipse 3160EC by Accuride or approved equal.

.4 Cabinet locks: to ANSI/BHMA A156.11, as follows:
- .1 Door or drawer locks: To suit application and containing lock core.
- .2 Cylinders: key into keying system as directed. Model 192 CT cam lock by Richelieu.

.5 Miscellaneous hardware:
- .1 Coat hooks:
  - .1 Heavy duty coat hook, 139 mm high x 90 mm projection with 10 kg load capacity.
  - .2 Finish: Brushed nickel.
  - .3 Basis of Design: Heavy Duty Coat Hook by Richelieu or approved equal.
- .2 Heavy duty shelving (storage room):
  - .1 Adjustable heavy duty steel standards, 1828 mm high.
  - .2 Brackets: Heavy duty bracket in size to suit shelf depth.
  - .3 Basis of Design: Anochrome KV by CRL or approved equal.

.3 Piano hinge:
  .1 Piano hinge for use at drone cabinet doors, fabricated by Section 05 70 00.
  .2 Basis of Design: Model 40072170 by Richelieu or approved equal.
.4 Workstation Bracket:
  .1 Heavy duty aluminum workstation bracket with 610 mm projection.
  .2 Basis of Design: Model 40182430 by Richelieu or approved equal.
.5 Cabinet fan:
  .1 Quiet cool cabinet fan.
  .2 Basis of Design: Model SKU CAB-COOL-2 by Legrand or approved equal.

2.03 FABRICATION

.1 Fabricate carpentry and millwork to AWMAC/WI NAAWS premium quality grade.

.2 Set nails and countersink screws apply matching wood filler to indentations, sand smooth and leave ready to receive finish.

.3 Shop install cabinet hardware for doors, shelves and drawers. Recess shelf standards unless noted otherwise.

.4 Shelving to cabinetwork to be adjustable unless otherwise noted.

.5 Provide cutouts for plumbing fixtures, inserts, appliances, outlet boxes and other fixtures.

.6 Shop assemble work for delivery to site in size easily handled and to ensure passage through building openings.

.7 Obtain governing dimensions before fabricating items which are to accommodate or abut appliances, equipment and other materials.

.8 Perform plastic laminate work in accordance with NAAWS and ISO 4586 Series.

.9 Ensure adjacent parts of continuous laminate work match in colour and pattern.

.10 Veneer laminated plastic to core material in accordance with adhesive manufacturer's instructions. Ensure core and laminate profiles coincide to provide continuous support and bond over entire surface. Use continuous lengths up to 2400 mm. Keep joints 600 mm from sink cutouts.

.11 Form shaped profiles and bends as indicated, using postforming grade laminate to laminate manufacturer's instructions.

.12 Use straight self-edging laminate strip for flatwork to cover exposed edge of core material. Chamfer exposed edges uniformly at approximately 20 degrees. Do not mitre laminate edges.

.13 Apply laminate backing sheet to reverse side of core of plastic laminate work.

.14 Apply laminated plastic liner sheet where indicated.

2.04 FINISHES

.1 Refer to Section 09 91 00.

3 EXECUTION

3.01 EXAMINATION

.1 Examine and verify previously installed Work upon which this Section depends. Report defects or unsatisfactory conditions to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.02 INSTALLATION

.1 Do architectural woodwork to AWMAC/WI NAAWS.

.2 Install prefinished millwork at locations shown on drawings.

.3 Position accurately, level, plumb straight.

.4 Fasten and anchor millwork securely.

.5 Supply and install heavy duty fixture attachments for wall mounted cabinets.

.6 Scribe and cut as required to fit abutting walls and to fit properly into recesses and to accommodate piping, columns, fixtures, outlets or other projecting, intersecting or penetrating objects.

.7 Apply bituminous coating over wood framing members in contact with masonry or cementitious construction.

.8 Fit hardware accurately and securely in accordance with manufacturer's written instructions.

.9 Fastening:
.1 Position items of finished carpentry work accurately, level, plumb, true and fasten or anchor securely.

.2 Design and select fasteners to suit size and nature of components being joined. Use proprietary devices as recommended by manufacturer.
.3 Set finishing nails to receive filler. Where screws are used to secure members, countersink screw in round smooth cut hole and plug with wood plug to match material being secured.
.4 Replace items of finish carpentry with damage to wood surfaces including hammer and other bruises.

3.03 FINISHING HARDWARE

.1 Install hardware to standard hardware location dimensions in accordance with manufacturer's recommendations and to project design requirements.

.2 Adjust cabinet hardware for optimum, smooth operating condition.

.3 Lubricate hardware and other moving parts.

.4 Adjust cabinet door hardware to ensure tight fit at contact points with frames.

3.04 PROTECTION

.1 Protect millwork and cabinet work from damage until final inspection.

.2 Protect installed products and components from damage during construction.

.3 Repair damage to adjacent materials caused by architectural woodwork installation.

3.05 SCHEDULE OF ITEMS

.1 Refer to drawings for details and further information.

.2 Butcher block counter: Fabricate counter as indicated on drawings with metal brackets. Refer to Section 05 70 00.

.3 Bench:
.1 Fabricate built-in benches of plywood frame with cushioned leather seat.
.2 Anchor wood to supports in a concealed manner.
.3 Mitre joints at corners and keep joints to a minimum.
.4 Round all corners, edges and ends.

.4 Garage shelving unit:
.1 Provide shelving unit consisting of shelving supports and brackets mounted on 16 mm thick plywood backing provided for full extent of shelving unit.
.2 Shelving: 16 mm thick smooth faced plywood with eased edges and sealed finish.

.5 Metal cage storage rack:
- .1 Provide baltic birch in thickness indicated on drawings with intermediate shelving.
- .2 Shelving to be closed in with metal cage doors provided by Section 05 70 00.

.6 Typical shelving:
- .1 Install shelving on shelf brackets as indicated.
- .2 Edge banding: provide 10 mm thick solid matching wood strip on plywood edges 12 mm or thicker, exposed in final assembly. Strips same width as plywood.

.7 Casework:
- .1 Core material: Composite wood products.
- .2 Finish: Plastic laminate.

.8 Plastic laminate finish:
- .1 Make allowances around perimeter where fixed objects pass through or project into laminated plastic work to permit normal movement without restriction.
- .2 Use draw bolts and splines in countertop joints. Maximum spacing 450 mm on centre, 75 mm from edge. Make flush hairline joints.
- .3 Provide cutouts for inserts, grilles, appliances, outlet boxes and other penetrations. Round internal corners, chamfer edges and seal exposed core.
- .4 At junction of laminated plastic counter back splash and adjacent wall finish, apply small bead of sealant.

.9 Engineered stone surfacing finish:
- .1 Install countertops with no more than 3 mm sag, bow or other variation from a straight line.
- .2 Adhere undermount sinks/bowls to countertops using manufacturer's recommended adhesive and mounting hardware.
- .3 Adhere topmount sinks/bowls to countertops using manufacturer recommended adhesives and colour-coordinated silicone sealant.
- .4 Provide backsplashes and endsplashes as indicated on Drawings. Adhere to countertops using a standard colour-coordinated silicone sealant.
- .5 Fabricate radius cove at intersection of counters with backsplashes to dimensions shown on reviewed Shop Drawings. Adhere to countertops using manufacturer's standard colour-coordinated joint adhesive.
- .6 Keep components and hands clean during installation. Remove adhesives, sealants and other stains.

END OF SECTION

1 GENERAL

1.01 SUMMARY

.1 Section includes all methods, materials and installation as required to complete the Work of this Section in accordance with the Conditions of the Contract.

1.02 REFERENCES

.1 ASTM D570 - Standard Test Method for Water Absorption of Plastics.

.2 ASTM D903 - Standard Test Method for Peel or Stripping Strength of Adhesive Bonds.

.3 ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials.

.4 ASTM E154 - Standard Test Methods for Water Vapour Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover.

1.03 ADMINISTRATIVE REQUIREMENTS

.1 Site Meetings: Convene pre-installation meeting prior to beginning waterproofing Work, with waterproofing contractor's representative and Consultant to:
- .1 Verify project requirements.
- .2 Review installation and substrate conditions.
- .3 Co-ordination with other building subtrades.
- .4 Review manufacturer's installation instructions and warranty requirements.

1.04 ACTION SUBMITTALS

.1 Submit action submittals in accordance with Section 01 33 00.

.2 Product data: Submit manufacturers product data for sheet waterproofing including product characteristics, performance criteria, surface preparation requirements and limitations.

.3 Shop Drawings: Submit Shop Drawings as follows:
- .1 Shop Drawings to illustrate details, dimensions, fabrication and installation details.
- .2 Flashing, control joints, transitions, termination, adjacent construction and details showing a continuous plane of water tightness below grade.

.4 Samples: Submit 300 mm x 300 mm samples as follows:
- .1 Sheet waterproofing membrane.
- .2 Fastening bar.
- .3 Protection board.

.5 Reports: Submit the following reports:
- .1 Submit documentation showing that sheet applied waterproofing membrane can waterproofing exterior of foundation walls in compliance with intent of the National Building Code of Canada (NBC).
- .2 Manufacturer's Certificate: certify that products meet or exceed specified requirements.

1.05 CLOSEOUT AND MAINTENANCE SUBMITTALS

.1 Submit closeout submittals in accordance with Section 01 78 00.

.2 Closeout Product data: Submit manufacturers product warranty documentation for incorporation into operation and maintenance manual.

1.06 QUALITY ASSURANCE

.1 Installers: Perform Work of this Section by a company that has a minimum of five (5) years proven experience in the installation of sheet waterproofing of a similar size and nature.

1.07 SITE CONDITIONS

.1 Ambient Conditions: Work of this Section shall be performed when air and surface temperatures are above -10 degrees C during installation and for 48 hours after installation.

.2 Provide adequate protection of materials and work of this section from damage by weather, backfilling operations and other causes.

.3 Protect adjacent surfaces and Work of other trades from damage resulting from Work of this section. Make good such damage at no additional cost to the Owner.

1.08 WARRANTY

.1 Provide extended warranty for sheet waterproofing in accordance with the General Conditions, except warranty is extended to five (5) years from date Ready-for-Takeover has been attained:
- .1 Warranty to cover defects including failure or leaking of membrane or membrane flashing.
- .2 Warranty shall cover complete replacement of Work, including adjacent work impacted.

2 PRODUCTS

2.01 MATERIALS

.1 Provide complete waterproofing system with all components supplied by single manufacturer.

.2 Sheet membrane waterproofing: Self-adhering waterproofing membrane consisting of SBS modified bitumen and a cross-laminated polyethylene film as follows:
- .1 Thickness: 1.5mm (60 mils).
- .2 Water Vapour Transmission (ASTM E96): between 0.02 and 0.04 perms.
- .3 Peel Strength (ASTM D903): Minimum 1576N/m.
- .4 Minimum Puncture Resistance - Membrane (ASTM E154): 222 N/m.
- .5 Moisture Absorption (ASTM D570): 0.1% Maximum.
- .6 Basis of Design:
  - .1 Blueskin WP200 by Henry Company Canada.
  - .2 Colphene 3000 by Soprema.
  - .3 Mel-Rol by W.R. Meadows.
  - .4 Or approved equal.

.3 Primer: Select primer to suit weather at time of installation as follows:
- .1 Warm weather adhesive (above 4 degrees C): Quick setting polymer emulsion based adhesive, low VOC content.
  - .1 Basis of Design:
    - .1 Aquatac Primer by Henry Company Canada.
    - .2 Elastocol Stick H20 by Soprema.
    - .3 Mel-Prime W/B by W.R. Meadows.
    - .4 Or approved equal.
- .2 Cold weather adhesive (above -10 degrees C): Quick setting adhesive.
  - .1 Basis of Design:
    - .1 Hi-Tac by Henry Company Canada.
    - .2 Elastocol Stick Zero by Soprema.
    - .3 Mel-Prime by W.R. Meadows.
    - .4 Or approved equal.

.4 Termination and crack sealant: Polymer modified sealing compound as follows:
- .1 Solids by volume: Minimum 70%.
- .2 Basis of Design:
  - .1 Polybitume 70-05 by Henry Company Canada.
  - .2 Sopramastic by Soprema.
  - .3 Pointing Mastic by W.R. Meadows.
  - .4 Or approved equal.

.5 Securement bars: Continuous aluminum, stainless steel or galvanized metal, 3 mm x 25 mm x 25 mm in size and shall be pre-drilled for non-corrosive screw attachment on a maximum of 200 mm centres.

3 EXECUTION

3.01 EXAMINATION

.1 Examine and verify previously installed Work upon which this Section depends. Report defects or unsatisfactory conditions to Consultant. Commencement of work of this Section means acceptance of existing conditions.

.2 New concrete should be cured for a minimum of seven (7) days after forms are removed. Structural lightweight concrete must be cured fourteen (14) days.

.3 All surfaces must be sound, dry, clean and free of oil, grease, dirt, excess mortar or other contaminants.

3.02 PREPARATION

.1 Use appropriate waterproofing membrane adhesive as recommended by manufacturer based on air and surface temperature at time of application.

.2 Non-moving crack treatment (up to 3 mm wide):
- .1 Sealant Method: Apply 1.5 mm coating of termination and crack sealant, 50 mm wide, centred on the gap and strike smooth. Allow to dry prior to application of sheet applied waterproofing membrane.
- .2 Sheet Applied Method: Apply adhesive and allow to dry. Apply 150 mm wide strip of sheet applied waterproofing membrane, centred over gap and roll in place. Provide 75 mm end laps.

.3 Corner treatments:
- .1 Horizontal to Vertical Inside Corners: Pre-treated with termination and joint sealant, fillet extending 19 mm vertically and horizontally from the corner. Apply a minimum 225 mm strip of sheet applied waterproofing membrane centred at the joint and roll in place.
- .2 Outside Corners: Apply adhesive and allow to dry. Apply a minimum 225 mm strip of sheet applied waterproofing membrane centred at the joint and roll in place.
- .3 Three or more planes come into contact, reinforce with cut sections of sheet applied waterproofing membrane as per manufacturer's instructions.

.4 Projections: Extend sheet applied waterproofing membrane tight to projection and seal with termination and crack sealant extending 65 mm along projection and 65 mm onto sheet applied waterproofing membrane.

.5 Drains: Install sheet applied waterproofing membrane collar centred on drain and extend 150 mm beyond flange onto substrate. Install sheet applied waterproofing membrane in full width centred over drain and apply clamping ring in 1.5 mm bed of termination and crack sealant.

3.03 INSTALLATION

.1 Apply primer over substrate at rate recommended by manufacturer. Primed surfaces not covered by sheet applied waterproofing membrane during the same working day must be re-applied.

.2 Align and position sheet applied waterproofing membrane, to prepared and primed substrate in lengths of 2400 mm or less.

.3 Provide 65 mm laps at both sides and ends. Position for alignment and remove protective film.

.4 Press firmly into place and promptly roll all laps to affect seal.

.5 Overlap additional sheets in shingle fashion, staggering all vertical joints, and in accordance with manufacturer's recommendations.

.6 Terminate sheet applied waterproofing membrane using termination sealant or termination bar, reglet or counter flashing as indicated. Refer to manufacturers standard details.

.7 Seal all laps within 305 mm of a 90 degrees change in plane with termination sealant. Trowel apply a feathered edge to all horizontal termination sealant applications to allow shedding of water.

3.04 SITE QUALITY CONTROL

.1 Conduct all final observations and verification reviews as required for extended warranty.

END OF SECTION

1 GENERAL

1.01 SUMMARY

.1 Section includes all methods, materials and installation as required to complete the Work of this Section in accordance with the Conditions of the Contract.

1.02 REFERENCES

.1 ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation.

.2 ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.

.3 ASTM C1320 - Standard Practice for Installation of Mineral Fiber Batt and Blanket Thermal Insulation for Light Frame Construction.

.4 CAN/ULC S701 - Standard for Thermal Insulation, Polystyrene Boards.

.5 CAN/ULC S770 - Standard Test Method for Determination of Long-term Thermal Resistance of Closed-cell Thermal Insulating Foams.

1.03 ACTION SUBMITTALS

.1 Submit action submittals in accordance with Section 01 33 00.

.2 Product data: Submit manufacturers product data for thermal insulation including product characteristics, performance criteria, and limitations.

.3 Reports/certificates: Submit the following:
- .1 Submit certified test reports showing compliance with specified performance characteristics and physical properties.
- .2 Submit product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

1.04 QUALITY ASSURANCE

.1 Installers: Perform Work of this Section by a company that has a minimum of five (5) years proven experience in the installation of thermal insulation of a similar size and nature.

2 PRODUCTS

2.01 BATT INSULATION

.1 Fire-rated and sound-rated batt Insulation:
- .1 ASTM C665; Paperless, semi-rigid spun mineral wool.
- .2 Density: 40 kg/m^3.
- .3 Greenguard certified.
- .4 Basis of Design:
  - .1 MinWool SAFB by Johns Manville.
  - .2 Thermafiber SAFB by Owens Corning Canada.
  - .3 Rockwool AFB by Rockwool

2.02 BOARD INSULATION

.1 Cavity wall board Insulation:
- .1 ASTM C612; Semi-rigid stone wool fibre.
- .2 Density: Minimum 69 kg/m^3.
- .3 Basis of Design:
  - .1 CladStone 45 by Johns Manville.
  - .2 Thermafiber Rainbarrier 45 by Owens Corning Canada.
  - .3 CavityRock by Rockwool.

.2 Foundation and below grade board Insulation:
- .1 CAN/ULC S701, Type 4; Extruded polystyrene produced with reduced global warming potential (GWP).
- .2 Compressive strength: Minimum 170 kPa.
- .3 Long-Term Thermal Resistance (LTTR) to CAN/ULC S770: Minimum RSI 0.88.
- .4 Basis of Design:
  - .1 Styrofoam SM30 by Dupont de Nemours Inc.
  - .2 Foamular NGX C-300 by Owens Corning Canada.
  - .3 Sopra-XPS 30 by Soprema.

.3 Cement faced foundation Insulation:
- .1 CAN/ULC S701, Type 4; Extruded closed-cell extruded polystyrene insulation fabricated with a factory applied 8 mm thick latex-modified concrete facing.
- .2 Compressive strength (insulation board): Minimum 240 kPa.
- .3 Basis of Design:
  - .1 WallGuard by T Clear Corporation.
  - .2 CFI by Tech-Crete.
  - .3 Or approved equal.

.4 High density underslab board Insulation:
- .1 CAN/ULC S701, Type 4; Extruded polystrene produced with reduced global warming potential (GWP).
- .2 Compressive strength: 275 kPa.
- .3 Long-Term Thermal Resistance (LTTR) to CAN/ULC S770: Minimum RSI 0.88.
- .4 Basis of Design:
  - .1 Highload 40 by Dupont de Nemours Inc.
  - .2 Foamular NGX 400 by Owens Corning Canada.
  - .3 Sopra-XPS 40 by Soprema.

2.03 ACCESSORIES

.1 Mineral fibre insulation:
- .1 Clip adhesive: High strength thermoplastic rubber adhesive with immediate grab, compatible with insulation adhesive, insulation air barrier and substrate, non-corrosive to galvanized steel.
- .2 Insulation clips: Impale type, cold rolled carbon steel, adhesive back, pin in length to suit insulation with self locking washer.
  - .1 Basis of Design:
    - .1 Continental Insulation Fasteners by Jordahl Company.
    - .2 Insulation Hanger Studs by McMaster-Carr.
    - .3 Insulation Anchors by Midwest Fasteners Inc.

.2 Foundation insulation:
- .1 Adhesive: As recommended by insulation manufacturer and approved by waterproofing manufacturer.
- .2 Protection board: Minimum 2 mm (80 mils) thick:
  - .1 Basis of Design:
    - .1 990-31 by Henry Company Canada.
    - .2 Sopraboard by Soprema.
    - .3 Vibraflex PC by W.R. Meadows.

.3 Cement faced foundation insulation:
- .1 Clips and fasteners: Corrosion resistant steel mounting clips and fasteners designed for use in below grade installations and as recommended by foundation insulation manufacturer.
- .2 Cap and side flashings: Provide manufacturers recommended UV stable rigid PVC flashings. Cap flashing to be provided with drip edge. Colour: grey to match cement facing.

3 EXECUTION

3.01 EXAMINATION

.1 Examine and verify previously installed Work upon which this Section depends. Report defects or unsatisfactory conditions to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.02 INSTALLATION

.1 Install insulation after building substrate materials are dry.

.2 Install insulation to maintain continuity of thermal protection to building elements and spaces.

.3 Fit insulation tight around electrical boxes, plumbing and heating pipes and ducts, around exterior doors and windows and other protrusions.

.4 Keep insulation minimum 75 mm from heat emitting devices such as recessed light fixtures, and minimum 50 mm from chimneys or vents.

.5 Cut and trim insulation neatly to fit spaces. Butt joints tightly, offset vertical joints. Use only insulation boards free from chipped or broken edges. Use largest possible dimensions to reduce number of joints.

.6 Offset both vertical and horizontal joints in multiple layer applications.

.7 Do not enclose insulation until it has been inspected and approved by Consultant.

3.03 INSTALLATION SCHEDULE

.1 Batt insulation:
- .1 Install insulation to maintain continuity of thermal protection to building elements and spaces and to ASTM C1320.
- .2 Do not compress insulation to fit into spaces.
- .3 Friction fit insulation in place with no voids.

.2 Mineral fibre board insulation:
- .1 Install clips to substrate ensuring clips are 100 mm from edges of panels where they abut other materials and at joints between panels, space clips at maximum 450 mm centres in all directions.
- .2 Clean supporting surfaces at insulation clips and apply 50 mm square film of adhesive; coat clips with adhesive and press firmly to wall, until adhesive seeps through perforations at clip base. Remove excess adhesive to permit curing and impale insulation panels on clips and secure with self locking washer.

.3 Install insulation in continuous contact with air/vapour retarder system, neatly fitted between anchoring system.
.4 Notch semi-rigid insulation at location of thermal clip system if required.
.5 Install insulation into place, compressing it at clip location and ensuring no gaps in adjacent insulation boards.
.6 Install insulation by adhesive clip method in accordance with manufacturer's written instructions and at 400 mm maximum on centre along centreline of insulation boards.

.3 Cement faced foundation insulation:
.1 Layout panels to maximize board sizes, boards under 150 mm wide shall not be used.
.2 Provide cement faced foundation insulation from bottom of exterior cladding to 600 mm below grade with caulked joints. Provide standard foundation insulation from 600 mm below grade to top of footing.
.3 Fasten clips to foundation wall and install boards ensuring each board is fitted into place ensuring tight flush joints. Cut boards around protrusions to ensure a snug fit and seal joints.
.4 Install cap and side flashings to protect exposed edges of cement faced insulation panels.

.4 Underslab insulation:
.1 Under slab application: provide high density insulation boards where indicated. Lay boards on level compacted fill.

END OF SECTION

1 GENERAL

1.01 SUMMARY

.1 Section includes all methods, materials and installation as required to complete the Work of this Section in accordance with the Conditions of the Contract.

.2 Work may include, but is not limited to;
- .1 Self adhered air/vapour retarder.
- .2 Fluid applied vapour retarder.

1.02 REFERENCES

.1 ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials.

.2 ASTM E2178 - Standard Test Method for Determining Air Leakage Rate and Calculation of Air Permeance of Building Materials.

1.03 ACTION SUBMITTALS

.1 Submit action submittals in accordance with Section 01 33 00.

.2 Product data: Submit manufacturers product data for vapour retarders including product characteristics, performance criteria, and limitations.

.3 Reports/certificates: Submit the following:
- .1 Submit product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

1.04 QUALITY ASSURANCE

.1 Installers: Perform Work of this Section by a company that has a minimum of five (5) years proven experience in the installation of vapour retarders of a similar size and nature.

.2 Mock-ups:
- .1 Construct one (1) mock-up of each type of vapour retarder in location as directed by Consultant.
- .2 Mock-up shall be 5 m^2 and demonstrate one lap joint, one inside corner and one electrical box.
- .3 Mock-up may form part of the Work if accepted by the Consultant.

1.05 SITE CONDITIONS

.1 Work of this Section shall not be performed when air and surface temperatures are outside of manufacturers recommended ranges.

.2 Do not perform work of this section during rain or inclement weather or on frost covered substrates or surfaces that are wet to the touch.

2 PRODUCTS

2.01 SELF-ADHERED AIR/ VAPOUR RETARDER

.1 Self-adhered air and vapour retarder membrane: Membrane consisting of rubberized asphalt integrally laminated to thermoplastic surface and providing the minimum values:
- .1 Thickness: 1.0 mm.
- .2 Water vapour permeance (ASTM E96): 0.02 perms.
- .3 Air permeance (ASTM E2178): 0.02 L/s.m.2.
- .4 Basis of Design:
  - .1 Blueskin SA by Henry Company Canada.
  - .2 Sopraseal Stick 1100T by Soprema Canada.
  - .3 ExoAir 110 by Tremco.
  - .4 Air-Shield by W.R. Meadows.

.2 Primer: Water based low VOC adhesive. Basis of Design:
- .1 Aquatac Primer by Henry Company Canada.
- .2 Elastocol Stick H20 by Soprema Canada.
- .3 ExoAir Primer by Tremco.
- .4 Mel-Prime W/B by W.R. Meadows.

.3 Mastic/sealant: Single component, low VOC sealing compound. Basis of Design:
- .1 925 BES Sealant by Henry Company Canada.
- .2 Sopramastic SP2 by Soprema Canada.
- .3 Dymonic 100 by Tremco.
- .4 BEM by W.R. Meadows.

.4 Termination: Continuous high strength plastic strip or single component termination mastic as recommended by membrane manufacturer for the sealing of vertical terminations.

2.02 FLUID APPLIED VAPOUR RETARDER

.1 Fluid applied vapour retarder: One component, fluid applied non-permeable air barrier membrane providing the minimum values:
- .1 Minimum thickness: 40 mil.
- .2 Air permeance (ASTM E2178): 0.005 L/s.m.2.

.3 Basis of Design:
.1 Air-Bloc 16MR by Henry Company Canada.
.2 Sopraseal LM203 by Soprema Canada.
.3 Or approved equal.

.2 Auxiliary materials: Provide additional materials as recommended by manufacturer for a complete installation.

3 EXECUTION

3.01 EXAMINATION

.1 Examine and verify previously installed Work upon which this Section depends. Report defects or unsatisfactory conditions to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.02 SELF-ADHERED AIR/ VAPOUR RETARDER INSTALLATION

.1 Install self-adhered air/vapour retarder in accordance with manufacturers written instructions.

.2 Apply primer to substrate at recommended application rate and allow primer to fully cure prior to installation of self-adhered membrane.

.3 Cured primer shall be covered with self-adhered membrane in same working day. Reprime any primed surfaces that are not covered with membrane on same day.

.4 Detail all construction gaps, fasteners, penetrations, corners, or tie-ins with mastic/sealant prior to installation of self-adhered membrane.

.5 Install self-adhered membrane, in vertical or lateral oriented courses, in a shingle fashion with all side joints overlapped 50 mm and other transitions lapped 75 mm.

.6 Peel release paper from leading edge of self-adhered membrane, and align top to verify positioning prior to complete release paper removal and membrane placement.

.7 Align and press self-adhered membrane into place from center of roll to outside edges, eliminating entrapped air bubbles and wrinkles.

.8 Roll self-adhered membrane and laps with approved roller immediately after application to obtain thorough adhesion.

.9 Seal end of day and permanently exposed reverse laps with building envelope sealant or termination bar as recommended by manufacturer.

3.03 FLUID APPLIED VAPOUR RETARDER APPLICATION

.1 Ensure services are installed and inspected prior to installation of sheet retarder.

.2 Spray or roll apply vapour retarder over prepared substrate to recommended thickness in accordance with manufacturers written instructions.

.3 Inspect for continuity. Patch thin spots or punctures as directed by manufacturer.

END OF SECTION

1 GENERAL

1.01 SUMMARY

.1 Section includes all methods, materials and installation as required to complete the Work of this Section in accordance with the Conditions of the Contract.

1.02 REFERENCES

.1 ASTM D1709 - Standard Test Methods for Impact Resistance of Plastic Film by the Free-Falling Dart Method.

.2 ASTM E1643 - Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs.

.3 ASTM E1745 - Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs.

1.03 ACTION SUBMITTALS

.1 Submit action submittals in accordance with Section 01 33 00.

.2 Product data: Submit manufacturers product data for underslab vapour barrier including product characteristics, performance criteria, and limitations.

.3 Reports/certificates: Submit the following:
- .1 Submit product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.
- .2 Laboratory Test Results: Submit full set of actual test results as per ASTM E1745 including all after conditioning permeance tests.

1.04 QUALITY ASSURANCE

.1 Installers: Perform Work of this Section by a company that has a minimum of five (5) years proven experience in the installation of underslab vapour barriers of a similar size and nature.

.2 Mock-ups:
- .1 Construct one (1) mock-up of underslab vapour barrier in location as directed by Consultant.
- .2 Mock-up shall be 5 m^2 and demonstrate one lap joint, one foundation intersection and one penetration boot.
- .3 Mock-up may form part of the Work if accepted by the Consultant.

1.05 SITE CONDITIONS

.1 Do not perform work of this section during rain or inclement weather or on frozen ground.

2 PRODUCTS

2.01 MATERIALS

.1 Underslab vapour barrier: Polyolefin based multi-layer sheet providing the minimum performance:
- .1 Thickness: 0.38 mm (15 mil).
- .2 Permeance after conditioning (ASTM E1745): less than 0.01 perms.
- .3 Performance class (ASTM E1745): Class A.
- .4 Puncture resistance (ASTM D1709): >2200 grams.
- .5 Basis of Design:
  - .1 Stego Wrap Vapor Barrier by Stego Industries (DRE Industries).
  - .2 Perimator by W.R. Meadows.
  - .3 Or approved equal.

.2 Seam tape:
- .1 High-density polyethylene film with pressure-sensitive adhesive, specially designed to seal seams and penetration.
- .2 Width: Approximately 100 mm.
- .3 Basis of Design:
  - .1 Stego Tape by Stego Industries (DRE Industries).
  - .2 Perimator Tape by W.R. Meadows.
  - .3 Or approved equal.

.3 Pipe boots:
- .1 Construct pipe boots from vapour barrier material and pressure sensitive tape as recommended by manufacturer at all slab penetrations.

.4 Mastic:
- .1 Single component polymer-modified emulsion for sealing vapour barrier.
- .2 Basis of Design:
  - .1 Stego Mastic by Stego Industries (DRE Industries).
  - .2 Pointing Mastic by W.R. Meadows.
  - .3 Or approved equal.

3 EXECUTION

3.01 EXAMINATION

.1 Examine and verify previously installed Work upon which this Section depends. Report defects or unsatisfactory conditions to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.02 PREPARATION

.1 Prepare surfaces in accordance with manufacturer's instructions.

.2 Level and tamp or roll aggregate.

3.03 INSTALLATION

.1 Ensure services are installed and inspected prior to installation of sheet barrier.

.2 Install in accordance with manufacturer's instructions and ASTM E1643.

.3 Unroll vapour barrier over the entire area where the slab is to be poured. Unroll vapour barrier with the longest dimension parallel with the direction of the pour. Completely cover concrete placement area.

.4 Lap vapour barrier over footings and seal to foundation walls.

.5 Overlap all joints 150 mm and seal with manufacturer's tape.

.6 Seal all penetrations including but not limited to; pipes, ducting, and rebar with manufacturer's pipe boot, or tape and mastic.

.7 No penetration of vapour barrier is allowed except for reinforcing steel and permanent utilities.

.8 Inspect for continuity. Repair punctures and tears with sealing tape before work is concealed. Repair damaged areas by cutting patches of vapour barrier, overlapping damaged area 150 mm. Clean all adhesion areas of dust, dirt and moisture. Tape all four sides with tape.

.9 Do not proceed until repair work has been inspected and approved by Consultant.

END OF SECTION

1 GENERAL

1.01 SUMMARY

.1 Section includes all methods, materials and installation as required to complete the Work of this Section in accordance with the Conditions of the Contract.

.2 Work may include, but is not limited to;
- .1 Self adhered air barrier.

1.02 REFERENCES

.1 ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials.

.2 ASTM E2178 - Standard Test Method for Determining Air Leakage Rate and Calculation of Air Permeance of Building Materials.

1.03 ADMINISTRATIVE REQUIREMENTS

.1 Site Meetings: Arrange a pre-installation meeting on Site to be attended by Consultant, Contractor, air barrier manufacturer's representative, and any other parties directly affecting work of this Section to:
- .1 Examine substrate conditions for compliance with manufacturer's requirements.
- .2 Review methods and procedures related to installation.
- .3 Review all typical and special details as required to complete the work of this section.

1.04 ACTION SUBMITTALS

.1 Submit action submittals in accordance with Section 01 33 00.

.2 Product data: Submit manufacturers product data for air barriers including product characteristics, performance criteria, and limitations.

.3 Shop Drawings: Submit Shop Drawings as follows:
- .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.
- .2 Shop Drawings to special joint detail conditions and interface with adjacent materials.

.4 Reports/certificates: Submit the following:
- .1 Submit product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

.2 Submit manufacturer's written reports within 3 days of review, verifying compliance of Work.

1.05 QUALITY ASSURANCE

.1 Installers: Perform Work of this Section by a company that has a minimum of five (5) years proven experience in the installation of air barriers of a similar size and nature.

.2 Mock-ups:
- .1 Construct one (1) mock-up of each type of air barrier in location as directed by Consultant.
- .2 Mock-up shall be 5 m^2 and demonstrate one lap joint, one corner condition, junction with roof system and interfacing with adjacent materials.
- .3 Mock-up may form part of the Work if accepted by the Consultant.

1.06 SITE CONDITIONS

.1 Work of this Section shall not be performed when air and surface temperatures are outside of manufacturers recommended ranges.

.2 Do not perform work of this section during rain or inclement weather or on frost covered substrates or surfaces that are wet to the touch.

2 PRODUCTS

2.01 SELF-ADHERED AIR BARRIER

.1 Self-adhered air barrier membrane: Membrane consisting of reinforced modified polyolefin tri-laminate film with permeable adhesive and providing the minimum values:
- .1 Minimum thickness: 0.58 mm (23 mils).
- .2 Water vapour permeance (ASTM E96): 17 perms.
- .3 Air permeance (ASTM E2178): 0.02 L/s.m.2.
- .4 Basis of Design:
  - .1 Blueskin VP160 by Henry Company Canada.
  - .2 Sopraseal Stick VP by Soprema Canada.
  - .3 AirOutshield SA 280 by SRP Canada.
  - .4 Air-Shield SMP by W.R. Meadows.

.2 Primer: Water based low VOC adhesive. Provision of primer to be as recommended by manufacturer. Basis of Design:
- .1 Aquatac Primer by Henry Company Canada.
- .2 Sopraseal VP Primer for Soprema Canada.
- .3 Not required for SRP Canada product.
- .4 Not required for W.R. Meadows product.

.3 Sealant and flashing: Single component, low VOC sealing compound. Basis of Design:
- .1 925 BES Sealant by Henry Company Canada.
- .2 MasterSeal NP 1 by Sika Canada.
- .3 Sopraseal Sealant by Soprema Canada.
- .4 Air-Shield Liquid Flashing by W.R. Meadows.

3 EXECUTION

3.01 EXAMINATION

.1 Examine and verify previously installed Work upon which this Section depends. Report defects or unsatisfactory conditions to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.02 SELF-ADHERED AIR BARRIER INSTALLATION

.1 Install self-adhered air barrier in accordance with manufacturers written instructions.

.2 Apply primer, if recommended by manufacturer, to substrate and allow primer to fully cure prior to installation of self-adhered membrane. Primed areas not covered by end of day must be re-primed prior to installation of air barrier.

.3 Cured primer shall be covered with self-adhered membrane in same working day. Reprime any primed surfaces that are not covered with membrane on same day.

.4 Detail and flashing all construction penetrations, corners, transitions, or tie-ins with sealant prior to installation of self-adhered membrane.

.5 Install self-adhered membrane in shingle fashion with all horizontal joints overlapped 50 mm and vertical seams lapped 75 mm.

.6 Peel release paper from self-adhered membrane, and align top to verify positioning prior to complete release paper removal and membrane placement.

.7 Align and press self-adhered membrane into place from centre of roll to outside edges, eliminating entrapped air bubbles and wrinkles.

.8 Roll self-adhered membrane and laps with approved roller immediately after application to obtain thorough adhesion.

.9 Seal end of day and permanently exposed reverse laps with sealant as recommended by manufacturer.

3.03 SITE QUALITY CONTROL

.1 Site inspection:
- .1 Manufacturers representative shall inspect installation. Completed reports to be submitted.
- .2 Do not cover Work until inspection is completed and accepted.
- .3 Correct deficient applications not passing inspections, make necessary repairs, and demonstrate compliance with requirements.

END OF SECTION

1 GENERAL

1.01 SUMMARY

.1 Section includes all methods, materials and installation as required to complete the Work of this Section in accordance with the Conditions of the Contract.

.2 Work may include, but is not limited to;
- .1 Composite panels at canopy.
- .2 Composite signage wall.

1.02 REFERENCES

.1 AAMA CW-10 - Care and Handling of Architectural Aluminum from Shop to Site.

.2 AAMA 501.1 - Standard Test Method for Water Penetration of Windows, Curtain Walls and Doors Using Dynamic Pressure.

.3 AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.

.4 ANSI H35.1/H35.1M - American National Standard Alloy and Temper Designation Systems for Aluminum.

.5 ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

.6 ASTM C920 - Standard Specification for Elastomeric Joint Sealants.

.7 ASTM C1330 - Standard Specification for Cylindrical Sealant Backing for Use with Cold Liquid-Applied Sealants.

.8 ASTM D2244 - Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates.

.9 ASTM D4214 - Standard Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films.

.10 ASTM E283/E283M - Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Skylights, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.

.11 ASTM E330/E330M - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.

.12 ASTM E331 - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference.

.13 CSA G40.20/G40.21 - General requirements for rolled or welded structural quality steel / Structural quality steel.

.14 CAN/ULC S102 - Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.

1.03 ADMINISTRATIVE REQUIREMENTS

.1 Coordination: Coordinate installation of the work of this section with installers of wall mounted items, equipment, mechanical, and electrical work to ensure integrity of cladding system is not affected.
- .1 Panel penetrations to be pre-approved by manufacturer prior to work starting.
- .2 Coordinate interface, transition, lapping, flashings and compatibility of membranes with other trades.

.2 Site Meetings: Arrange a pre-installation meeting on Site to be attended by Consultant, Contractor, panel manufacturer's representative, and any other parties directly affecting work of this Section to:
- .1 Examine substrate conditions for compliance with manufacturer's requirements.
- .2 Review methods and procedures related to installation.
- .3 Review all typical and special details as required to complete the work of this section.

1.04 ACTION SUBMITTALS

.1 Submit action submittals in accordance with Section 01 33 00.

.2 Product data: Submit manufacturers product data for composite panels including product characteristics, performance criteria, and limitations.

.3 Shop Drawings: Submit Shop Drawings as follows:
- .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.
- .2 Shop Drawings to illustrate details, dimensions, fabrication and installation details.
- .3 Clearly indicate wall openings, head, jamb, sill and mullion details, size, spacing and location of support framing, sub-girts, penetrations, connections, types and locations of fastenings. Indicate provisions for structural and thermal movement between panel system and adjacent materials.

.4 Samples: Submit samples illustrating colours, textures and finishes including, but not limited to:
.1 300 mm x 300 mm panel complete with specified finish.

.5 Reports/certificates: Submit the following:
.1 Test Reports: Submit certified test reports showing compliance with specified performance characteristics and physical properties.
.2 Certificates: Submit product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.
.3 Submit installers letter of certification from manufacturer.

1.05 CLOSEOUT AND MAINTENANCE SUBMITTALS

.1 Submit closeout and maintenance submittals in accordance with Section 01 78 00.

.2 Closeout Product data: Submit manufacturers maintenance and cleaning data for incorporation into operation and maintenance manual including product warranty documentation.

1.06 QUALITY ASSURANCE

.1 Installers: Perform Work of this Section by a company that has a minimum of ten (10) years proven experience in the installation of composite panels of a similar size and nature. Installer to be trained and approved by panel manufacturer.

.2 Mock-ups:
.1 Construct one (1) mock-up of each type of composite panel system in location as directed by Consultant.
.2 Mock-up shall be 5 m^2 and demonstrate use of all components including support system, fastenings, flashings and finishing details.
.3 Mock-up may form part of the Work if accepted by the Consultant.

1.07 DELIVERY, STORAGE, AND HANDLING

.1 Conform to AAMA CW-10 for the care and handling of composite panels.

.2 Handle panels in a manner to prevent scratching or breakage.

.3 Store composite panels and support system materials in dry location.

1.08 WARRANTY

.1 Provide extended warranty for composite panels in accordance with the General Conditions, except warranty is extended to five (5) years from date Ready-for-Takeover has been attained:
- .1 Warranty to cover defects including staining, leaking, delamination, and joint failure.
- .2 Warranty shall cover complete replacement of Work, including adjacent work impacted.

.2 Provide manufacturers finish warranty for composite panel finish in accordance with the General Conditions, except warranty is extended to twenty (20) years from date Ready-for-Takeover has been attained:
- .1 Warranty to cover defects including peeling, checking, cracking, chalking in excess of 8 measured to ASTM D4214, or fading in excess of 5 measured to ASTM D2244.
- .2 Warranty shall cover complete replacement of Work, including adjacent work impacted.

2 PRODUCTS

2.01 SYSTEMS AND MANUFACTURERS

.1 Non fire rated composite panels:
- .1 Alucobond Plus by 3A Composites.
- .2 ACM Cladding by Alcotex Inc.
- .3 Accumet 2000 by Northern Facades.
- .4 Metal Composite Panel PE Core Panels by Vicwest Canada.
- .5 Alpolic Panels by Exterior Technologies Group.

2.02 PERFORMANCE CRITERIA

.1 Design composite panel system based on rainscreen principle and as a dry joint system. System shall conform to the following testing criteria:
- .1 Air Infiltration: Air leakage through assembly of not more that 0.3 L/s per sq. m. of wall area when tested according to ASTM E283/E283M at a pressure difference of 75 Pa.
- .2 Water Penetration under Static Pressure: No water penetration when tested according to ASTM E331 at a pressure difference of 300 Pa.
- .3 Water Penetration under Dynamic Pressure: No water penetration when tested according to AAMA 501.1.

.4 Structural Performance: Metal wall panel assemblies shall withstand the effects of the following loads and stresses within limits and under conditions indicated, based on testing to ASTM E330/E330M:
.1 Wind Loads: Design wall system to resist wind loads, positive and negative, for location as indicated in National Building Code without causing rattling, vibration or excessive deflection of panels, overstressing of fasteners, clips or other detrimental effects on wall system.
.2 Deflection Limit: Panels must return to an essentially flat condition after design wind load is removed with permanent set not to exceed L/800.

.2 Fire performance:
.1 Surface-Burning Characteristics: Provide materials conforming to the following when tested to CAN/ULC S102:
.1 Flame-Spread Index: 0 or less.
.2 Smoke-Developed Index: 20 or less.

.3 Structural & thermal movements: Accommodate movement of building structure and movement caused by thermal expansion and contraction of system component parts without causing bowing, buckling, oil canning, opening of joints, excessive stress on fasteners or any other detrimental effects.

.4 Design tolerance shall be as follows:
.1 Composite panels shall have even rises and falls across panel Panels shall meet the following maximum tolerances:
.1 1.5 mm in convex direction, measured perpendicularly to normal plane.
.2 1.5 mm in concave direction, measured perpendicularly to normal plane.

.5 Design system to allow for removal of any individual panel within system.

2.03 MATERIALS

.1 Composite panels:
.1 Face sheets: Two 0.51 mm thick sheets, aluminum alloy to ANSI H35.1/H35.1M, series 3105-H14.
.2 Core: Extruded thermoplastic core thermally bonded between face sheets in continuous process without glue or adhesives. Bond integrity to be tested to ASTM D1781.
.3 Panel Thickness: 4 mm.
.4 Attachment clips: As provided by manufacturer for installation of panels to framing system.
.5 Aluminum infill strips: manufacturers matching strip.

.2 Support system:
- .1 Structural components: Provide framing, plates, and similar items conforming to CSA G40.20/G40.21.
- .2 Adjustable angles, Z-bars and channel subgirts: to ASTM A653/A653M, Z275 galvanized steel, designed to accommodate expansion and contraction, dynamic movements and design load requirements.
- .3 Installation clips: Installation clip designed for simple installation. Alucobond EasyFix by 3A Composites or approved equal.

.3 Air/vapour retarders: Refer to Section 07 26 13.

.4 Insulation: Refer to Section 07 21 00.

.5 Flashings, trims and closures: Provide inside corners, outside corners, control joints, wall fixtures and termination trims in material and finish to match panels.

.6 Sealing materials:
- .1 Sealant: Single-component, moisture cure silicone sealant to ASTM C920, Type S, Grade NS.
  - .1 Dowsil 795 Silicone by Dow.
  - .2 Spectrum 1 by Tremco.
  - .3 Or approved equal.
- .2 Joint backing: to ASTM C1330; Round, solid section, soft polyethylene foam gasket compatible with primer and sealant materials.
- .3 Primer: As recommended by sealant manufacturer.

.7 Fasteners: Concealed stainless steel fasteners as recommended by panel manufacturer. Size and spacing as recommended by manufacturer.

2.04 FABRICATION

.1 Fabricate panels in controlled environment with all panel lines, breaks and angles sharp and true.

.2 Fabricate panels with flanges on all sides and all corners and ends smooth, and free from sharp edges or burrs.

.3 Fabricate work to profiles and sizes as indicated on drawings and complete with trims, flashings and filler components as required to interface with work of other Sections. Confirm all dimensions on Site prior to fabrication.

.4 Fabricate panels to allow for thermal and structural movements without deformation or damage to panels.

.5 Confirm locations and sizes of all penetrations as required by other trades prior to submission of Shop Drawings.

2.05 FINISHES

.1 Paint finishes: Three-coat fluoropolymer coating finish containing 100% thermoset resin conforming to AAMA 2605; Lumiflon FEVE in metallic colour to be selected by Consultant.

3 EXECUTION

3.01 EXAMINATION

.1 Examine and verify previously installed Work upon which this Section depends. Report defects or unsatisfactory conditions to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.02 PREPARATION

.1 Provide isolation coating at all metal surfaces in contact with cementitious surfaces including concrete, and masonry. Provide isolation coating at aluminum to steel surfaces.

3.03 INSTALLATION

.1 Install work of this Section in accordance with manufacturer's written instructions, plumb with intersecting parts joined together to provide accurately fitted joints with adjoining surfaces in true planes. Attach components in manner not restricting movement.

.2 Support system:
- .1 Install supporting framing required to support work of this section.
- .2 Mechanically fasten installation clips to substrate following manufacturer’s installation guidelines.

.3 Air/vapour retarders: Installed in accordance with Section 07 26 13.

.4 Insulation: Installed in accordance with Section 07 21 00.

.5 Flashings, trims and closures:
- .1 Supply and install all closures, caps, fascia covers, flashings and trims.
- .2 Provide required metal flashings around penetrations through composite panels. Ensure complete watertight seal.

.6 Composite panels:
- .1 Erect panels in accordance with system manufacturer's details and instructions and so as to meet specified design and performance requirements.

.2 Finished work shall be securely anchored, free of distortion and surface imperfections, uniform in colour and gloss.
.3 Install panels plumb, true, level and in alignment to established lines and elevations.
.4 Ensure drainage of any moisture which may occur within system to exterior.
.5 Damaged panels, waviness, warp or distortion of finished work will not be accepted.
.6 Completed installation shall be free from rattles, wind whistles, noise due to thermal movement and other noises.

.7 Sealing materials:
.1 Prepare substrate surface, mask, and prime as recommended by sealant manufacturer.
.2 Install joint backing and sealant at perimeter of composite panel system and where indicated on drawings for weathertight installation. Tool sealant to concave profile.
.3 Seal around all openings and penetrations to provide weathertight and watertight seal.

.8 Installation tolerances:
.1 Maximum deviation from vertical and horizontal alignment of erected panels: 6 mm in 6 m.
.2 Maximum deviation from panel flatness shall be 3 mm in 1.5 m panel in any direction for assembled units (non-accumulative).
.3 All walls and openings to be within ±3 mm of location shown on Shop Drawings.

3.04 CLEANING

.1 Clean exposed panel surfaces in accordance with manufacturer's instructions.

.2 Repair and touch up with colour matching minor surface damage, only where permitted by the Consultant and only where appearance after touch-up is acceptable to Consultant.

.3 Replace damaged panels and components that, in opinion of the Consultant, cannot be satisfactorily repaired.

END OF SECTION

1 GENERAL

1.01 SUMMARY

.1 Section includes all methods, materials and installation as required to complete the Work of this Section in accordance with the Conditions of the Contract.

.2 Work may include, but is not limited to;
- .1 Metal roof screen.

1.02 REFERENCES

.1 ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

.2 ASTM B209 - Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).

.3 CSA G40.20/G40.21 - General requirements for rolled or welded structural quality steel / Structural quality steel.

.4 CSA S136 - North American Specification for the Design of Cold-Formed Steel Structural Members.

1.03 ADMINISTRATIVE REQUIREMENTS

.1 Coordination: Coordinate the design and installation of the metal roof siding screen with the insulated metal wall and roof panel supplied under separate Contract.

1.04 ACTION SUBMITTALS

.1 Submit action submittals in accordance with Section 01 33 00.

.2 Product data: Submit manufacturers product data for metal siding including product characteristics, performance criteria, and limitations.

.3 Shop Drawings: Submit Shop Drawings as follows:
- .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.
- .2 Shop Drawings to illustrate details, dimensions, fabrication and installation details.
- .3 Clearly indicate finish, profiles, standing seam clamp system, attachment methods, support framing, sub-girts, penetrations, connections, types and locations of fastenings.

.4 Samples: Submit samples illustrating colours, textures and finishes including, but not limited to:
- .1 600 mm long support framing, trims and corner pieces.
- .2 300 mm x 300 mm siding panel complete with specified finish and profile.

.5 Reports/certificates: Submit the following:
- .1 Test Reports: Submit certified test reports showing compliance with specified performance characteristics and physical properties.
- .2 Certificates: Submit product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

1.05 CLOSEOUT AND MAINTENANCE SUBMITTALS

.1 Submit closeout and maintenance submittals in accordance with Section 01 78 00.

.2 Closeout Product data: Submit manufacturers maintenance and cleaning data for incorporation into operation and maintenance manual including product warranty documentation.

1.06 QUALITY ASSURANCE

.1 Mock-ups:
- .1 Construct one (1) mock-up of each type of metal siding screen in location as directed by Consultant.
- .2 Mock-up shall be 5 m^2 and demonstrate use of all components including support system, fastenings, and finishing details.
- .3 Mock-up may form part of the Work if accepted by the Consultant.

1.07 DELIVERY, STORAGE, AND HANDLING

.1 Store siding and support system materials covered and tilted to provide water run-off.

1.08 WARRANTY

.1 Provide extended warranty for metal siding in accordance with the General Conditions, except warranty is extended to two (2) years from date Ready-for-Takeover has been attained:
- .1 Warranty to cover defects including warping, twisting, and finish failure.
- .2 Warranty shall cover complete replacement of Work, including adjacent work impacted.

2 PRODUCTS

2.01 MANUFACTURERS

.1 Agway Metals Inc.

.2 Forma Steel.

.3 Morin Corporation.

.4 Vicwest.

2.02 PERFORMANCE CRITERIA

.1 Design members to withstand their own weight, and the design loads due to the pressure and suction of wind as calculated in accordance with Ontario Building Code and applicable municipal regulations

.2 Design metal siding system to CSA S136, and to a maximum allowable deflection of L/180 of span between attachments.

.3 Structural & Thermal Movements: Accommodate movement of building structure and movement caused by thermal expansion and contraction of system component parts without causing bowing, buckling, cracking, oil canning, excessive stress on fasteners or any other detrimental effects.

2.03 MATERIALS

.1 Steel siding: Exposed fastener cladding conforming to the following:
- .1 Aluminum: to ASTM B209, 3003-H14 alloy and temper.
- .2 Minimum steel thickness: 1.0 mm.
- .3 Profile depth: 22 mm.
- .4 Perforated: 3 mm diameter hole, 4.8 mm staggered spacing with 40% open area.
- .5 Profile: To match Exposed C-29 Profile A by Morin.

.2 Support system:
- .1 Structural components: Provide framing, plates, and similar items conforming to CSA G40.20/G40.21.
- .2 Adjustable angles, Z-bars and channel subgirts: to ASTM A653/A653M, Z275 galvanized steel, designed to accommodate expansion and contraction, dynamic movements and design load requirements.
- .3 Miscellaneous brackets, and supports by Section 05 50 00.
- .4 Standing seam roof clamps:
  - .1 Roof clamp: Engineered metal standing seam roof clamp, type to suit standing seam profile.

.2 Strut and rail: Gripper fix aluminum strut and rail system.
.3 Basis of Design: S-5! or approved equal.

.3 Flashings, trims and closures: Provide inside corners, outside corners, control joints, wall fixtures and termination trims in material and finish to match siding.

.4 Fasteners: Stainless steel fasteners as recommended by siding manufacturer. Size and spacing as recommended by manufacturer. Provide coloured heads to match siding where exposed.

2.04 FINISHES

.1 Factory applied paint finish: Two coat silicone modified polyester paint system applied to a minimum dry film thickness of 1 mil; Perspectra Plus by ArcelorMittal Dofasco or Silperpon (Weather XL) by Valspar Corporation, in Medium Grey colour.

3 EXECUTION

3.01 EXAMINATION

.1 Examine and verify previously installed Work upon which this Section depends. Report defects or unsatisfactory conditions to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.02 PREPARATION

.1 Provide isolation coating at all metal surfaces in contact with cementitious surfaces including concrete, and masonry.

3.03 INSTALLATION

.1 Install work of this Section in accordance with manufacturer's written instructions, plumb with intersecting parts joined together to provide accurately fitted joints with adjoining surfaces in true planes. Attach components in manner not restricting movement.

.2 Support system: Install supporting framing required to support work of this section.

.3 Flashings, trims and closures:
.1 Supply and install all closures, caps, fascia covers, flashings and trims.
.2 Provide required metal flashings around penetrations through metal siding screen.

.4 Metal siding screen:
.1 Erect screen in accordance with manufacturer's details and instructions and to meet specified design and performance requirements.

.2 Finished work shall be securely anchored, free of distortion and surface imperfections, uniform in colour and gloss.

.3 Install screen plumb, true, level and in alignment to established lines and elevations.

.4 Damaged screen panels, waviness, warp or distortion of finished work will not be accepted.

.5 Completed installation shall be free from rattles, wind whistles, noise due to thermal movement and other noises.

.5 Installation tolerances:

.1 Maximum variation from plane or location shown on approved Shop Drawings: 10 mm/10 m of length and 20 mm/100 m max.

.2 Maximum offset from true alignment between two adjacent members abutting end to end, in line: 0.75 mm.

3.04 CLEANING

.1 Clean exposed siding surfaces in accordance with manufacturer's instructions.

.2 Repair and touch up with colour matching minor surface damage, only where permitted by the Consultant and only where appearance after touch-up is acceptable to Consultant.

.3 Replace damaged siding and components that, in opinion of the Consultant, cannot be satisfactorily repaired.

END OF SECTION

1 GENERAL

1.01 SUMMARY

.1 Section includes all methods, materials and installation as required to complete the Work of this Section in accordance with the Conditions of the Contract.

.2 Work may include, but is not limited to;
- .1 Uninsulated canopy roof using polymethyl methacrylate-based (PMMA) fluid applied roofing.
- .2 Flashings at insulated metal panel roof penetrations.

1.02 REFERENCES

.1 CSA A123.21 - Standard Test Method For the Dynamic Wind Uplift Resistance of Membrane-Roofing Systems.

.2 Canadian Roofing Contractors Association (CRCA).

.3 Ontario Industrial Roofing Contractors Association (OIRCA).

1.03 ADMINISTRATIVE REQUIREMENTS

.1 Coordination: Coordinate roofing work with mechanical and electrical trades for roof penetrations as required.

.2 Site Meetings: Arrange a pre-installation meeting on Site to be attended by Consultant, Contractor, roofing manufacturer's representative, and any other parties directly affecting work of this Section to:
- .1 Examine substrate conditions for compliance with manufacturer's requirements.
- .2 Review methods and procedures related to installation.
- .3 Review all typical and special details as required to complete the work of this section.

1.04 ACTION SUBMITTALS

.1 Submit action submittals in accordance with Section 01 33 00.

.2 Product data: Submit manufacturers product data for fluid applied roofing system including product characteristics, performance criteria, and limitations.

.3 Shop Drawings: Submit Shop Drawings as follows:
- .1 Shop Drawings to illustrate details, dimensions, fabrication and installation details.
- .2 Indicate flashing, control joints, penetrations, and details.

.4 Reports/certificates: Submit the following:
- .1 Submit current proof of membership with OIRCA.
- .2 Submit proof that manufacturers pre-installation notification process has been followed and that installation has been approved by the manufacturer.
- .3 Submit manufacturers certification indicating that components are compatible and that installer is certified or approved by membrane manufacturer.
- .4 Reports: Indicate procedures followed, ambient temperatures and wind velocity during application.

1.05 CLOSEOUT AND MAINTENANCE SUBMITTALS

.1 Submit closeout and maintenance submittals in accordance with Section 01 78 00.

.2 Closeout Product data: Submit manufacturers product warranty documentation for incorporation into operation and maintenance manual.

1.06 QUALITY ASSURANCE

.1 Installers: Perform Work of this Section by a company that has a minimum of five (5) years proven experience in the installation of fluid applied PMMA roofing of a similar size and nature, is certified by the membrane manufacturer, and that is a member in good standing of OIRCA.

1.07 DELIVERY, STORAGE, AND HANDLING

.1 Delivery and acceptance requirements:
- .1 Deliver materials in original containers, sealed, with labels intact. Ensure shelf life of materials has not expired.
- .2 Deliver fasteners in boxes or kegs and keep in protective storage until used.

.2 Identification for delivery: Indicate on containers or wrappings of materials:
- .1 Manufacturer's name and brand.
- .2 Compliance with applicable standard.

.3 Storage and Handling Requirements:
- .1 Provide and maintain dry, off-ground weatherproof storage.
- .2 Remove only in quantities required for same day use.
- .3 Store materials in accordance with manufacturers written instructions.
- .4 Store insulation protected from exposure to sunlight, weather and deleterious materials.
- .5 Remove damaged and rejected materials from site.

1.08 SITE CONDITIONS

.1 Ambient Conditions:
- .1 Apply fluid applied membranes only when surfaces and ambient temperatures are within manufacturers' prescribed limits.
- .2 Do not install PMMA membrane when air and substrate temperature remains below 13°C, or when wind chill gives equivalent cooling effect.
- .3 Install PMMA membrane on dry substrate, free of snow and ice, use only dry materials and apply only during weather that will not introduce moisture into system.

1.09 WARRANTY

.1 Provide signed OIRCA warranty for fluid applied PMMA roofing covering defects in workmanship for two (2) years from date Ready-for -Takeover has been attained, in accordance with the General Conditions. Warranty to cover non-compliance with approved plans, specifications and changes or deficiencies in workmanship leading to leakage.

.2 Provide extended warranty for fluid applied PMMA roofing in accordance with the General Conditions, except warranty is extended to five (5) years from date Ready-for-Takeover has been attained:
- .1 Warranty to cover defects including material defects, water leakage and ballast displacement or loss.
- .2 Warranty shall cover complete replacement of Work, including adjacent work impacted.

2 PRODUCTS

2.01 MANUFACTURERS

.1 Henry Company Canada.

.2 Soprema Canada.

.3 Tremco Canada.

.4 Or approved equal.

2.02 PERFORMANCE CRITERIA

.1 Design system using components of one manufacturers system to ensure compatibility between components and adjacent materials.

.2 Design fluid applied PMMA roofing system to CAN/CSA A123.21 for wind uplift resistance.

.3 Perform roofing work in accordance with CRCA Roofing Specifications Manual.

2.03 PMMA ROOF MATERIALS

.1 Overlay board with integral modified bituminous layer:
- .1 Board: Minimum 15 mm thick polyisocyanurate insulation board with modified bituminous base sheet factory laminated to panel. Basis of Design:
  - .1 2-1 Soprasmart ISO HD Sanded by Soprema.
  - .2 Or approved equal.
- .2 Cover strip: 330 mm wide strip of SBS modified bitumen with a composite reinforcement to CSA A123.23. Basis of Design:
  - .1 Sopralap Stick by Soprema.
  - .2 Or approved equal.
- .3 Adhesive: Purpose made adhesive designed for use on sheathing boards and insulation in roofing systems. Basis of Design:
  - .1 Duotack by Soprema.
  - .2 Or approved equal.

.2 Deck primer: Two component polymethyl methacrylate-based (PMMA) primer.
- .1 Alsan RS 276 by Soprema.
- .2 Or approved equal.

.3 Liquid membrane: Two-component polymethyl methacrrylate-base (PMMA) liquid membrane combined with reinforcement fabric. Basis of Design:
- .1 Alsan RS 230 Field by Soprema.
- .2 Or approved equal.

.4 Reinforcement fabric: Non-woven, needle-punched polyester fabric. Basis of Design:
- .1 Alsan RS Fleece by Soprema.
- .2 Or approved equal.

.5 Flashing membrane: Two-component polymethyl methacrrylate-base (PMMA) liquid membrane combined with reinforcement fabric. Basis of Design:
- .1 Alsan RS 230 Flash by Soprema.
- .2 Or approved equal.

.6 Coloured finish: Two-component polymethyl methacrrylate-base (PMMA) clear liquid resin with coloured paste additive. Colour: to be selected by Consultant. Basis of Design:
- .1 Alsan RS 287 Base / Colour Additive by Soprema.
- .2 Or approved equal.

2.04 FLASHING AT INSULATED METAL PANEL ROOF

.1 Flashing membrane: One-component polyurethane / bitumen resin liquid membrane combined with reinforcement fabric. Basis of Design:
- .1 Alsan Flashing by Soprema.
- .2 Or approved equal.

.2 Reinforcement fabric: Non-woven, polyester reinforcement fabric. Basis of Design:
- .1 Polyfleece by Soprema.
- .2 Or approved equal.

3 EXECUTION

3.01 EXAMINATION

.1 Examine and verify previously installed Work upon which this Section depends. Report defects or unsatisfactory conditions to Consultant. Commencement of work of this Section means acceptance of existing conditions.

.2 Prior to beginning of work ensure:
- .1 Substrates are firm, straight, smooth, dry, free of snow, ice or frost, contamination and swept clean of dust and debris.
- .2 Curbs have been built.
- .3 Drains have been installed at proper elevations relative to finished roof surface.
- .4 Sleeves, vents, pipes and other items passing through substrates receiving work of this Section are properly and rigidly installed.
- .5 Plywood and lumber nailer plates have been installed to walls and parapets as indicated.

3.02 PREPARATION

.1 Protection of In-Place Conditions:
- .1 Cover walls, walks and adjacent work where materials are hoisted or used.
- .2 Use warning signs and barriers. Maintain in good order until completion of work.
- .3 Dispose of rain water off substrates and away from face of building until drains or hoppers installed and connected.
- .4 Protect from traffic and damage. Comply with precautions deemed necessary by Consultant.
- .5 Place plywood runways over work to enable movement of material and other traffic.
- .6 At end of each day's work or when stoppage occurs due to inclement weather, provide protection for completed work and materials out of storage.

3.03 PMMA ROOF INSTALLATION

.1 Do examination, preparation and roofing Work in accordance with Roofing Manufacturer's Specification Manual and CRCA Roofing Specification Manual.

.2 Overlay board with integral modified bituminous membrane:
- .1 Install board with adhesive in continuous strips spaced 300 mm. Apply adhesive a minimum 150 mm at perimeter and 100 mm at corners.
- .2 Adhere first 60 mm of self-adhesive side and end laps by removing silicone release paper and using membrane roller. Heat-weld last 40 mm.
- .3 Install cover strip centered on joint to seal end laps.
- .4 Ensure all boards are evenly and tightly butted together.
- .5 Avoid forming wrinkles, swelling or fishmouths.

.3 Primer:
- .1 Mix primer to manufacturers written instructions.
- .2 Apply primer with manufacturers approved roller, brush or squeegee ensuring primer is spread evenly over substrate.

.4 Flashings:
- .1 Install flashings a minimum 200 mm wide coordinating installation with surface area of membrane.
- .2 Apply first layer of resin to wet thickness of 1.3 mm to 1.5 mm thick.
- .3 Layout reinforcement, overlapping all edges by minimum 50 mm and fully saturate reinforcement using roller, brushes or notched squeegee. Ensure there are no wrinkles, swellings or fishmouths in reinforcement.
- .4 Apply second layer of resin to consistent 0.6 mm to 0.7 mm wet thickness. Final resin coating to be smooth and even.

.5 Membrane:
- .1 Apply first layer of resin to wet thickness of 1.3 mm to 1.5 mm thick.
- .2 Layout reinforcement, overlapping all edges by minimum 50 mm and ends by 100 mm, fully saturate reinforcement using roller, brushes or notched squeegee. Ensure there are no wrinkles, or air bubbles under reinforcement.
- .3 Apply second layer of resin to consistent 0.6 mm to 0.7 mm wet thickness. Final resin coating to be smooth and even.

.6 Coloured finish:
- .1 Apply coloured finish resin to membrane using manufacturers approved methods ensuring a smooth, even coat.

3.04 FLASHING AT INSULATED METAL PANEL ROOF

.1 Apply first coat of flashing membrane to surface and install reinforcing using trowel and embedding reinforcement fully into membrane.

.2 Apply second coat of flashing membrane to fully saturate reinforcement and allow to dry.

.3 Apply third coat of flashing membrane ensuring smooth even coat.

3.05 SITE QUALITY CONTROL

.1 Inspection and testing of fluid applied PMMA roof membrane application will be carried out by testing laboratory designated by Consultant.

3.06 CLEANING

.1 Clean soiled surfaces, spatters, and damage caused by work of this Section.

.2 Check drains to ensure cleanliness and proper function, and remove debris, equipment and excess material from site.

END OF SECTION

1 GENERAL

1.01 SUMMARY

.1 Section includes all methods, materials and installation as required to complete the Work of this Section in accordance with the Conditions of the Contract.

1.02 REFERENCES

.1 AA ADM - Aluminum Design Manual.

.2 AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.

.3 ANSI H35.1/H35.1M - American National Standard Alloy and Temper Designation Systems for Aluminum.

.4 ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

.5 ASTM C920 - Standard Specification for Elastomeric Joint Sealants.

.6 ASTM F1667 - Standard Specification for Driven Fasteners: Nails, Spikes, and Staples.

.7 CSA A123.21 - Standard Test Method for the Dynamic Wind Uplift Resistance of Membrane-roofing Systems.

.8 Canadian Roofing Contractors Association (CRCA) - Roofing Manual.

1.03 ADMINISTRATIVE REQUIREMENTS

.1 Site Meetings: Arrange a pre-installation meeting on Site to be attended by Consultant, Contractor, and any other parties directly affecting work of this Section to:
- .1 Examine substrate conditions for compliance with manufacturer's requirements.
- .2 Review methods and procedures related to installation.
- .3 Review all typical and special details as required to complete the work of this section.
- .4 Co-ordination with other building sub-trades.

1.04 ACTION SUBMITTALS

.1 Submit action submittals in accordance with Section 01 33 00.

.2 Product data: Submit manufacturers product data for sheet metal flashing system materials including product characteristics, performance criteria, and limitations.

.3 Shop Drawings: Submit Shop Drawings as follows:
- .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.
- .2 Shop Drawings to illustrate details, dimensions, fabrication and installation details.

.4 Samples: Submit 50 mm x 50 mm samples illustrating materials, colours and finishes.

2 PRODUCTS

2.01 PERFORMANCE CRITERIA

.1 Design sheet metal flashings to resist wind loading and uplift pressures for roof system in accordance with CSA A123.21.

2.02 MATERIALS

.1 Zinc coated steel sheet: Minimum 0.60 mm thickness, commercial quality to ASTM A653/A653M, with Z275 designation zinc coating.

.2 Aluminum sheet: ANSI H35.1/H35.1M, series 1100-H14, proprietary utility sheet, 1.0 mm minimum thickness.

.3 Gutter membrane: 1.5 mm thick, non-reinforced, cured, synthetic single-ply EPDM. Adhesive as recommended by EPDM manufacturer.

.4 Isolation coating: Alkali resistant bituminous paint.

.5 Sealant: Single-component, medium modulus, neutral cure silicone sealant to ASTM C920, Type S, Grade NS.
- .1 Dowsil CWS by Dow.
- .2 Sikasil WS-305 CN by Sika.
- .3 Tremsil 400 by Tremco.
- .4 Or approved equal.

.6 Cleats: Same material, and temper as sheet metal, minimum 50 mm wide. Thickness same as sheet metal being secured.

.7 Fasteners: Same material as sheet metal, to ASTM F1667, flat head roofing nails of length and thickness suitable for metal flashing application.

.8 Washers: Same material as sheet metal, 1 mm thick with rubber packings.

.9 Touch-up paint: As recommended by prefinished material manufacturer.

2.03 FABRICATION

.1 Fabricate metal flashings and other sheet metal work in accordance with applicable CRCA 'FL' series details and as indicated.

.2 Fabricate aluminum flashings and other sheet aluminum work in accordance with AA ADM-Aluminum Design Manual.

.3 Form pieces in 2400 mm maximum lengths. Make allowance for expansion at joints.

.4 Hem exposed edges on underside 12 mm. Mitre and seal corners with sealant.

.5 Form sections square, true and accurate to size, free from distortion and other defects detrimental to appearance or performance.

.6 Apply isolation coating to metal surfaces to be embedded in concrete or mortar.

.7 Metal Flashings: Form miscellaneous flashings to profiles indicated of prefinished steel.

.8 Eaves Troughs and Downpipes:
- .1 Form eaves troughs and downpipes from prefinished steel sheet metal.
- .2 Sizes and profiles as indicated on drawings.
- .3 Provide goosenecks, strainer baskets and necessary fastenings.
- .4 Form 600 x 600 mm splash pans.

.9 Scuppers:
- .1 Form scuppers from prefinished steel sheet metal.
- .2 Sizes and profiles as indicated.
- .3 Provide necessary fastenings.
- .4 Form 600 x 600 mm splash pans.

2.04 FINISHES

.1 Factory applied paint finish: Two coat silicone modified polyester paint system applied to a minimum dry film thickness of 1 mil; Perspectra Plus by ArcelorMittal Dofasco or Silperpon Weather XL by Valspar Corporation, in colour to be selected by Consultant.

.2 Paint finishes: Three-coat fluoropolymer coating finish containing Kynar 500 resin conforming to AAMA 2605; PPG Duranar XL in colour to be selected by Consultant.

3 EXECUTION

3.01 EXAMINATION

.1 Examine and verify previously installed Work upon which this Section depends. Report defects or unsatisfactory conditions to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.02 INSTALLATION

.1 Install sheet metal work in accordance with CRCA FL series details, AA ADM-Aluminum Design Manual and as detailed.

.2 Use concealed fastenings except where approved before installation.

.3 Counterflash bituminous flashings at intersections of roof with vertical surfaces and curbs. Flash joints using S-lock forming tight fit over hook strips, as detailed.

.4 Lock end joints and caulk with sealant.

.5 Eaves Troughs and Downpipes:
- .1 Install eaves troughs and secure to building at 750 mm on centre with eaves trough spikes through spacer ferrules:
  - .1 Slope eaves troughs to downpipes as indicated.
  - .2 Seal joints watertight.
- .2 Install downpipes and provide goosenecks back to wall:
  - .1 Secure downpipes to wall with straps at 1800 mm on centre; minimum two straps per downpipe.
  - .2 Install splash pans as indicated.

.6 Waterproof gutters:
- .1 Provide gutters in accordance with reviewed shop drawing and manufacturer's written instructions.
- .2 Line gutter with fully adhered EPDM and ensure gutters are water-tight.

.7 Scuppers: Install scuppers as indicated.

3.03 CLEANING

.1 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

.2 Leave work areas clean, free from grease, finger marks and stains.

END OF SECTION

1 GENERAL

1.01 SUMMARY

.1 Section includes all methods, materials and installation as required to complete the Work of this Section in accordance with the Conditions of the Contract.

1.02 ACTION SUBMITTALS

.1 Submit action submittals in accordance with Section 01 33 00.

.2 Product data: Submit manufacturers product data for roof accessories including product characteristics, performance criteria, and limitations.

.3 Shop Drawings: Submit Shop Drawings as follows:
- .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.
- .2 Shop Drawings to illustrate details, dimensions, fabrication and installation details.

.4 Reports/certificates: Submit the following:
- .1 Test Reports: submit certified test reports showing compliance with specified performance characteristics and physical properties.
- .2 Certificates: submit product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

1.03 CLOSEOUT AND MAINTENANCE SUBMITTALS

.1 Submit closeout and maintenance submittals in accordance with Section 01 78 00.

.2 Closeout Product data: Submit manufacturers maintenance and cleaning data for incorporation into operation and maintenance manual. Provide data for hardware complete with pertinent details, spare parts lists and warnings against harmful maintenance materials and practices for incorporation into manual.

1.04 QUALITY ASSURANCE

.1 Manufacturers: Manufacturers to have a minimum five (5) years experience in manufacturing similar units.

.2 Installers: Perform Work of this Section by a company that has a minimum of two (2) years proven experience in the installation of roof accessories of a similar size and nature.

2 PRODUCTS

2.01 PERFORMANCE CRITERIA

.1 Design roof hatches to withstand minimum live load of 195 kg/m², and design pressure of 488 kg/m² without damage to unit or permanent deformation to seals.

2.02 ROOF HATCHES

.1 Roof hatch: 762 mm x 2438 mm single metal leaf roof hatch for service stair access:
- .1 Metal cover and frame: Preformed, 2 mm (14 ga.) galvanized steel insulated sandwich construction with 25 mm thick insulation.
- .2 Preformed metal curb: 305 mm high insulated sandwich construction, with 254 mm deck flange for attachment.
- .3 Hinges: Heavy duty pintle type of galvanized steel.
- .4 Latch: Enclosed two point slam latch with turn handles inside and out and padlock hasps.
- .5 Lift assistance: Compression spring operators in telescoping tube and automatic hold-open arm with vinyl grip handle to permit one-handed release.
- .6 Gasket: Extruded EPDM rubber permanently adhered to cover.
- .7 Hardware: Stainless steel.
- .8 Basis of Design:
  - .1 Type L by The Bilco Company.
  - .2 Or approved equal.

2.03 ROOF HATCH ACCESSORIES

.1 Safety post: Telescoping post for mounting to ladder:
- .1 Post: High strength square steel post with pull-up loop at upper end of post.
- .2 Operation: Stainless steel spring balancing mechanism, to automatically lock into place. Provide release lever for lowering.
- .3 Mounting brackets: Adjustable mounting and clamp brackets.
- .4 Hardware: Type 316 stainless steel.
- .5 Finish: Safety yellow powder coat.
- .6 Basis of Design:
  - .1 LadderUp Safety Post by The Bilco Company.
  - .2 Or approved equal.

2.04 FABRICATION

.1 Fabricate components free of twists, bends, or visual distortion and insulated. Weld corners and joints.

.2 Assemble roof accessory components as indicated.

.3 Ensure continuity of weather-tight seal.

.4 Zinc plate hardware and attachments and shop prime ready for field painting.

3 EXECUTION

3.01 EXAMINATION

.1 Examine and verify previously installed Work upon which this Section depends. Report defects or unsatisfactory conditions to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.02 INSTALLATION

.1 Roof hatches:
- .1 Erect components plumb, level and in proper alignment.
- .2 Ensure continuity of building envelope air barrier and vapour retarder systems.
- .3 Adjust and seal assembly with provision for expansion and contraction of components.
- .4 Secure prefabricated curb assembly to structure.
- .5 Coat aluminum and copper in contact with dissimilar materials, with isolation coating.
- .6 Secure and seal frame to curb.

.2 Safety post:
- .1 Install in accordance with manufacturers written instructions.
- .2 Ensure safety post are secure, level and operate correctly.

3.03 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by roof hatch installation.

END OF SECTION

1 GENERAL

1.01 SUMMARY

.1 Section includes all methods, materials and installation as required to complete the Work of this Section in accordance with the Conditions of the Contract.

1.02 DEFINITIONS

.1 Fire Stop Material: Device intended to close off opening or penetration during fire or materials that fill openings in wall or floor assembly where penetration is by cables, cable trays, conduits, ducts and pipes and poke-through termination devices, including electrical outlet boxes along with their means of support through wall or floor openings.

.2 Single Component Fire Stop System: Fire stop material that has Listed Systems Design and is used individually without use of high temperature insulation or other materials to create fire stop system.

.3 Multiple Component Fire Stop System: Exact group of fire stop materials that are identified within Listed Systems Design to create on site fire stop system.

.4 Continuity of Fire Separations: Wall, partition or floor assemblies required to be a fire separation shall be:
- .1 Constructed as a continuous element;
- .2 Have a fire resistance rating;
- .3 Have openings protected by a closure; and
- .4 Have penetrations sealed by a firestop.

1.03 REFERENCES

.1 ASTM E2174 - Standard Practice for On-Site Inspection of Installed Firestop Systems.

.2 CAN/ULC S101 - Standard Methods of Fire Endurance Tests of Building Construction and Materials.

.3 CAN/ULC S102 - Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.

.4 CAN/ULC S115 - Standard Method of Fire Tests of Firestop Systems.

1.04 ADMINISTRATIVE REQUIREMENTS

.1 Site Meetings: Arrange a pre-installation meeting on Site to be attended by Consultant, Contractor, firestopping and smoke seal manufacturer's representative, and any other parties directly affecting work of this Section to:
- .1 Examine substrate conditions for compliance with manufacturer's requirements.
- .2 Verify Project requirements.
- .3 Co-ordination with other building sub-trades.
- .4 Review methods and procedures related to installation.
- .5 Review all typical and special details as required to complete the work of this section.

1.05 ACTION SUBMITTALS

.1 Submit action submittals in accordance with Section 01 33 00.

.2 Product data: Submit manufacturers product data for firestopping and smoke seals including product characteristics, performance criteria, and limitations.

.3 Shop Drawings: Submit Shop Drawings as follows:
- .1 Shop Drawings to illustrate details, dimensions, and installation details.
- .2 Indicate location, proposed material, reinforcement, anchorage, and fastenings.
- .3 Ensure construction details accurately reflect actual job conditions.

.4 Samples: Submit 300 mm x 300 mm samples illustrating actual firestop and smoke seal materials proposed for project.

.5 Reports/certificates: Submit the following:
- .1 Submit certified test reports from approved independent testing laboratories, indicating compliance of applied firestopping and smoke seals with specifications for specified performance characteristics and physical properties.
- .2 Certificates: Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .3 Submit manufacturers field reports within 3 days of review.

1.06 QUALITY ASSURANCE

.1 Installers: Perform Work of this Section by a company that has a minimum of five (5) years proven experience in the installation of firestopping and smoke seal systems of a similar size and nature.

.2 Manufacturer's Site inspections: Schedule site visits to review Work at the following stages:
  .1 After delivery and storage of products, and when preparatory Work is complete but before installation begins.
  .2 Twice during progress of Work at 25% and 60% complete.
  .3 Upon completion of Work, after cleaning is carried out.

1.07 DELIVERY, STORAGE, AND HANDLING

.1 Deliver materials to Site in undamaged condition and in original unopened containers, marked to indicate brand name, manufacturer, and ULC markings.

.2 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

2 PRODUCTS

2.01 MANUFACTURERS

.1 3M.

.2 Hilti Canada Corporation.

.3 STI Specified Technologies Inc.

.4 Tremco Canada Ltd.

2.02 PERFORMANCE CRITERIA

.1 Materials to have been tested in accordance with CAN/ULC S101 for fire endurance and CAN/ULC S102 for surface burning characteristics.

2.03 MATERIALS

.1 General:
  .1 All firestopping and smoke seal material shall be from one manufacturer.
  .2 All firestopping and smoke seal installation work for entire project shall be by a single contractor experienced in firestopping and smoke seal installations.

.2 Firestopping and smoke seal systems: in accordance with CAN/ULC S115 and as follows:
  .1 Asbestos-free materials and systems capable of maintaining effective barrier against flame, smoke and gases in compliance with requirements of CAN/ULC S115 and not to exceed opening sizes for which they are intended.

.2 Fire stop system rating: Systems shall achieve fire resistance rating and smoke seal rating equal to that of assemblies into which they are installed.

.3 Provide systems consisting of ULC or Intertek Testing Services listed Products and systems.

.4 Firestop applications for which no ULC or cUL tested system is available will require a manufacturer's engineering judgment follow requirements set forth by the International Firestop Council. Engineering judgement will be submitted to local authorities having jurisdiction for their review and approval prior to installation and will be derived from similar ULC or cUL system designs.

.3 Service penetration assemblies: Systems tested to CAN/ULC S115.

.4 Service penetration fire stop components: certified by test laboratory to CAN/ULC S115.

.5 Fire-resistance rating of installed firestopping assembly in accordance with NBC.

.6 Fire stopping and smoke seals at openings intended for ease of re-entry such as cables: Elastomeric seal.

.7 Fire stopping and smoke seals at openings around penetrations for pipes, ductwork and other mechanical items requiring sound and vibration control: elastomeric seal.

.8 Primers: to manufacturer's recommendation for specific material, substrate, and end use.

.9 Water (if applicable): potable, clean and free from injurious amounts of deleterious substances.

.10 Damming and backup materials, supports and anchoring devices: to manufacturer's recommendations, and in accordance with tested assembly being installed as acceptable to authorities having jurisdiction.

.11 Sealants for vertical joints: non-sagging.

3 EXECUTION

3.01 EXAMINATION

.1 Examine and verify previously installed Work upon which this Section depends. Report defects or unsatisfactory conditions to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.02 PREPARATION

.1 Examine sizes and conditions of voids to be filled to establish correct thicknesses and installation of materials.

.2 Ensure that substrates and surfaces are clean, dry and frost free.

.3 Prepare surfaces in contact with fire stopping materials and smoke seals to manufacturer's instructions.

.4 Maintain insulation around pipes and ducts penetrating fire separation.

.5 Mask where necessary to avoid spillage and over coating onto adjoining surfaces; remove stains on adjacent surfaces.

3.03 INSTALLATION

.1 Install fire stopping and smoke seal material and components in accordance with manufacturer's certified tested system listing.

.2 Seal holes or voids made by through penetrations, poke-through termination devices, and unpenetrated openings or joints to ensure continuity and integrity of fire separation are maintained.

.3 Provide temporary forming as required and remove forming only after materials have gained sufficient strength and after initial curing.

.4 Tool or trowel exposed surfaces to neat finish.

.5 Remove excess compound promptly as work progresses and upon completion.

.6 Sequences of Operation:
- .1 Proceed with installation only when submittals have been reviewed by Consultant.
- .2 Install floor fire stopping before interior partition erections.
- .3 Metal deck bonding: Firestopping to precede spray applied fireproofing to ensure required bonding.
- .4 Mechanical pipe insulation: Certified fire stop system component. Ensure pipe insulation installation precedes firestopping.

3.04 SITE QUALITY CONTROL

.1 Manufacturer's Field Services:
- .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's field reports.

.2 Inspection and Site Tests:
  .1 Inspection and testing of firestopping and smoke seals will be carried out by Testing Laboratory designated by Consultant.
  .2 Testing to meet the requirements of the authorities having jurisdiction.
  .3 Tests to be performed in accordance with ASTM E2174.

3.05 CLEANING

.1 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

.2 Remove temporary dams after initial set of firestopping and smoke seal materials.

3.06 SCHEDULE

.1 Generally allow for firestopping and smoke seals at the following locations. The following list has been provided for convenience and is not to be assumed to be complete. Review Contract Documents to determine the full extent of the Work of this Section and to satisfy the requirements of Ontario Building Code:
  .1 Penetrations through fire-resistance rated masonry, concrete, and gypsum board partitions and walls.
  .2 Top of fire-resistance rated masonry and gypsum board partitions.
  .3 Intersection of fire-resistance rated masonry and gypsum board partitions.
  .4 Control and sway joints in fire-resistance rated masonry and gypsum board partitions and walls.
  .5 Penetrations through fire-resistance rated floor slabs, ceilings and roofs.
  .6 Openings and sleeves installed for future use through fire separations.
  .7 Around mechanical and electrical assemblies penetrating fire separations.

END OF SECTION

1 GENERAL

1.01 SUMMARY

.1 Section includes all methods, materials and installation as required to complete the Work of this Section in accordance with the Conditions of the Contract.

1.02 REFERENCES

.1 ASTM C834 - Standard Specification for Latex Sealants.

.2 ASTM C920 - Standard Specification for Elastomeric Joint Sealants.

.3 ASTM C1330 - Standard Specification for Cylindrical Sealant Backing for Use with Cold Liquid-Applied Sealants.

1.03 ACTION SUBMITTALS

.1 Submit action submittals in accordance with Section 01 33 00.

.2 Product data: Submit manufacturers product data for joint sealant including product characteristics, performance criteria, compatibility and limitations.

.3 Samples: Submit 300 mm x 300 mm samples illustrating materials and colours, of each type and colour required for Work.

1.04 QUALITY ASSURANCE

.1 Installers: Perform Work of this Section by a company that has a minimum of five (5) years proven experience in the installation of joint sealants of a similar size and nature.

1.05 DELIVERY, STORAGE, AND HANDLING

.1 Deliver and store materials in original wrappings and containers with manufacturer's seals and labels, intact. Protect from freezing, moisture, water and contact with ground or floor.

1.06 SITE CONDITIONS

.1 Ambient Conditions: Work of this Section shall be performed when air and surface temperatures are above 5 degree C.

.2 Do not proceed with installation of joint sealants when joint substrates are wet.

.3 Joint-Width Conditions: Do not proceed with installation of joint sealants where joint widths are less than those allowed by joint sealant manufacturer for applications indicated.

.4 Joint-Substrate Conditions: Do not proceed with installation of joint sealants until contaminants capable of interfering with adhesion are removed from joint substrates.

2 PRODUCTS

2.01 MATERIALS

.1 General:
- .1 Do not use caulking that emits strong odours, contains toxic chemicals or is not certified as mould resistant in air handling units.
- .2 When low toxicity caulks are not possible, confine usage to areas which offgas to exterior, are contained behind air barriers, or are applied several months before occupancy to maximize offgas time.
- .3 Where sealants are qualified with primers use only these primers.
- .4 Colours of sealants to be selected by Consultant from manufacturers standard colour range.

.2 Sealant (Type 1):
- .1 Single-component, medium modulus, neutral cure, silicone sealant.
- .2 Sealant properties: to ASTM C920, Type S, Grade NS.
- .3 Basis of Design:
  - .1 Dowsil CWS by Dow.
  - .2 Sikasil WS-305 CN by Sika Canada.
  - .3 Tremsil 400 by Tremco.
  - .4 Or approved equal.

.3 Sealant (Type 2):
- .1 Single-component, non-staining, paintable, fast setting, acrylic latex sealant.
- .2 Sealant properties: to ASTM C834, Type OP, Grade 18C.
- .3 Basis of Design:
  - .1 Tremflex 834 by Tremco.
  - .2 Or approved equal.

.4 Sealant (Type 3):
- .1 Single-component, mildew-resistant, silicone rubber sealant.
- .2 Sealant properties: to ASTM C920, Type S, Grade NS.
- .3 Basis of Design:
  - .1 Dowsil 786 Silicone Sealant by Dow.
  - .2 Sikasil GP by Sika Canada.
  - .3 Tremsil 200 by Tremco.
  - .4 Or approved equal.

.5 Sealant (Type 4):
- .1 Single-component, neutral cure, silicone sealant.
- .2 Sealant properties: to ASTM C920, Type S, Grade NS, Class 50.
- .3 Basis of Design:
  - .1 Dowsil 795 Silicone Building Sealant by Dow.
  - .2 Sikasil WS-295 by Sika Canada.
  - .3 Spectrum 2 by Tremco.
  - .4 Or approved equal.

.6 Sealant (Type 5):
- .1 Single component, non-skinning, non-hardening, sound damping synthetic rubber sealant.
- .2 Basis of Design:
  - .1 Acoustical/Curtainwall Sealant by Tremco.
  - .2 Or approved equal.

.7 Sealant (Type 6):
- .1 Single-component, neutral cure, no-bleed silicone sealant.
- .2 Sealant properties: to ASTM C920, Type S, Grade NS.
- .3 Basis of Design:
  - .1 Dowsil 791 Weatherproofing Sealant by Dow.
  - .2 Sikasil WS-290 by Sika Canada.
  - .3 Spectrum 3 by Tremco.
  - .4 Or approved equal.

2.02 ACCESSORIES

.1 Primer: As recommended by sealant manufacturer.

.2 Joint backing: to ASTM C1330; Round, solid section, soft polyethylene foam gasket compatible with primer and sealant materials.

.3 Bond breaker: Polyethylene bond breaker tape which will not bond to sealant.

.4 Joint cleaner: Non-corrosive and non-staining type, compatible with joint forming materials and sealant recommended by sealant manufacturer.

2.03 MIXING

.1 Mix materials in strict accordance with sealant manufacturer's instructions.

3 EXECUTION

3.01 EXAMINATION

.1 Examine and verify previously installed Work upon which this Section depends. Report defects or unsatisfactory conditions to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.02 PREPARATION

.1 Protect installed Work of other trades from staining or contamination.

.2 Examine joint sizes and conditions to establish correct depth to width relationship for installation of backup materials and sealants.

.3 Clean bonding joint surfaces of harmful matter substances including dust, rust, oil grease, and other matter which may impair Work.

.4 Do not apply sealants to joint surfaces treated with sealer, curing compound, water repellent, or other coatings unless tests have been performed to ensure compatibility of materials. Remove coatings as required.

.5 Ensure joint surfaces are dry and frost free.

.6 Prepare surfaces in accordance with manufacturer's directions.

.7 Priming:
- .1 Where necessary to prevent staining, mask adjacent surfaces prior to priming and caulking.
- .2 Prime sides of joints in accordance with sealant manufacturer's instructions immediately prior to caulking.

.8 Backup material:
- .1 Apply bond breaker tape where required to manufacturer's instructions.
- .2 Install joint filler to achieve correct joint depth and shape, with approximately 30% compression.

3.03 APPLICATION

.1 Apply sealant in accordance with manufacturer's written instructions.

.2 Mask edges of joint where irregular surface or sensitive joint border exists to provide neat joint.

.3 Apply sealant in continuous beads.

.4 Apply sealant using gun with proper size nozzle.

.5 Use sufficient pressure to fill voids and joints solid.

.6 Form surface of sealant with full bead, smooth, free from ridges, wrinkles, sags, air pockets, embedded impurities.

.7 Tool exposed surfaces before skinning begins to give slightly concave shape.

.8 Remove excess compound promptly as work progresses and upon completion.

.9 Curing:
- .1 Cure sealants in accordance with sealant manufacturer's instructions.
- .2 Do not cover up sealants until proper curing has taken place.

3.04 CLEANING

.1 Clean adjacent surfaces immediately and leave Work neat and clean.

.2 Remove excess and droppings, using recommended cleaners as work progresses.

.3 Remove masking tape after initial set of sealant.

3.05 SCHEDULE

.1 The following list has been provided for convenience and is not to be assumed to be complete. Review Contract Documents to determine the full extent of the Work of this Section.

.2 Generally seal the following:
- .1 Concrete, masonry, wood and stone to metal.
- .2 Wood to masonry, concrete and stone.
- .3 Metal to metal.
- .4 All dissimilar materials.

.3 Sealant Type 1:
- .1 Interior joints between dissimilar materials.
- .2 Interior joints at perimeter of all built-in equipment.
- .3 Interior joints at perimeter of metal door and window frames.

.4 Sealant Type 2:
- .1 Interior non-movement joints 6 mm or less for painting.

.5 Sealant Type 3:
- .1 Interior joints where mildew resistance is required.
- .2 Interior joints at perimeter of all plumbing fixtures.

.3 Interior joints between counter backsplash and wall surfaces.
.4 Interior tile work.

.6 Sealant Type 4:
.1 Glass to glass joints.
.2 Glass to metal joints.
.3 Metal to metal curtain wall joints.
.4 Interior face of metal panel joints.

.7 Sealant Type 5:
.1 Perimeter of all gypsum board partitions where sound insulation is indicated.
.2 Acoustical joints at curtainwalls, and corridors.

.8 Sealant Type 6:
.1 Exterior joints between dissimilar building veneer materials.
.2 Exterior control joints in building veneers.
.3 Exterior joints at perimeter of all door and window frames.

END OF SECTION

1 GENERAL

1.01 SUMMARY

.1 Section includes all methods, materials and installation as required to complete the Work of this Section in accordance with the Conditions of the Contract.

.2 Work may include, but is not limited to;
- .1 Floor joint at frost slab to interior slab interface.

1.02 REFERENCES

.1 AAMA 611 - Voluntary Specifications for Anodized Finishes Architectural Aluminum.

.2 ASTM B221 - Specification for Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric).

.3 ASTM E1399/E1399M - Standard Test Method for Cyclic Movement and Measuring the Minimum and Maximum Joint Widths of Architectural Joint Systems.

.4 UL 2079 - Tests for Fire Resistance of Building Joint Systems.

1.03 ACTION SUBMITTALS

.1 Submit action submittals in accordance with Section 01 33 00.

.2 Product data: Submit manufacturers product data for expansion joint cover assemblies including product characteristics, performance criteria, and limitations.

.3 Shop Drawings: Submit Shop Drawings as follows:
- .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.
- .2 Shop Drawings to illustrate lengths, fasteners, accessories, anchors, seals, joints, finishes and profiles required for each condition.

.4 Samples: Submit 300 mm long samples illustrating final finish of expansion joint cover assembly.

.5 Reports/certificates:
- .1 Submit product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

1.04 CLOSEOUT AND MAINTENANCE SUBMITTALS

.1 Submit closeout and maintenance submittals in accordance with Section 01 78 00.

.2 Closeout Product data: Submit manufacturers maintenance and cleaning data for incorporation into operation and maintenance manual including product warranty documentation.

1.05 QUALITY ASSURANCE

.1 Installers: Perform Work of this Section by a company that has a minimum of five (5) years proven experience in the installation of expansion joint cover assemblies of a similar size and nature.

1.06 WARRANTY

.1 Provide extended warranty for expansion joint cover assemblies in accordance with the General Conditions, except warranty is extended to five (5) years from date Ready-for-Takeover has been attained:
- .1 Warranty to cover defects including joint failure.
- .2 Warranty shall cover complete replacement of Work, including adjacent work impacted.

2 PRODUCTS

2.01 SYSTEMS AND MANUFACTURERS

.1 Floor to Floor Joint:
- .1 Aluminum glide plate joint with serrated cover plate.
- .2 Attachment method: Mechanical fasteners.
- .3 Load capacity: Heavy duty.
- .4 Basis of Design: 734 Series by inpro Architectural Products or approved equivalent.

2.02 PERFORMANCE CRITERIA

.1 Joint movement: Design to permit a minimum 50% unrestricted movement in accordance with ASTM E1399/E1399M.

.2 Service Temperature: Design exterior expansion joint cover assemblies to accommodate joint movements within service temperature range of -35 degrees C to 65 degrees C.

2.03 MATERIALS

.1 Aluminum extrusions: ASTM B221, alloy and temper to suit project requirements.

.2 Accessories: Manufacturers standard anchors, clips, fasteners and components as required for a complete installation.

2.04 FABRICATION

.1 Fabricate expansion joint covers, square, true, straight and accurate to required sizes and profiles.

.2 Fabricate in maximum practical lengths to minimize joints.

.3 Shop assemble covers ready for installation where practicable.

.4 Fabricate joint cover assemblies with anchors, levelling nuts, filler inserts and all required accessories as required for a complete installation to suit installation and project requirements.

.5 Fabricate acceptable means of anchorage, such as anchor clips, expansion bolts and shields, welded studs or toggles.

.6 Factory fabricate terminations and transitions.

2.05 FINISHES

.1 Finish exposed surfaces of aluminum components in accordance with Aluminum Association Designation System for Aluminum Finishes.
- .1 Concealed components: Mill finish to AA-M10 mechanical finish.
- .2 Exposed components: Class II clear anodized to AAMA 611, AA-M12C22A31.

.2 Surfaces in contact with cementitious materials: Manufacturers standard protective coating.

3 EXECUTION

3.01 EXAMINATION

.1 Examine and verify previously installed Work upon which this Section depends. Report defects or unsatisfactory conditions to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.02 INSTALLATION

.1 Install expansion joint cover assemblies in accordance with manufacturer's written data, including product technical bulletins, product catalogue installation recommendations, product carton installation recommendations and data sheets.

.2 Set work plumb, square, level, free from distortion.

.3 Secure work accurately to structure in manner not restricting joint movement.

.4 Maintain continuity of vapour retarder and thermal break.

.5 Seal butt joints in accordance with manufacturer's written recommendations to provide watertight joints using sealant.

.6 Protect cover plates during construction. Remove shop protection prior to final inspection.

.7 Ensure sound and clean substrates before installation.

3.03 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by control and expansion joint cover assembly installation.

END OF SECTION

1 GENERAL

1.01 SUMMARY

.1 Section includes all methods, materials and installation as required to complete the Work of this Section in accordance with the Conditions of the Contract.

1.02 REFERENCES

.1 ASTM A653/A653M - Specification for Steel Sheet, Zinc-coated Galvanized or Zinc-iron Alloy-coated Galvannealed by the Hot-dip Process.

.2 ASTM C578 - Specification for Rigid, Cellular Polystyrene Thermal Insulation.

.3 CSA G40.20/G40.21 - General Requirements for Rolled or Welded Structural Quality Steel / Structural Quality Steel.

.4 CSA W59 - Welded Steel Construction.

.5 Canadian Steel Doors Manufacturers Association (CSDMA) - Recommended Specifications for Commercial Steel Door and Frame Products.

.6 Canadian Steel Doors Manufacturers Association (CSDMA) - Installation and Storage of Hollow Metal Doors and Frames.

.7 CAN/ULC S104 - Standard Method for Fire Tests of Door Assemblies.

.8 CAN/ULC S105 - Standard Specification for Fire Door Frames Meeting the Performance Required by CAN/ULC-S104.

.9 CAN/ULC S702 - Standard for Mineral Fibre Thermal Insulation for Buildings.

.10 NFPA 80 - Standard for Fire Doors and Other Opening Protectives.

.11 NFPA 252 - Standard Methods of Fire Tests of Door Assemblies.

1.03 ACTION SUBMITTALS

.1 Submit action submittals in accordance with Section 01 33 00.

.2 Product data: Submit manufacturers product data for metal doors and frames including product characteristics, performance criteria, and limitations.

.3 Shop Drawings: Submit Shop Drawings as follows:
- .1 Indicate each type of door, material, steel core thicknesses, mortises, reinforcements, location of exposed fasteners, openings, glazed components, arrangement of hardware, fire rating and finishes.
- .2 Indicate each type frame material, core thickness, reinforcements, glazing stops, location of anchors and exposed fastenings, reinforcing, fire rating and finishes.
- .3 Include schedule identifying each unit, with door marks and numbers relating to numbering on drawings and door schedule.

.4 Samples: Submit 300 mm x 300 mm corner samples of each type frame illustrating cutouts, glazing stops, connections and trims.

.5 Reports/certificates: Submit the following:
- .1 Test Reports: Certified test reports showing compliance with specified performance characteristics and physical properties.
- .2 Certificates: Product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

1.04 QUALITY ASSURANCE

.1 Manufacturers: Manufacturers to be a member in good standing of Canadian Steel Doors Manufacturers Association (CSDMA).

1.05 DELIVERY, STORAGE, AND HANDLING

.1 Store metal doors and frames to the requirements outlined in the CSDMA Guide Specification for receiving and storage of doors.

2 PRODUCTS

2.01 MANUFACTURERS

.1 Anemostat Door Products.

.2 Daybar Industries Limited.

.3 Fleming Doors Products (Assa Abloy).

.4 Vision Hollow Metal Limited.

.5 Or approved equal.

2.02 PERFORMANCE CRITERIA

.1 Design exterior frame assembly to accommodate to expansion and contraction when subjected to minimum and maximum surface temperature of -35 degrees C to 35 degrees C.

.2 Steel fire rated doors and frames: labelled and listed by an organization accredited by Standards Council of Canada in conformance with CAN/ULC S104, CAN/ULC S105 and NFPA 252 for ratings specified or indicated.

.3 Provide fire labelled frames for openings requiring fire protection ratings. Test products in conformance with CAN/ULC S104, or NFPA 252 and listed by nationally recognized agency having factory inspection services.

2.03 MATERIALS

.1 Hot dipped galvanized steel sheet: to ASTM A653/A653M, ZF120, minimum base steel thickness in accordance with CSDMA Specification, Table 1, Minimum Steel Gauges for Component Parts. Steel to have minimum 30% recycled content.

.2 Reinforcement channel: to CSA G40.20/G40.21, Type 44W, coating designation to ASTM A653/A653M, ZF120, minimum 30% recycled content.

.3 Door Core Materials:
- .1 Honeycomb construction (typical interior door): Structural small cell, 25.4 mm maximum kraft paper 'honeycomb', weight: 36.3 kg per ream minimum, density: 16.5 kg/m³ minimum, sanded to required thickness. Provide fire rating as indicated on Door Schedule.
- .2 Polystyrene (exterior doors): Extruded fire retardant closed cell board in accordance with ASTM C578, Type 1, density 16 to 32 kg/m³. Minimum RSI 1.06.

.4 Adhesives:
- .1 Honeycomb cores and steel components: heat resistant, spray grade, resin reinforced neoprene/rubber (polychloroprene) based, low viscosity, contact cement.
- .2 Polystyrene cores: heat resistant, epoxy resin based, low viscosity, contact cement.
- .3 Lock-seam doors: fire resistant, resin reinforced polychloroprene, high viscosity, sealant/adhesive.

.5 Zinc-rich primer:
- .1 Carbozinc 11WB by Carboline.
- .2 Dimetcote 9H by PPG.
- .3 Zinc Clad XL by Sherwin Williams.

.6 Door silencers: single stud rubber/neoprene type.

.7 Exterior top caps and frame thermal breaks: Rigid polyvinylchloride extrusion.

.8 Glazing stops: Formed channel, minimum 16 mm high, accurately fitted, butted at corners and fastened to frame sections with counter-sunk oval head sheet metal screws. Exterior glazing stops to be tamperproof.

.9 Glass and glazing materials: Refer to Section 08 81 00.

.10 Metallic paste filler: to manufacturer's standard.

.11 Fire labels: Metal rivetted.

2.04 FRAME FABRICATION

.1 Fabricate frames including steel frames, transom panels, sidelights and windows in accordance with CSDMA specifications.

.2 Fabricate frames to profiles and maximum face sizes as indicated.

.3 Fabricate frames of the following construction unless specifically noted otherwise:
- .1 Exterior frames: 1.2 mm welded type construction, thermally broken type.
- .2 Interior frames: 1.2 mm welded type construction.

.4 Blank, reinforce, drill and tap frames for mortised, templated hardware, and electronic hardware using templates provided by finish hardware supplier. Reinforce frames for surface mounted hardware.

.5 Protect mortised cutouts with steel guard boxes.

.6 Prepare frame for door silencers, 3 for single door, 2 at head for double door.

.7 Manufacturer's nameplates on frames and screens are not permitted.

.8 Conceal fastenings except where exposed fastenings are indicated.

.9 Provide factory-applied touch up primer at areas where zinc coating has been removed during fabrication.

.10 Insulate exterior frame components with polyurethane insulation.

.11 Frame Anchorage:
- .1 Provide appropriate anchorage to floor and wall construction.
- .2 Locate each wall anchor immediately above or below each hinge reinforcement on hinge jamb and directly opposite on strike jamb.

.3 Provide two anchors for rebate opening heights up to 1520 mm and one additional anchor for each additional 760 mm of height or fraction thereof.

.12 Welded Frames:
- .1 Welding in accordance with CSA W59.
- .2 Accurately mitre or mechanically joint frame product and securely weld on inside of profile.
- .3 Cope accurately and securely weld butt joints of mullions, transom bars, centre rails and sills.
- .4 Grind welded joints and corners to flat plane, fill with metallic paste and sand to uniform smooth finish.
- .5 Securely attach floor anchors to inside of each jamb profile.
- .6 Weld in two temporary jamb spreaders per frame to maintain proper alignment during shipment.

.13 Thermally broken frames: Fabricate thermally broken frames separating exterior parts form interior parts with continuous interlocking thermal break.

2.05 DOOR FABRICATION

.1 Doors: swing type, flush, with provision for glass and/or louvre openings as indicated.

.2 Fabricate doors of the following construction unless specifically noted otherwise:
- .1 Exterior frames: laminated core construction.
- .2 Interior frames: laminated core construction.

.3 Fabricate doors with longitudinal edges tack welded at top and bottom of door, above and below each edge cutout and at 150 mm on center, filled and sanded. Seams: Grind welded joints to a flat plane, fill with metallic paste filler and sand to a uniform smooth finish.

.4 Blank, reinforce, drill doors and tap for mortised, templated hardware and electronic hardware.

.5 Factory prepare holes 12.7 mm diameter and larger except mounting and through-bolt holes, which shall be completed on-site at time of hardware installation. Holes less than 12.7 mm diameter shall be factory prepared when required for function of device (knob, lever, cylinder, thumb or turn pieces) or when these holes over-lap function holes.

.6 Reinforce doors where required, for surface mounted hardware. Provide flush PVC top caps to exterior doors. Provide inverted, recessed, spot welded channels to top and bottom of doors.

.7 Provide factory-applied touch-up primer at areas where zinc coating has been removed during fabrication.

.8 Provide fire labelled doors for those openings requiring fire protection ratings, as scheduled. Test such products in conformance with CAN/ULC S104 and NFPA 252. Provide ULC label plate on door at hinged edge midway between top hinge and head of door.

.9 Manufacturer's nameplates on doors are not permitted.

.10 Laminated Core Construction:
- .1 Form face sheets for exterior doors from 1.2 mm sheet steel with polystyrene core laminated under pressure to face sheets.
- .2 Form face sheets for interior doors from 1.2 mm sheet steel with honeycomb core laminated under pressure to face sheets.

.11 Thermally broken doors: Fabricate thermally broken doors by using insulated core and separating exterior parts from interior parts with continuous interlocking thermal break.

2.06 FINISHES

.1 Field paint steel doors and frames in accordance with Section 09 91 00.

.2 Protect weatherstrips from paint.

.3 Provide final finish free of scratches or other blemishes.

3 EXECUTION

3.01 EXAMINATION

.1 Examine and verify previously installed Work upon which this Section depends. Report defects or unsatisfactory conditions to Consultant. Commencement of work of this Section means acceptance of existing conditions.

.2 Check all door and frame products for correct size, swing, rating and opening number.

3.02 PREPARATION

.1 Remove temporary shipping spreaders.

.2 Check area of floor on which frames are to be installed, and within path of door swing for flatness. Report defects or unsatisfactory conditions to Consultant.

3.03 INSTALLATION

.1 Install doors and frames to CSDMA Installation Guide, reviewed Shop Drawings, and manufacturer's written instructions.

.2 Install labelled steel fire rated doors and frames to NFPA 80 except where specified otherwise.

.3 Install doors and hardware in accordance with hardware templates, manufacturer's instructions, and Section 08 71 00.

.4 Frame Installation:
- .1 Set frames plumb, square, level and at correct elevation.
- .2 Secure anchorages and connections to adjacent construction.
- .3 Brace frames rigidly in position while building-in. Install temporary horizontal wood spreader at third points of door opening to maintain frame width. Provide vertical support at centre of head for openings over 1200 mm wide. Remove temporary spreaders after frames are built-in.
- .4 Make allowances for deflection of structure to ensure structural loads are not transmitted to frames.
- .5 Caulk perimeter of frames between frame and adjacent material.
- .6 Maintain continuity of air barrier and vapour retarder at exterior frames.

.5 Door Installation:
- .1 Provide even margins between fire doors and jambs and fire doors and finished floor and thresholds as follows:
  - .1 Hinge side: 1.0 mm.
  - .2 Latch side and head: 1.5 mm.
  - .3 Finished floor, noncombustible sill and thresholds: 13 mm.
- .2 Adjust operable parts for correct function.
- .3 Install louvres.

.6 Install glazing for doors and frames in accordance with Section 08 81 00.

3.04 REPAIRS

.1 Touch up with primer finishes damaged during installation.

.2 Fill exposed frame anchors and surfaces with imperfections with metallic paste filler and sand to a uniform smooth finish.

END OF SECTION

1 GENERAL

1.01 SUMMARY

.1 Section includes all methods, materials and installation as required to complete the Work of this Section in accordance with the Conditions of the Contract.

.2 Work may include, but is not limited to;
- .1 Sectional doors.
- .2 Sectional doors with full view insulated units as indicated on drawings.

1.02 REFERENCES

.1 ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

.2 ASTM A653/A653M - Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.

.3 ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Required Hardness, Solution Hardened, and Bake Hardenable.

1.03 ADMINISTRATIVE REQUIREMENTS

.1 Site Meetings: Arrange a pre-installation meeting on Site to be attended by Consultant, Contractor, sectional door manufacturer's representative, and any other parties directly affecting work of this Section to:
- .1 Examine substrate conditions for compliance with manufacturer's requirements.
- .2 Review methods and procedures related to installation.
- .3 Review all typical and special details as required to complete the work of this section.

1.04 ACTION SUBMITTALS

.1 Submit action submittals in accordance with Section 01 33 00.

.2 Product data: Submit manufacturers product data for sectional doors including product characteristics, performance criteria, door components and limitations.

.3 Shop Drawings: Submit Shop Drawings as follows:
- .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.

.2 Shop Drawings to illustrate details, dimensions, fabrication and installation details.

.3 Indicate sizes, service rating, types, materials, operating mechanisms, glazing locations and details, hardware and accessories, required clearances and electrical connections.

.4 Reports/certificates: Submit the following:

.1 Certified test reports showing compliance with specified performance characteristics and physical properties.

.2 Certifications: product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

1.05 CLOSEOUT AND MAINTENANCE SUBMITTALS

.1 Submit closeout and maintenance submittals in accordance with Section 01 78 00.

.2 Closeout Product data: Submit manufacturers maintenance and cleaning data for incorporation into operation and maintenance manual including product warranty documentation.

1.06 WARRANTY

.1 Provide extended warranty for sectional doors in accordance with the General Conditions, except warranty is extended to three (3) years from date Ready-for-Takeover has been attained:

.1 Warranty to cover defects including failure to meet specified design criteria, and finish failure.

.2 Warranty shall cover complete replacement of Work, including adjacent work impacted.

.2 Provide extended warranty for sectional door panels in accordance with the General Conditions, except warranty is extended to ten (10) years from date Ready-for-Takeover has been attained and shall cover delamination of panels from core material. Warranty shall cover complete replacement of Work.

2 PRODUCTS

2.01 SYSTEMS AND MANUFACTURERS

.1 Thermostop Energex Mark IV-266 by Thermostop.

.2 Or approved equal.

2.02 PERFORMANCE CRITERIA

.1 Design exterior door assembly to withstand wind load of 1 kPa with a maximum horizontal deflection of 1/240 of opening width.

.2 Design door panel assemblies with minimum thermal insulation factor R-24.

.3 Design door assembly to withstand minimum 50,000 cycles per annum, and 15 years total life cycle.

2.03 OPERATION

.1 Doors to be electrically operated and be provided with safety edge to reverse door back to fully open position upon contact with object during closing cycle. Electrically operated doors to be provided with emergency chain hoist assembly to automatically cut electrical power when engaged. Provide the following controls:
  .1 Push buttons: Surface mounted push button stations, in locations indicated, with OPEN-STOP-CLOSE push buttons.

2.04 MATERIALS

.1 Galvanized steel sheet: ASTM A653/A653, commercial quality Z275 zinc coating.

.2 Steel sheet (tracks and ancillary items): commercial quality to ASTM A1008/A1008M.

.3 Insulation: Foamed in place, CFC and HCFC free polyurethane totally encapsulated.

.4 Black square frame glazed unit: Insulated glazed unit consisting of 305 mm x 610 mm tempered glazing contained within frame. Type B style by Thermostop or approved equal.

.5 Cable: Multi-strand galvanized steel aircraft cable.

.6 Zinc-rich primer:
  .1 Carbozinc 11WB by Carboline.
  .2 Dimetcote 9H by PPG.
  .3 Zinc Clad XL by Sherwin Williams.

.7 Airseal transition membrane:
  .1 Membrane: Self-adhering 1.0 mm thick rubberised asphalt water resistive air barrier. Basis of Design:
    .1 Blueskin SA by Henry Company Canada.
    .2 Sopraseal Stick 1100T by Soprema Canada.
    .3 ExoAir 110 by Tremco.

.4 Air-Shield by W.R. Meadows.

.2 Primer: Water based low VOC adhesive. Basis of Design:
- .1 Aquatac Primer by Henry Company Canada.
- .2 Elastocol Stick H20 by Soprema Canada.
- .3 ExoAir Primer by Tremco.
- .4 Mel-Prime W/B by W.R. Meadows.

.8 Expansion joint cover threshold: Refer to Section 07 95 13.

2.05 DOOR FABRICATION

.1 Fabricate minimum 101.6 mm thick insulated panel doors of roll formed steel sections as indicated.

.2 Fabricate panel frames in a continuous box frame with internal reinforcement.

.3 Install glazing for door sections. Sizes and number of lights as indicated.

.4 Assemble components by means of spot or arc welding or coated rivet system or adhesive and self-tapping screws to manufacturer's recommendations.

2.06 HARDWARE FABRICATION

.1 Standard Duty Industrial Track: high lift hardware with 75 mm size, 2.28 mm core thickness galvanized steel track.

.2 Track Supports: 2.3 mm core thickness continuous galvanized steel angle track supports.

.3 Spring counter balance: heavy duty oil tempered torsion spring with manufacturers standard brackets.
- .1 Drum: 133 mm diameter die cast aluminum.
- .2 Shaft: 25 mm diameter solid steel.

.4 Top roller carrier: galvanized steel minimum 2.28 mm thick.

.5 Rollers: full floating, grease packed hardened steel, ball bearing minimum 75 mm diameter, stamped tire.

.6 Roller brackets: adjustable, galvanized steel, minimum 2.5 mm thick.

.7 Hinges: Standard duty industrial 2.28 mm thick galvanized steel.

.8 Cable: minimum 4 mm diameter galvanized steel aircraft cable.

2.07 ACCESSORIES

.1 Overhead horizontal track and operator supports: Galvanized steel, type and size to suit installation.

.2 Track guards: 5 mm thick formed sheet 1500 mm high track guards.

.3 Pusher springs.

.4 Weatherstripping:
- .1 Sills: Bulb type full width extruded neoprene weatherstrip.
- .2 Jambs and head: extruded aluminum and arctic grade vinyl weatherstrip to manufacturer's standard.

2.08 ELECTRICAL OPERATOR

.1 Electrical jack shaft type operator.

.2 Electrical motors, controller units, pushbutton stations, relays and other electrical components: to CSA and ULC approval.

.3 Power supply: As indicated on Electrical Drawings.

.4 Controller units with integral motor reversing starter, braking system, 3 heater elements for overload protection, including pushbuttons, and control relays as applicable. Provide the following:
- .1 Floor level disconnect device to allow for manual operation in event of power failure.
- .2 Equip jack shaft operator with:
  - .1 Electrical interlock switch to disconnect power to operator when in manual operation.
  - .2 Built-in chain hoist for manual operation in event of power failure.

.5 Include hand chain interlocked auxiliary operator to disconnect motor mechanically and electrically when engaged and allow manual operation of door.

.6 Safety switch: combination roll rubber with limit switches for full length of bottom rail of bottom section of door, to reverse door to open position when coming in contact with object on closing cycle.

.7 Automatic illumination complete with time delay, self-extinguishing.

.8 Door speed: 300 mm per second.

.9 Control transformer: for 24 VAC control voltage.

.10 Mounting brackets: galvanized steel, size and gauge to suit conditions.

2.09 FINISHES

.1 Baked on polyvinylidene fluoride finish: Provide 0.2 mil baked-on primer coat, followed by 0.7 mil thick polyester top coat in custom Dark Grey colour to match insulated metal panels as approved by Consultant.

.2 Finish ferrous hardware items with zinc coating of 300 g/m² to ASTM A123/A123M.

3 EXECUTION

3.01 EXAMINATION

.1 Examine and verify previously installed Work upon which this Section depends. Report defects or unsatisfactory conditions to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.02 INSTALLATION

.1 Install sectional doors in accordance with manufacturer's written instructions, and reviewed Shop Drawings.

.2 Airseal transition membrane:
- .1 Install airseal transition membrane overlapped by minimum 75 mm in direction of waterflow. Hand roll membrane to ensure full adhesion to substrates.
- .2 Coordinate work to ensure continuity of weather and air seal is maintained throughout and at interface with adjacent components or systems.
- .3 Provide terminations fabricated from same material as airseal transition membrane or material recommended by membrane manufacturer at sills, lintels, openings, and where surfaces intersect to ensure moisture is shed to exterior.

.3 Rigidly support rail and operator and secure to supporting structure.

.4 Touch-up steel doors with primer where galvanized finish damaged during fabrication.

.5 Install operator including electrical motors, controller units, pushbutton stations, relays and other electrical equipment required for door operation.

.6 Lubricate and adjust door operating components to ensure smooth opening and closing of doors.

.7 Adjust weatherstripping to form a weather tight seal.

.8 Adjust doors for smooth operation.

3.03 SITE QUALITY CONTROL

.1 Test sectional doors in presence of Consultant.

END OF SECTION

1 GENERAL

1.01 SUMMARY

.1 Section includes all methods, materials and installation as required to complete the Work of this Section in accordance with the Conditions of the Contract.

.2 Work may include, but is not limited to;
- .1 Aluminum framed entrances.
- .2 Aluminum curtain wall.
- .3 Steel fire rated curtain wall and doors.
- .4 Aluminum vestibules.
- .5 Aluminum doors.

1.02 REFERENCES

.1 AAMA CWM - Curtain Wall Design Manual.

.2 AAMA 501 - Methods of Test for Exterior Walls.

.3 AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.

.4 AAMA/WDMA/CSA 101/I.S.2/A440 (NAFS), North American Fenestration Standard / Specification for Windows, Doors, and Skylights.

.5 ANSI/NFRC 100 - Procedure for Determining Fenestration Product U-Factors.

.6 ANSI/NFRC 200 - Determining Fenestration Product Solar Heat Gain Coefficient.

.7 ASTM A167 - Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.

.8 ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

.9 ASTM B209 - Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).

.10 ASTM B221 - Specification for Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric).

.11 ASTM C920 - Standard Specification for Elastomeric Joint Sealants.

.12 ASTM C1330 - Standard Specification for Cylindrical Sealant Backing for Use with Cold Liquid-Applied Sealants.

.13 ASTM E283 - Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.

.14 ASTM E330 - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights, and Curtain Walls, by Uniform Static Air Pressure Difference.

.15 ASTM E331 - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform Static Air Pressure Difference.

.16 CSA S157/S157.1 - Strength Design in Aluminum/Commentary on CSA S157, Strength Design in Aluminum.

.17 CAN/CSA W59 - Welded Aluminum Construction.

.18 ULC S710.1 - Standard for Bead-applied One Component Polyurethane Air Sealant Foam, Part 1: Material Specification.

1.03 ADMINISTRATIVE REQUIREMENTS

.1 Coordination: Co-ordinate work of this Section with installation of fire stopping, air and vapour retarders, flashing placement, and components or materials.

.2 Site Meetings: Arrange a pre-installation meeting on Site to be attended by Consultant, Contractor, curtain wall and aluminum framed system manufacturer's representative, and any other parties directly affecting work of this Section to:

- .1 Examine substrate conditions for compliance with manufacturer's requirements.
- .2 Review methods and procedures related to installation.
- .3 Review all typical and special details as required to complete the work of this section.

1.04 ACTION SUBMITTALS

.1 Submit action submittals in accordance with Section 01 33 00.

.2 Product data: Submit manufacturers product data for aluminum framed systems including system components, anchorage and fasteners, glass and infill, and internal drainage details and include product characteristics, performance criteria, physical size, finish and limitations and water flow diagrams.

.3 Shop Drawings: Submit Shop Drawings as follows:
- .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.
- .2 Shop Drawings to illustrate details, dimensions, fabrication and installation details.
- .3 Indicate system dimensions, framed opening requirements and tolerances, adjacent construction, anchor details anticipated deflection under load, affected related Work, weep drainage network, expansion and contraction joint location and details, and field welding required.
- .4 Include structural support framing components and physical characteristics, calculations, dimensional limitations, and special installation requirements.

.4 Samples: Submit 300 mm x 300 mm samples illustrating colours, textures and finishes including, but not limited to:
- .1 Prefinished aluminum surface, finish, colour, and texture.
- .2 Prefinished steel curtain wall surface, finish, colour, and texture.
- .3 Specified glass units, insulated infill panels, and glazing materials illustrating edge and corner.

.5 Reports/certificates: Submit the following:
- .1 Test Reports: Submit substantiating engineering data, test results of previous tests by independent laboratory which purport to meet performance criteria, and supportive data.

1.05 CLOSEOUT AND MAINTENANCE SUBMITTALS

.1 Submit closeout and maintenance submittals in accordance with Section 01 78 00.

.2 Closeout Product data: Submit manufacturers maintenance and cleaning data for incorporation into operation and maintenance manual including product warranty documentation.

1.06 QUALITY ASSURANCE

.1 Manufacturers: Company specializing in manufacturing the products specified in this section with minimum 5 years experience.

.2 Installers: Perform Work of this Section by a company that has a minimum of five (5) years proven experience in the installation of curtain walls and aluminum framed systems of a similar size and nature.

.3 Mock-ups:
- .1 Construct one (1) mock-up of each type of curtain wall and aluminum framed system in location as directed by Consultant.
- .2 Provide one (1) 1067 mm x 2650 mm thermal model of representative unit.

.3 Mock-up shall be full scale and demonstrate conformance to specified design requirements. Assemble to illustrate component assembly including glazing materials, weep drainage system, attachments, anchors, and perimeter sealant.
.4 Mock-up shall include mullions, and vision glass light.
.5 Mock-up may form part of the Work if accepted by the Consultant.

1.07 DELIVERY, STORAGE, AND HANDLING

.1 Handle work of this Section in accordance with AAMA CW-10.

.2 Store and protect aluminum framed systems from nicks, scratches, and blemishes.

.3 Protect prefinished aluminum surfaces with wrapping or strippable coating. Do not use adhesive papers or sprayed coatings which bond when exposed to sunlight or weather.

1.08 SITE CONDITIONS

.1 Ambient Conditions: Install sealants when ambient and surface temperature is above 5 degrees C minimum. Maintain this minimum temperature during and for 48 hours minimum after installation of sealants.

1.09 WARRANTY

.1 Provide extended warranty for curtain walls and aluminum framed systems in accordance with the General Conditions, except warranty is extended to five (5) years from date Ready-for-Takeover has been attained:
.1 Warranty to cover defects including sealant failure, leakage, frame condensation and finish failure.
.2 Warranty shall cover complete replacement of Work, including adjacent work impacted.

.2 Refer to Section 08 81 00 for insulated glass unit warranty.

2 PRODUCTS

2.01 SYSTEMS AND MANUFACTURERS

.1 Aluminum framed curtainwall: Vertical glazed aluminum curtainwall system of thermally broken tubular aluminum sections, shop fabricated, factory prefinished; related flashings, anchorage and attachment devices.
.1 Profile: Minimum 63.5 mm.
.2 Pressure caps: Profile as selected by Consultant.
.3 Designed for triple glazing.

.4 Basis of Design:
.1 ThermaWall 2600 by Alumicor Limited.
.2 1600UT System 2 by Kawneer
.3 Series HP3253 by United States Aluminum (CRL).
.4 Or approved equal by Oldcastle Building Envelope.

.2 Steel fire rated curtainwall with doors: Steel fire rated glazed curtainwall system with steel tubing permanently joined with steel bolts, factory prefinished; related flashings, anchorage and attachment devices.
.1 Pressure caps: Profile as selected by Consultant.
.2 Designed for double glazing.
.3 Doors: Pre-hung and prefinished, complete with door hardware.
.4 Basis of Design curtainwall:
.1 FireFrames Curtainwall Series by Technical Glass Products.
.2 Or approved equal.
.5 Basis of Design doors:
.1 FireFrames Designer Series Doors by Technical Glass Products.
.2 Or approved equal.

.3 Vestibule framing: Non-thermally broken aluminum framing, factory fabricated and finished; related flashings, anchorage and attachment devices.
.1 Profile: Minimum 44.5 mm.
.2 Designed for single glazing.
.3 Basis of Design:
.1 FlushGlaze TL 1800 by Alumicor Limited.
.2 Trifab VersaGlaze 450 by Kawneer
.3 Series 450 by United States Aluminum (CRL).
.4 FG-2000 by Oldcastle Building Envelope.

.4 Aluminum framed doors:
.1 Exterior Doors: Thermally broken aluminum doors with glazing, factory fabricated and finished.
.1 Profile: Minimum 50.8 mm.
.2 Stiles: narrow.
.3 Basis of Design:
.1 Phantom Door 100A by Alumicor Limited.
.2 Or approved equal by Kawneer, Oldcastle Building Envelope, or United States Aluminum (CRL).
.2 Interior Doors: Non-thermally broken aluminum doors with glazing, factory fabricated and finished.
.1 Profile: Minimum 44.5 mm.
.2 Stiles: narrow.
.3 Basis of Design:
.1 Canadiana 100 by Alumicor Limited.
.2 Standard Entrance 190 by Kawneer.
.3 Series 250 by United States Aluminum (CRL).

.4 Or approved equal by Oldcastle Building Envelope.

2.02 PERFORMANCE CRITERIA

.1 Design curtain walls and aluminum framed systems to resist loads and climatic data for the Place of the Work, and as follows:
- .1 Design systems to follow rainscreen principles.
- .2 Ensure horizontal members are sealed to vertical members to form individual compartments in accordance with rainscreen principles.
- .3 Ventilate and pressure equalize air space outside exterior surface of insulation to exterior.

.2 Design aluminum framed curtainwall systems to AAMA CWM.

.3 Design structural support framing components to CSA S157/S157.1.

.4 Design and size curtain walls and aluminum framed system components to withstand dead and live loads caused by pressure and suction of wind, acting normal to plane of wall using design pressure to ASTM E330 and as outlined below:
- .1 Design system for expansion and contraction caused by cycling temperature range of 95 degrees C over 12 hour period without causing detrimental effect to system components.
- .2 Thermal expansion: Ensure framed system can withstand temperature differential of 85 degrees C and is able to accommodate interior and exterior system expansion and contraction without damage to components or deterioration of seals.
- .3 Design vertical expansion joints with baffled overlaps and compressed resilient air seal laid between mullion ends.
- .4 Ensure system is designed to accommodate:
  - .1 Movement within framed assembly.
  - .2 Movement between system and perimeter framing components.
  - .3 Dynamic loading and release of loads.
  - .4 Deflection of structural support framing.
  - .5 Shortening of building concrete structural columns.
  - .6 Creep of concrete structural members.
- .5 Thermal resistance: Design curtain wall and aluminum framed systems including insulated glass units to meet the following maximums as calculated to ANSI/NFRC 100 and ANSI/NFRC 200:
  - .1 U-factor: Maximum 1.136 W/m2.K.
  - .2 SHGC: Maximum 0.3.
- .6 Limit mullion deflection to L/200 maximum with full recovery of glazing materials.
- .7 Deadload prevention: Design curtain wall and aluminum framed system with separate, integrated support for insulating glass units.

.8 Air infiltration:
  .1 Curtainwalls and entrance assemblies: 0.3 L/s/m2 maximum of wall area to ASTM E283 at differential pressure across assembly of 300 Pa.
  .2 Doors: 0.3 L/s/m2 maximum of wall area to ASTM E283 at differential pressure across assembly of 300 Pa.

.9 Water infiltration: None to ASTM E331 at differential pressure across assembly of 720 Pa.

.10 Ensure interior surfaces have no condensation before exposed edges of sealed units reach dew point temperatures during testing to AAMA 501.

.11 Maintain continuous air barrier and vapour retarder throughout building envelope and aluminum framed system assembly.

.12 Ensure no vibration harmonics, wind whistles, noises caused by thermal movement, thermal movement transmitted to other building elements, loosening, weakening, or fracturing of attachments or components of system occur.

.5 Window classification rating: to AAMA/WDMA/CSA 101/I.S.2/A440 (NAFS) as follows:
  .1 Primary designation:
    .1 Performance classes: CW.
    .2 Performance grade (PG): 30.
  .2 Secondary designation:
    .1 Minimum positive design pressure: 1440 Pa.
    .2 Minimum negative design pressure: -1440 Pa.
    .3 Minimum water penetration resistance test pressure: 220 Pa.
    .4 Canadian air infiltration and exfiltration levels: A2.
  .3 Surface condensation control: compliant with standard CAN/CSA-A440.2/A440.3.
  .4 Forced Entry: F2.

.6 Design system to permit re-glazing of individual glass and infill panels from exterior without requiring removal of structural mullions.

2.03 MATERIALS

.1 Extruded aluminum: To ASTM B221, 6063 alloy with T6 temper.

.2 Sheet aluminum: To ASTM B209, utility grade for unexposed surfaces.

.3 Steel sections: to ASTM A167 Type 304 stainless; shaped to suit mullion sections.

.4 Insulating glass units: In accordance with Section 08 81 00.

.5 Thermal Break: Glass fibre reinforced polyamide porthole extrusion.

.6 Foam Insulation: Single component, moisture cure, low expansion rate spray-in-place polyurethane liquid foam insulation to ULC S710.1 and in accordance with manufacturer's written recommendations.

.7 Fasteners, screws and bolts: Tamperproof, cadmium plated stainless steel 300 series to meet aluminum framed system requirements and as recommended by manufacturer.

.8 Anchors: Extruded aluminum or stainless steel with three-way adjustment.

.9 Sealant Materials:
- .1 Sealant:
  - .1 Single-component, neutral cure, silicone sealant conforming to ASTM C920, Type S, Grade NS, Class 50.
  - .2 Verify compatibility with insulating glass unit sealants prior to purchase.
  - .3 Colour: To be selected by Consultant.
  - .4 Basis of Design:
    - .1 Dowsil 795 Silicone Building Sealant by Dow.
    - .2 Sikasil WS-295 by Sika Canada.
    - .3 Spectrum 2 by Tremco.
    - .4 Or approved equal.
- .2 Joint backing: to ASTM C1330; Round, solid section, soft polyethylene foam gasket compatible with primer and sealant materials.
- .3 Primer: As recommended by sealant manufacturer.

.10 Airseal transition membrane:
- .1 Membrane: Self-adhering 1.0 mm thick rubberised asphalt water resistive air barrier. Basis of Design:
  - .1 Blueskin SA by Henry Company Canada.
  - .2 Sopraseal Stick 1100T by Soprema Canada.
  - .3 ExoAir 110 by Tremco.
  - .4 Air-Shield by W.R. Meadows.
- .2 Primer: Water based low VOC adhesive. Basis of Design:
  - .1 Aquatac Primer by Henry Company Canada.
  - .2 Elastocol Stick H20 by Soprema Canada.
  - .3 ExoAir Primer by Tremco.
  - .4 Mel-Prime W/B by W.R. Meadows.

2.04 FABRICATION

.1 Fabricate system components with minimum clearances and shim spacing around perimeter of assembly, yet enabling installation and dynamic movement of perimeter seal.

.2 Accurately fit and secure joints and corners. Make joints flush, hairline, and weatherproof.

.3 Construct units square, plumb and free from distortion, waves, twists, buckles or other defects detrimental to performance or appearance.

.4 Perform aluminum welding to CAN/CSA W59.2.

.5 Fabricate aluminum assemblies of extruded sections to sizes and profiles indicated:
- .1 Ensure vertical and horizontal members are tubular extrusions designed for shear block corner construction.
- .2 Mullion depth sizes as indicated.
- .3 Fabricate aluminum framed systems with separate, integrated support for insulating glass unit.
- .4 Structural silicone joints where indicated.

.6 Prepare components to receive anchor devices. Install anchors.

.7 Arrange fasteners and attachments to ensure concealment from view.
- .1 Ensure fasteners do not penetrate thermal break.
- .2 If fasteners cannot be concealed, countersunk screws finished to match adjacent material may be acceptable only upon written approval from Consultant.

.8 Prepare system components to receive doors and openings as indicated on drawings.

.9 Reinforce framing members for external imposed loads.

.10 Visible manufacturer's identification labels not permitted.

.11 Doors:
- .1 Fabricate stiles and rails of tubular extrusions designed for mechanical shear block fastening in combination with SIGMA deep penetration plug welds and fillet welds at all stile/rail connections.
- .2 Construct doors square, plumb and free from distortion, waves, twists, buckles or other defects detrimental to performance or appearance.
- .3 Install door hardware.

.12 Flashings: Minimum 3 mm thick aluminum, finish to match aluminum framed systems, secured with concealed fastening method.

2.05 FINISHES

.1 Exterior exposed surfaces:
- .1 To AAMA 2605, 3-coat, thermal setting enamel consisting of primer, colour coat and clear coat with 70% minimum fluoropolymer resin and polvinyldiene fluoride (PVDF).
- .2 Dry film thickness: 0.03 mm (1.2 mil) minimum total thickness.
- .3 Acceptable coating: Duranar XL by PPG Industries.
- .4 Colour: Medium Grey to be selected by Consultant.

.2 Interior exposed surfaces:
- .1 To AAMA 2605, 3-coat, thermal setting enamel consisting of primer, colour coat and clear coat with 70% minimum fluoropolymer resin and polvinyldiene fluoride (PVDF).
- .2 Dry film thickness: 0.03 mm (1.2 mil) minimum total thickness.
- .3 Acceptable coating: Duranar XL by PPG Industries.
- .4 Colour: Medium Grey to be selected by Consultant.

3 EXECUTION

3.01 EXAMINATION

.1 Examine and verify previously installed Work upon which this Section depends. Report defects or unsatisfactory conditions to Consultant. Commencement of work of this Section means acceptance of existing conditions.

.2 Verify wall openings and adjoining air barrier and vapour retarder materials are ready to receive work of this Section.

3.02 INSTALLATION

.1 Install curtain walls and aluminum framed systems in accordance with manufacturer's instructions.

.2 Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.

.3 Use alignment attachments and shims to permanently fasten system to building structure. Clean weld surfaces; apply protective primer to field welds and adjacent surfaces.

.4 Align assembly plumb and level, free of warp or twist. Maintain assembly dimensional tolerances and align with adjacent work.

.5 Use thermal isolation where components penetrate or disrupt building insulation.

.6 Install flashings.

.7 Co-ordinate installation of firestop insulation, specified in Section 07 84 00, at each floor slab edge and intersection with vertical construction where indicated.

.8 Co-ordinate attachment and seal of perimeter air barrier and vapour retarder materials.

.9 Airseal transition membrane:
- .1 Install airseal transition membrane overlapped by minimum 75 mm in direction of waterflow. Hand roll membrane to ensure full adhesion to substrates.
- .2 Coordinate work to ensure continuity of weather and air seal is maintained throughout aluminum work and at interface with adjacent components or systems.
- .3 Provide terminations fabricated from same material as airseal transition membrane or material recommended by membrane manufacturer at sills, lintels, openings, and where surfaces intersect to ensure moisture is shed to exterior.

.10 Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.

.11 Install fireproofing in areas as indicated.

.12 Install glass in accordance with Section 08 81 00.

.13 Install perimeter sealant to method required to achieve performance criteria.

.14 Install swing doors in accordance with manufacturer's written instructions. Adjust operable parts for correct function and ensure doors do not bind while opening and closing.

3.03 SITE TOLERANCES

.1 Maximum variation from plumb: 1.5 mm/m non-cumulative or 12 mm/30 m, whichever is less.

.2 Maximum misalignment of two adjoining members abutting in plane: 0.8 mm.

.3 Maximum sealant space between aluminum framed system and adjacent construction: 13 mm.

3.04 CLEANING

.1 Leave Work area clean at end of each day.

.2 Remove protective material from prefinished aluminum surfaces.

.3 Wash down surfaces with a solution of mild detergent in warm water, applied with soft, clean wiping cloths. Take care to remove dirt from corners. Wipe surfaces clean.

.4 Remove excess sealant by moderate use of mineral spirits or other solvent acceptable to sealant manufacturer.

3.05 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by curtain walls and glazed aluminum framed system installation.

END OF SECTION

SECTION 087100 - DOOR HARDWARE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes commercial door hardware for the following:

1. Swinging doors.
2. Sliding doors.
3. Other doors to the extent indicated.

B. Door hardware includes, but is not necessarily limited to, the following:

1. Mechanical door hardware.
2. Electromechanical door hardware.
3. Automatic operators.
4. Cylinders specified for doors in other sections.

C. Related Sections:

1. Division 01 Section “Cash Allowances”.
2. Division 01 Section “Product Allowances”.
3. Division 01 Section “Closeout Procedures”
4. Division 08 Section “Door Hardware Schedule”.
5. Division 08 Section “Hollow Metal Doors and Frames”.
6. Division 08 Section “Interior Aluminum Doors and Frames”.
7. Division 08 Section “Aluminum-Framed Entrances and Storefronts”.
8. Division 08 Section “Automatic Door Operators”.
9. Division 28 Section “Access Control Hardware Devices”.

D. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.

1. OBC – Ontario Building Code
2. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
3. ICC/IBC - International Building Code.
4. NFPA 70 - National Electrical Code.
5. NFPA 80 - Fire Doors and Windows.
6. NFPA 101 - Life Safety Code.
7. NFPA 105 - Installation of Smoke Door Assemblies.

8. UL/ULC and CSA C22.2 - Standards for Automatic Door Operators Used on Fire and Smoke Barrier Doors and Systems of Doors.
9. Local Building Codes, Local Amendments.

E. Standards: All hardware specified herein shall comply with the following industry standards as applicable. Any undated reference to a standard shall be interpreted as referring to the latest edition of that standard:

1. ANSI/BHMA Certified Product Standards - A156 Series.
2. UL10C - Positive Pressure Fire Tests of Door Assemblies.
3. ANSI/UL 294 - Access Control System Units.
4. UL 305 - Panic Hardware.

1.3 SUBMITTALS

A. Product Data: Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, operational descriptions and finishes.

B. Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing, fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."
2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening. Organize door hardware sets in same order as in the Door Hardware Sets at the end of Part 3. Submittals that do not follow the same format and order as the Door Hardware Sets will be rejected and subject to resubmission.
3. Content: Include the following information:

    a. Type, style, function, size, label, hand, and finish of each door hardware item.
    b. Manufacturer of each item.
    c. Fastenings and other pertinent information.
    d. Location of door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
    e. Explanation of abbreviations, symbols, and codes contained in schedule.
    f. Mounting locations for door hardware.
    g. Door and frame sizes and materials.
    h. Warranty information for each product.

4. Submittal Sequence: Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.

C. Shop Drawings: Details of electrified access control hardware indicating the following:

1. Wiring Diagrams: Upon receipt of approved schedules, submit detailed system wiring diagrams for power, signaling, monitoring, communication, and control of the access control system electrified hardware. Differentiate between manufacturer-installed and field-installed wiring. Include the following:

   a. Elevation diagram of each unique access controlled opening showing location and interconnection of major system components with respect to their placement in the respective door openings.
   b. Complete (risers, point-to-point) access control system block wiring diagrams.
   c. Wiring instructions for each electronic component scheduled herein.

2. Electrical Coordination: Coordinate with related sections the voltages and wiring details required at electrically controlled and operated hardware openings.

D. Keying Schedule: After a keying meeting with the owner has taken place prepare a separate keying schedule detailing final instructions. Submit the keying schedule in electronic format. Include keying system explanation, door numbers, key set symbols, hardware set numbers and special instructions. Owner must approve submitted keying schedule prior to the ordering of permanent cylinders/cores.

E. Informational Submittals:

1. Product Test Reports: Indicating compliance with cycle testing requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified independent testing agency.

1.4 CLOSEOUT SUBMITTALS

A. Operating and Maintenance Manuals: Provide manufacturers operating and maintenance manuals for each item comprising the complete door hardware installation in quantity as required in Division 01, Closeout Procedures.

B. Project Record Documents: Provide record documentation of as-built door hardware sets in digital format (.pdf, .docx, .xlsx, .csv) and as required in Division 01, Project Record Documents.

1.5 QUALITY ASSURANCE

A. Manufacturers Qualifications: Engage qualified manufacturers with a minimum 5 years of documented experience in producing hardware and equipment similar to that indicated for this Project and that have a proven record of successful in-service performance.

B. Certified Products: Where specified, products must maintain a current listing in the Builders Hardware Manufacturers Association (BHMA) Certified Products Directory (CPD).

C. Installer Qualifications: A minimum 3 years documented experience installing both standard and electrified door hardware similar in material, design, and extent to that indicated for this

Project and whose work has resulted in construction with a record of successful in-service performance.

D. Door Hardware Supplier Qualifications: Experienced commercial door hardware distributors with a minimum 5 years documented experience supplying both mechanical and electromechanical hardware installations comparable in material, design, and extent to that indicated for this Project. Supplier recognized as a factory direct distributor by the manufacturers of the primary materials with a warehousing facility in Project's vicinity. Supplier to have on staff a certified Architectural Hardware Consultant (AHC) available during the course of the Work to consult with Contractor, Architect, and Owner concerning both standard and electromechanical door hardware and keying.

E. Building Information Modeling (BIM) Qualifications: BIM software tools and processes are used to produce and support data integration of product and technical information used in specifications, submittals, project reviews, decision support, and quality assurance during all phases of Project design, construction, and facility management. Door and hardware schedules and the associated product data parameters are to be derived, updated, and fully integrated with the coordinated Building Information Modeling as required under Division 01.

F. Source Limitations: Obtain each type and variety of door hardware specified in this section from a single source unless otherwise indicated.

1. Electrified modifications or enhancements made to a source manufacturer's product line by a secondary or third party source will not be accepted.
2. Provide electromechanical door hardware from the same manufacturer as mechanical door hardware, unless otherwise indicated.

G. Each unit to bear third party permanent label indicating compliance with the referenced testing standards.

H. Keying Conference: Conduct conference to comply with requirements in Division 01 Section "Project Meetings." Keying conference to incorporate the following criteria into the final keying schedule document:

1. Function of building, purpose of each area and degree of security required.
2. Plans for existing and future key system expansion.
3. Requirements for key control storage and software.
4. Installation of permanent keys, cylinder cores and software.
5. Address and requirements for delivery of keys.

I. Pre-Submittal Conference: Conduct coordination conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier(s), Installer(s), and Contractor(s) to review proper methods and the procedures for receiving, handling, and installing door hardware.

1. Prior to installation of door hardware, conduct a project specific training meeting to instruct the installing contractors' personnel on the proper installation and adjustment of their respective products. Product training to be attended by installers of door hardware (including electromechanical hardware) for aluminum, hollow metal and wood doors.

Training will include the use of installation manuals, hardware schedules, templates and physical product samples as required.

2. Inspect and discuss electrical roughing-in, power supply connections, and other preparatory work performed by other trades.
3. Review sequence of operation narratives for each unique access controlled opening.
4. Review and finalize construction schedule and verify availability of materials.
5. Review the required inspecting, testing, commissioning, and demonstration procedures

J. At completion of installation, provide written documentation that components were applied according to manufacturer's instructions and recommendations and according to approved schedule.

1.6 DELIVERY, STORAGE AND HANDLING

A. Inventory door hardware on receipt and provide secure lock-up and shelving for door hardware delivered to Project site. Do not store electronic access control hardware, software or accessories at Project site without prior authorization.

B. Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.

C. Deliver, as applicable, permanent keys, cylinders, cores, access control credentials, software and related accessories directly to Owner via registered mail or overnight package service. Instructions for delivery to the Owner shall be established at the "Keying Conference".

1.7 COORDINATION

A. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing standard and electrified hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing hardware to comply with indicated requirements.

B. Door Hardware and Electrical Connections: Coordinate the layout and installation of scheduled electrified door hardware and related access control equipment with required connections to source power junction boxes, low voltage power supplies, detection and monitoring hardware, and fire and detection alarm systems.

C. Door and Frame Preparation: Doors and corresponding frames are to be prepared, reinforced and pre-wired (if applicable) to receive the installation of the specified electrified, monitoring, signaling and access control system hardware without additional in-field modifications.

1.8 WARRANTY

A. General Warranty: Reference Division 01, General Requirements. Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

B. Warranty Period: Written warranty, executed by manufacturer(s), agreeing to repair or replace components of standard and electrified door hardware that fails in materials or workmanship within specified warranty period after final acceptance by the Owner. Failures include, but are not limited to, the following:

1. Structural failures including excessive deflection, cracking, or breakage.
2. Faulty operation of the hardware.
3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
4. Electrical component defects and failures within the systems operation.

C. Warranty Period: Unless otherwise indicated, warranty shall be one year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 BUTT HINGES

A. Hinges: ANSI/BHMA A156.1 butt hinges with number of hinge knuckles and other options as specified in the Door Hardware Sets.

1. Quantity: Provide the following hinge quantity:

a. Two Hinges: For doors with heights up to 60 inches.
b. Three Hinges: For doors with heights 61 to 90 inches.
c. Four Hinges: For doors with heights 91 to 120 inches.
d. For doors with heights more than 120 inches, provide 4 hinges, plus 1 hinge for every 30 inches of door height greater than 120 inches.

2. Hinge Size: Provide the following, unless otherwise indicated, with hinge widths sized for door thickness and clearances required:

a. Widths up to 3’0”: 4-1/2” standard or heavy weight as specified.
b. Sizes from 3’1” to 4’0”: 5” standard or heavy weight as specified.

3. Hinge Weight and Base Material: Unless otherwise indicated, provide the following:

a. Exterior Doors: Heavy weight, non-ferrous, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate standard weight.
b. Interior Doors: Standard weight, steel, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate heavy weight.

4. Hinge Options: Comply with the following:

a. Non-removable Pins: With the exception of electric through wire hinges, provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for all out-swinging lockable doors.

5. Manufacturers:

a. McKinney (MK) - TA Series, 3-knuckle.

2.2 CONTINUOUS HINGES

A. Continuous Geared Hinges: ANSI/BHMA A156.26 Grade 1-600 continuous geared hinge. with minimum 0.120-inch thick extruded 6063-T6 aluminum alloy hinge leaves and a minimum overall width of 4 inches. Hinges are non-handed, reversible and fabricated to template screw locations. Factory trim hinges to suit door height and prepare for electrical cut-outs.

1. Manufacturers:.

a. Pemko (PE).

2.3 POWER TRANSFER DEVICES

A. Electrified Quick Connect Transfer Hinges: Provide electrified transfer hinges with Molex™ standardized plug connectors and sufficient number of concealed wires (up to 12) to accommodate the electrified functions specified in the Door Hardware Sets with a 1-year warranty. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Wire nut connections are not acceptable.

1. Manufacturers:

a. McKinney (MK) - QC (# wires) Option.

B. Electric Door Wire Harnesses: Provide electric/data transfer wiring harnesses with standardized plug connectors to accommodate up to twelve (12) wires. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Provide sufficient number and type of concealed wires to accommodate electric function of specified hardware. Provide a connector for through-door electronic locking devices and from hinge to junction box above the opening. Wire nut connections are not acceptable. Determine the length required for each electrified hardware component for the door type, size and construction, minimum of two per electrified opening.

1. Provide one each of the following tools as part of the base bid contract:

a. McKinney (MK) - Electrical Connecting Kit: QC-R001.
b. McKinney (MK) - Connector Hand Tool: QC-R003.

2. Manufacturers:

a. McKinney (MK) - QC-C Series.

2.4 DOOR OPERATING TRIM

A. Flush Bolts and Surface Bolts: Provide products conforming to ANSI/BHMA A156.3 and A156.16, Grade 1.

1. Flush bolts to be furnished with top rod of sufficient length to allow bolt retraction device location approximately six feet from the floor.
2. Furnish dust proof strikes for bottom bolts.
3. Surface bolts to be minimum 8” in length and U.L. listed for labeled fire doors and U.L. listed for windstorm components where applicable.
4. Provide related accessories (mounting brackets, strikes, coordinators, etc.) as required for appropriate installation and operation.
5. Manufacturers:

    a. Rockwood (RO).

B. Coordinators: ANSI/BHMA A156.3 door coordinators consisting of active-leaf, hold-open lever and inactive-leaf release trigger. Model as indicated in hardware sets.

1. Manufacturers:

    a. Rockwood (RO).

2.5 CYLINDERS AND KEYING

A. General: Medeco By Owner.

B. Cylinder Types: Original manufacturer cylinders able to supply the following cylinder formats and types:

1. Threaded mortise cylinders with rings and cams to suit hardware application.
2. Rim cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
3. Mortise and rim cylinder collars to be solid and recessed to allow the cylinder face to be flush and be free spinning with matching finishes.
4. Keyway: Manufacturer’s Standard.
5. New System: Key locks to a new key system as directed by the Owner.

C. Key Registration List (Bitting List):

1. Furnish a list of opening numbers with locking devices, showing cylinder types and quantities required when cylinders or cores are to be owner furnished.

2.6 MORTISE LOCKS AND LATCHING DEVICES

A. Mortise Locksets, Grade 1 (Heavy Duty): Provide ANSI/BHMA A156.13, Series 1000, Operational Grade 1 Certified Products Directory (CPD) listed mortise locksets. Listed manufacturers shall meet all functions and features as specified herein.

1. Electromechanical locksets shall have the following functions and features:

    a. Universal Molex plug-in connectors that have standardized color-coded wiring and are available in fail safe or fail secure and operate from 12vdc to 24vdc regulated.

b. EcoFlex or equivalent technology that reduces energy consumption up to 92% as certified by GreenCircle.
c. Motorized electric latch retraction where the latchbolt retracts in 0.5 seconds of power being applied; removing power allows the latch to project back to the extended position. Motorized latch retraction force exceeds ANSI/BHMA 50 lbs. warped door test.
d. Options to be available for request-to-exit or enter signaling, latchbolt and deadbolt monitoring.
e. Optional high security monitoring with internal end-of-line monitoring alongside deadbolt privacy and integrated door position monitoring.
f. Two-year limited warranty on electrified functions.

2. Manufacturers:

a. Corbin Russwin Hardware (RU) - ML2000 Series.

2.7 LOCK AND LATCH STRIKES

A. Strikes: Provide manufacturer's standard strike with strike box for each latch or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, unless otherwise indicated, and as follows:

1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.
3. Aluminum-Frame Strike Box: Provide manufacturer's special strike box fabricated for aluminum framing.
4. Double-lipped strikes: For locks at double acting doors. Furnish with retractable stop for rescue hardware applications.

B. Standards: Comply with the following:

1. Strikes for Mortise Locks and Latches: BHMA A156.13.
2. Strikes for Bored Locks and Latches: BHMA A156.2.
3. Strikes for Auxiliary Deadlocks: BHMA A156.36.
4. Dustproof Strikes: BHMA A156.16.

2.8 ELECTRIC STRIKES

A. Standard Electric Strikes: Electric strikes conforming to ANSI/BHMA A156.31, Grade 1, for use on non-rated or fire rated openings. Strikes shall be of stainless steel construction tested to a minimum of 1500 pounds of static strength and 70 foot-pounds of dynamic strength with a minimum endurance of 1 million operating cycles. Provide strikes with 12 or 24 VDC capability, fail-secure unless otherwise specified. Where specified provide latchbolt and latchbolt strike monitoring indicating both the position of the latchbolt and locked condition of the strike.

1. Manufacturers:

a. Rutherford Controls (RC) - F2100/F2300 Series.

B. Surface Mounted Rim Electric Strikes: Surface mounted rim exit device electric strikes conforming to ANSI/BHMA A156.31, Grade 1, and UL Listed for both Burglary Resistance and for use on fire rated door assemblies. Construction includes internally mounted solenoid with two heavy-duty, stainless steel locking mechanisms operating independently to provide tamper resistance. Strikes tested for a minimum of 500,000 operating cycles. Provide strikes with 12 or 24 VDC capability supplied standard as fail-secure unless otherwise specified. Option available for latchbolt and latchbolt strike monitoring indicating both the position of the latchbolt and locked condition of the strike. Strike requires no cutting to the jamb prior to installation.

1. Manufacturers:

a. HES (HS) - 9600.

C. Provide electric strikes with in-line power controller and surge suppressor by the same manufacturer as the strike with the combined products having a five year warranty.

2.9 CONVENTIONAL EXIT DEVICES

A. General Requirements: All exit devices specified herein shall meet or exceed the following criteria:

1. At doors not requiring a fire rating, provide devices complying with NFPA 101 and listed and labeled for "Panic Hardware" according to UL305. Provide proper fasteners as required by manufacturer including sex nuts and bolts at openings specified in the Hardware Sets.
2. Where exit devices are required on fire rated doors, provide devices complying with NFPA 80 and with UL labeling indicating "Fire Exit Hardware". Provide devices with the proper fasteners for installation as tested and listed by UL. Consult manufacturer’s catalog and template book for specific requirements.
3. Except on fire rated doors, provide exit devices with hex key dogging device to hold the pushbar and latch in a retracted position. Provide optional keyed cylinder dogging on devices where specified in Hardware Sets.
4. Devices must fit flat against the door face with no gap that permits unauthorized dogging of the push bar. The addition of filler strips is required in any case where the door light extends behind the device as in a full glass configuration.
5. Lever Operating Trim: Where exit devices require lever trim, furnish manufacturer's heavy duty escutcheon trim with threaded studs for thru-bolts.

a. Lock Trim Design: As indicated in Hardware Sets, provide finishes and designs to match that of the specified locksets.
b. Where function of exit device requires a cylinder, provide a cylinder (Rim or Mortise) as specified in Hardware Sets.

6. Vertical Rod Exit Devices: Where surface or concealed vertical rod exit devices are used at interior openings, provide as less bottom rod (LBR) unless otherwise indicated. Provide dust proof strikes where thermal pins are required to project into the floor.

7. Narrow Stile Applications: At doors constructed with narrow stiles, or as specified in Hardware Sets, provide devices designed for maximum 2” wide stiles.
8. Dummy Push Bar: Nonfunctioning push bar matching functional push bar.
9. Rail Sizing: Provide exit device rails factory sized for proper door width application.
10. Through Bolt Installation: For exit devices and trim as indicated in Door Hardware Sets.

B. Conventional Push Rail Exit Devices (Heavy Duty): ANSI/BHMA A156.3, Grade 1 Certified Products Directory (CPD) listed exit devices. Listed manufacturers shall meet all functions and features as specified herein.

1. Electromechanical exit devices shall have the following functions and features:

    a. Universal Molex plug-in connectors that have standardized color-coded wiring and are field configurable in fail safe or fail secure and operate from 12vdc to 24vdc regulated.
    b. EcoFlex or equivalent technology that reduces energy consumption up to 92% as certified by GreenCircle.
    c. Options to be available for request-to-exit or enter signaling, latchbolt and touchbar monitoring.
    d. Field configurable electrified trim to fail-safe or fail-secure that operates from 12-24VDC.
    e. Five-year limited warranty for electromechanical features.

2. Manufacturers:

    a. Corbin Russwin Hardware (RU) - ED4000 / ED5000 Series.

2.10 SURFACE DOOR CLOSERS

A. All door closers specified herein shall meet or exceed the following criteria:

1. General: Door closers to be from one manufacturer, matching in design and style, with the same type door preparations and templates regardless of application or spring size. Closers to be non-handed with full sized covers.
2. Standards: Closers to comply with UL-10C for Positive Pressure Fire Test and be U.L. listed for use of fire rated doors.
3. Size of Units: Comply with manufacturer's written recommendations for sizing of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Where closers are indicated for doors required to be accessible to the Americans with Disabilities Act, provide units complying with ANSI ICC/A117.1.
4. Closer Arms: Provide heavy duty, forged steel closer arms unless otherwise indicated in Hardware Sets.
5. Closers shall not be installed on exterior or corridor side of doors; where possible install closers on door for optimum aesthetics.
6. Closer Accessories: Provide door closer accessories including custom templates, special mounting brackets, spacers and drop plates as required for proper installation. Provide through-bolt and security type fasteners as specified in the hardware sets.

B. Door Closers, Surface Mounted (Large Body Cast Iron): ANSI/BHMA A156.4, Grade 1 Certified Products Directory (CPD) listed surface mounted, heavy duty door closers with complete spring power adjustment, sizes 1 thru 6; and fully operational adjustable according to door size, frequency of use, and opening force. Closers to be rack and pinion type, one piece cast iron body construction, with adjustable backcheck and separate non-critical valves for closing sweep and latch speed control.

1. Large body cast iron surface mounted door closers shall have a 30-year warranty.
2. Manufacturers:

a. Corbin Russwin Hardware (RU) - DC8000 Series.
b. LCN Closers (LC) - 4040XP Series.

2.11 ELECTROMECHANICAL DOOR OPERATORS

A. Electromechanical Door Operators (Moderate Traffic): Provide ANSI/BHMA A156.19 Certified Products Directory (CPD) listed low energy operators that are UL325/991 and UL10C certified and comply with requirements for the Americans with Disabilities Act (ADA). Operators shall accommodate openings up to 200 pounds and 48” wide.

1. Provide operators with features as follows:

a. Non-handed with push and pull side mounting.
b. Activation by push button, hands-free or radio frequency devices.
c. Adjustable opening force and closing power.
d. Two-year limited warranty.
e. Wi-Fi interface where the operator is a secure, password protected WiFi hot spot with no connection to building’s IT required.
    1) Simple setup with no app required.
    2) View status and make adjustments without removing the cover.
    3) Built-in logic to support single use restroom applications with no external relay boards, logic modules, position switches required.
f. Mounting backplate to simplify and speed up installation.

2. Operators shall have the following functionality:

a. Adjustable Hold Open: Amount of time a door will stay in the full open position after an activation.
b. Emergency Interface Relay: Door closes and ignores any activation input until signal is discontinued.
c. Infinite Hold Open: Door will hold open at set position until power is turned off.
d. Latch Assist: At closed position, after an activation, the door is pulled in. After the door has closed, the door is pulled in to assist with latch release/engagement.
e. Obstruction Detection: Door closes if it hits an obstruction while opening; door will reverse to open position if it hits an obstruction while closing. Door will stop once it hits an obstruction and will rest against the obstruction until removed.
f. Open Delay: Delays operator opening for locking hardware.
g. Outside Wall Switch Disable: When contact is closed, outside wall switch is disabled.

h. Power Assist: Senses the door is being opened manually and applies small amount of power to assist the user in opening the door with force less than 5 lbs. The door opens only as far as it is moved manually, then closes once released.
i. Power Close: Additional force to assist door closing between 7° and 2°.
j. Push & Go: As the door is manually opened, the operator "senses" movement and opens door to the full-open position.
k. Selector Mode Switch: Off disables the signal inputs, on activates the signal inputs, hold open activates the unit to the hold open position.
l. Vestibule Delay: When the wall switch is pressed, first door in vestibule will open the second door will open once vestibule door delay has expired. Delay shall be adjustable.
m. Executive Mode Feature: When the door receives an activation signal it opens and remains open until either a second signal is received, or the door is manually moved in closing direction.

3. Manufacturers:

a. ASSA ABLOY Entrance Systems (BE) - SW100 Series.

B. Electromechanical Door Operators (High Traffic): Provide ANSI/BHMA A156.19 Certified Products Directory (CPD) listed low energy operators that are UL325/991 and UL10C certified and comply with requirements for the Americans with Disabilities Act (ADA). Operators shall accommodate openings up to 250 pounds and 48” wide.

1. Provide operators with features as follows:

a. Non-handed with push and pull side mounting.
b. Activation by push button, hands-free or radio frequency devices.
c. Adjustable opening force and closing power.
d. Two-year limited warranty.
e. Wi-Fi interface where the operator is a secure, password protected WiFi hot spot with no connection to building’s IT required.
1) Simple setup with no app required.
2) View status and make adjustments without removing the cover.
3) Built-in logic to support single use restroom applications with no external relay boards, logic modules, position switches required.
f. Mounting backplate to simplify and speed up installation.
g. Integration with access control systems.

2. Operators shall have the following functionality:

a. Adjustable Hold Open: Amount of time a door will stay in the full open position after an activation.
b. Blow Open for Smoke Ventilation: Door opens when signal is received from alarm system allowing air or smoke to flow through opening. Door will stay open until signal from alarm system is stopped.
c. Emergency Interface Relay: Door closes and ignores any activation input until signal is discontinued.
d. Infinite Hold Open: Door will hold open at set position until power is turned off.

e. Latch Assist: At closed position, after an activation, the door is pulled in. After the door has closed, the door is pulled in to assist with latch release/engagement.
f. Obstruction Detection: Door closes if it hits an obstruction while opening; door will reverse to open position if it hits an obstruction while closing. Door will stop once it hits an obstruction and will rest against the obstruction until removed.
g. Open Delay: Delays operator opening for locking hardware.
h. Outside Wall Switch Disable: When contact is closed, outside wall switch is disabled.
i. Power Assist: Senses the door is being opened manually and applies small amount of power to assist the user in opening the door with force less than 5 lbs. The door opens only as far as it is moved manually, then closes once released.
j. Power Close: Additional force to assist door closing between 7° and 2°.
k. Presence Detector Input: Input for external sensor to detect presence at door open or close position only.
l. Push & Go: As the door is manually opened, the operator "senses" movement and opens door to the full-open position.
m. Selector Mode Switch: Off disables the signal inputs unless Blow Open is activated, on activates the signal inputs, hold open activates the unit (unless Blow Closed is activated) to the hold open position.
n. Vestibule Delay: When the wall switch is pressed, first door in vestibule will open. Second door will open once vestibule door delay has expired. Delay is adjustable.
o. Executive Mode Feature: When the door receives an activation signal it opens and remains open until either a second signal is received, or the door is manually moved in closing direction.

3. Manufacturers:

a. ASSA ABLOY Entrance Systems (BE) - SW200 Series.
b. Horton 7100 Series.

2.12 ARCHITECTURAL TRIM

A. Door Protective Trim

1. General: Door protective trim units to be of type and design as specified below or in the Hardware Sets.
2. Size: Fabricate protection plates (kick, armor, or mop) not more than 2" less than door width (LDW) on stop side of single doors and 1” LDW on stop side of pairs of doors, and not more than 1" less than door width on pull side. Coordinate and provide proper width and height as required where conflicting hardware dictates. Height to be as specified in the Hardware Sets.
3. Where plates are applied to fire rated doors with the top of the plate more than 16” above the bottom of the door, provide plates complying with NFPA 80. Consult manufacturer’s catalog and template book for specific requirements for size and applications.
4. Protection Plates: ANSI/BHMA A156.6 protection plates (kick, armor, or mop), fabricated from the following:

a. Stainless Steel: 300 grade, 050-inch thick.

5. Options and fasteners: Provide manufacturer's designated fastener type as specified in the Hardware Sets. Provide countersunk screw holes.
6. Manufacturers:

    a. Gallery Speciality Hardware (GA).

2.13 DOOR STOPS AND HOLDERS

A. General: Door stops and holders to be of type and design as specified below or in the Hardware Sets.

B. Door Stops and Bumpers: ANSI/BHMA A156.16, Grade 1 door stops and wall bumpers. Provide wall bumpers, either convex or concave types with anchorage as indicated, unless floor or other types of door stops are specified in Hardware Sets. Do not mount floor stops where they will impede traffic. Where floor or wall bumpers are not appropriate, provide overhead type stops and holders.

1. Manufacturers:

    a. Gallery Speciality Hardware (GA).

C. Overhead Door Stops and Holders: ANSI/BHMA A156.8, Grade 1 Certified Products Directory (CPD) listed overhead stops and holders to be surface or concealed types as indicated in Hardware Sets. Track, slide, arm and jamb bracket to be constructed of extruded bronze and shock absorber spring of heavy tempered steel. Provide non-handed design with mounting brackets as required for proper operation and function.

1. Manufacturers:

    a. Sargent Manufacturing (SA).

2.14 ARCHITECTURAL SEALS

A. General: Thresholds, weatherstripping, and gasket seals to be of type and design as specified below or in the Hardware Sets. Provide continuous weatherstrip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated. At exterior applications provide non-corrosive fasteners and elsewhere where indicated.

B. Smoke Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke control ratings indicated, based on testing according to UL 1784.

1. Provide smoke labeled perimeter gasketing at all smoke labeled openings.

C. Fire Labeled Gasketing: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to UL-10C.

1. Provide intumescent seals as indicated to meet UL10C Standard for Positive Pressure Fire Tests of Door Assemblies, and NFPA 252, Standard Methods of Fire Tests of Door Assemblies.

D. Sound-Rated Gasketing: Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated.

E. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.

F. Manufacturers:

1. Pemko (PE).

2.15 ELECTRONIC ACCESSORIES

A. Request-to-Exit Motion Sensor: Request-to-Exit Sensors motion detectors specifically designed for detecting exiting through a door from the secure area to a non-secure area. Include built-in timers (up to 60 second adjustable timing), door monitor with sounder alert, internal vertical pointability coverage, 12VDC or 24VDC power and selectable relay trigger with fail safe/fail secure modes.

1. Manufacturers:

a. Alarm Controls (AK) - SREX Series.
b. Securitron (SU) - XMS Series.

B. Door Position Switches: Door position magnetic reed contact switches specifically designed for use in commercial door applications. On recessed models the contact and magnetic housing snap-lock into a 1" diameter hole. Surface mounted models include wide gap distance design complete with armored flex cabling. Provide SPDT, N/O switches with optional Rare Earth Magnet installation on steel doors with flush top channels.

1. Manufacturers:

a. Sargent Manufacturing (SA) - 3280 Series.
b. Securitron (SU) - DPS Series.

C. Switching Power Supplies: Provide power supplies with either single or dual voltage configurations at 12 or 24VDC. Power supplies shall have battery backup function with an integrated battery charging circuit and shall provide capability for power distribution, direct lock control and Fire Alarm Interface (FAI) through add on modules. Power supplies shall be expandable up to 16 individually protected outputs. Output modules shall provide individually protected, continuous outputs and/or individually protected, relay controlled outputs.

1. Manufacturers:

a. Securitron (SU) - AQD Series.

2.16 FABRICATION

A. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to manufacturers recognized installation standards for application intended.

2.17 FINISHES

A. Standard: Designations used in the Hardware Sets and elsewhere indicate hardware finishes complying with ANSI/BHMA A156.18, including coordination with traditional U.S. finishes indicated by certain manufacturers for their products.

B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware

C. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine scheduled openings, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.

B. Notify architect of any discrepancies or conflicts between the door schedule, door types, drawings and scheduled hardware. Proceed only after such discrepancies or conflicts have been resolved in writing.

3.2 PREPARATION

A. Hollow Metal Doors and Frames: Comply with ANSI/DHI A115 series.

3.3 INSTALLATION

A. Install each item of mechanical and electromechanical hardware and access control equipment to comply with manufacturer's written instructions and according to specifications.

1. Installers are to be trained and certified by the manufacturer on the proper installation and adjustment of fire, life safety, and security products including: hanging devices; locking devices; closing devices; and seals.

B. Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:

1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
2. DHI TDH-007-20: Installation Guide for Doors and Hardware.
3. Where indicated to comply with accessibility requirements, comply with ANSI A117.1 "Accessibility Guidelines for Buildings and Facilities."
4. Provide blocking in drywall partitions where wall stops or other wall mounted hardware is located.

C. Retrofitting: Install door hardware to comply with manufacturer's published templates and written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 9 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.

D. Push Plates and Door Pulls: When through-bolt fasteners are in the same location as a push plate, countersink the fasteners flush with the door face allowing the push plate to sit flat against the door.

E. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 7 Section "Joint Sealants."

F. Storage: Provide a secure lock up for hardware delivered to the project but not yet installed. Control the handling and installation of hardware items so that the completion of the work will not be delayed by hardware losses before and after installation.

3.4 FIELD QUALITY CONTROL

A. Field Inspection (Punch Report): Reference Division 01 Sections “Closeout Procedures”. Produce project punch report for each installed door opening indicating compliance with approved submittals and verification hardware is properly installed, operating and adjusted. Include list of items to be completed and corrected, indicating the reasons or deficiencies causing the Work to be incomplete or rejected.

1. Organization of List: Include separate Door Opening and Deficiencies and Corrective Action Lists organized by Mark, Opening Remarks and Comments, and related Opening Images and Video Recordings.

B. Fire Door Assembly Inspection: Reference Division 01 Sections "Closeout Procedures". Conduct an initial fire door assembly inspection, including documentation reporting, upon completion of door hardware installation according to NFPA 80 Standard for Fire Doors and Other Opening Protectives, paragraph 5.2.4, requirements.

3.5 ADJUSTING

A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

3.6 CLEANING AND PROTECTION

A. Protect all hardware stored on construction site in a covered and dry place. Protect exposed hardware installed on doors during the construction phase. Install any and all hardware at the latest possible time frame.

B. Clean adjacent surfaces soiled by door hardware installation.

C. Clean operating items as necessary to restore proper finish. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of owner occupancy.

3.7 DEMONSTRATION

A. Instruct Owner's maintenance personnel to adjust, operate, and maintain mechanical and electromechanical door hardware.

3.8 DOOR HARDWARE SETS

A. The hardware sets represent the design intent and direction of the owner and architect. They are a guideline only and should not be considered a detailed hardware schedule. Discrepancies, conflicting hardware and missing items should be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application and functionality.

1. Quantities listed are for each pair of doors, or for each single door.
2. The supplier is responsible for handing and sizing all products.
3. Where multiple options for a piece of hardware are given in a single line item, the supplier shall provide the appropriate application for the opening.
4. At existing openings with new hardware the supplier shall field inspect existing conditions prior to the submittal stage to verify the specified hardware will work as required. Provide alternate solutions and proposals as needed.

B. Manufacturer’s Abbreviations:

1. MK - McKinney
2. PE - Pemko
3. RO - Rockwood
4. RU - Corbin Russwin
5. AD - Adams Rite
6. OT - Other
7. HS - HES
8. SA - SARGENT
9. BM - Besam
10. GA - Gallery Specialty Hardware
11. SU - Securitron

Hardware Schedule

Set: 1.0
Doors: E110, E122b, E124b, E126b
Description: Overhead Doors

1	All Hardware	BY DOOR SUPPLIER		OT

Set: 2.0
Doors: 112, 127
Description: Single Sliding Auto

1	All Hardware	BY DOOR SUPPLIER		OT

Note - Ensure the hardware can accommodate a Medeco 6pin cylinder and will not damage the wall/frame when doors are opened. especially important with pocket doors.

Set: 3.0
Doors: E100V
Description: Single x Ext x AL x ED Nightlatch ES x DO x Seals - CR

1	Continuous Hinge	CFMXXSLF-HD1 WIDTH		PE
1	Rim Exit Device, Storeroom	ED4200 L859ET M51	626	RU
1	Cylinder Housing & Collar	31T0175 & CP-160180 OR EQUIVALENT x CAM TO SUIT SUPPLIED AND INSTALLED BY GC	26	MC
1	Permanent Core	MEDECO BY OWNER		OT
1	Electric Strike	9600	630	HS
1	Concealed Overhead Stop	69XS	EN	SA
1	Door Operator	SW200i		BM
1	Gasketing	BY DOOR SUPPLIER		OT
1	Rain Guard	346C WIDTH		PE
1	Sweep (w/raindrip)	3452CPK WIDTH		PE
1	Threshold	2746x292AFGPK WIDTH		PE
1	ElectroLynx Harness (in frame)	QC-CXXXXP LENGTH		MK
1	Motion Sensor (REX)	XMS		SU
1	Door Contact	3287		SA
2	Actuator Switch	CM-332/42SW/SGLR		OT
1	Power Supply	AQD1		SU

DIVISION 26 TO PROVIDE 120VAC POWER TO FRAME HEADER, FINAL CONNECTION TO AUTO DOOR OPERATOR, ALL BACK BOXES, AND CONDUIT WITH LOW-VOLTAGE WIRING.

Operational Narrative:
- Doors normally closed and secure.
- Authorized access by security releasing electric strike. Strike can remain released for open access.
- ADA access by actuator switch. In locked condition, actuator is deactivated.
- Free egress at all times. ADA egress by actuator switch.
- REX allows authorized exit without alarm condition.
- Door position switch monitor open/closed status.

- Upon loss of power entry by key and free exit. Keyed cylinder override for emergency access.

Set: 4.0
Doors: E125K
Description: Single x Ext x AL x ED Nightlatch ES x UNI x Seals x DC

1	Continuous Hinge	CFMXXSLF-HD1 WIDTH		PE
1	Rim Exit Device, Nightlatch	ED4200 M51	626	RU
1	Electric Strike	9600	630	HS
1	Door Pull (offset)	RM3311-24	US32D	RO
1	Surface Closer	DC8210 A11	689	RU
1	Gasketing	BY DOOR SUPPLIER		OT
1	Rain Guard	346C WIDTH		PE
1	Sweep (w/raindrip)	3452CPK WIDTH		PE
1	Threshold	2746x292AFGPK WIDTH		PE
1	ElectroLynx Harness (in frame)	QC-CXXXXP LENGTH		MK
1	Door Contact	3287		SA
1	Power Supply	AQD1		SU

Operational Narrative:
- Opening locked or unlocked by Security. Strike can remain released for open access.
- Free egress at all times.
- Door position switch monitor open/closed status.
- Upon loss of power entry by key and free exit. Keyed cylinder override for emergency access.

Set: 5.0
Doors: E120
Description: Pair x Ext x Fail Secure x UNI x Seals - CR

5	Hinge, Full Mortise, Hvy Wt	TA786 127 x 114 (NRP AT OUTSWING SECURE DOORS)	US26D	MK
1	Hinge, Full Mortise, Hvy Wt	TA786 QC12 127 x 114	US26D	MK
1	Flush Bolt (self latching)	2845	US26D	RO
1	Dust Proof Strike	570	US26D	RO
1	Fail Secure Lock	ML20906-SEC LWA M92 LC	626	RU
1	Cylinder Housing & Collar	31T0175 & CP-160180 OR EQUIVALENT x CAM TO SUIT SUPPLIED AND INSTALLED BY GC	26	MC
1	Permanent Core	MEDECO BY OWNER		OT
1	Coordinator	1700	US28	RO
2	Surface Closer	DC8210 A11	689	RU
2	Kickplate	GSH80A 200mm x WIDTH x TAPE	C32D	GA
1	Astragal	S772BL HEIGHT		PE
1	Astragal	357C HEIGHT		PE
1	Rain Guard	346C WIDTH		PE
1	Gasketing	2891APK 1WIDTH x 2HEIGHT		PE
1	Threshold	2746x292AFGPK WIDTH		PE
1	ElectroLynx Harness (in frame)	QC-CXXXXP LENGTH		MK
1	ElectroLynx Harness (in door)	QC-CXXX LENGTH		MK
1	Card Reader	BY SECURITY CONTRACTOR		OT
1	Power Supply	AQD1		SU

Note - Install gasketing before installing the closer.

Operational Narrative:
- Door normally closed and secure.
- Authorized access by card reader.
- Free egress at all times.
- REX switch allows authorized exit without alarm condition.
- Door position switch monitor open/closed status.
- Opening remains locked (fail secure) in event of power loss. Keyed cylinder override for emergency access.

Set: 6.0
Doors: E126
Description: Single x Ext x ED Nightlatch ES x DO x Seals - CR

3	Hinge, Full Mortise, Hvy Wt	TA786 127 x 114 (NRP AT OUTSWING SECURE DOORS)	US26D	MK
1	Fire Rated Rim Exit, Nightlatch	ED5200(A) L957ET M51 LC	626	RU
1	Cylinder Housing & Collar	31T0175 & CP-160180 OR EQUIVALENT x CAM TO SUIT SUPPLIED AND INSTALLED BY GC	26	MC
1	Permanent Core	MEDECO BY OWNER		OT
1	Electric Strike	9600	630	HS
1	Door Operator	SW200i		BM
1	Kickplate	GSH80A 200mm x WIDTH x TAPE	C32D	GA
1	Rain Guard	346C WIDTH		PE
1	Gasketing	2891APK 1WIDTH x 2HEIGHT		PE
1	Sweep (w/raindrip)	3452CPK WIDTH		PE
1	Threshold	2746x292AFGPK WIDTH		PE
1	ElectroLynx Harness (in frame)	QC-CXXXXP LENGTH		MK
1	Motion Sensor (REX)	XMS		SU
1	Door Contact	3287		SA
1	Advanced Logic Relay	CX-33		OT
2	Actuator Switch	CM-332/42SW/SGLR		OT
1	Card Reader	BY SECURITY CONTRACTOR		OT
1	Power Supply	AQD1		SU

DIVISION 26 TO PROVIDE 120VAC POWER TO FRAME HEADER, FINAL CONNECTION TO AUTO DOOR OPERATOR, ALL BACK BOXES, AND CONDUIT WITH LOW-VOLTAGE WIRING.

Note - Install gasketing before installing the closer.

Operational Narrative:
- Doors normally closed and secure.
- Authorized access by card reader releasing electric strike. Strike can remain released for open access.
- ADA access by actuator switch. In locked condition, actuator energized only upon valid card reader presentation.
- Free egress at all times. ADA egress by actuator switch.
- REX allows authorized exit without alarm condition.
- Door position switch monitor open/closed status.
- Upon loss of power entry by key and free exit. Keyed cylinder override for emergency access.

Set: 7.0
Doors: E122, E124
Description: Single x Ext x ED Nightlatch ES x UNI x Seals - CR

3	Hinge, Full Mortise, Hvy Wt	TA786 127 x 114 (NRP AT	US26D	MK

		OUTSWING SECURE DOORS)		
1	Fire Rated Rim Exit, Nightlatch	ED5200(A) L957ET M51 LC	626	RU
1	Cylinder Housing & Collar	31T0175 & CP-160180 OR EQUIVALENT x CAM TO SUIT SUPPLIED AND INSTALLED BY GC	26	MC
1	Permanent Core	MEDECO BY OWNER		OT
1	Electric Strike	9600	630	HS
1	Surface Closer	DC8210 A11	689	RU
1	Kickplate	GSH80A 200mm x WIDTH x TAPE	C32D	GA
1	Rain Guard	346C WIDTH		PE
1	Gasketing	2891APK 1WIDTH x 2HEIGHT		PE
1	Sweep (w/raindrip)	3452CPK WIDTH		PE
1	Threshold	2746x292AFGPK WIDTH		PE
1	ElectroLynx Harness (in frame)	QC-CXXXXP LENGTH		MK
1	Motion Sensor (REX)	XMS		SU
1	Door Contact	3287		SA
1	Card Reader	BY SECURITY CONTRACTOR		OT
1	Power Supply	AQD1		SU

Note - Install gasketing before installing the closer.

Operational Narrative:
- Door normally closed and secure.
- Authorized access by card reader releasing electric strike. Strike can remain released for open access.
- Free egress at all times.
- REX switch allows authorized exit without alarm condition.
- Door position switch monitor open/closed status.
- Electric strike remains locked (fail secure) in event of power loss. Keyed cylinder override for emergency access.

Set: 8.0
Doors: 126
Description: Single x Ext x Storeroom ES x DO x Seals

3	Hinge, Full Mortise, Hvy Wt	TA786 127 x 114 (NRP AT OUTSWING SECURE DOORS)	US26D	MK
1	Storeroom Lock	ML2057 LWA LC	626	RU
1	Cylinder Housing & Collar	31T0175 & CP-160180 OR EQUIVALENT x CAM TO SUIT SUPPLIED AND INSTALLED BY GC	26	MC
1	Permanent Core	MEDECO BY OWNER		OT
1	Electric Strike	F2164		OT
1	Door Operator	SW200i		BM
1	Kickplate	GSH80A 200mm x WIDTH x TAPE	C32D	GA
1	Rain Guard	346C WIDTH		PE
1	Gasketing	2891APK 1WIDTH x 2HEIGHT		PE
1	Sweep (w/raindrip)	3452CPK WIDTH		PE
1	Threshold	2746x292AFGPK WIDTH		PE
1	ElectroLynx Harness (in frame)	QC-CXXXXP LENGTH		MK
1	Door Contact	3287		SA
1	Advanced Logic Relay	CX-33		OT
2	Actuator Switch	CM-332/42SW/SGLR		OT
1	Power Supply	AQD1		SU

DIVISION 26 TO PROVIDE 120VAC POWER TO FRAME HEADER, FINAL CONNECTION TO AUTO DOOR OPERATOR, ALL BACK BOXES, AND CONDUIT WITH LOW-VOLTAGE WIRING.

Note - Install gasketing before installing the closer.

Operational Narrative:
- Doors locked and unlocked by security.
- ADA access by actuator switch. Outside actuator inactive when opening is locked.
- Free egress at all times. ADA egress by actuator switch.
- Door contact monitors door open/close status.
- Upon loss of power free exit. Access by key if door is locked.

Set: 9.0
Doors: 100V
Description: Single x ED Passage ES x DO x Seals

3	Hinge, Full Mortise, Hvy Wt	TA786 127 x 114 (NRP AT OUTSWING SECURE DOORS)	US26D	MK
1	Fire Rated Rim Exit, Passage	ED5200(A) L910ET M51	626	RU
1	Electric Strike	9600	630	HS
1	Concealed Overhead Stop	69XS	EN	SA
1	Door Operator	SW200i		BM
1	Gasketing	S773BL 1WIDTH x 2HEIGHT		PE
1	ElectroLynx Harness (in frame)	QC-CXXXXP LENGTH		MK
1	Motion Sensor (REX)	XMS		SU
1	Door Contact	3287		SA
2	Actuator Switch	CM-332/42SW/SGLR		OT
1	Power Supply	AQD1		SU

DIVISION 26 TO PROVIDE 120VAC POWER TO FRAME HEADER, FINAL CONNECTION TO AUTO DOOR OPERATOR, ALL BACK BOXES, AND CONDUIT WITH LOW-VOLTAGE WIRING.

Operational Narrative:
- Doors always closed and unlocked.
- ADA access and egress by actuator switch.
- Door position switch monitor open/closed status. REX monitors exit.
- Upon loss of power free entry and exit.

Set: 10.0
Doors: 102, 125
Description: Single x Storeroom ES x DO x A.Seals

3	Hinge, Full Mortise, Hvy Wt	TA786 127 x 114 (NRP AT OUTSWING SECURE DOORS)	US26D	MK
1	Storeroom Lock	ML2057 LWA LC	626	RU
1	Cylinder Housing & Collar	31T0175 & CP-160180 OR EQUIVALENT x CAM TO SUIT SUPPLIED AND INSTALLED BY GC	26	MC
1	Permanent Core	MEDECO BY OWNER		OT
1	Electric Strike	F2164		OT
1	Concealed Overhead Stop	69XS	EN	SA
1	Door Operator	SW200i		BM
1	Kickplate	GSH80A 200mm x WIDTH x TAPE	C32D	GA
1	Gasketing	S773BL 1WIDTH x 2HEIGHT		PE
1	Gasketing	S44BL 1WIDTH x 2HEIGHT		PE

1	Door Bottom	3692APK773BL WIDTH	PE
1	ElectroLynx Harness (in frame)	QC-CXXXXP LENGTH	MK
1	Motion Sensor (REX)	XMS	SU
1	Door Contact	3287	SA
2	Actuator Switch	CM-332/42SW/SGLR	OT
1	Card Reader	BY SECURITY CONTRACTOR	OT
1	Power Supply	AQD1	SU

DIVISION 26 TO PROVIDE 120VAC POWER TO FRAME HEADER, FINAL CONNECTION TO AUTO DOOR OPERATOR, ALL BACK BOXES, AND CONDUIT WITH LOW-VOLTAGE WIRING.

Operational Narrative:
- Doors normally closed and secure.
- Authorized access by card reader releasing electric strike. Strike can remain released for open access.
- ADA access by actuator switch. In locked condition, actuator energized only upon valid card reader presentation.
- Free egress at all times. ADA egress by actuator switch.
- REX allows authorized exit without alarm condition.
- Door position switch monitor open/closed status.
- Upon loss of power entry by key and free exit. Keyed cylinder override for emergency access.

Set: 11.0
Doors: 101, 107, 109, 121, 123
Description: Single x Storeroom ES x CL x Seals

3	Hinge, Full Mortise, Hvy Wt	TA786 127 x 114 (NRP AT OUTSWING SECURE DOORS)	US26D	MK
1	Storeroom Lock	ML2057 LWA LC	626	RU
1	Cylinder Housing & Collar	31T0175 & CP-160180 OR EQUIVALENT x CAM TO SUIT SUPPLIED AND INSTALLED BY GC	26	MC
1	Permanent Core	MEDECO BY OWNER		OT
1	Electric Strike	F2164		OT
1	Surface Closer	DC8210 DROP PLATE TO SUIT	689	RU
1	Floor/Wall Stop	GSH210 / GSH250	C26	GA
1	Gasketing	S773BL 1WIDTH x 2HEIGHT		PE
1	ElectroLynx Harness (in frame)	QC-CXXXXP LENGTH		MK
1	Motion Sensor (REX)	XMS		SU
1	Door Contact	3287		SA
1	Card Reader	BY SECURITY CONTRACTOR		OT
1	Power Supply	AQD1		SU

Operational Narrative:
- Door normally closed and secure.
- Authorized access by card reader.
- Free egress at all times.
- REX switch allows authorized exit without alarm condition.
- Door position switch monitor open/closed status.
- Opening remains locked (fail secure) in event of power loss. Keyed cylinder override for emergency access.

Set: 12.0
Doors: 110
Description: Single x Storeroom ES x CL x A.Seals

3	Hinge, Full Mortise, Hvy Wt	TA786 127 x 114 (NRP AT	US26D	MK

		OUTSWING SECURE DOORS)		
1	Storeroom Lock	ML2057 LWA LC	626	RU
1	Cylinder Housing & Collar	31T0175 & CP-160180 OR EQUIVALENT x CAM TO SUIT SUPPLIED AND INSTALLED BY GC	26	MC
1	Permanent Core	MEDECO BY OWNER		OT
1	Electric Strike	F2164		OT
1	Surface Closer	DC8210 DROP PLATE TO SUIT	689	RU
1	Kickplate	GSH80A 200mm x WIDTH x TAPE	C32D	GA
1	Floor/Wall Stop	GSH210 / GSH250	C26	GA
1	Gasketing	S773BL 1WIDTH x 2HEIGHT		PE
1	Gasketing	S44BL 1WIDTH x 2HEIGHT		PE
1	Door Bottom	3692APK773BL WIDTH		PE
1	ElectroLynx Harness (in frame)	QC-CXXXXP LENGTH		MK
1	Motion Sensor (REX)	XMS		SU
1	Door Contact	3287		SA
1	Card Reader	BY SECURITY CONTRACTOR		OT
1	Power Supply	AQD1		SU

Operational Narrative:
- Door normally closed and secure.
- Authorized access by card reader.
- Free egress at all times.
- REX switch allows authorized exit without alarm condition.
- Door position switch monitor open/closed status.
- Opening remains locked (fail secure) in event of power loss. Keyed cylinder override for emergency access.

Set: 13.0
Doors: 111
Description: Single x Office x OHS

3	Hinge, Full Mortise, Hvy Wt	TA786 127 x 114 (NRP AT OUTSWING SECURE DOORS)	US26D	MK
1	Mortise Lock	2190 1 02-ROUND	US32D	AD
1	Cylinder Housing & Collar	31T0175 & CP-160180 OR EQUIVALENT x CAM TO SUIT SUPPLIED AND INSTALLED BY GC	26	MC
1	Permanent Core	MEDECO BY OWNER		OT
1	Thumbturn	4066-XX	130	AD
1	Concealed Overhead Stop	69XS	EN	SA

Note - Verify hardware compatibility with door supplier.

Set: 14.0
Doors: 122, 124
Description: Single x Classroom x CL x Seals

3	Hinge, Full Mortise, Hvy Wt	TA786 127 x 114 (NRP AT OUTSWING SECURE DOORS)	US26D	MK
1	Classroom Lock	ML2055 LWA LC	626	RU
1	Cylinder Housing & Collar	31T0175 & CP-160180 OR EQUIVALENT x CAM TO SUIT SUPPLIED AND INSTALLED BY GC	26	MC
1	Permanent Core	MEDECO BY OWNER		OT

1	Concealed Overhead Stop	69XS	EN	SA
1	Surface Closer	DC8210 DROP PLATE TO SUIT	689	RU
1	Kickplate	GSH80A 200mm x WIDTH x TAPE	C32D	GA
1	Gasketing	S773BL 1WIDTH x 2HEIGHT		PE

Set: 15.0
Doors:
Description: Single x Storeroom x CL x Seals

3	Hinge, Full Mortise, Hvy Wt	TA786 127 x 114 (NRP AT OUTSWING SECURE DOORS)	US26D	MK
1	Storeroom Lock	ML2057 LWA LC	626	RU
1	Cylinder Housing & Collar	31T0175 & CP-160180 OR EQUIVALENT x CAM TO SUIT SUPPLIED AND INSTALLED BY GC	26	MC
1	Permanent Core	MEDECO BY OWNER		OT
1	Concealed Overhead Stop	69XS	EN	SA
1	Surface Closer	DC8210 DROP PLATE TO SUIT	689	RU
1	Kickplate	GSH80A 200mm x WIDTH x TAPE	C32D	GA
1	Gasketing	S773BL 1WIDTH x 2HEIGHT		PE

RFI - 110 - Door schedule calls for access control but access control drawings do not show it. Please clarify. Mechanical hardware provided.

Set: 16.0
Doors: 220
Description: Single x Storeroom x CL x Seals

3	Hinge, Full Mortise, Hvy Wt	TA786 114 x 114 (NRP AT OUTSWING SECURE DOORS)	US26D	MK
1	Storeroom Lock	ML2057 LWA LC	626	RU
1	Cylinder Housing & Collar	31T0175 & CP-160180 OR EQUIVALENT x CAM TO SUIT SUPPLIED AND INSTALLED BY GC	26	MC
1	Permanent Core	MEDECO BY OWNER		OT
1	Concealed Overhead Stop	69XS	EN	SA
1	Surface Closer	DC8210 DROP PLATE TO SUIT	689	RU
1	Kickplate	GSH80A 200mm x WIDTH x TAPE	C32D	GA
1	Gasketing	S773BL 1WIDTH x 2HEIGHT		PE

Set: 17.0
Doors: 105
Description: Universal Washroom

3	Hinge, Full Mortise, Hvy Wt	TA786 127 x 114 (NRP AT OUTSWING SECURE DOORS)	US26D	MK
1	Storeroom Lock	ML2057 LWA LC	626	RU
1	Cylinder Housing & Collar	31T0175 & CP-160180 OR EQUIVALENT x CAM TO SUIT SUPPLIED AND INSTALLED BY GC	26	MC
1	Permanent Core	MEDECO BY OWNER		OT
1	Electric Strike	F2164		OT

1	Concealed Overhead Stop	69XS	EN	SA
1	Door Operator	SW100		BM
1	Kickplate	GSH80A 200mm x WIDTH x TAPE	C32D	GA
1	Gasketing	S773BL 1WIDTH x 2HEIGHT		PE
1	ElectroLynx Harness (in frame)	QC-CXXXXP LENGTH		MK
1	Door Contact	3287		SA
1	Advanced Logic Relay	CX-33		OT
1	Transformer	CX-TRX-4024 + CX-5024		OT
2	Actuator Switch	CM-332/42SW/SGLR		OT
1	Push to Lock	CM332/43SW/SGLR		OT
1	Universal Washroom Control Kit	CX-WEC10BK2		OT
1	Power Supply	AQD1		SU

DIVISION 26 TO PROVIDE 120VAC POWER TO FRAME HEADER, FINAL CONNECTION TO AUTO DOOR OPERATOR, ALL BACK BOXES, AND CONDUIT WITH LOW-VOLTAGE WIRING.

Note - Universal Emergency Call System Kit, w/ White Dome Light includes (1) CM-AF540SO Double gang, push/pull mushroom push button, red, 'Assistance Required', w/ LED annunciator and adjustable sounder, 'Assistance Requested'; (1) CM-AF141SO Single Gang LED Dome Light, w/ Sounder.; (1) CM-SE21A English, solid white sign, ‘IN THE EVENT OF AN EMERGENCY PUSH EMERGENCY BUTTON AND AUDIBLE AND VISUAL SIGNAL WILL ACTIVATE’.

RFI - Verify door swing. Door should typically swing out of the washroom.

END OF SECTION

1 GENERAL

1.01 SUMMARY

.1 Section includes all methods, materials and installation as required to complete the Work of this Section in accordance with the Conditions of the Contract.

1.02 REFERENCES

.1 AAADM - American Association of Automatic Door Manufacturers.

.2 AAMA 611 - Voluntary Specifications for Anodized Finishes Architectural Aluminum.

.3 ASTM B209 - Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).

.4 ASTM B221 - Specification for Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric).

.5 ANSI/BHMA A156.10 - Power Operated Pedestrian Doors.

.6 ANSI/BHMA A156.19 - Power Assist and Low Energy Power Operated Doors.

1.03 ADMINISTRATIVE REQUIREMENTS

.1 Coordination: Co-ordinate work of this Section with installation of electrical wiring and connections as well as coordination with security systems as required.

1.04 ACTION SUBMITTALS

.1 Submit action submittals in accordance with Section 01 33 00.

.2 Product data: Submit manufacturers product data for power door operators including product characteristics, performance criteria, and limitations.

.3 Shop Drawings: Submit Shop Drawings as follows:
- .1 Shop Drawings to illustrate electrical connections, attachments, reinforcing, anchorage and installation details.
- .2 Mounting heights for operators and electrical wiring.

1.05 CLOSEOUT AND MAINTENANCE SUBMITTALS

.1 Submit closeout and maintenance submittals in accordance with Section 01 78 00.

.2 Closeout Product data: Submit manufacturers maintenance and cleaning data for incorporation into operation and maintenance manual.

1.06 QUALITY ASSURANCE

.1 Manufacturers: Company specializing in manufacturing the products specified in this section with minimum 5 years experience.

.2 Installers: Perform Work of this Section by a company that has a minimum of five (5) years proven experience in the installation of power door operators of a similar size and nature and hold a current certificate issued by AAADM.

2 PRODUCTS

2.01 SYSTEMS AND MANUFACTURERS

.1 Besam Power Swing by Assa Abloy Group.

.2 HD Swing LE by Horton.

.3 M-Force LE by Stanley Access Technologies.

.4 Or Consultant approved equal.

2.02 PERFORMANCE CRITERIA

.1 Design self contained, low-energy electro-hydraulic door opener conforming to ANSI/BHMA A156.10 and A156.19.

.2 Provide operators to resist thermal, dead and live loads calculated for the Place of the Work.

.3 In the event of power failure, doors shall open with manual force, not to exceed 133 N to set door in motion, and not more than 66 N to fully open door. Forces shall be applied at 25 mm from latch edge of door.

.4 Emergency-Exit Door Requirements: Comply with requirements of authorities having jurisdiction for swinging automatic entrance doors serving as a required means of egress.

2.03 MATERIALS

.1 Extruded aluminum bars, rods, profiles and tubes: to ASTM B221, 6063 alloy with T6 temper.

.2 Aluminum sheet and plate: to ASTM B209.

.3 Fasteners and Accessories: Manufacturer's standard corrosion-resistant, non-staining, non-bleeding fasteners and accessories compatible with adjacent materials.

.4 Electrical service: Provide by Division 26.

2.04 COMPONENTS

.1 Header Case: Header case shall not exceed 150 mm square in section and shall be fabricated from extruded aluminum with structurally integrated end caps, and be designed to conceal door operators and controls. Seal operator against dust, dirt, and corrosion within header case. Operator and electronic control box shall be provided with a removable full-length cover secured to prevent unauthorized access.

.2 Door Arms: Combination of door arms and linkage providing positive control of door through entire swing; units shall permit use of butt hung, centre pivot, and offset pivot-hung doors.

.3 Signage: Provide signage in accordance with ANSI/BHMA A156.19.

.4 Electromechanical Operator: Self-contained unit powered by a minimum 3/16 horsepower, permanent-magnet DC motor; through high torque reduction gear system.
- .1 Operation: Power opening and spring closing.
- .2 Operator Type: Low energy; readily convertible to full energy without the use of tools.
- .3 Handing: Non-handed.
- .4 Capacity: Rated for door panels weighing up to 318 kg (700 lb).
- .5 Mounting: Visible

.5 Electrical Control System: Microprocessor controller and high-resolution position encoder. Encoder shall monitor revolutions of operator shaft and send signals to microprocessor controller to define door position and speed.
- .1 High-resolution encoder shall have a resolution of not less than 1024 counts per revolution. Systems utilizing external magnets and magnetic switches are not acceptable.
- .2 Electrical control system shall include 24 VDC auxiliary output rated at 1 amp.
- .3 Microprocessor controller shall be field programmable for the following parameters:
  - .1 Operating speeds and forces as required to meet specified ANSI/BHMA standard.
  - .2 Adjustable and variable features specified.
- .4 Manual programming shall be available through local interface which has a two-digit display with a selection control including three push buttons.

2.05 OPERATION

.1 Activation Device: Motion Detector with narrow or wide zone adjustable from 0 to 70 degrees. Sensitivity of detection shall be adjustable from 0 MW to 10 MW maximum.

.2 Spring Closing Operation: The operator shall close the door by spring energy employing the motor, as a dynamic brake to provide closing speed control. The closing spring shall be a helical compression spring, adjustable for positive closing action. The spring shall be adjustable, without removing the operator from the header, to accommodate a wide range of field conditions.

.3 Emergency Breakout Switch: A cam actuated emergency breakout switch shall be provided to disconnect power to the motor when an in-swinging door is manually pushed in the emergency out direction. The operator will then automatically reset, and power will be resumed.

.4 Control Switch: Automatic door operators shall be equipped with a three-position function switch to control the operation of the door. Control switch shall provide three modes of operation, Automatic, Off, and Hold-Open.

.5 Power Switch: Automatic door operators shall be equipped with a two position On/Off switch to control power to the door.

.6 Independent Adjustable Closing and Latching Speed Control: The operator shall employ a rheostat module to allow for independent field adjustment of closing and latching speeds using the motor as a dynamic brake.

.7 Field Adjustable Open Stop: The operator shall provide a field adjustable open stop to accommodate opening angles from 80 to 135 degrees without the need for additional components.

.8 Consistent Cycle: The operator shall deliver an even, consistent open manual push force across the entire transition from door fully closed to door fully open. Additionally, the force shall be field adjustable to accommodate a wide range of on-site conditions.

.9 Manual Use: The operator shall function as a manual door closer in the direction of swing with or without electrical power. The operator shall deliver an even, consistent open force across the entire transition from door fully closed to door fully open.

.10 Power Assist: Operator mode that lowers opening forces when the door is used manually. Power assist is active only while pushing or pulling the door. The door will close when an opening force is no longer applied.

.11 Power Close: When enabled, engages the operator to close a door that does not close completely at the end of a cycle.

.12 Force Compensation: Utilizing the closed loop speed control, the operator shall maintain constant opening and closing speeds when subjected to excessive outside forces, such as positive or negative stack pressures.

.13 Slam Protection: The operators speed control system prevents door from slamming at the full open or full closed position.

.14 Lock Release: On doors with electric locking, operator shall include a closing function to release tension on a latch mechanism prior to opening the door.

2.06 FINISHES

.1 Exposed aluminum surfaces:
- .1 To AAMA 611, Architectural Class 2 anodized AA-M10C21A31.
- .2 Dry film thickness: 0.4 mil minimum total thickness.
- .3 Colour: Clear.

3 EXECUTION

3.01 EXAMINATION

.1 Examine and verify previously installed Work upon which this Section depends. Report defects or unsatisfactory conditions to Consultant. Commencement of work of this Section means acceptance of existing conditions.

.2 Inspect doors, frames and other surfaces to receive power door operators and report any defects, which might adversely affect the installation and function of the operators.

.3 Verify that power supply is available to power operated devices.

3.02 INSTALLATION

.1 Install power door operators in accordance with manufacturers' instructions and recommendations.

.2 Fit joints to produce hairline joints free of burrs and distortion. Rigidly secure non-movement joints.

.3 Install automatic door operators/headers plumb and true in alignment with established lines and grades. Anchor securely in place.

.4 Install surface-mounted hardware using concealed fasteners to greatest extent possible.

.5 Set headers, arms and linkages level and true to location with anchorage for permanent support.

.6 Connect door operators to electrical power distribution system as specified in Division 26.

3.03 SITE QUALITY CONTROL

.1 Factory Trained Installer shall test and inspect each swinging automatic entrance door to determine compliance of installed systems with applicable ANSI standards.

3.04 ADJUSTMENT

.1 Adjust door operators, controls, and hardware for smooth and safe operation, for tight closure, and complying with requirements in ANSI/BHMA A156.19 by AAADM Certified Technician.

END OF SECTION

1 GENERAL

1.01 SUMMARY

.1 Section includes all methods, materials and installation as required to complete the Work of this Section in accordance with the Conditions of the Contract.

1.02 REFERENCES

.1 ASTM C542 - Standard Specification for Lock-Strip Gaskets.

.2 ASTM C1048 - Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass.

.3 ASTM C1172 - Standard Specification for Laminated Architectural Flat Glass.

.4 ASTM C1376 - Standard Specification for Pyrolytic and Vacuum Deposition Coatings on Flat Glass.

.5 ASTM D2240 - Standard Test Method for Rubber Property—Durometer Hardness.

.6 ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

.7 ASTM E330/E330M - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.

.8 BS EN 14179-1 - Glass in Building. Heat Soaked Thermally Toughened Soda Lime Silicate Safety Glass.

.9 CAN/CGSB 12.1 - Safety Glazing.

.10 CAN/CGSB 12.3 - Flat, Clear Float Glass.

.11 CAN/CGSB 12.8 - Insulating Glass Units.

.12 CSA A460 - Bird-Friendly Building Design.

.13 IGMAC - Insulating Glass Manufacturers Association of Canada.

.14 FGIA - Fenestration and Glazing Industry Alliance.

.15 CAN/ULC S104 - Standard Method for Fire Tests of Door Assemblies.

.16 CAN/ULC S106 - Standard Method for Fire Tests of Window and Glass Block Assemblies.

1.03 ACTION SUBMITTALS

.1 Submit action submittals in accordance with Section 01 33 00.

.2 Product data: Submit manufacturers product data for glass and glazing materials including product characteristics, performance criteria, and limitations.

.3 Shop Drawings: Submit Shop Drawings as follows:
- .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.
- .2 Shop Drawings to illustrate details, dimensions, fabrication and installation details.
- .3 Detail connections, methods of anchorage, reinforcement, and supports.

.4 Samples: Submit 300 mm x 300 mm samples illustrating colours, textures and finishes including, but not limited to:
- .1 Each type insulating unit.
- .2 Fire rated glazing.
- .3 Laminated/frosted glass.
- .4 Glass film.

.5 Reports/certificates: Submit the following:
- .1 Test Reports: certified test reports showing compliance with specified performance characteristics and physical properties.
- .2 Compatibility test reports: Submit compatibility and adhesion test reports from sealant manufacturer indicating that glazing materials were tested for compatibility and adhesion with glazing sealants.
- .3 Certificates: submit product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.
- .4 Sealed unit certification: Submit current IGMAC Certification, issued within last 6 months, that insulated glass units meet program requirements.

1.04 CLOSEOUT AND MAINTENANCE SUBMITTALS

.1 Submit closeout and maintenance submittals in accordance with Section 01 78 00.

.2 Closeout Product data: Submit manufacturers maintenance and cleaning data for incorporation into operation and maintenance manual including product warranty documentation.

1.05 QUALITY ASSURANCE

.1 Manufacturers: Insulated glass unit manufacturers to be a certified member of FGIA and have passed the certification program.

.2 Installers: Perform Work of this Section by a company that has a minimum of five (5) years proven experience in the installation of glazing units of a similar size and nature.

.3 Fire rated glass: Each fire rated glass lite shall bear permanent, nonremovable label of ULC certifying it for use in tested and rated fire protective assemblies.

1.06 SITE CONDITIONS

.1 Ambient Conditions: Work of this Section shall be performed when air and surface temperatures are above 10 degrees C for 24 hours before, during and after installation.

.2 Maintain ventilated environment for 24 hours after application.

1.07 WARRANTY

.1 Provide extended warranty for insulated glass units in accordance with the General Conditions, except warranty is extended to ten (10) years from date Ready-for-Takeover has been attained:

- .1 Warranty to cover defects including defects or deterioration in performance or visual clarity including, but not limited to the following:
  - .1 Dust or film formation on internal glass surfaces.
  - .2 Condensation, or fogging material obstruction of vision. Internal fogging shall be deemed to occur when light transmission of glass has been reduced by 5% in any 50 mm square area.
  - .3 Changes to mechanical design properties.
  - .4 Breakage due to thermal shock and temperature differential due to inherent glass faults, other than extrinsic glass breakage.
  - .5 Breaking of seals, leaking or loss of water and weather tightness.
  - .6 Cracked, or scratched glass, rattling of glazing.
- .2 Warranty shall cover complete replacement of Work, including adjacent work impacted.

2 PRODUCTS

2.01 MANUFACTURERS

.1 AGC Glass Company.

.2 Cardinal Glass Industries.

.3 Guardian Glass Industries.

.4 Viracon.

.5 Vitro Architectural Glass.

2.02 PERFORMANCE CRITERIA

.1 Design glass and glazing systems to resist loads and climatic data as indicated, and in accordance with applicable building codes.

.2 All glass units containing similar coatings are to be produced in a single production run to ensure continuity of colour and finish.

.3 Ensure continuity of building enclosure vapour and air barrier using glass and glazing materials as follow:
- .1 Utilize inner light of multiple light sealed units for continuity of air and vapour seal.
- .2 Size glass to withstand wind loads, dead loads and positive and negative live loads to ASTM E330/E330M.
- .3 Limit glass deflection to flexural limit of glass with full recovery of glazing materials.

.4 Design exterior glazing to conform to Bird Friendly Guidelines outlined in CSA A460.

.5 Insulating unit thermal stress:
- .1 Perform thermal stress analysis on insulated glass units, including those containing Low-E coatings, and provide heat strengthening and/or tempered units as necessary to prevent thermal breakage.
- .2 Design glass units to prevent thermal stress fracture due to heat build-up behind insulating units as required.

.6 Structural silicone glazing systems:
- .1 Ensure working stress of sealants is limited to 138 kPa.
- .2 Structural silicone system to have all glass, gasket, glazing accessory and glass-framing member that will contact or affect glazing sealants tested for compatibility and adhesion. Submit testing reports.

.7 Ensure all glass edges are free of defects which could compromise the integrity of the glass unit or its seals.

2.03 MATERIALS

.1 Float glass: to CAN/CGSB 12.3, glazing quality.

.2 Heat strengthened glass: to CAN/CGSB 12.3, glazing quality float glass, kind HS, heat strengthened to ASTM C1048.

.3 Tempered glass: to CAN/CGSB 12.1, glazing quality tempered, kind FT, produced in accordance with ASTM C1048.
- .1 Provide heat soaking for tempered glazing located in structural glazing with fittings, and frameless glass assemblies.
- .2 Heat soak glass by heating to 290 degree C and then slowly cooling in accordance with BS EN 14179-1.

.4 Laminated glass: to CAN/CGSB 12.1, glazing quality tempered, kind LT, produced in accordance with ASTM C1172. Interlayer to be 0.8 mm thick decorative PVB. Interlayer to be frosted as selected by Consultant.

.5 Fire rated glass: Fire rating tested to CAN/ULC S104 and CAN/ULC S106, types as follows:
- .1 Rating up to 1.5 hours: 5 mm thick clear polished glass with appropriate labelling stating fire rating and approval. Basis of Design: Firelite by Technical Glass Products or approved equal.
- .2 Laminated fire rated glass (single glazed): 27 mm thick glazing consisting of multiple sheets of low iron float glass laminated with intumescent interlayer with appropriate labelling stating fire rating and approval. Basis of Design: Pyrostop 60-201 by Pilkington or approved equal.
- .3 Insulated fire rated glass unit: 57 mm thick double glazed unit consisting of laminated fire rated glass with appropriate labelling stating fire rating and approval. Basis of Design: Pyrostop 120-106 by Pilkington or approved equal.

.6 Bird friendly glass: to ASTM C1048, condition B, tempered glass.
- .1 Ceramic frit: Single colour, dot pattern printed in ceramic enamel applied to second surface and fire-fused. Basis of Design: Spandrel, Standard Printing by Viracon or approved equal.
- .2 Colour/pattern: 5 mm diameter dots in 75 mm x 75 mm diagonal spacing as required to conform to bird friendly design guidelines.

.7 Low emissivity (LOW E) coating:
- .1 ASTM C1376, soft, sputtered metallic coating. Provide edge deletion through all coating layers using method approved by manufacturer.
- .2 Basis of Design:
  - .1 EnergySelect 36 by AGC Glass Company.
  - .2 Cardinal LoE^2-272 by Cardinal Glass Industries.
  - .3 SunGuard SuperNeutral SN 68 by Guardian Glass Industries.
  - .4 Or approved equal.

.8 Insulating glass units:
- .1 CAN/CGSB 12.8, triple glazed, hermetically sealed, argon filled insulating glass units with low conductance stainless steel warm edge spacer.
- .2 Comply with IGMA labelling requirements to provide certified insulating glass units, including providing materials, excluding glass, from same manufacturer.

.9 Glass film: Blackout film by 3M or approved equal. Type to be selected by Consultant.

2.04 ACCESSORIES

.1 Setting blocks: EPDM, 80-90 Shore A durometer hardness to ASTM D2240, size to suit glazing method, glass light weight and area.

.2 Spacer shims: Neoprene, 50-60 Shore A durometer hardness to ASTM D2240, 75 mm long x one half height of glazing stop x thickness to suit application. Self adhesive on one face.

.3 Glazing tape:
- .1 Windows, curtainwalls, etc.: Preformed butyl compound with integral EPDM shim, coiled on release paper, black colour.
- .2 Fire rated glazing tape: Closed cell polyvinyl chloride foam, coiled on release paper over adhesive on two sides, maximum water absorption by volume 2%, designed for compression of 25%, to effect an air and vapour seal.

.4 Glazing splines: resilient polyvinyl chloride, extruded shape to suit glazing channel retaining slot, colour as selected.

.5 Structural glazed systems:
- .1 Setting blocks: Silicone, 80-90 Shore A durometer hardness to ASTM D2240, sized to suit glazing method, glass light weight and area.
- .2 Sealant: Refer to Section 07 92 00.
- .3 Additional materials: Provide any additional components as may be required by sealant manufacturer to suit design.

.6 Glazing clips: manufacturer's standard type.

.7 Lock-strip gaskets: to ASTM C542.

2.05 FABRICATION

.1 Clearly label all glazing with maker's name and glass type. Ensure labels are easily removable, non-residue depositing type.

.2 Perform glass and glazing work in accordance with GANA providing smooth finished surfaces free from distortion and defects detrimental to appearance and performance.

3 EXECUTION

3.01 EXAMINATION

.1 Examine and verify previously installed Work upon which this Section depends. Report defects or unsatisfactory conditions to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.02 PREPARATION

.1 Clean contact surfaces with solvent and wipe dry.

.2 Seal porous glazing channels or recesses with substrate compatible primer or sealer.

.3 Prime surfaces scheduled to receive sealant.

3.03 INSTALLATION

.1 Install glazing in accordance with manufacturer's written data, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.

.2 Perform work in accordance with GANA Glazing Manual for glazing installation methods.

.3 Exterior: Wet/Dry Method:

- .1 Cut glazing tape to length and set against permanent stops, 6 mm below sight line. Seal corners by butting tape and dabbing with sealant.
- .2 Apply heel bead of sealant along intersection of permanent stop with frame ensuring full perimeter seal between glass and frame to complete continuity of air and vapour seal.
- .3 Place setting blocks at 1/4 points, with edge block maximum 150 mm from corners.
- .4 Rest glazing on setting blocks and push against tape and heel head of sealant with sufficient pressure to attain full contact at perimeter of light or glass unit.
- .5 Place glazing tape on glazing light or unit with tape flush with sight line.
- .6 Fill gap between glazing and stop with sealant to depth equal to bite of frame on glazing, maximum 9 mm below sight line.
- .7 Apply cap head of sealant along void between stop and glazing, to uniform line, flush with sight line. Tool or wipe sealant surface smooth.

.4 Interior: Dry Method:
- .1 Cut glazing tape to length and set against permanent stops, projecting 1.6 mm above sight line.
- .2 Place setting blocks at 1/4 points, with edge block maximum 150 mm from corners.
- .3 Rest glazing on setting blocks and push against tape for full contact at perimeter of light or unit.
- .4 Place glazing tape on free perimeter of glazing in same manner described.
- .5 Install removable stop without displacement of tape. Exert pressure on tape for full continuous contact.
- .6 Knife trim protruding tape.

.5 Glass film:
- .1 Install glass film in accordance with manufacturer's instructions.
- .2 Install glass film aligned square to glass with smooth razor cut edges.
- .3 Ensure glass film is adhered without air bubbles, creases or visible distortion.

3.04 CLEANING

.1 Remove traces of primer, caulking.

.2 Remove glazing materials from finish surfaces.

.3 Remove labels.

.4 Clean glass using approved non-abrasive cleaner in accordance with manufacturer's instructions.

.5 Glass film shall not be washed for 30 days after installation. Bristle brushed shall not be used.

3.05 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Mark each light with an "X" by using removable plastic tape or paste.

3.06 GLAZING SCHEDULE

.1 The following listed glass thicknesses are minimums and provided for convenience. Provide thicker glass where required by design.

.2 GL1: Triple glazed insulated unit:
- .1 Glass thickness: 6 mm float inner light, 6 mm heat strengthened middle light, 6 mm float outer light.
- .2 Inter-cavity space thickness: 12 mm between middle and outer lights with low conductivity spacers.
- .3 Glass coating: surface number 3 and 5, low "E".
- .4 Bird friendly markings: surface number 2.
- .5 Inert gas fill: 95% pure argon.

.3 GL2: Triple glazed insulated unit located within 450 mm of floor level:
- .1 Glass thickness: 6 mm tempered inner light, 6 mm heat strengthened middle light, 6 mm tempered outer light.
- .2 Inter-cavity space thickness: 12 mm between middle and outer lights with low conductivity spacers.
- .3 Glass coating: surface number 3 and 5, low "E".
- .4 Bird friendly markings: surface number 2.
- .5 Inert gas fill: 95% pure argon.

.4 GL3: Single glazed interior fire rated doors and partitions:
- .1 Glass thickness: 8 mm fire rated glass.

.5 GL4: Single glazed non-rated doors and partitions:
- .1 Glass thickness: 10 mm tempered glass.

.6 GL5: Single glazed non-rated doors and partitions where indicated:
- .1 Glass thickness: 10 mm laminated glass.

.7 GL6: Single glazed fire rated doors in fire rated curtainwall:
- .1 Glass thickness: 27 mm laminated fire rated glass.

.8 GL7: Insulated glazed unit in fire rated curtainwall:
- .1 Glass thickness: 57 mm insulated fire rated unit.

END OF SECTION

1 GENERAL

1.01 SUMMARY

.1 Section includes all methods, materials and installation as required to complete the Work of this Section in accordance with the Conditions of the Contract.

.2 Work may include, but is not limited to;
- .1 Non-structural metal framing.
- .2 Gypsum board wall and ceilings.

1.02 REFERENCES

.1 ASTM A641/A641M - Standard Specification for Zinc–Coated (Galvanized) Carbon Steel Wire.

.2 ASTM C475/C475M - Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board.

.3 ASTM C645 - Standard Specification for Nonstructural Steel Framing Members.

.4 ASTM C754 - Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products.

.5 ASTM C840 - Standard Specification for Application and Finishing of Gypsum Board.

.6 ASTM C1002 - Standard Specification for Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.

.7 ASTM C1047 - Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base.

.8 ASTM C1178/C1178M - Standard Specification for Coated Glass Mat Water-Resistant Gypsum Backing Panel.

.9 ASTM C1280 - Standard Specification for Application of Exterior Gypsum Panel Products for Use as Sheathing.

.10 ASTM C1396/C1396M - Standard Specification for Gypsum Board.

.11 ASTM C1629/C1629M - Standard Classification for Abuse-Resistant Nondecorated Interior Gypsum Panel Products and Fiber-Reinforced Cement Panels.

.12 AWCI - The Association of the Wall and Ceiling Industry.

.13 CAN/CGSB 51.34M - Vapor Barrier, Polyethylene Sheet for Use in Building Construction (Withdrawn).

.14 CAN/ULC S115 - Standard Method of Fire Tests of Firestop Systems.

1.03 ADMINISTRATIVE REQUIREMENTS

.1 Site Meetings: Arrange a pre-installation meeting on Site to be attended by Consultant, Contractor, gypsum board manufacturer's representative, and any other parties directly affecting work of this Section to:
- .1 Examine substrate conditions for compliance with manufacturer's requirements.
- .2 Review methods and procedures related to installation.
- .3 Review all typical and special details as required to complete the work of this section.

1.04 ACTION SUBMITTALS

.1 Submit action submittals in accordance with Section 01 33 00.

.2 Product data: Submit manufacturers product data for gypsum board assemblies including product characteristics, performance criteria, and limitations.

.3 Shop Drawings: Submit Shop Drawings as follows:
- .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.
- .2 Shop Drawings to illustrate framing, supports, bracing, reinforcing, details, dimensions, fabrication and installation details.
- .3 Provide fire rated designs.

.4 Samples: Submit 300 mm long samples illustrating colours, textures and finishes including, but not limited to:
- .1 Corner and casing beads.
- .2 Vinyl mouldings.
- .3 Insulating strip.

.5 Reports/certificates: Submit the following:
- .1 Test Reports: submit certified test reports showing compliance with specified performance characteristics and physical properties.
- .2 Certificates: submit product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

1.05 QUALITY ASSURANCE

.1 Installers: Perform Work of this Section by a company that has a minimum of five (5) years proven experience in the installation of gypsum board assemblies of a similar size and nature.

1.06 SITE CONDITIONS

.1 Ambient Conditions: Work of this Section shall be performed when air and surface temperatures are between 10 degrees C and 21 degrees C for 48 hours prior to and during application of gypsum boards and joint treatment, and for 48 hours minimum after completion of joint treatment.

.2 Apply board and joint treatment to dry, frost free surfaces.

.3 Ventilation: ventilate building spaces as required to remove excess moisture that would prevent drying of joint treatment material immediately after its application.

2 PRODUCTS

2.01 PERFORMANCE CRITERIA

.1 Design gypsum board assemblies to resist loads and climatic data as indicated, and in accordance with applicable building codes including seismic loads.

.2 Design non-structural framing system in accordance with manufacturer's printed directions and ASTM C754.

.3 Design wall framing system and reinforce as necessary to accommodate and support items attached to and supported by wall framing system and as required to suit height of partitions and indicated gypsum boards.

.4 Design suspension systems to support entire system including mechanical and electrical items not exceeding 25% of their ultimate load.

2.02 FRAMING MATERIALS

.1 Non-load bearing channel stud framing: to ASTM C645, 32 mm wide by width as indicated on drawings stud, roll formed hot dipped galvanized steel sheet, for screw attachment of gypsum board. Provide framing as follows:
- .1 Framing under 3000 mm high: minimum 0.53 mm.
- .2 Framing over 3000 mm high and non-standard assemblies: 0.91 mm.
- .3 Knock-out service holes at 460 mm centres.

.2 Floor and ceiling tracks: to ASTM C645, in widths to suit stud sizes, 32 mm flange height.

.3 Deflection track: to ASTM C645, top runner with 50 mm deep flange, in thickness to match studs and width to accommodate depth of studs.

.4 Deflection track (fire rated): to CAN/ULC S115, deflection track designed to allow partition heads to expand and contract with movement while maintaining fire-resistance rating indicated on rated walls in thickness to match studs and width to accommodate depth of studs.

.5 Metal channel stiffener: 1.4 mm thick cold rolled steel, coated with rust inhibitive coating.

.6 Drywall furring channels: to ASTM C645, 0.5 mm core thickness galvanized steel channels for screw attachment of gypsum board.

.7 Resilient drywall furring: to ASTM C645, 0.5 mm base steel thickness galvanized steel for resilient attachment of gypsum board.

.8 Hanger wires: to ASTM A641, galvanized soft annealed wire, minimum 2.0 mm (12 gauge) or as required to meet design.

.9 Tie wire: Galvanized soft annealed wire, minimum 1.0 mm (18 gauge).

2.03 GYPSUM BOARD MATERIALS

.1 Acceptable manufacturers:
- .1 Certainteed Gypsum Canada.
- .2 CGC (USG) Inc.
- .3 Georgia-Pacific Canada.

.2 Standard board: to ASTM C1396/C1396M, minimum 40% recycled content, 1200 mm wide x maximum practical length, ends square cut.
- .1 Regular: 12.7 mm thick.
- .2 Fire-rated: 15.9 mm thick.

.3 Abuse resistant, fiber-reinforced gypsum panel (very high impact): to ASTM C1629/C1629M Level III, fibre-reinforced impact and water resistant gypsum board, 15.9 mm thick, 1200 mm wide x maximum practical length.

.4 Moisture and mould resistant panel: to ASTM C1396/C1396M, minimum 40% recycled content, moisture and mould resistant core and face, 1200 mm wide x maximum practical length, ends square cut.

.5 Glass mat water-resistant gypsum tile backing board: to ASTM C1178/C1178M, 15.9 mm thick, 1200 mm wide x maximum practical length.

2.04 ACCESSORIES

.1 Acoustic/fire insulation: Refer to Section 07 21 00.

.2 Acoustical sealant: Refer to Section 07 92 00.

.3 Non-rated access door: Flush inlay access panel constructed of extruded aluminum frame with gypsum board panel inlay.
- .1 Hardware: Concealed hinge and torx cam latch.
- .2 Basis of Design:
  - .1 Bauco plus II by Bauco Access Panel Solutions.
  - .2 Or approved equal.

.4 Insulating strip: rubberized, moisture resistant 3 mm thick foam strip, 12 mm wide, with self sticking adhesive on one face, lengths as required.

.5 Steel drill screws: to ASTM C1002, corrosion resistant.

.6 Laminating compound: as recommended by manufacturer, asbestos-free.

.7 Casing beads, corner beads, control joints and edge trim: to ASTM C1047, zinc-coated galvanized steel, 0.5 mm base thickness, perforated flanges, one piece length per location. Allow for tear-away casing beads.

.8 Polyethylene: to CAN/CGSB 51.34, Type 2.

.9 Joint compound: to ASTM C475/C475M, asbestos-free.

.10 Joint tape: to ASTM C475/C475M.
- .1 Paper tape for standard gypsum board.
- .2 Glass mesh tape for abuse and water resistant gypsum board.

3 EXECUTION

3.01 EXAMINATION

.1 Examine and verify previously installed Work upon which this Section depends. Report defects or unsatisfactory conditions to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.02 WALL FRAMING INSTALLATION

.1 Align partition tracks at floor and ceiling and secure at 600 mm on centre maximum.

.2 Install dampproof course under stud shoe tracks of partitions on slabs on grade.

.3 Place studs vertically at 400 mm on centre and not more than 50 mm from abutting walls, and at each side of openings and corners.

.4 Position studs in tracks at floor and ceiling. Cross brace steel studs as required to provide rigid installation to manufacturer's instructions.

.5 Erect metal studding to tolerance of 1:1000.

.6 Attach studs to tracks using screws.

.7 Co-ordinate simultaneous erection of studs with installation of service lines. When erecting studs ensure web openings are aligned.

.8 Co-ordinate erection of studs with installation of door/window frames and special supports or anchorage for work specified in other Sections.

.9 Provide two studs extending from floor to ceiling at each side of openings wider than stud centres specified. Secure studs together, 50 mm apart using column clips or other approved means of fastening placed alongside frame anchor clips.

.10 Install heavy gauge single jamb studs at openings.

.11 Erect track at head of door/window openings and sills of sidelight/window openings to accommodate intermediate studs.
- .1 Secure track to studs at each end, in accordance with manufacturer's instructions.
- .2 Install intermediate studs above and below openings in same manner and spacing as wall studs.

.12 Frame openings and around built-in equipment, cabinets, access panels, on four sides. Extend framing into reveals. Check clearances with equipment suppliers.

.13 Provide 40 mm stud or furring channel secured between studs for attachment of fixtures behind lavatory basins, toilet and bathroom accessories, and other fixtures including grab bars and towel rails, attached to steel stud partitions.

.14 Install steel studs or furring channel between studs for attaching electrical and other boxes.

.15 Extend partitions to ceiling height except where noted otherwise on drawings.

.16 Maintain clearance under beams and structural slabs to avoid transmission of structural loads to studs. Use double track slip joint as indicated.

.17 Install continuous insulating strips to isolate studs from uninsulated surfaces.

.18 Install two continuous beads of acoustical sealant or insulating strip under studs and tracks around perimeter of sound control partitions.

3.03 CEILING FRAMING INSTALLATION

.1 Erect hangers and runner channels for suspended gypsum board ceilings to ASTM C840 except where specified otherwise.

.2 Support light fixtures by providing additional ceiling suspension hangers within 150 mm of each corner and at maximum 600 mm around perimeter of fixture.

.3 Install work level to tolerance of 1:1200.

.4 Frame with furring channels, perimeter of openings for access panels, light fixtures, diffusers, grilles, and other components.

.5 Install 19 x 64 mm furring channels parallel to, and at exact locations of steel stud partition header track.

.6 Furr for gypsum board faced vertical bulkheads within and at termination of ceilings.

.7 Furr above suspended ceilings for gypsum board fire and sound stops and to form plenum areas as indicated.

.8 Install wall furring for gypsum board wall finishes to ASTM C840, except where specified otherwise.

.9 Furr openings and around built-in equipment, cabinets, access panels, and other components, on four sides. Extend furring into reveals. Check clearances with equipment suppliers.

.10 Furr duct shafts, beams, columns, pipes and exposed services where indicated.

.11 Erect drywall resilient furring transversely across studs, spaced maximum 600 mm on centre and not more than 150 mm from ceiling/wall juncture. Secure to each support with 25 mm drywall screw.

.12 Install 150 mm continuous strip of 12.7 mm gypsum board along base of partitions where resilient furring installed.

3.04 GYPSUM BOARD INSTALLATION

.1 Do application and finishing of gypsum board to ASTM C840 except where specified otherwise.

.2 Do application of gypsum sheathing to ASTM C1280.

.3 Apply gypsum board after bucks, anchors, blocking, sound attenuation, electrical and mechanical work have been approved.

.4 Apply gypsum board to metal framing using approved fastening system and as follows:
- .1 Single-Layer Application:
  - .1 Apply gypsum board on ceilings prior to application of walls to ASTM C840.
  - .2 Apply gypsum board vertically or horizontally, providing sheet lengths that will minimize end joints.
- .2 Double-Layer Application:
  - .1 Install gypsum board for base layer and exposed gypsum board for face layer.
  - .2 Apply base layer to ceilings prior to base layer application on walls; apply face layers in same sequence. Offset joints between layers at least 250 mm.
  - .3 Apply base layers at right angles to supports unless otherwise indicated.
  - .4 Apply base layer on walls and face layers vertically with joints of base layer over supports and face layer joints offset at least 250 mm with base layer joints.

.5 Apply water-resistant gypsum board where indicated on drawings. Apply water-resistant sealant to edges, ends, cut-outs which expose gypsum core and to fastener heads. Do not apply joint treatment on areas to receive tile finish.

.6 Apply 12 mm diameter bead of acoustic sealant continuously around periphery of each face of partitioning to seal gypsum board/structure junction where partitions abut fixed building components. Seal full perimeter of cut-outs around electrical boxes, ducts, and other components, in partitions where perimeter sealed with acoustic sealant.

.7 Install ceiling boards in direction that will minimize number of end-butt joints. Stagger end joints at least 250 mm.

.8 Install gypsum board on walls vertically to avoid end-butt joints. At stairwells and similar high walls, install boards horizontally with end joints staggered over studs, except where local codes or fire-rated assemblies require vertical application.

.9 Fire rated assembly:
- .1 Install components in fire rated assemblies in strict accordance with reviewed Shop Drawings and applicable tested and approved designs required by Authorities Having Jurisdiction.

.2 Install assemblies tightly to enclosing constructions to maintain integrity of the separations.

.10 Install gypsum board with face side out.

.11 Do not install damaged or damp boards.

.12 Locate edge or end joints over supports. Stagger vertical joints over different studs on opposite sides of wall.

3.05 ACCESSORIES AND FINISHING

.1 Erect accessories straight, plumb or level, rigid and at proper plane. Use full length pieces where practical. Make joints tight, accurately aligned and rigidly secured. Mitre and fit corners accurately, free from rough edges. Secure using fasteners or adhesive as recommended by manufacturer.

.2 Install casing beads around perimeter of suspended ceilings.

.3 Install tear-away casing beads where gypsum board butts against surfaces having no trim concealing junction and where indicated. Seal joints with sealant.

.4 Install insulating strips continuously at edges of gypsum board and casing beads abutting metal window and exterior door frames, to provide thermal break.

.5 Construct control joints of preformed units or two back-to-back casing beads set in gypsum board facing and supported independently on both sides of joint.

.6 Provide continuous polyethylene dust barrier behind and across control joints.

.7 Locate control joints at changes in substrate construction, at approximate 10 m spacing on long corridor runs and at approximate 15 m spacing on ceilings.

.8 Install control joints straight and true.

.9 Ensure that screws or nails are properly applied in process of attaching gypsum board to framing without damaging of gypsum board edges and ends.

.10 Construct expansion joints at building expansion and construction joints. Provide continuous dust barrier.

.11 Install expansion joint straight and true.

.12 Splice corners and intersections together and secure to each member with 3 screws.

.13 Install access doors for electrical and mechanical fixtures. Rigidly secure frames to furring or framing systems.

.14 Finish face panel joints and internal angles with joint system consisting of joint compound, joint tape and taping compound installed according to manufacturer's directions and feathered out onto panel faces.

.15 Gypsum Board Finish: finish gypsum board walls and ceilings to following levels in accordance with AWCI Levels of Gypsum Board Finish:

.1 Level 0: no tapping, finishing or accessories required. Provide for temporary construction.

.2 Level 1: embed tape for joints and interior angles in joint compound. Surfaces to be free of excess joint compound; tool marks and ridges are acceptable. Provide in plenum areas above ceilings, in attics or in areas where assembly will be concealed.

.3 Level 2: embed tape for joints and interior angles in joint compound and apply one separate coat of joint compound over joints, angles, fastener heads and accessories; surfaces free of excess joint compound; tool marks and ridges are acceptable. Provide where water resistant gypsum backing board is used as tile substrate.

.4 Level 3: embed tape for joints and interior angles in joint compound and apply two separate coats of joint compound over joints, angles, fastener heads and accessories; surfaces smooth and free of tool marks and ridges. Provide in areas to receive heavy or medium coat of textured material, or where heavy grade wall coverings are to be applied.

.5 Level 4: embed tape for joints and interior angles in joint compound and apply three separate coats of joint compound over joints, angles, fastener heads and accessories; surfaces smooth and free of tool marks and ridges. Provide where light textures or wall coverings are to be applied.

.6 Level 5: embed tape for joints and interior angles in joint compound and apply three separate coats of joint compound over joints, angles, fastener heads and accessories; apply a thin skim coat of joint compound to entire surface; surfaces smooth and free of tool marks and ridges. Provide where gloss, semi-gloss, enamel or non-textural flat paints are specified or where severe lighting conditions occur.

.16 Finish corner beads, control joints and trim as required with two coats of joint compound and one coat of taping compound, feathered out onto panel faces.

.17 Fill screw head depressions with joint and taping compounds to bring flush with adjacent surface of gypsum board so as to be invisible after surface finish is completed.

.18 Sand lightly to remove burred edges and other imperfections. Avoid sanding adjacent surface of board.

.19 Completed installation to be smooth, level or plumb, free from waves and other defects and ready for surface finish.

3.06 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by gypsum board assembly work.

END OF SECTION

1 GENERAL

1.01 SUMMARY

.1 Section includes all methods, materials and installation as required to complete the Work of this Section in accordance with the Conditions of the Contract.

1.02 REFERENCES

.1 ANSI A108/A118/A136.1 - Installation of Ceramic Tile, including the following standards:
- .1 ANSI A108.1 - Installation of Ceramic Tile.
- .2 ANSI A118.3 - Standard Specifications for Chemical Resistant, Water Cleanable Tile-Setting and -Grouting Epoxy and Water Cleanable Tile-Setting Epoxy Adhesive.
- .3 ANSI A118.4 - Standard Specification for Modified Dry-Set Cement Mortar.
- .4 ANSI A118.6 - Standard Specifications for Standard Cement Grouts for Tile Installation.
- .5 ANSI A118.7 - Standard Specifications for High Performance Cement Grouts for Tile Installation.
- .6 ANSI A136.1 - Organic Adhesives for Installation of Ceramic Tile.

.2 ANSI A137.1 - Specification for Ceramic Tile.

.3 ASTM C144 - Standard Specification for Aggregate for Masonry Mortar.

.4 ASTM C920 - Standard Specification for Elastomeric Joint Sealants.

.5 ASTM C1330 - Standard Specification for Cylindrical Sealant Backing for Use with Cold Liquid-Applied Sealants.

.6 ASTM F1869 - Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.

.7 CSA A3000 - Cementitious Materials Compendium.

.8 Terrazzo Tile and Marble Association of Canada (TTMAC) - Tile Installation Manual and Maintenance Guide.

1.03 ACTION SUBMITTALS

.1 Submit action submittals in accordance with Section 01 33 00.

.2 Product data: Submit manufacturers product data for tile, mortars and grouts, waterproofing, and sealants including product characteristics, performance criteria, and limitations.

.3 Shop Drawings: Submit Shop Drawings as follows:
- .1 Shop Drawings to illustrate tile layout and patterns.
- .2 Indicate perimeter conditions, connections to dissimilar materials and setting details.

.4 Samples: Submit 300 mm x 300 mm samples illustrating colours, textures and finishes including, but not limited to:
- .1 300 mm x 300 mm sample panels of each colour, texture, size, and pattern of tile. Adhere tile samples to 12 mm thick plywood and grout joints to represent project installation.
- .2 Trim shapes, bullnose cap and cove including bullnose cap and base pieces at internal and external corners of vertical surfaces, each type, colour, and size.

1.04 CLOSEOUT AND MAINTENANCE SUBMITTALS

.1 Submit closeout and maintenance submittals in accordance with Section 01 78 00.

.2 Closeout Product data: Submit manufacturers maintenance and cleaning data for incorporation into operation and maintenance manual.

.3 Maintenance materials: Submit extra 2% or to nearest full carton of each type and colour of tile.

1.05 QUALITY ASSURANCE

.1 Installers: Perform Work of this Section by a company that has a minimum of five (5) years proven experience in the installation of tile of a similar size and nature. Company shall also be a member of good standing of TTMAC.

1.06 DELIVERY, STORAGE, AND HANDLING

.1 Deliver materials in adequate crates or containers with manufacturer's name and product description clearly marked.

.2 Store and handle tiles in manner to avoid chipping, breakage or the introduction of foreign matter.

.3 Store mortar and grout admixtures in location to protect materials from freezing or from excessive heat.

1.07 SITE CONDITIONS

.1 Ambient Conditions: Work of this Section shall be performed when air and surface temperatures are between 12 degrees C and 38 degrees C for 48 hours before, during and 48 hours after installation.

.2 Do not apply epoxy mortar and grouts at substrate temperatures below 15 degrees C or above 25 degrees C.

2 PRODUCTS

2.01 TILE

.1 Tile:
- .1 to ANSI A137.1.
- .2 Provide finished corners and bullnose tiles as required.

.2 Floor Tile (FF2): 300 mm x 600 mm, to match Regal Series by Olympia Tile in Royale Nero colour with matte finish.

.3 Wall Tile (WF1): 300 mm x 600 mm, to match Regal Series by Olympia Tile in Shell White colour with matte finish.

2.02 METAL TRIMS

.1 Floor transition strips:
- .1 Stainless steel edge, continuous at all exposed tile edges, depth as required to suit tile thickness.
- .2 Basis of Design:
  - .1 Proangle by Mapei Inc.
  - .2 Schiene by Schluter Systems.
  - .3 Or approved equal.

.2 Wall edge protection strips:
- .1 Aluminum edge protection strip, continuous at all exposed tile edges, depth as required to suit tile thickness.
- .2 Finish: Anodized.
- .3 Basis of Design:
  - .1 Proangle by Mapei Inc.
  - .2 Jolly by Schluter Systems.
  - .3 Or approved equal.

.3 Cove wall profiles:
- .1 Stainless steel profile with thermoplastic rubber movement zone, for use at floor to wall transitions, depth as required to suit tile thickness.
- .2 Finish: To be selected by Consultant.

.3 Basis of Design:
.1 Dilex HKS by Schluter Systems.
.2 Or approved equal.

2.03 ACCESSORIES

.1 Levelling Bed Mortar Materials:
.1 Cement: to CSA A3000, type GU.
.2 Sand: to ASTM C144, passing 16 mesh.
.3 Latex additive: formulated for use in cement mortar and thin set bond coat.
.4 Water: potable and free of minerals and chemicals which are detrimental to mortar and grout mixes.

.2 Latex additive:
.1 Thin-set mortar: Single component to ANSI A108/A118/A136.1, provided with white mortar at glass, or light coloured tiles as recommended by tile manufacturer. Basis of Design:
.1 Ardex X77 Microtec by Ardex.
.2 Versabond LFT by Custom Building Products.
.3 254 Platinum by Laticrete International.
.4 Ultralite by Mapei Inc.
.5 Or approved equal.
.2 Medium-bed mortar (large format tile): to ANSI A118.4, provided with white mortar at glass, or light coloured tiles as recommended by tile manufacturer. Basis of Design:
.1 ProLite Premium LFT by Custom Building Products.
.2 Flextile 56 SR by Flextile Ltd.
.3 220 Marble & Granite Thick Bed Adhesive by Laticrete International Inc.
.4 Ultraflex LFT by Mapei Inc.

.3 Organic adhesive: to ANSI A136.1.

.4 Grout:
.1 Cement Grout: to ANSI A118.6. Use one part white cement to one part white sand passing a number 30 screen.
.2 Latex Cement Grout: to ANSI A118.7, fast curing, high early strength, polymer-modified, stain resistant, sanded mix for floors, unsanded mix for walls and floors with polished tiles.
.3 Epoxy grout: to ANSI A118.3, having quality, colour and characteristics to match epoxy bond coat. Adhesive and grout by same manufacturer.
.4 Colours: To be selected by Consultant from manufacturers full colour range.
.5 Basis of Design manufacturers:
.1 Ardex.
.2 Custom Building Products.
.3 Flextile Ltd.

.4 Laticrete International.
.5 Mapei Inc.

.5 Sealant:
.1 Joint backing: to ASTM C1330; Round, solid section, soft polyethylene foam gasket compatible with primer and sealant materials.
.2 Primer: for use on porous tile surfaces as recommended by manufacturer.
.3 Tile sealant at horizontal floor joints: Multi-component polyurethane sealant with self levelling properties to ASTM C920, Type M, Grade P, Class 25. Colours: To be selected by Consultant from standard colour selection. Basis of Design:
.1 Commercial 100% Silicone Sealant by Custom Building Products.
.2 Mapesil T Plus by Mapei Inc.
.3 Vulkem 445SSL by Tremco Ltd.
.4 Or approved equal.
.4 Tile sealant for remainder of work: Refer to Section 07 92 00.

.6 Cleaner:
.1 Specifically designed for cleaning masonry and concrete and which will not prevent bond of subsequent tile setting materials including patching and leveling compounds and elastomeric waterproofing membrane and coat.
.2 Material in accordance with TTMAC's requirements and as recommended by tile manufacturer.

2.04 MIXES

.1 Cement bed for floors:
.1 1 part cement, 4 parts sand, 1 part water. Adjust water volume depending on water content of sand. Latex additive as recommended.
.2 Measure mortar ingredients by volume.

.2 Dry set mortar: mix to manufacturer's instructions.

.3 Organic adhesive: pre-mixed.

.4 Mix grout to manufacturer's instructions.

.5 Adjust water volumes to suit water content of sand.

3 EXECUTION

3.01 EXAMINATION

.1 Examine and verify previously installed Work upon which this Section depends. Report defects or unsatisfactory conditions to Consultant. Commencement of work of this Section means acceptance of existing conditions.

.2 Concrete floors shall be tested to the following standards to ensure compliance with flooring manufacturer's recommendations.
  .1 Moisture Test: Moisture emissions from concrete subfloors (cured for a minimum of 28 days) to be tested in accordance with ASTM F1869.

3.02 PREPARATION

.1 Clean and dry surfaces thoroughly. Remove oil, wax, grease, dust, dirt, paint, tar, primers, form release agents, curing compound, and other foreign material from substrate surfaces which may prevent or reduce adhesion.

.2 Neutralize any trace of strong acids or alkali from the substrate.

3.03 CEMENT LEVELLING BED

.1 Install cement levelling bed on uneven substrate surfaces. Ensure level and plumb substrates conforming to the following tolerances:
  .1 Vertical surfaces: 3 mm in 2.4 m maximum.
  .2 Horizontal surfaces: 6 mm in 3 m from finished levels of the surface, or better.

.2 Clean structural substrate control joints and blow-clean with compressed air. Fill control joints flush to levelling bed with grout.

3.04 INSTALLATION

.1 Perform tile work in accordance with TTMAC Tile Installation Manual, except where specified otherwise.

.2 Apply tile to clean and sound surfaces.

.3 Fit tile around corners, fitments, fixtures, drains and other built-in objects. Maintain uniform joint appearance. Cut edges smooth and even. Do not split tiles.

.4 Maximum surface tolerance 1:800.

.5 Make joints between tile uniform and approximately 1.5 mm wide, plumb, straight, true, even and flush with adjacent tile. Ensure sheet layout not visible after installation. Align patterns.

.6 Lay out tiles so perimeter tiles are minimum 1/2 size.

.7 Sound tiles after setting and replace hollow-sounding units to obtain full bond.

.8 Make internal angles square, external angles rounded or bullnosed.

.9 Use round or bullnose edged tiles at termination of wall tile panels, except where panel abuts projecting surface, differing plane or where wall edge protection strips are provided.

.10 Install divider strips at junction of tile flooring and dissimilar materials.

.11 Allow minimum 48 hours after installation of tiles, before grouting.

.12 Clean installed tile surfaces after installation and grouting has cured.

.13 Make control joints in accordance with TTMAC guidelines unless indicated otherwise. Make joint width same as tile joints. Fill control joints with sealant in accordance with Section 07 92 00. Keep building expansion joints free of mortar and grout. Control joints to be provided at perimeter walls, fixed objects, room thresholds, changes in directions and in spacing as outlined in TTMAC.

3.05 PROTECTION

.1 Prevent traffic over tiled areas, and protect tiled assemblies from weather, freezing, and water immersion, in accordance with mortar manufacturers recommendations.

.2 Prevent direct impact, vibration and heavy hammering on adjacent and opposite walls for 24 hours minimum, after final installation.

.3 Cover work temporarily with building paper properly lapped and taped at joints until work has been approved by Consultant.

END OF SECTION

1 GENERAL

1.01 SUMMARY

.1 Section includes all methods, materials and installation as required to complete the Work of this Section in accordance with the Conditions of the Contract.

1.02 REFERENCES

.1 ASTM C635/C635M - Standard Specification for Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings.

.2 ASTM C636/C636M - Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels.

.3 ASTM C645 - Standard Specification for Nonstructural Steel Framing Members.

.4 CAN/ULC S102 - Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.

1.03 ACTION SUBMITTALS

.1 Submit action submittals in accordance with Section 01 33 00.

.2 Product data: Submit manufacturers product data for ceiling baffles and suspension system including product characteristics, performance criteria, and limitations.

.3 Shop Drawings: Submit Shop Drawings as follows:
- .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.
- .2 Submit reflected layout plans for grid patterns as indicated.
- .3 Indicate insert and hanger spacing and fastening details, splicing method for main runners, acoustic baffle support and accessories.

.4 Samples: Submit full size samples of the following:
- .1 One sample of suspension system.
- .2 One sample of each type ceiling baffle.

1.04 CLOSEOUT AND MAINTENANCE SUBMITTALS

.1 Submit closeout and maintenance submittals in accordance with Section 01 78 00.

.2 Closeout Product data: Submit manufacturers maintenance and cleaning data for incorporation into operation and maintenance manual.

.3 Maintenance materials: Submit extra 3% or to nearest full carton of each type of ceiling baffle.

1.05 QUALITY ASSURANCE

.1 Mock-ups:
- .1 Construct one (1) mock-up of each type of baffle system in location as directed by Consultant.
- .2 Mock-up shall be 3 m^2 and demonstrate installation of typical light fixtures, and other mechanical and electrical fixtures.
- .3 Mock-up may form part of the Work if accepted by the Consultant.

1.06 SITE CONDITIONS

.1 Ambient Conditions: Work of this Section shall be performed when air and surface temperatures are above 10 degrees C.

.2 Work of this Section shall be performed when relative humidity is below 80% and ventilation is adequate to remove excess moisture.

2 PRODUCTS

2.01 PERFORMANCE CRITERIA

.1 Design acoustic baffle system to resist loads and climatic data as indicated, and in accordance with applicable building codes.

.2 Design ceiling suspension systems in accordance with ASTM C635/C635M and manufacturer's printed directions to provide a maximum deflection of 1/360.

.3 Design entire suspension system including hanger anchors to not exceed 25% of their ultimate capacity including lighting fixture dead loads.

.4 Design subframing as necessary to accommodate and avoid conflicts and interferences where ducts or equipment prevent regular spacing of hangers.

2.02 ACOUSTIC BAFFLES

.1 Acoustic baffles:
- .1 Type: straight blade.
- .2 Material: 50 mm thick fiberglass with scrim on face and sides.
- .3 Flame spread rating of 25 or less in accordance with CAN/ULC S102.
- .4 Smoke developed 50 or less in accordance with CAN/ULC S102.
- .5 Colour: To be selected by Consultant.
- .6 Size: 229 mm deep, spaced 457 mm.

.7 Basis of Design:
.1 Soundscapes Blades by Armstrong Ceilings Canada.
.2 Ceiling Baffle by Ezo Bord.
.3 Acoustic Ceiling Baffle by Turf Design.

2.03 SUSPENSION SYSTEM

.1 Suspension system: non fire rated, two directional exposed tee bar grid system to ASTM C635/C635M. Colour: White. Basis of Design as follows:
.1 Prelude XL by Armstrong World Industries Inc.
.2 Donn DX by CGC Inc.
.3 EZ Stab Classic by Certainteed Ceilings Canada.
.4 Seismic 1200 by Rockfon/Chicago Metallic.

.2 Basic materials for suspension system:
.1 Commercial quality cold rolled steel, zinc coated.

.3 Exposed tee bar grid components: shop painted satin sheen, white colour. Components die cut. Main tee with double web, rectangular bulb and 25 mm rolled cap on exposed face. Cross tee with rectangular bulb; web extended to form positive interlock with main tee webs; lower flange extended and offset to provide flush intersection.

.4 Subframing and carrying channels: ASTM C645, formed from galvanized steel sheet in sizing as required to suit design.

.5 Hanger wire: galvanized soft annealed steel wire, 3.6 mm diameter.

.6 Hanger inserts: Purpose made.

.7 Carrying channels: 38 mm x 19 mm channel of galvanized steel.

.8 Accessories: brackets, clips, wire ties, and hanging accessories as recommended by system manufacturer.

3 EXECUTION

3.01 EXAMINATION

.1 Examine and verify previously installed Work upon which this Section depends. Report defects or unsatisfactory conditions to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.02 SUSPENSION SYSTEM

.1 Install suspension system in accordance with ASTM C636/C636M and to manufacturers written instructions.

.2 Erect ceiling suspension system after work above ceiling has been inspected.

.3 Secure hangers to overhead structure using attachment methods as indicated, ensuring system is independent of walls, pipes, ducts, and metal deck. Provide additional framing, supports and hangers as required to bridge interference items.

.4 Install hangers spaced at maximum 1200 mm centres and within 150 mm from ends of main tees.

.5 Lay out centreline of ceiling both ways, to provide balanced borders at room perimeter with border units not less than 50% of standard unit width.

.6 Completed suspension system to support super-imposed loads, such as lighting fixtures, diffusers, grilles and speakers.

.7 Support at light fixtures and diffusers with additional ceiling suspension hangers within 150 mm of each corner and at maximum 600 mm around perimeter of fixture.

.8 Interlock cross member to main runner to provide rigid assembly.

.9 Ensure finished ceiling system is square with adjoining walls and level within 1:1000.

3.03 ACOUSTIC BAFFLE

.1 Install acoustic baffles from ceiling suspension system.

.2 Co-ordinate ceiling work with work of other sections such as interior lighting, fire protection communication, and intrusion and detection systems.

3.04 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by acoustic baffle installation.

END OF SECTION

1 GENERAL

1.01 SUMMARY

.1 Section includes all methods, materials and installation as required to complete the Work of this Section in accordance with the Conditions of the Contract.

1.02 REFERENCES

.1 ASTM F1861 - Standard Specification for Resilient Wall Base.

1.03 ACTION SUBMITTALS

.1 Submit action submittals in accordance with Section 01 33 00.

.2 Product data: Submit manufacturers product data for resilient base and accessories including product characteristics, performance criteria, and limitations.

.3 Samples: Submit 300 mm long samples illustrating colours, textures and finishes including, but not limited to:
- .1 Resilient base.
- .2 Resilient stair treads.

1.04 CLOSEOUT AND MAINTENANCE SUBMITTALS

.1 Submit closeout and maintenance submittals in accordance with Section 01 78 00.

.2 Closeout Product data: Submit manufacturers maintenance and cleaning data for incorporation into operation and maintenance manual..

.3 Maintenance materials: Submit extra 3% or to nearest full roll/carton of each type of resilient base and accessory.

1.05 SITE CONDITIONS

.1 Ambient Conditions: Work of this Section shall be performed when air and surface temperatures are above 20 degree C for 48 hours before, during and 48 hours after installation.

.2 Ensure high ventilation rate, with maximum outside air, during installation as follows:
- .1 Vent directly to outside.
- .2 Do not let contaminated air recirculate through a district or whole building air distribution system.
- .3 Maintain extra ventilation for 1 month minimum after building occupation.

2 PRODUCTS

2.01 MATERIALS

.1 Resilient base: ASTM F1861, continuous, top set base complete with premoulded end stops and external corners as follows:
- .1 Type: TS - Thermoset rubber, 3.18 mm.
- .2 Style: coved.
- .3 Height: 101.6 mm.
- .4 Colour: to be selected by Consultant.
- .5 Basis of Design:
  - .1 BurkeBase TS Molded Wall Base by Mannington Commercial.
  - .2 Baseworks Thermoset Rubber by Tarket (Johnsonite).
  - .3 Or approved equal.

.2 Primers and adhesives: Low VOC of types recommended by resilient base and accessory manufacturer for specific material on applicable substrate, above, on or below grade.

3 EXECUTION

3.01 EXAMINATION

.1 Examine and verify previously installed Work upon which this Section depends. Report defects or unsatisfactory conditions to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.02 PREPARATION

.1 Prepare for installation in accordance with manufacturer's written recommendations.

3.03 RESILIENT BASE INSTALLATION

.1 Lay out base to keep number of joints at minimum.

.2 Clean substrate and ensure compliance with manufacturers written instructions.

.3 Apply adhesive to back of base.

.4 Set base against wall and floor surfaces in straight and level manner and roll with small hand roller.

.5 Scribe and fit to door frames and other obstructions. Use premoulded end pieces at flush door frames.

.6 Form corners using premoulded corner units for right angle external corners and formed straight base material for external corners of other angles. Provide field-made corners at locations where premoulded cannot be used.

3.04 CLEANING

.1 Remove excess adhesive from base and wall surfaces using manufacturers recommended methods.

.2 Clean, seal and wax base surface to flooring manufacturer's printed instructions.

3.05 PROTECTION

.1 Protect installed products and components from damage during construction

END OF SECTION

1 GENERAL

1.01 SUMMARY

.1 Section includes all methods, materials and installation as required to complete the Work of this Section in accordance with the Conditions of the Contract.

1.02 REFERENCES

.1 ASTM F710 - Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring.

.2 ASTM F1859 - Standard Specification for Rubber Sheet Floor Covering Without Backing.

.3 ASTM F1869 - Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.

.4 ASTM F2170 - Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes.

1.03 ACTION SUBMITTALS

.1 Submit action submittals in accordance with Section 01 33 00.

.2 Product data: Submit manufacturers product data for resilient sheet flooring including product characteristics, performance criteria, and limitations.

.3 Samples: Submit samples illustrating colours, textures and finishes including, but not limited to:
- .1 300 mm x 300 mm each type sheet material.
- .2 300 mm long of feature strips, coved base.

1.04 CLOSEOUT AND MAINTENANCE SUBMITTALS

.1 Submit closeout and maintenance submittals in accordance with Section 01 78 00.

.2 Closeout Product data: Submit manufacturers maintenance and cleaning data for incorporation into operation and maintenance manual.

.3 Maintenance materials: Submit extra 3% or to nearest full roll of each type of sheet flooring.

1.05 SITE CONDITIONS

.1 Ambient Conditions: Work of this Section shall be performed when air and surface temperatures are above 20 degree C for 48 hours before, during and 48 hours after installation.

.2 Provide high ventilation rate, with maximum outside air, during installation, and for 48 to 72 hours after installation. If possible, vent directly to outside. Do not let contaminated air recirculate through district or whole building air distribution system.

2 PRODUCTS

2.01 MATERIALS

.1 Sheet rubber: ASTM F1859, resilient rubber sheet flooring as follows:
- .1 Thickness: 3 mm.
- .2 Texture: smooth.
- .3 Colour: S05 Cement.
- .4 Basis of Design:
  - .1 Massetto by Mondo
  - .2 Or approved equal.

.2 Resilient base: Refer to Section 09 65 13.

.3 Primers and adhesives: Low VOC of types recommended by resilient flooring manufacturer for specific material on applicable substrate, above, on or below grade and as required to suit test results of concrete subfloor.

.4 Self-levelling sub-floor filler: Low VOC, self-levelling cement-based underlayment meeting ASTM F710 and providing a cured density of 2 kg/L. Basis of Design:
- .1 NovoPlan 2 Plus by Mapei.
- .2 Or approved equal.

.5 Metal edge strips: Aluminum extruded, smooth, [mill finish] [polished] trim with lip to extend under floor finish, shoulder flush with top of adjacent floor finish.

3 EXECUTION

3.01 EXAMINATION

.1 Examine and verify previously installed Work upon which this Section depends. Report defects or unsatisfactory conditions to Consultant. Commencement of work of this Section means acceptance of existing conditions.

.2 Concrete floors shall be tested to the following standards to ensure compliance with flooring manufacturer's adhesive recommendations. Ensure selected adhesive meets substrate's test results.

.1 Internal Relative Humidity Test: Humidity tested in accordance with ASTM F2170.

.2 Moisture Test: Moisture emissions from concrete subfloors (cured for a minimum of 28 days) to be tested in accordance with ASTM F1869.

.3 Subfloor surface pH level. Surfaces with pH over recommended level shall be neutralized.

3.02 PREPARATION

.1 Remove sub-floor ridges and bumps.

.2 Apply subfloor filler and leveller to fill low spots, cracks, joints, and other defects to provide a smooth monolithic surface.

.3 Prime sub-floor to resilient flooring manufacturer's printed instructions.

.4 Concrete subfloors shall conform to ASTM F710.

3.03 APPLICATION

.1 Apply adhesive uniformly using recommended trowel. Do not spread more adhesive than can be covered by flooring before initial set takes place.

.2 Lay flooring with seams parallel to building lines to produce a minimum number of seams. Border widths minimum 1/3 width of full material.

.3 Run sheets in direction of traffic. Double cut sheet joints and continuously seal or heat weld according to manufacturer's printed instructions.

.4 As installation progresses, and after installation roll flooring with minimum 45 kg minimum roller to ensure full adhesion.

.5 Cut flooring around fixed objects.

.6 Continue flooring over areas which will be under built-in furniture.

.7 Continue flooring through areas to receive movable type partitions without interrupting floor pattern.

.8 Terminate flooring at centreline of door in openings where adjacent floor finish or colour is dissimilar.

.9 Install metal edge strips at unprotected or exposed edges where flooring terminates.

3.04 CLEANING

.1 Seventy-two hours after installation, clean sheet flooring surfaces with a mild soap solution approved by finish manufacturer. Rinse clean and allow to dry.

3.05 PROTECTION

.1 Protect new floors from time of final set of adhesive until final inspection.

.2 Prohibit traffic on floor for 72 hours after installation.

END OF SECTION

1 GENERAL

1.01 SUMMARY

.1 Section includes all methods, materials and installation as required to complete the Work of this Section in accordance with the Conditions of the Contract.

1.02 REFERENCES

.1 ANSI/ESD STM7.1 - Flooring Systems Resistive Characterization.

.2 ASTM F710 - Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring.

.3 ASTM F1700 - Standard Specification for Solid Vinyl Floor Tile.

.4 ASTM F1869 - Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.

.5 ASTM F2170 - Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes.

1.03 ACTION SUBMITTALS

.1 Submit action submittals in accordance with Section 01 33 00.

.2 Product data: Submit manufacturers product data for resilient tile flooring including product characteristics, performance criteria, and limitations.

.3 Samples: Submit 300 mm x 300 mm samples illustrating colours, textures and finishes of each tile material and colour.

1.04 CLOSEOUT AND MAINTENANCE SUBMITTALS

.1 Submit closeout and maintenance submittals in accordance with Section 01 78 00.

.2 Closeout Product data: Submit manufacturers maintenance and cleaning data for incorporation into operation and maintenance manual.

.3 Maintenance materials: Submit extra 3% or to nearest full carton of each colour and type of resilient tile.

1.05 SITE CONDITIONS

.1 Ambient Conditions: Work of this Section shall be performed when air and surface temperatures are above 20 degree C for 48 hours before, during and 48 hours after installation.

.2 Provide high ventilation rate, with maximum outside air, during installation, and for 48 to 72 hours after installation. If possible, vent directly to outside. Do not let contaminated air recirculate through district or whole building air distribution system.

2 PRODUCTS

2.01 MATERIALS

.1 Static Control Vinyl Composition Tile: ASTM F1700, Homogeneous composition of additives and colourants as follows:
- .1 Static Dissipative Tile (ANSI/ESD STM7.1): 1×10^6 to 1×10^9 ohms.
- .2 Size: 305 mm x 305 mm x 3.2 mm.
- .3 Colour: Reverse Grey.
- .4 Basis of Design:
  - .1 8400 Series Static Control Vinyl Floor Tile by 3M.
  - .2 Or approved equal.

.2 Primers and adhesives: Low VOC of types recommended by resilient flooring manufacturer for specific material on applicable substrate, above, on or below grade and as required to suit test results of concrete subfloor.

.3 Self-levelling sub-floor filler: Low VOC, self-levelling cement-based underlayment meeting ASTM F710 and providing a cured density of 2 kg/L. Basis of Design:
- .1 NovoPlan 2 Plus by Mapei.
- .2 Or approved equal.

.4 Metal edge strips: Aluminum extruded, smooth, mill finish trim with lip to extend under floor finish, shoulder flush with top of adjacent floor finish.

3 EXECUTION

3.01 EXAMINATION

.1 Examine and verify previously installed Work upon which this Section depends. Report defects or unsatisfactory conditions to Consultant. Commencement of work of this Section means acceptance of existing conditions.

.2 Concrete floors shall be tested to the following standards to ensure compliance with flooring manufacturer's adhesive recommendations. Ensure selected adhesive meets substrate's test results.
- .1 Internal Relative Humidity Test: Humidity tested in accordance with ASTM F2170.
- .2 Moisture Test: Moisture emissions from concrete subfloors (cured for a minimum of 28 days) to be tested in accordance with ASTM F1869.
- .3 Subfloor surface pH level. Surfaces with pH over recommended level shall be neutralized.

3.02 PREPARATION

.1 Clean floor and apply filler; trowel and float to leave smooth, flat hard surface. Prohibit traffic until filler cured and dry.

.2 Remove sub-floor ridges and bumps.

.3 Apply subfloor filler and leveller to fill low spots, cracks, joints, and other defects to provide a smooth monolithic surface.

.4 Prime sub-floor to resilient flooring manufacturer's printed instructions.

.5 Concrete subfloors shall conform to ASTM F710.

3.03 APPLICATION

.1 Apply adhesive uniformly using recommended trowel in accordance with flooring manufacturer's instructions. Do not spread more adhesive than can be covered by flooring before initial set takes place.

.2 Lay flooring with joints parallel to building lines to produce symmetrical tile pattern. Border tiles minimum half tile width.

.3 Roll flooring in 2 directions with 45 kg minimum roller to ensure full adhesion within adhesive working time.

.4 Cut tile and fit neatly around fixed objects.

.5 Continue flooring through areas to receive movable type partitions without interrupting floor pattern.

.6 Terminate flooring at centerline of door in openings where adjacent floor finish or colour is dissimilar.

.7 Install metal edge strips at unprotected or exposed edges where flooring terminates.

3.04 CLEANING

.1 Remove excess adhesive from floor, base and wall surfaces without damage.

3.05 PROTECTION

.1 Protect new floors from time of final set of adhesive until final inspection.

.2 Prohibit traffic on floor for 72 hours after installation.

END OF SECTION

1 GENERAL

1.01 SUMMARY

.1 Section includes all methods, materials and installation as required to complete the Work of this Section in accordance with the Conditions of the Contract.

1.02 REFERENCES

.1 International Concrete Repair Institute (ICRI) - Guideline Number 310.2R, Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair.

1.03 ADMINISTRATIVE REQUIREMENTS

.1 Site Meetings: Arrange a pre-installation meeting on Site to be attended by Consultant, Contractor, epoxy flooring manufacturer's representative, and any other parties directly affecting work of this Section to:
- .1 Examine substrate conditions for compliance with manufacturer's requirements.
- .2 Review methods and procedures related to installation.
- .3 Review all typical and special details as required to complete the work of this section.

1.04 ACTION SUBMITTALS

.1 Submit action submittals in accordance with Section 01 33 00.

.2 Product data: Submit manufacturers product data for epoxy flooring including product characteristics, performance criteria, and limitations.

.3 Samples: Submit 300 mm x 300 mm samples illustrating colours, textures and finishes of each colour and type of epoxy flooring mounted to hardboard.

1.05 CLOSEOUT AND MAINTENANCE SUBMITTALS

.1 Submit closeout and maintenance submittals in accordance with Section 01 78 00.

.2 Closeout Product data: Submit manufacturers maintenance and cleaning data for incorporation into operation and maintenance manual.

1.06 QUALITY ASSURANCE

.1 Installers: Perform Work of this Section by a company that has a minimum of five (5) years proven experience in the installation of epoxy flooring of a similar size and nature.

.2 Mock-ups:
- .1 Construct one (1) mock-up of each type of epoxy flooring in location as directed by Consultant.
- .2 Mock-up shall be 3 m^2 and demonstrate colours, textures and finishes.
- .3 Mock-up may form part of the Work if accepted by the Consultant.

1.07 DELIVERY, STORAGE, AND HANDLING

.1 Store materials at Site in an area specifically set aside for purpose that is locked, ventilated, and maintained at a minimum temperature of 15 degree C.

.2 Ensure that health and fire regulations are complied with in storage area, and during handling and application.

1.08 SITE CONDITIONS

.1 Ambient Conditions: Work of this Section shall be performed when air and surface temperatures are between 15 degree C and 30 degree C.

2 PRODUCTS

2.01 MATERIALS

.1 Substrate preparation: Moisture barrier layer consisting of following materials as required to suit substrate moisture content:
- .1 Water resistant mortar/barrier: For use where concrete moisture content is over 6%. Basis of Design:
  - .1 Planiseal MB by Mapei Inc.
  - .2 Sikafloor-81 EpoCem by Sika Canada.
  - .3 Or approved equal.
- .2 Moisture mitigation primer: For use over water resistant mortar/barrier or where concrete moisture content is under 6%. Basis of Design:
  - .1 Mapefloor I 900 by Mapei Inc.
  - .2 Sikafloor-1610 by Sika Canada.
  - .3 Or approved equal.

.2 Epoxy flooring:
- .1 3 mm thick broadcast epoxy flooring system.
- .2 Colour and finish: To match 1130 by Sika and as confirmed by Consultant.

.3 Basis of Design:
.1 Mapecoat Universal - Mapefloor DQ by Mapei Inc.
.2 Sikafloor Quartzite Broadcast System by Sika Canada.
.3 Stonchem 877 by Stonhard.
.4 Or approved equal.

3 EXECUTION

3.01 EXAMINATION

.1 Examine and verify previously installed Work upon which this Section depends. Report defects or unsatisfactory conditions to Consultant. Commencement of work of this Section means acceptance of existing conditions.

.2 Allow concrete floor to cure 28 days and then test surface for moisture content to establish type of primer or moisture barrier will be required.

3.02 PREPARATION

.1 Provide protection to adjacent surfaces to prevent damage resulting from the Work of this Section.

.2 Mechanically profile substrate to achieve minimum CSP 4 to ICRI Guideline 310.2.

.3 Apply primer or moisture barrier, as required, to concrete substrate in accordance with manufacturers written instructions.

3.03 APPLICATION

.1 Apply epoxy flooring system in accordance with manufacturer's printed instructions, allow for epoxy manufacturer to oversee application.

.2 Apply epoxy to thicknesses as indicated, ensuring no laps, voids, or other marks or irregularities are visible. Finished appearance shall be uniform in colour, sheen and texture, all within limitations of materials and areas concerned.

.3 Ensure clean true junctions with no visible overlap between adjoining applications of epoxy and chase edge of adjacent floor systems so that epoxy finishes flush with adjacent floor systems.

.4 Control joints: Stop epoxy in a straight line on each side of control joints and fill space over expansion joint with self-levelling, non-sag polyurethane sealant.

.5 Cove base: Provide 100 mm cove base at room perimeter and at built-in fitment locations. Form cove with 25 mm radius.

.6 Tolerance: Finish surfaces shall be level, or straight where sloped to drains, within a tolerance of 1.5 mm in 3 m, and shall not vary more than 0.8 mm in any running 300 mm.

.7 Touch-up and refinish minor defective work. Refinish entire coated surface areas where finish is damaged or otherwise unacceptable.

3.04 CLEANING

.1 Remove spilled or spattered material promptly as work progresses. Clean floors on completion of work. Do not mar surfaces while removing.

.2 Leave storage and mixing areas in same condition as equivalent spaces in project.

3.05 PROTECTION

.1 Erect barriers to prevent the entry and presence of personnel not performing work of this Section during application of epoxy flooring, and for 72 hours following completion of application.

END OF SECTION

1 GENERAL

1.01 SUMMARY

.1 Section includes all methods, materials and installation as required to complete the Work of this Section in accordance with the Conditions of the Contract.

1.02 REFERENCES

.1 ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

1.03 ACTION SUBMITTALS

.1 Submit action submittals in accordance with Section 01 33 00.

.2 Product data: Submit manufacturers product data for rigid sheet wall coverings including product characteristics, performance criteria, and limitations.

.3 Samples: Submit 300 mm x 300 mm samples illustrating colours and textures of each type rigid sheet wall coverings.

.4 Reports/certificates: Submit the following:
- .1 Submit certification that rigid sheet wall covering meet requirements of Fire Hazard Ratings of the Building Code.

1.04 CLOSEOUT AND MAINTENANCE SUBMITTALS

.1 Submit closeout and maintenance submittals in accordance with Section 01 78 00.

.2 Closeout Product data: Submit manufacturers maintenance and cleaning data for incorporation into operation and maintenance manual.

.3 Maintenance materials: Submit extra 3% or to nearest full roll of each type of wall covering.

1.05 QUALITY ASSURANCE

.1 Mock-ups:
- .1 Construct one (1) mock-up of each type of rigid sheet wall covering in location as directed by Consultant.
- .2 Mock-up shall be 2 m^2 and demonstrate use of trims and accessories, and treatment of material edges and transitions.
- .3 Mock-up may form part of the Work if accepted by the Consultant.

1.06 SITE CONDITIONS

.1 Ambient Conditions: Work of this Section shall be performed when air and surface temperatures are above 15 degree C and a relative humidity below 45% for 24 hours before, during and 24 hours after installation.

.2 Provide high ventilation rate, with maximum outside air, during installation, and for 48 to 72 hours after installation. If possible, vent directly to outside. Do not let contaminated air recirculate through district or whole building air distribution system.

2 PRODUCTS

2.01 MATERIALS

.1 Rigid Sheet wall covering:
- .1 Material: Fiberglass reinforced plastic (FRP) sheet.
- .2 Surface burning characteristics: Class A to ASTM E84.
- .3 Colour and texture: White, smooth.
- .4 Basis of Design:
  - .1 Liquid Diamond Panels.
  - .2 Marlite.
  - .3 Or approved equal.

.2 Accessories and trims: Provide colour matched trim and accessory pieces as recommended by manufacturer.

.3 Adhesive and sealant: Low VOC of types recommended by wall covering manufacturer for specific application.

3 EXECUTION

3.01 EXAMINATION

.1 Examine and verify previously installed Work upon which this Section depends. Report defects or unsatisfactory conditions to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.02 PREPARATION

.1 Prepare surfaces according to covering manufacturer's instructions and to remove dust, debris and loose particles.

3.03 APPLICATION

.1 Install rigid sheet wall covering in accordance with reviewed Shop Drawings and manufacturer's written instructions.

.2 Dry lay panels ensuring joints are minimum 300 mm from any corner and 2 mm to 3 mm joint between panels and any rigid abutments including ceilings, windows, doors, and services to allow for expansion.

.3 Ensure all panel edges (where joints are to be formed) are clean, smooth, true and level.

.4 Prepare for panel joints by marking and applying joint tape to substrate at panel joint locations.

.5 Apply adhesive to back of panel leaving adhesive 25 mm to 30 mm back from prepared joints.

.6 Place panels to wall and roll to ensure adhesion.

.7 Check all edges are clean and free of adhesive.

.8 Hot weld joints following manufacturers written instructions.

3.04 CLEANING

.1 Remove panel protective film and clean rigid sheet wall covering with clean warm water to manufacturers written instructions.

END OF SECTION

1 GENERAL

1.01 SUMMARY

.1 Section includes all methods, materials and installation as required to complete the Work of this Section in accordance with the Conditions of the Contract.

.2 Work may include, but is not limited to;
- .1 Interior painting.
- .2 Exterior painting.

1.02 REFERENCES

.1 Master Painters Institute (MPI) - Architectural Painting Specification Manual.

1.03 ACTION SUBMITTALS

.1 Submit action submittals in accordance with Section 01 33 00.

.2 Product data: Submit manufacturers product data for paint and coating materials including product characteristics, performance criteria, and limitations including:
- .1 Manufacturer's Product names, types, codes and names.
- .2 Number of coats, and dry film thicknesses.
- .3 Submit listing minimum of 8 weeks before materials are required with Product data listed for each required Painting Schedule code.

.3 Samples: Submit 300 mm x 300 mm samples of each paint, stain and coating type illustrating colours, gloss/sheen and textures.

.4 Reports/certificates: Submit the following:
- .1 Certificates: submit product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.
- .2 Submit documentation confirming each worker has Qualification Certificate of Proficiency.

1.04 CLOSEOUT AND MAINTENANCE SUBMITTALS

.1 Submit closeout and maintenance submittals in accordance with Section 01 78 00.

.2 Closeout Product data: Submit manufacturers maintenance and cleaning data for incorporation into operation and maintenance manual.

.3 Maintenance materials: Submit extra 3% or to nearest full L can of each type and colour of paint.

1.05 QUALITY ASSURANCE

.1 Installers: Perform Work of this Section by a company that has a minimum of five (5) years proven experience in the application of paint and coating systems of a similar size and nature.

.2 Qualified journeymen who have a "Tradesman Qualification Certificate of Proficiency" shall be engaged in painting work. Apprentices may be employed provided they work under the direct supervision of a qualified journeyman in accordance with trade regulations.

.3 Conform to latest MPI requirements for painting work including preparation and priming.

.4 Materials: in accordance with MPI Painting Specification Manual "Approved Product" listing and from a single manufacturer for each system used.

.5 Mock-ups:
- .1 Construct one (1) mock-up of each type of paint schedule code material in location as directed by Consultant.
- .2 Mock-up shall be 3 m^2 and demonstrate gloss/sheen, textures, workmanship, and coverage/hiding power of finish.
- .3 Mock-up may form part of the Work if accepted by the Consultant.

1.06 DELIVERY, STORAGE, AND HANDLING

.1 Store materials and equipment in well ventilated area with temperature range 7 degrees C to 30 degrees C. Ensure materials and supplies are kept away from heat generating devices.

.2 Keep areas used for storage, cleaning and preparation, clean and orderly. After completion of operations, return areas to clean condition.

.3 Remove paint materials from storage only in quantities required for same day use.

.4 Provide one 9 kg Type ABC fire extinguisher adjacent to storage area. Store oily rags, waste products, empty containers and materials subject to spontaneous combustion in ULC approved, sealed containers and remove from site on a daily basis. Handle, store, use and dispose of flammable and combustible materials in accordance with the National Fire Code of Canada (NFC).

1.07 SITE CONDITIONS

.1 Ambient Conditions: Work of this Section shall be performed when air and surface temperatures are between 10 degrees C and 32 degrees C. Maintain temperature conditions for 24 hours before, during and 24 hours after painting.

.2 Ensure relative humidity is below 85%.

.3 Ensure no rain or snow are forecast to occur before paint has thoroughly cured. Do not apply paint when it is foggy, misty, raining or snowing at site.

.4 Provide minimum lighting level of 323 Lux on surfaces to be painted.

.5 Apply paint finish in areas where dust is no longer being generated by related construction operations or when wind or ventilation conditions are such that airborne particles will not affect quality of finished surface.

.6 Do not apply paint when:
- .1 Substrate and ambient air temperatures are expected to fall outside MPI or paint manufacturer's limits.
- .2 Surface to be painted is wet, damp or frosted.

.7 Provide and maintain cover when paint must be applied in damp or cold weather. Heat substrates and surrounding air to comply with temperature and humidity conditions specified by manufacturer. Protect until paint is dry or until weather conditions are suitable.

.8 Schedule painting operations such that surfaces exposed to direct, intense sunlight are scheduled for completion during early morning.

2 PRODUCTS

2.01 MANUFACTURERS

.1 AkzoNobel.

.2 Benjamin Moore and Co. Ltd.

.3 PPG Industries Inc.

.4 Sherwin-Williams Company.

2.02 PERFORMANCE CRITERIA

.1 Environmental Performance Requirements:
- .1 Provide paint products meeting MPI "Environmentally Friendly" E2 ratings based on VOC (EPA Method 24) content levels.
- .2 Green Performance in accordance with MPI Standard GPS-1.

2.03 MATERIALS

.1 Only paint materials listed in latest edition of MPI Approved Products List (APL) are acceptable for use on this project.

.2 Paint materials for paint systems: to be products of single manufacturer.

2.04 COLOUR SCHEDULE

.1 Consultant will provide Colour Schedule after Contract award.

.2 Colour schedule will be based upon selection of 5 base colours and 3 accent colours. No more than 8 colours will be selected for entire project and no more than 3 colours will be selected in each area.

.3 Selection of colours will be from manufacturers' full range of colours.

.4 Where specific products are available in restricted range of colours, selection will be based on limited range.

.5 Second coat in three coat system to be tinted slightly lighter colour than top coat to show visible difference between coats if requested by Consultant.

.6 Perform colour tinting operations prior to delivery of paint to site.

.7 For deep and ultra deep colours 4 coats may be required.

2.05 GLOSS/SHEEN RATINGS

.1 Paint gloss: defined as sheen rating of applied paint, in accordance with following values:

Gloss Level Category	**Units @ 60 Degrees**	**Units @ 85 Degrees**
G1 - matte finish	0 to 5	max. 10
G2 - velvet finish	0 to 10	10 to 35
G3 - eggshell finish	10 to 25	10 to 35
G4 - satin finish	20 to 35	min. 35
G5 - semi-gloss finish	35 to 70	
G6 - gloss finish	70 to 85	
G7 - high gloss finish	> 85	

.2 Gloss level ratings of painted surfaces as noted on Finish Schedule.

2.06 EXTERIOR PAINTING SYSTEMS

.1 Concrete Vertical Surfaces:
- .1 EXT 3.1F - Elastomeric coating. For use over exposed cement faced foundation insulation.

.2 Structural Steel and Metal Fabrications:
- .1 EXT 5.1L - Polyurethane, Pigmented finish (over inorganic zinc primer and h.b. epoxy).

.3 Galvanized Metal: not chromate passivated:
- .1 EXT 5.3K - W.B. light industrial coating (over epoxy primer). For use at bollards, handrails, etc.
- .2 EXT 5.3L - Polyurethane, Pigmented (over epoxy primer) high contact/traffic. For use at hollow metal doors and frames and structural steel components with galvanized finish.

2.07 INTERIOR PAINTING SYSTEMS

.1 Structural Steel and Metal Fabrications: columns, beams, joists, steel stairs, ladders, etc.:
- .1 INT 5.1R High performance architectural latex finish.

.2 Steel - High Heat: (boilers, furnaces, heat exchangers, breeching, pipes, flues, stacks, etc., with temperature range as noted):
- .1 INT 5.2A Heat resistant enamel finish, maximum 205°C.

.3 Galvanized Metal: doors, frames, railings, misc. steel, pipes, overhead decking, ducts, etc.:
- .1 INT 5.3A Latex finish. For use at ducts, pipes, metal deck.
- .2 INT 5.3M High performance architectural latex finish. For use on hollow metal doors and frames.

.4 Wood Paneling and Casework: partitions, panels, shelving, millwork, etc.:
- .1 INT 6.4A Latex finish (over alkyd sealer).
- .2 INT 6.4C Semi-transparent stain finish.
- .3 INT 6.4E Polyurethane varnish finish (over stain).

.5 Plaster and Gypsum Board: gypsum wallboard, drywall, "sheet rock type material", etc., and textured finishes:
- .1 INT 9.2B High performance architectural latex finish.
- .2 INT 9.2F Waterborne epoxy (tile-like) finish. For use in wet/damp areas.

3 EXECUTION

3.01 EXAMINATION

.1 Examine and verify previously installed Work upon which this Section depends. Report defects or unsatisfactory conditions to Consultant. Commencement of work of this Section means acceptance of existing conditions.

.2 Test concrete, masonry and plaster surfaces for alkalinity as required.

.3 Conduct moisture tests using a properly calibrated electronic Moisture Meter, except test concrete floors for moisture using a simple "cover patch test". Perform no painting work when maximum moisture content of substrate exceeds:
- .1 12% for concrete and masonry (clay and concrete brick/block).
- .2 15% for hard wood.
- .3 17% for soft wood.
- .4 12% for plaster and gypsum board.

3.02 PROTECTION

.1 Protect existing building surfaces and adjacent structures from paint spatters, markings and other damage by suitable non-staining covers or masking. If damaged, clean and restore such surfaces as directed by Consultant.

.2 Protect items that are permanently attached such as Fire Labels on doors and frames.

.3 Protect factory finished products and equipment.

.4 Protect passing pedestrians, and general public in and about the building.

.5 Removal of electrical cover plates, light fixtures, surface hardware on doors, bath accessories and other surface mounted equipment, fittings and fastenings shall be done prior to undertaking any painting operations by General Contractor. Items shall be securely stored and re-installed after painting is completed by General Contractor.

.6 As painting operations progress, place "WET PAINT" signs in occupied areas and restrict or prevent traffic as necessary.

3.03 PREPARATION

.1 Clean and prepare surfaces in accordance with MPI Painting Specification Manual requirements. Refer to MPI Manual in regard to specific requirements and as follows:

- .1 Remove dust, dirt, and other surface debris by vacuuming, wiping with dry, clean cloths.
- .2 Wash surfaces with a biodegradable detergent and clean warm water using a stiff bristle brush to remove dirt, oil and other surface contaminants.
- .3 Rinse scrubbed surfaces with clean water until foreign matter is flushed from surface.
- .4 Allow surfaces to drain completely and allow to dry thoroughly.
- .5 Prepare surfaces for water-based painting, water-based cleaners should be used in place of organic solvents.
- .6 Use trigger operated spray nozzles for water hoses.
- .7 Many water-based paints cannot be removed with water once dried. However, minimize the use of kerosene or any such organic solvents to clean up water-based paints.

.2 Prevent contamination of cleaned surfaces by salts, acids, alkalis, other corrosive chemicals, grease, oil and solvents before prime coat is applied and between applications of remaining coats. Apply primer, paint, or pretreatment as soon as possible after cleaning and before deterioration occurs.

.3 Where possible, prime surfaces of new wood surfaces before installation. Use same primers as specified for exposed surfaces.

- .1 Apply vinyl sealer to MPI #36 over knots, pitch, sap and resinous areas.
- .2 Apply wood filler to nail holes and cracks.
- .3 Tint filler to match stains for stained woodwork.

.4 Sand and dust between coats as required to provide adequate adhesion for next coat and to remove defects visible from a distance up to 1000 mm.

.5 Clean metal surfaces to be painted by removing rust, loose mill scale, welding slag, dirt, oil, grease and other foreign substances in accordance with MPI requirements.

.6 Touch up of shop primers with primer as specified in applicable section. Major touch-up including cleaning and painting of field connections, welds, rivets, nuts, washers, bolts, and damaged or defective paint and rusted areas, shall be by supplier of fabricated material.

3.04 APPLICATION

.1 Perform preparation and operations for painting in accordance with MPI Painting Specifications Manual except where specified otherwise.

.2 Apply paint materials in accordance with paint manufacturer's written application instructions.

.3 Apply paint finish in areas where dust is no longer being generated by related construction operations or when wind or ventilation conditions are such that airborne particles will not affect quality of finished surface.

.4 Apply paint to adequately prepared surfaces and to surfaces within moisture limits noted herein.

.5 Apply paint when previous coat of paint is dry or adequately cured.

.6 Apply coats of paint as a continuous film of uniform thickness. Repaint thin spots or bare areas before next coat of paint is applied.

.7 Allow surfaces to dry and properly cure after cleaning and between subsequent coats for minimum time period as recommended by manufacturer.

.8 Sand and dust between coats to remove visible defects.

.9 Finish surfaces both above and below sight lines as specified for surrounding surfaces, including such surfaces as tops of interior cupboards and cabinets and projecting ledges.

.10 Finish closets and alcoves as specified for adjoining rooms.

.11 Finish top, bottom, edges and cutouts of doors after fitting as specified for door surfaces.

.12 Mechanical/Electrical Equipment:
- .1 Coordinate painting of mechanical and electrical components with Divisions 21, 22, 23 and 26.
- .2 Paint conduits, piping, hangers, ductwork and other mechanical and electrical equipment exposed in finished areas, to match adjacent surfaces, except as indicated.
- .3 Do not paint over nameplates.
- .4 Keep sprinkler heads free of paint.
- .5 Paint both sides and edges of backboards for telephone and electrical equipment before installation.
- .6 Leave equipment in original finish except for touch-up as required, and paint conduits, mounting accessories and other unfinished items.

3.05 SITE QUALITY CONTROL

.1 Painted surfaces to be inspected as required. Cooperate with inspection firm and provide access to areas of work.

.2 Standard of Acceptance:
- .1 Walls: no defects visible from a distance of 1000 mm at 90 degrees to surface.
- .2 Ceilings/Soffits: no defects visible from floor at 45 degrees to surface when viewed using final lighting source.
- .3 Final coat to exhibit uniformity of colour and uniformity of sheen across full surface area.

.3 Defects include, but are not limited to;
- .1 Improper cleaning and preparation of surfaces.
- .2 Entrapped dust, dirt, rust.
- .3 Alligatoring, blisters, peeling.
- .4 Scratches, blemishes.
- .5 Uneven coverage, misses, drips, runs, and poor cutting in.

3.06 CLEANING AND RESTORATION

.1 Clean and re-install all hardware items removed before undertaken painting operations.

.2 Remove protective coverings and warning signs as soon as practical after operations cease.

.3 Remove paint splashings on exposed surfaces that were not painted. Remove smears and spatter immediately as operations progress, using compatible solvent.

.4 Restore areas used for storage, cleaning, mixing and handling of paint to clean condition as approved by Consultant.

3.07 PROTECTION

.1 Protect freshly completed surfaces from paint droppings and dust to approval of Consultant. Avoid scuffing newly applied paint.

END OF SECTION

1 GENERAL

1.01 SUMMARY

.1 Section includes all methods, materials and installation as required to complete the Work of this Section in accordance with the Conditions of the Contract.

1.02 ACTION SUBMITTALS

.1 Submit action submittals in accordance with Section 01 33 00.

.2 Product data: Submit manufacturers product data for visual display units including product characteristics, performance criteria, and limitations.

.3 Shop Drawings: Submit Shop Drawings as follows:
- .1 Shop Drawings to illustrate details, dimensions, panel arrangement, backing, hardware and anchor or mounting details.

.4 Samples: Submit samples illustrating colours, textures and finishes including, but not limited to:
- .1 300 mm x 300 mm of markerboard.
- .2 300 mm x 300 mm of tackboard.
- .3 300 mm long of trims.

1.03 DELIVERY, STORAGE, AND HANDLING

.1 Pack, brace or crate products as required to prevent distortion in shipment and handling. All packages and crates to be labelled.

2 PRODUCTS

2.01 MARKERBOARDS

.1 Whiteboard:
- .1 Porcelain on steel laminated to moisture resistant core with polyester foil backing sheet.
- .2 Colour and finish: Matte finish in white, suitable for projection.
- .3 Basis of Design: Porcelain Surface by ASI Visual Display Products, Sharewall Full Wall System by Mooreco or approved equal.

.2 Adhesive: As recommended by whiteboard manufacturer.

2.02 TACKBOARDS

.1 Tackboard:
- .1 Natural cork: Consisting of 6 mm natural cork laminated under heat and pressure to 6 mm hardboard.
- .2 Basis of Design: Natural Cork by ASI Visual Display Products or approved equal.

.2 Frame: Clear aluminum frame as follows:
- .1 Reveal frame: Minimal frame style with 3 mm reveal.
- .2 Basis of Design: Elite Reveal by ASI Visual Display Products or approved equal.

2.03 FABRICATION

.1 Fabricate visual display units to sizes indicated.

.2 Make finished panels flat and rigid.

.3 Install trim on panels in factory. Make mitres and joints to hair-line fit, free of rough edges.

.4 Overlap trim 6 mm onto panels. Include closed ends for open-end extrusions.

.5 Factory fit assemblies too large for shipment to site in one piece, disassemble for delivery and site assembly.

3 EXECUTION

3.01 EXAMINATION

.1 Examine and verify previously installed Work upon which this Section depends. Report defects or unsatisfactory conditions to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.02 INSTALLATION

.1 Install visual display units in accordance with manufacturer's instructions, parallel to floor with uniform vertical surface, plumb and level, to provide rigid, secure surface.

.2 Mechanical attachment:
- .1 To concrete or solid masonry use lag screw and expansion bolts or screws and fibre plugs as appropriate for stresses involved.
- .2 To hollow masonry use toggle bolts or equivalent.
- .3 To wood or sheet metal use screws. Secure into framing members in stud walls.

.3 Adhesive attachment:

.1 Use recommended adhesive applied using spot method with daubs 40 mm diameter x 25 mm high at 200 mm on centre each way to adhere visual display units to wall. Press firmly into adhesive to ensure adhesion.

.4 Multiple panels to be butted together and splined to create seamless appearance.

3.03 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by visual display unit installation.

END OF SECTION

1 GENERAL

1.01 SUMMARY

.1 Section includes all methods, materials and installation as required to complete the Work of this Section in accordance with the Conditions of the Contract.

.2 Work may include, but is not limited to;
- .1 Phenolic toilet compartments.
- .2 Phenolic urinal screens.

1.02 REFERENCES

.1 ASTM A480/A480M - Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.

.2 CSA B651 - Accessible Design for the Built Environment.

1.03 ACTION SUBMITTALS

.1 Submit action submittals in accordance with Section 01 33 00.

.2 Product data: Submit manufacturers product data for compartments and cubicles including product characteristics, performance criteria, and limitations.

.3 Shop Drawings: Submit Shop Drawings as follows:
- .1 Shop Drawings to illustrate fabrication details, plans, elevations, hardware and installation details.

.4 Samples: Submit samples illustrating including, but not limited to:
- .1 300 mm x 300 mm sample of panel indicating finish on both sides, finished edges and core construction.
- .2 One each of hardware, brackets, fasteners and trims.

1.04 CLOSEOUT AND MAINTENANCE SUBMITTALS

.1 Submit closeout and maintenance submittals in accordance with Section 01 78 00.

.2 Closeout Product data: Submit manufacturers maintenance and cleaning data for incorporation into operation and maintenance manual including product warranty documentation.

1.05 QUALITY ASSURANCE

.1 Mock-ups:
- .1 Construct one (1) mock-up of each type of compartment in location as directed by Consultant.
- .2 Mock-up may form part of the Work if accepted by the Consultant.

1.06 DELIVERY, STORAGE, AND HANDLING

.1 Deliver and store products in manufacturer's unopened packaging bearing the brand name and manufacturer's identification until ready for installation.

.2 Handling: Handle materials to avoid damage.

1.07 SITE CONDITIONS

.1 Maintain environmental conditions including temperature, humidity, and ventilation within limits recommended by manufacturer. Do not install products under environmental conditions outside manufacturer's recommended limits.

1.08 WARRANTY

.1 Provide extended warranty for compartments and cubicles in accordance with the General Conditions, except warranty is extended to two (2) years from date Ready-for-Takeover has been attained:
- .1 Warranty to cover defects including corrosion, breakage, delamination and defects.
- .2 Warranty shall cover complete replacement of Work, including adjacent work impacted.

2 PRODUCTS

2.01 MANUFACTURERS

.1 ASI Global Partitions.

.2 Bobrick Washroom Equipment Inc.

.3 Or approved equal.

2.02 MATERIALS

.1 Panels:
- .1 Face sheets: Solidly fused compact grade laminate with melamine surface with matte finish.

.2 Core: Black core resin phenolic.
.3 Colour: To be selected by Consultant.

.2 Hardware:
.1 Hinges:
.1 Balanced, with field-adjustable cam to permit door to be fully closed or partially open when compartment is unoccupied.
.2 Materials: Stainless Steel 18-8, Type 304, heavy-gauge stainless steel with satin finish.
.3 Hinges to require operating force of less than 2.25 kg (5 lb) and come complete with emergency access feature.
.2 Latch set: Surface mounted, combination latch, door-stop, keeper and bumper, stainless steel with emergency access feature.
.3 Emergency Access: Hinges and latch shall allow door to be lifted over keeper from outside compartment on inswing doors.
.4 Wall and connecting brackets: stainless steel extrusion or casting.
.5 Coat hook: combination hook and rubber door bumper, stainless steel.
.6 Door pull: Barrier-free type suited for outswinging doors, stainless steel.

.3 Stainless steel sheet: to ASTM A480/A480M, Type 304 with satin finish.

.4 Ceiling framing: Provide suspended channel support for ceiling hung partitions in accordance with Section 05 50 00.

.5 Fasteners: Stainless steel tamper proof type screws and bolts.

.6 Sealer: Water resistant sealer or glue as recommended by laminate manufacturer.

2.03 FABRICATION

.1 Panels to be fabricated from solidly fused face bonded to core material. Edges shall be black. Splices or joints in faces or edges are to be avoided where possible.

.2 Stiles, and doors: 19 mm thick, to maximum height of 1822 mm, sightline-free interlocking doors and stiles, in sizes indicated.

.3 Panels and screens: 12 mm thick, to maximum height of 1822 mm, to sizes indicated.

.4 Provide formed and closed edges for doors, panels and pilasters. Mitre and weld corners and grind smooth.

.5 Pilaster shoe: One piece 0.8 mm stainless steel shoe designed to be fastened through the use of clips to stiles.

3 EXECUTION

3.01 EXAMINATION

.1 Examine and verify previously installed Work upon which this Section depends. Report defects or unsatisfactory conditions to Consultant. Commencement of work of this Section means acceptance of existing conditions.

.2 Ensure supplementary anchorage is in place.

3.02 INSTALLATION

.1 Complete work in accordance with CSA B651.

.2 General partition installation:
- .1 Install partitions secure, plumb and square.
- .2 Leave 12 mm space between wall and panel or end pilaster.
- .3 Anchor mounting brackets to steel supports with bolts in threaded holes.
- .4 Attach panel and pilaster to brackets with through type sleeve bolt and nut.
- .5 Provide for adjustment of ceiling variations with screw jack through steel saddles made integral with pilaster. Conceal ceiling fixings with stainless steel shoes.
- .6 Provide templates for locating threaded studs through finished ceilings.
- .7 Equip each door with hinges, latch set, and each stall with coat hook. Adjust and align hardware for proper function. Set door open position. Install door bumper.
- .8 Equip outswinging doors with door pulls in accordance with CSA B651.
- .9 Install hardware.

.3 Ceiling hung partitions erection:
- .1 Secure pilasters to supporting structural framing using pilaster hangers.
- .2 Ensure pilaster hangers do not transmit load to finished ceiling.
- .3 Secure pilaster shoe in position.
- .4 Set bottoms of doors level with bottom of pilasters when doors are in closed position. Floor clearance to be 110 mm.

.4 Screen erection:
- .1 Provide urinal stall screens consisting of panel and wall bracket as indicated on drawings.
- .2 Anchor screen panels to walls with 3 panel brackets.

.5 Adjust hardware for proper operation after installation. Set hinge cam on in-swinging doors to hold doors open when unlatched. Set hinge cam on out-swinging doors to hold unlatched doors in closed position.

3.03 CLEANING AND PROTECTION

.1 Touch-up, repair or replace damaged products.

.2 Clean exposed surfaces of compartments, hardware, and fittings.

END OF SECTION

1 GENERAL

1.01 SUMMARY

.1 Section includes all methods, materials and installation as required to complete the Work of this Section in accordance with the Conditions of the Contract.

1.02 REFERENCES

.1 CSA G40.20/G40.21 - General Requirements for Rolled or Welded Structural Quality Steel / Structural Quality Steel.

1.03 ACTION SUBMITTALS

.1 Submit action submittals in accordance with Section 01 33 00.

.2 Product data: Submit manufacturers product data for wire mesh partitions including product characteristics, performance criteria, finish and limitations.

.3 Shop Drawings: Submit Shop Drawings as follows:

.1 Shop Drawings to illustrate details, dimensions, fabrication and installation details.

.2 Indicate partition panel modules and types, materials, gauges, finishes, door and other openings, hardware, and fastening methods to adjacent structure.

1.04 DELIVERY, STORAGE, AND HANDLING

.1 Store and protect wire mesh partitions from damage.

2 PRODUCTS

2.01 SYSTEMS AND MANUFACTURERS

.1 Modular Welded Wire Partition System by Spinnaker Industries Inc.

.2 Single Tier Storage Lockers by Cogan Wire & Metal Products Limited.

.3 Wire Mesh Partitions by Major Partitions.

.4 ScreenWall by Morningstar Industries Ltd.

.5 Or approved equal.

2.02 COMPONENTS

.1 Panels: Fabricated from 3.4 mm (10 ga) diameter steel wire, welded into 50 mm x 50 mm mesh and spot welded to 32 mm x 32 mm x 3 mm steel angle frames. Provide non-modular size panels as required to complete Work.

.2 Sliding doors: Fabricated same as panels with manufacturer's standard reinforcement at corners and at intermediate points. Equip doors with box-type sliding door track, hangers/trolleys with ball bearing rollers in quantity and type to suit door size. Provide door stops, cylinder lock and guide. Provide all secondary steel framing required for attachment and support of sliding gates, tracks and hardware.

.3 Steel sections and plates: Cold rolled steel to CSA G40.20/G40.21.

.1 Posts: Minimum 50 mm x 50 mm x 2 mm (16 ga.) hollow steel tubing welded to base plate, and designed for fastening to structure with anchor bolts.

.4 Miscellaneous: Provide miscellaneous hardware, bolts, brackets, shields, cinch anchors as required for installation of partitions and doors.

2.03 FINISHES

.1 Provide manufacturers standard powder coated system. Colour to be selected by Consultant.

3 EXECUTION

3.01 EXAMINATION

.1 Examine and verify previously installed Work upon which this Section depends. Report defects or unsatisfactory conditions to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.02 INSTALLATION

.1 Install wire mesh partitions and doors plumb and level and in accordance with reviewed Shop Drawings.

.2 Anchor posts extending to underside of structure above in a way to allow for 25 mm deflection in the structure.

.3 Hang doors and mount miscellaneous hardware supplied as part of work. Align in correct position with ample clearances. Ensure correct fit; test and adjust hardware as required for ease of operation.

END OF SECTION

1 GENERAL

1.01 SUMMARY

.1 Section includes all methods, materials and installation as required to complete the Work of this Section in accordance with the Conditions of the Contract.

1.02 REFERENCES

.1 ANSI H35.1 - Alloy and Temper Designation Systems for Aluminum.

.2 ASTM B209 - Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).

.3 ASTM B221 - Specification for Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric).

.4 ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.

1.03 ADMINISTRATIVE REQUIREMENTS

.1 Site Meetings: Arrange a pre-installation meeting on Site to be attended by Consultant, Contractor, demountable glass partition manufacturer's representative, and any other parties directly affecting work of this Section to:
  .1 Examine substrate conditions for compliance with manufacturer's requirements.
  .2 Review methods and procedures related to installation.
  .3 Review all typical and special details as required to complete the work of this section.

.2 Scheduling: Coordinate installation of demountable glass partitions for after completion of other finishing operations, including flooring and painting.

1.04 ACTION SUBMITTALS

.1 Submit action submittals in accordance with Section 01 33 00.

.2 Product data: Submit manufacturers product data for demountable glass partitions including product characteristics, performance criteria, and limitations.

.3 Shop Drawings: Submit Shop Drawings as follows:
  .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.
  .2 Shop Drawings to illustrate details, dimensions, fabrication and installation details.

.3 Drawings shall also show reinforcement, connections, anchorage, and hardware.

.4 Reports/certificates: Submit the following:
.1 Submit acoustical test data to ASTM E90 and ensure construction details and weight are provided.
.2 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

1.05 CLOSEOUT AND MAINTENANCE SUBMITTALS

.1 Submit closeout and maintenance submittals in accordance with Section 01 78 00.

.2 Closeout Product data: Submit manufacturers maintenance and cleaning data for incorporation into operation and maintenance manual including product warranty documentation.

1.06 QUALITY ASSURANCE

.1 Installers: Perform Work of this Section by a company that has a minimum of five (5) years proven experience in the installation of demountable glass partitions of a similar size and nature.

1.07 DELIVERY, STORAGE, AND HANDLING

.1 Deliver materials to site in original factory packaging, labelled with numbering system as used on reviewed Shop Drawings. Markings are not to be permanent or cause any damage to panels.

1.08 WARRANTY

.1 Provide extended warranty for demountable glass partitions in accordance with the General Conditions, except warranty is extended to ten (10) years from date Ready-for-Takeover has been attained:
.1 Warranty to cover defects including failure to meet design, or deterioration of metal finishes or failure of glass panels.
.2 Warranty shall cover complete replacement of Work, including adjacent work impacted.

2 PRODUCTS

2.01 MANUFACTURERS

.1 Optos by Teknion Corporation or approved equal by:
.1 Dirtt Classic Glass Walls.

.2 PC350 Architectural Interiors.

2.02 PERFORMANCE CRITERIA

.1 Design partition system as fully relocatable with interchangeable standardized units allowing for rearrangement in any desired combination within given area.

.2 Design partition system to allow for installation and disassembly in manner that prevents damage to finished surfaces, including floors, walls, ceilings, columns and window mullions.

.3 Design door units as interchangeable with like-sized panels using same connection method as panels. Pivot doors shall be designed with non-handed, reconfigurable door leafs to be reversible in field without additional modifications or materials.

.4 Design and fabricate demountable partitions with minimum STC of 35 tested to ASTM E90.

2.03 MATERIALS

.1 Aluminum extrusions: to ASTM B221 and ANSI H35.1, AA6063 alloy, T5 temper.

.2 Aluminum sheet: to ASTM B209 and ANSI H35.1, AA1100 aluminum alloy, H14 temper, minimum 3.0 mm thick.

.3 Sliding doors: SRT In-Line Sliding profile extruded aluminum frame with 10 mm thick tempered glazing, hardware to provide smooth, gentle soft close glide and come with braking mechanism and seal, in size shown on drawings. Door pull handle to be vertical aluminum bar as selected by Consultant.

.4 Glazing frames: Extruded aluminum, complete with snap-on glazing stops and neoprene gaskets for setting glass.

.5 Glazing and glass film: 10 mm tempered and laminated glass in accordance with Section 08 81 00.

.6 Finish hardware: In accordance with Section 08 71 00.

.7 Trim: Aluminum, colour to match frames.

.8 Fasteners: As recommended by manufacturer.

2.04 FABRICATION

.1 Take site measurements prior to fabrication.

.2 Accurately follow thicknesses and methods of fabrication reinforcement and anchorage shown on reviewed Shop Drawings to ensure safe support and rigidity of system.

.3 Ensure finished Work is free of warp, open seams, buckles and other surface defects detrimental to appearance.

2.05 FINISHES

.1 Powder coat finish: Manufacturers standard powder coat finish in Graphite colour.

3 EXECUTION

3.01 EXAMINATION

.1 Examine and verify previously installed Work upon which this Section depends. Report defects or unsatisfactory conditions to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.02 INSTALLATION

.1 Install demountable glass partitions in accordance with manufacturer's printed instructions, and reviewed Shop Drawings.

.2 Install partition system on top of floor finish and accurately fitted to ceiling finish. Provide reinforcement and bracing as required.

.3 Provide reinforcement and bracing wherever necessary to assure lateral stability.

.4 Install hardware and ensure it is visually aligned.

.5 Install finish hardware in accordance with Section 08 70 00.

.6 Install wood doors in accordance with Section 08 14 00.

.7 Complete installation to be free of exposed screws or other fasteners, with surfaces free of tool marks, scratches or any other surface detrimental to appearance.

.8 Install all finishing trims and light/sound seals to provide a complete system.

.9 Touch up damaged finishes, repair damage to partitions to match original finish.

3.03 CLEANING

.1 Remove factory installed strippable protective coating from system.

.2 Clean and make good surfaces soiled or damaged. Replace materials that cannot be satisfactorily cleaned and restored as determined by Consultant.

END OF SECTION

1 GENERAL

1.01 SUMMARY

.1 Section includes all methods, materials and installation as required to complete the Work of this Section in accordance with the Conditions of the Contract.

1.02 REFERENCES

.1 ASTM A480/A480M - Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.

.2 CSA B651 - Accessible Design for the Built Environment.

1.03 ACTION SUBMITTALS

.1 Submit action submittals in accordance with Section 01 33 00.

.2 Product data: Submit manufacturers product data for washroom accessories including product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings: Submit Shop Drawings to illustrate:
- .1 Size and description of components, base material, surface finish inside and out, hardware and locks,
- .2 Attachment devices, description of rough-in-frame, and building-in details of anchors for grab bars.

1.04 CLOSEOUT AND MAINTENANCE SUBMITTALS

.1 Submit closeout and maintenance submittals in accordance with Section 01 78 00.

.2 Closeout Product data: Submit manufacturers maintenance and cleaning data for incorporation into operation and maintenance manual including product warranty documentation.

.3 Maintenance materials: Submit special tools required for assembly, disassembly, or removal of washroom accessories.

1.05 DELIVERY, STORAGE, AND HANDLING

.1 Pack, brace or crate products as required to prevent distortion in shipment and handling. All packages and crates to be labelled.

2 PRODUCTS

2.01 MATERIALS

.1 Stainless steel sheet metal: to ASTM A480/A480M, Type 304, with finish as noted.

.2 Stainless steel tubing: Type 304, commercial grade, seamless welded, 1.2 mm wall thickness.

.3 Fasteners: Concealed screws and bolts hot dip galvanized, exposed fasteners to match face of unit. Expansion shields fibre, lead or rubber as recommended by accessory manufacturer for component and its intended use.

2.02 COMPONENTS

.1 The following accessories are provided as a basis of design. Approved equivalents may be considered provided they are approved prior to purchase.

.2 90 degree grab bar (GB1):
- .1 38 mm diameter bar x 762 mm x 762 mm with flange secured by set screws.
- .2 Colour and finish: Type 304 stainless steel with satin finish and peened grip.
- .3 Basis of Design: Model B-6898.99 by Bobrick.

.3 Straight grab bar (GB2):
- .1 38 mm diameter bar x 610 mm long with flange secured by set screws.
- .2 Colour and finish: Type 304 stainless steel with satin finish.
- .3 Basis of Design: Model B-5806 x 24" by Bobrick.

.4 Coat hook:
- .1 Surface mounted double hook.
- .2 Colour and finish: Type 304 stainless steel with bright polished finish.
- .3 Basis of Design: Model B-672 by Bobrick.

.5 Shelf:
- .1 Surface mounted stainless steel shelf projecting 32 mm from wall with all corners welded and ground smooth.
- .2 Size: 457 mm.
- .3 Colour and finish: Type 304 stainless steel with satin finish.
- .4 Basis of Design: Model MS-18 by Gamco.

.6 Barrier-free tilt washroom mirror:
- .1 Fixed position tilt mirror with frame with concealed wall hanger. Size: 406 mm wide x 760 mm high.
- .2 Mirror: 6 mm thick glass mirror with galvanized steel back.

.3 Frame: 19 mm x 19 mm one piece frame with bevel front, Type 304 stainless steel with satin finish.
.4 Basis of Design: Model B-293 1630 by Bobrick.

.7 Toilet tissue dispenser:
.1 Surface mounted jumbo roll toilet tissue dispenser.
.2 Colour and finish: Plastic in colour to be selected.
.3 Basis of Design: Jumbo Twin Bath Tissue Roll Dispenser by Tork.

.8 Sanitary napkin disposal:
.1 Free standing sanitary napkin disposal. Disposal door to be fully automatic.
.2 Basis of Design: Bioguard Disposal System by biochem environmental solutions.

.9 Hand dryer:
.1 Surface mounted automatic hand dryer projecting 100 mm with HEPA filter and 12 second dry time. Touch-free capacitive sensor.
.2 Electrical: 100-120 V, single phase.
.3 Colour and finish: Grey finish.
.4 Basis of Design: Airblade V Lo Voltage by Dyson.

.10 Soap dispenser:
.1 Surface mounted vertical tank soap with clear acrylic re-fill window.
.2 Colour and finish: white plastic.
.3 Basis of Design: Deb Proline Host 1L Dispenser by Johnson Deb Products.

.11 Adult change table:
.1 Horizontal surface mounted adult changing station designed to support 500 lbs.
.2 Structural framing: Refer to Section 05 50 00.
.3 Construction: Powder coated tube frame with polyurethane foam bed surface and stainless steel retaining bars.
.4 Changing surface to electrically adjust from 300 mm to 1000 mm from floor and come complete with safety rail.
.5 Basis of Design: SCT3000 by Pressalit.

.12 Ceiling lift:
.1 Ceiling lift and track designed to support 440 lbs.
.2 Structural framing: Refer to Section 05 50 00.
.3 Lift to include emergency stop and emergency power lowering as well as emergency manual raising and lowering.
.4 Lift to have wall mount bracket for control docking and unit to recharge at docking station.
.5 Basis of Design: Model C450 by Prism Medical.

2.03 FABRICATION

.1 Weld and grind joints of fabricated components flush and smooth. Use mechanical fasteners only where approved.

.2 Wherever possible form exposed surfaces from one sheet of stock, free of joints.

.3 Brake form sheet metal work with 1.5 mm radius bends.

.4 Form surfaces flat without distortion. Maintain flat surfaces without scratches or dents.

.5 Shop assemble components and package complete with anchors and fittings.

.6 Deliver inserts and rough-in frames to job site at appropriate time for building-in. Provide templates, details and instructions for building in anchors and inserts.

.7 Provide steel anchor plates and components for installation on studding and building framing.

3 EXECUTION

3.01 EXAMINATION

.1 Examine and verify previously installed Work upon which this Section depends. Report defects or unsatisfactory conditions to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.02 INSTALLATION

.1 Install washroom accessories in accordance with manufacturer's instructions, CSA B651 and reviewed Shop Drawings. Units to be installed rigid, straight, plumb, and level.

.2 Install grab bars to built-in anchors provided by bar manufacturer. Installed grab bars to withstand minimum load of 1.3 kN applied in any direction to CSA B651.

.3 Use tamper proof screws/bolts for fasteners.

.4 Adjust washroom accessories components and systems for correct function and operation.

.5 Lubricate moving parts to operate smoothly and fit accurately.

.6 Fill units with necessary supplies shortly before final acceptance of building.

3.03 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by washroom accessory installation.

END OF SECTION

1 GENERAL

1.01 SUMMARY

.1 Section includes all methods, materials and installation as required to complete the Work of this Section in accordance with the Conditions of the Contract.

1.02 ACTION SUBMITTALS

.1 Submit action submittals in accordance with Section 01 33 00.

.2 Product data: Submit manufacturers product data for phenolic lockers including product characteristics, performance criteria, finish and limitations.

.3 Shop Drawings: Submit Shop Drawings as follows:

- .1 Shop Drawings to illustrate details, dimensions, fabrication and installation details.
- .2 Indicate type and class of locker, thicknesses of phenolic, assembled banks of lockers, tops and bases, interior fittings and shelves, numbering, filler panels, doors complete with handles and locking method, ventilation method, and finishes.

.4 Samples: Submit 50 mm x 50 mm samples of phenolic finishes illustrating colours, textures and finish.

1.03 CLOSEOUT AND MAINTENANCE SUBMITTALS

.1 Submit closeout and maintenance submittals in accordance with Section 01 78 00.

.2 Closeout Product data: Submit manufacturers maintenance and cleaning data for incorporation into operation and maintenance manual.

1.04 QUALITY ASSURANCE

.1 Manufacturers: Manufacturers to have a minimum of five (5) years experience manufacturing phenolic lockers of a similar size and nature.

1.05 DELIVERY, STORAGE, AND HANDLING

.1 Store and protect phenolic lockers from nicks, scratches, and blemishes.

2 PRODUCTS

2.01 MANUFACTURED UNITS

.1 Lockers:
- .1 Size and Configuration: Custom as indicated on drawings.
- .2 Material: 19 mm thick solid phenolic with thru-colour construction.
- .3 Doors: 12 mm thick solid phenolic with perimeter ventilation.
- .4 Top panel: phenolic panel.
- .5 Door handle: Recessed handle with hasp to accept padlock.
- .6 Colour: To be selected by Consultant.
- .7 Basis of Design:
  - .1 Phenolic Traditional Collection by ASI Storage Solutions.
  - .2 Phenolic Classic Locker by Spectrum.
  - .3 Or approved equal.

3 EXECUTION

3.01 EXAMINATION

.1 Examine and verify previously installed Work upon which this Section depends. Report defects or unsatisfactory conditions to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.02 INSTALLATION

.1 Assemble and install lockers in accordance with manufacturer's written instructions.

.2 Securely fasten lockers to grounds and nailing strips.

.3 Install wall trim around recessed locker banks.

.4 Install filler panels (false fronts) where indicated and where obstructions occur.

.5 Install finished panels to exposed ends or backs of locker banks.

.6 Install locker numbers.

3.03 ADJUSTING

.1 Adjust phenolic lockers for correct function and operation in accordance with manufacturer's written instructions.

.2 Lubricate moving parts to operate smoothly and fit accurately.

3.04 CLEANING

.1 Clean lockers prior to final acceptance by Consultant.

END OF SECTION

1 GENERAL

1.01 SUMMARY

.1 Section includes all methods, materials and installation as required to complete the Work of this Section in accordance with the Conditions of the Contract.

.2 Work may include, but is not limited to;
- .1 Entrance mats.
- .2 Lectern.
- .3 Counterbalancer.
- .4 Automated external difibrillator (AED).
- .5 Paper towel dispenser.
- .6 Mop rack.
- .7 Hose rack.

1.02 ACTION SUBMITTALS

.1 Submit action submittals in accordance with Section 01 33 00.

.2 Product data: Submit manufacturers product data for each specified Product including product characteristics, performance criteria, and limitations.

.3 Shop Drawings: Submit Shop Drawings as follows:
- .1 Shop Drawings to illustrate details, dimensions, materials, gauges, and finishes.

1.03 CLOSEOUT AND MAINTENANCE SUBMITTALS

.1 Submit closeout and maintenance submittals in accordance with Section 01 78 00.

.2 Closeout Product data: Submit manufacturers maintenance and cleaning data for incorporation into operation and maintenance manual.

1.04 DELIVERY, STORAGE, AND HANDLING

.1 Pack, brace or crate products as required to prevent distortion in shipment and handling. All packages and crates to be labelled.

2 PRODUCTS

2.01 MANUFACTURED UNITS

.1 Entrance mats: Entrance mat consisting of the following:

.1 8 mm thick entrance mat with solid backing. Mat to consist of absorbant inserts and monofilament scraper fabricated from flexible PVC.
.2 Colour: Black/grey.
.3 Perimeter trim: Provide stainless steel edge. Schiene by Schluter Systems or approved equal.
.4 Basis of Design:
.1 Gateway SB Plus by GO Resilient Canada.
.2 Or approved equal.

.2 Lectern:
.1 ADA compliant lectern/teaching station designed to support full AV system. Lectern to be adjustable height.
.2 Finish: High pressure laminate in colour to be selected by Consultant.
.3 Basis of Design:
.1 Forum Lectern, Model Q-354835 by Middle Atlantic Products Inc. (Legrand).
.2 Or approved equal.

.3 Counterbalancer:
.1 Enclosed reel counterbalancer without cable lock. Cable to be 2134 mm long with automatic retraction.
.2 Mounting: Hanging.
.3 Capacity: Minimum 125 lbs to maximum 135 lbs.
.4 Basis of Design:
.1 Model 6644A38 by McMaster-Carr.
.2 Or approved equal.

.4 Automated external difibrillator (AED):
.1 AED with detailed CPR guidance and real CPR help technology complete with full-colour images and CPR cycle timer. Simple to activate child mode for paediatric rescue.
.2 Self test mode: Automatic self-test checks.
.3 Screen size: 54 mm x 95 mm.
.4 Basis of Design:
.1 Model ZOLL AED 3 by Zoll.
.2 Or approved equal.

.5 Paper towel dispenser:
.1 Jumbo roll, centre pull paper towel dispenser.
.2 Basis of Design:
.1 Model 1004 by Merfin.
.2 Or approved equal.

.6 Mop rack: Shelf with mop/broom holders
.1 Shelf: 90 mm deep x 914 mm long, 0.9 mm thick stainless steel channel.
.2 Components: four anti-slip mop holders.

.3 Finish: Satin finish stainless steel.
.4 Basis of Design:
.1 Model 8215-4 by American Specialties Inc.
.2 Or approved equal.

.7 Hose rack:
.1 Garden hose hanger, 178 mm high x 254 mm wide fabricated from heavy duty steel.
.2 Hose capacity: 38 metres of 16 mm diameter hose.
.3 Finish: Tan plastic coating.
.4 Basis of Design:
.1 Model GGS2LRL1 by Grainger Canada.
.2 Or approved equal.

3 EXECUTION

3.01 EXAMINATION

.1 Examine and verify previously installed Work upon which this Section depends. Report defects or unsatisfactory conditions to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.02 INSTALLATION

.1 Install manufactured units in accordance with manufacturer's instructions, rigid and secure and to reviewed Shop Drawings.

.2 Adjust and clean manufactured units after installation in accordance with manufacturer’s written instructions.

3.03 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by installation of manufactured units.

END OF SECTION

1 GENERAL

1.01 SUMMARY

.1 Section includes all methods, materials and installation as required to complete the Work of this Section in accordance with the Conditions of the Contract.

1.02 ACTION SUBMITTALS

.1 Submit action submittals in accordance with Section 01 33 00.

.2 Product data: Submit manufacturers product data for laboratory equipment including product characteristics, performance criteria, and limitations.

.3 Samples: Submit 300 mm x 300 mm samples illustrating colours, textures and finishes.

1.03 CLOSEOUT AND MAINTENANCE SUBMITTALS

.1 Submit closeout and maintenance submittals in accordance with Section 01 78 00.

.2 Closeout Product data: Submit manufacturers maintenance and cleaning data for incorporation into operation and maintenance manual.

1.04 QUALITY ASSURANCE

.1 All electrical equipment shall have attached labels attesting to CSA or Electrical Safety Authority approval, and shall have magnetic starters for motors, transformers, and overload protection.

1.05 DELIVERY, STORAGE, AND HANDLING

.1 Package equipment to prevent damage or distortion during shipment and handling. Label packages and protect finish surfaces by sturdy wrappings, strippable plastic or equivalent protection.

.2 Do not deliver equipment to site until conditions are such that no damage will occur to them while in storage. Store equipment on site in a manner to prevent damage.

.3 Provide equipment or its parts ready for installation in accordance with construction schedule. Verify required delivery date sufficiently before delivery to ensure that construction is not delayed.

2 PRODUCTS

2.01 EQUIPMENT

.1 Equipment shall include all components required by jurisdictional authorities, and to protect the equipment from damage during operation.

.2 Equipment shall include all components, connections, devices and controls required to make it fully and safely operable.

.3 Provide reinforcing and anchorage for built-in products.

.4 Insulate between dissimilar metals, and metal and masonry, to prevent electrolysis.

2.02 FABRICATION

.1 Fabricate work with materials and component sizes, metal gauges, reinforcing anchors, and fastenings of adequate strength to ensure that it will remain free of warping, buckling, opening of joints and seams, and distortion within limits of intended and specified use. Conceal and weld connections wherever possible.

.2 Cleanly and smoothly finish exposed edges of materials including holes and cutouts.

.3 Fit joints and junctions between components tightly in true plane to prevent entry of water. Cap open ends of sections exposed to view.

.4 Provide reinforcing and attached anchorage for built-in products.

.5 Provide holes and connections for work installed under other Sections.

3 EXECUTION

3.01 EXAMINATION

.1 Examine and verify previously installed Work upon which this Section depends. Report defects or unsatisfactory conditions to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.02 PREPARATION

.1 Take site measurements of construction to which work of this Section must conform, and through which access must be made, before work is delivered to site, to ensure that adaptation is not required which would result in construction delay.

3.03 INSTALLATION

.1 Obtain and pay for all permits and connection fees as per authorities having jurisdiction.

.2 Perform mechanical and electrical work in accordance with applicable codes and standards.

.3 Obtain from manufacturer or supplier, anchorage information, roughing-in dimensions, templates and service requirements for installation of work of this Section. Also obtain assistance from manufacturer or supplier, for the setting of anchorage devices, and construction of other work incorporated with equipment specified in this Section in order that they function as intended.

.4 Install work to meet manufacturer's recommended specifications, true, tightly fitted, and level or flush to adjacent surfaces, as suitable for installation.

.5 Work shall include rough hardware, fastenings and other items necessary for secure installation.

.6 Use only fastenings suitable for materials. Do not use through fastening at floors or walls.

.7 Install work straight, plumb, level, and secured to prevent distortion or displacement, or both. Shim as necessary with concealed shims. Where required, use grout on which iron oxide deposits will not form.

.8 Secure fixed equipment to building structure or construction as required to maintain it permanently in place, and so that it functions properly with no damaging vibration to the building or itself.

.9 Install equipment with connections provided and as required for plumbing and electrical services.

.10 Provision of mechanical services and connection of equipment to mechanical work is specified in Division 22.

.11 Provision of electrical service and connections of equipment to the services is specified in Division 26.

3.04 CLEANING

.1 Clean and polish all surfaces that are exposed to view from any location on completion of installation.

.2 Remove packaging materials and debris from installation from the site.

3.05 DEMONSTRATION

.1 After start-up, adjusting and cleaning, demonstrate operation of equipment to Owner and Consultant, prior to Substantial Performance of the Work. Demonstrations shall be made:
- .1 When the Work is certified complete by the Consultant.
- .2 When the Work is turned over to the Owner.

.2 Knowledgeable representatives of the manufacturers and installers of the equipment being demonstrated shall be present at time of demonstrations.

3.06 SCHEDULE OF EQUIPMENT

.1 Emergency Eye Wash (Type 1):
- .1 Dual purpose eyewash/drench hose conforming to ANSI Z358.1 with two spray heads mounted side-by-side and covered by flip top dust cover.
- .2 Mounting: Deck mounted for countertops.
- .3 Hose: 2438 mm long reinforced PVC hose rated for 275 PSI working pressure.
- .4 Provide ANSI compliant identification sign.
- .5 Basis of Design:
  - .1 Model G5022 by Guardian Equipment.
  - .2 Or approved equal.

.2 Emergency Eye Wash (Type 2):
- .1 Dual purpose eyewash/drench hose conforming to ANSI Z358.1 with two spray heads mounted side-by-side and covered by flip top dust cover.
- .2 Mounting: Wall mounted with bracket.
- .3 Hose: 2438 mm long reinforced PVC hose rated for 275 PSI working pressure.
- .4 Provide ANSI compliant identification sign.
- .5 Basis of Design:
  - .1 Model G5026 by Guardian Equipment.
  - .2 Or approved equal.

.3 Fume Hood:
- .1 Self supporting fume hood designed for use in standing or sitting positions to allow safe use by wheelchairs.
- .2 Face velocities: 80 - 100 feet per minute.
- .3 Operation: Adjustable work surface by pushbutton from 762 mm to 915 mm.
- .4 Liner: Fiberglass reinforced polyester.
- .5 Included services:
  - .1 Two UL/CSA approved duplex receptacles for 120 V service.
  - .2 Factory pre-plumbed for compressed air.

.6 Basis of Design:
.1 Optima Fume Hood by Mott Manufacturing.
.2 Or approved equal.

.4 Battery Cabinet:
.1 Free standing battery cabinet for charging and storage of batteries with locking heavy-duty stability feet and shelf spacing of 284 mm.
.2 Size: 919 mm wide x 561 mm deep x 1969 mm high.
.3 Energy containment rating (ECR): 8.5 kWh.
.4 Basis of Design:
.1 Model CBSC3672 Floor Cabinet by Cellblock Fire Containment Systems.
.2 Or approved equal.

END OF SECTION

1 GENERAL

1.01 SUMMARY

.1 Section includes all methods, materials and installation as required to complete the Work of this Section in accordance with the Conditions of the Contract.

.2 Work may include, but is not limited to;
- .1 Manual roller shades.

1.02 REFERENCES

.1 CAN/ULC S109 - Flame Tests of Flame-resistant Fabrics and Films.

.2 CWCR - Corded Window Coverings Regulations by Health Canada.

.3 NFPA 701 - Standard Methods of Fire Tests for Flame Propagation of Textiles and Films.

1.03 ACTION SUBMITTALS

.1 Submit action submittals in accordance with Section 01 33 00.

.2 Product data: Submit manufacturers product data for roller shades including product characteristics, performance criteria, and limitations.

.3 Shop Drawings: Submit Shop Drawings as follows:
- .1 Shop Drawings to illustrate details, dimensions, fabrication and installation details including operational clearances.
- .2 Drawings to contain all required wiring diagrams and operational sequence.

.4 Samples: Submit 300 mm x 300 mm samples of each type of shading fabric illustrating colours, opacity and design.

1.04 CLOSEOUT AND MAINTENANCE SUBMITTALS

.1 Submit closeout and maintenance submittals in accordance with Section 01 78 00.

.2 Closeout Product data: Submit manufacturers maintenance and cleaning data for incorporation into operation and maintenance manual including product warranty documentation.

1.05 QUALITY ASSURANCE

.1 Manufacturers: Obtain Work of this Section from a company that has a minimum of five (5) years proven experience in the manufacturing of roller shades of a similar size and nature.

.2 Installers: Perform Work of this Section by a company that has a minimum of five (5) years proven experience in the installation of roller shades of a similar size and nature.

1.06 DELIVERY, STORAGE, AND HANDLING

.1 Deliver products in factory packages, marked with manufacturer, product name, and location of installation using same designations indicated on Drawings.

.2 Store cassette units on flat horizontal surface to prevent sagging and deformation/twisting of contents, until ready for installation.

1.07 SITE CONDITIONS

.1 Do not install shade units until interior painting, wet work, ceilings, window pockets, and mechanical/electrical work above window site is complete.

1.08 WARRANTY

.1 Provide extended warranty for roller shades in accordance with the General Conditions, except warranty is extended to ten (10) years from date Ready-for-Takeover has been attained:
- .1 Warranty to cover defects including operators, finish failure, fading of fabrics.
- .2 Warranty shall cover complete replacement of Work, including adjacent work impacted.

2 PRODUCTS

2.01 MANUFACTURERS

.1 Mecho 5 by MechShade Systems or approved equal by:
- .1 Elite Pro Shading Systems.
- .2 Fraser Shading Systems.
- .3 Legrand North America.
- .4 SunProject.
- .5 Sun Protection Group.

2.02 PERFORMANCE CRITERIA

.1 Manual roller shade system: Provide smooth operating chain and sprocket roller shade system shade contained in factory assembled shade cassette unit.

.2 Design shade and mounting system to allow air between shade and glass.

.3 Design and fabricate shades to ensure a maximum 12 mm gap both sides of fabric.

2.03 FABRIC

.1 Shading Fabric (Room Darkening):
- .1 Material: 73% vinyl coating and 27% fiberglass weave with the minimum performance:
  - .1 Weight: 12.50 oz/yd2.
  - .2 Thickness: 0.33 mm.
  - .3 Fire Classification: NFPA 701.
  - .4 Green standard: GreenGuard Gold.
- .2 Basis of Design: Classic Blackout 0700 by MechoShade or approved equal.
- .3 Colour: Graphite.
- .4 Location: Forensics Garage.

.2 Shading Fabric (3% Openness):
- .1 Material: 100% Thermoplastic olefin weave with the minimum performance:
  - .1 Weight: 13.57 oz/yd2.
  - .2 Thickness: 0.86 mm.
  - .3 Fire Classification: CAN/ULC S109.
  - .4 Green standard: GreenGuard Gold.
- .2 Basis of Design: EcoVeil Series by MechoShade or approved equal.
- .3 Colour: Dark Grey, final colour to be selected by Consultant.
- .4 Location: Classrooms.

.3 Fabric shall be sealed under heat and pressure to retain weave pattern, with additional heat seal at sides, to prevent fraying and to eliminate rough edges.

2.04 MANUAL ROLLER SHADE COMPONENTS

.1 Fully factory assembled and pre-tested shade cassette unit consisting of two end brackets, chain installed as required, shade tube, extruded aluminum fascia, hembar, fabric shade material, regular or reverse roll of shade material, and cassette mounting attachment brackets.

.2 Attachment Brackets: Aluminum brackets designed and fabricated to allow for direct installation of shade cassette unit to building structure. Brackets shall be adjustable to level the unit for building irregularities and to minimize light gap above the shade cassette unit.

.3 Removal of shade cassette unit shall not require disassembly of the shade unit or roller shade tube.

.4 End Bracket within Cassette Unit: 77 mm x 96 mm zinc plated steel. End bracket shall be two-piece moulded ABS construction with 64 mm diameter nylon drive sprocket pop-riveted onto bracket. Brackets to match fascia colour.

.5 Shade Tube: Extruded aluminum shade tube shall be 1.52 mm thick, complete with continuous screw fins 4.82 mm high. Fins shall be spaced on tube and placed according to weight and sizing characteristics necessary to ensure appropriate support for shade. Manufacturer designed diameter as required to suit shade style, and size.

.6 Fascia and End Caps: 1.7 mm thick extruded aluminum fascia with front towards room interior complete with two continuous screw flutes. Finish: as selected by Consultant.

.7 Shade Drive Assembly:
- .1 Factory set for size and travel of shades; chain installed.
- .2 Unit to be field adjustable from exterior of cassette shade unit without requiring disassembly.
- .3 Provide built-in shock absorber to prevent chain breakage under normal usage conditions.
- .4 Factory installed upper bead stop to prevent shade from rolling beyond preset upper limit. Lower bead stop to be field installed in consultation with Consultant.
- .5 Provide Lift Assist Mechanism (LAM), sized according to shade weight and consisting of spring device installed in roller shade tube.
- .6 Drive Chain: No. 10 Stainless Steel bead chain formed in continuous loop. Chain with 90-pound tensile strength.
- .7 Ensure any chains or cords conform to the requirements of the Corded Window Coverings Regulations (CWCR) by Health Canada.

.8 Exterior Hembar: Extruded aluminum with plastic end finials, attached in factory to shadeband fabric material.

.9 Shadeband Material Attachment: Attach shadeband material to roller shade tube in factory. All finished shades must be fabricated with one complete wrap of material minimum, to cover the attachment of the shade and material to the shade tube.

.10 Light Gap: All Cassette Shade Units shall maintain equal symmetrical light gaps on both sides.

.11 Room Darkening Side Channels: Provide at all room darkening shade locations.

.12 Chain Operation:

.1 Cluchless, easy-lift action, chain operated with infinite positioning, the shade could be closed at any point across its length of travel. Left hand, right hand or both sides operation available as standard and factory installed into the shade cassette unit.

.2 Manual shade shall include a "manual override" requirement that allows the shade to be pulled down by the hembar without using the chain or damaging the shade system.

2.05 FABRICATION

.1 Shades shall be fully factory assembled units.

.2 Fabric shall hang flat, without buckling or distortion. Trimmed edges shall hang straight without curling or ravelling.

.3 Provide stops at highest and lowest shade positions to prevent over winding and unrolling.

3 EXECUTION

3.01 EXAMINATION

.1 Examine and verify previously installed Work upon which this Section depends. Report defects or unsatisfactory conditions to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.02 PREPARATION

.1 Coordinate requirements for blocking and structural supports to ensure adequate means for installation of window shades.

.2 Coordinate requirements for power supply conduit, and wiring required for window shade motors and controls.

3.03 INSTALLATION

.1 Install in accordance with manufacturer's instructions, ensuring roller shades are in conformance with CWCR requirements for cord lengths as required.

.2 Install roller shades level, plumb, square, and true. Allow proper clearances for window operation hardware.

.3 Install all accessories and components as required for a complete installation.

3.04 SITE QUALITY CONTROL

.1 Test roller shades to verify that operating mechanism, fabric retainer, and other operating components are functional. Correct deficiencies.

.2 During daylight hours, lower shades and turn off interior lights. Verify that there are no light leaks at perimeter or within shade assembly. Correct deficiencies.

3.05 ADJUSTING AND CLEANING

.1 Adjust and balance roller shades and operators to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

.2 Clean roller shade surfaces, after installation, according to manufacturer's written instructions.

.3 Provide final protection and maintain conditions, in manner acceptable to manufacturer and installer.

.4 Replace damaged roller shades that cannot be repaired, in a manner approved by Consultant.

END OF SECTION

1 GENERAL

1.01 SUMMARY

.1 Section includes all methods, materials and installation as required to complete the Work of this Section in accordance with the Conditions of the Contract.

.2 Work may include, but is not limited to;
- .1 Laboratory casework including cabinets.
- .2 Laboratory furniture including tables and islands.
- .3 Countertops.
- .4 Fixtures.

1.02 REFERENCES

.1 ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.

.2 ASTM A269/A269M - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.

.3 ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

.4 BHMA A156.11 - Cabinet Locks.

.5 FM 6050 - Examination Standard for Storage Cabinets for Ignitable (Flammable or Combustible) Liquids.

.6 NFPA 30 - Flammable and Combustible Liquids Code.

.7 NFPA 251 - Standard Methods of Tests of Fire Resistance of Building Construction and Materials.

.8 SEFA 3 - Laboratory Work Surfaces.

.9 SEFA 7 - Laboratory Fixtures.

.10 SEFA 8-M - Laboratory Grade Metal Casework.

.11 UL 1275 - Flammable Liquid Storage Cabinets.

1.03 ACTION SUBMITTALS

.1 Submit action submittals in accordance with Section 01 33 00.

.2 Product data: Submit manufacturers product data for laboratory furniture including product characteristics, performance criteria, and limitations.

.3 Shop Drawings: Submit Shop Drawings as follows:
- .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.
- .2 Shop Drawings to illustrate laboratory casework construction, with related and dimensional position including the following:
  - .1 Laboratory casework, leg frame assembly, countertops.
  - .2 Coordinate elevations with plans for each room and indicate locations and dimensions required for services.
- .3 Location of each furniture item unit in plan and elevation.
- .4 Locations for roughing-in of mechanical and plumbing including sinks, faucets, strainers, and electrical services.

.4 Samples: Submit 300 mm x 300 mm samples illustrating colours, textures and finishes including, but not limited to:
- .1 Countertop material.
- .2 Standard colour of cabinet finish on steel sheet.
- .3 Cabinet hardware.
- .4 Plumbing brass and electrical outlets.

.5 Reports/certificates: Submit the following:
- .1 Submit certification from an independent inspection company that items listed meet specified design requirements for chemical resistance and physical properties:
  - .1 Countertops.
  - .2 Finishes.

1.04 CLOSEOUT AND MAINTENANCE SUBMITTALS

.1 Submit closeout and maintenance submittals in accordance with Section 01 78 00.

.2 Closeout Product data: Submit manufacturers maintenance and cleaning data for incorporation into operation and maintenance manual including product warranty documentation.

1.05 QUALITY ASSURANCE

.1 Installers: Perform Work of this Section by a company that has a minimum of five (5) years proven experience in the installation of laboratory furniture of a similar size and nature.

.2 Mock-ups:
- .1 Construct one (1) mock-up of each type of base cabinet and wall case in location as directed by Consultant.
- .2 Mock-up of base cabinet to be minimum 1200 mm long and contain cupboard, drawers, specified bench top, splashback, end return and curb shelf.
- .3 Mock-up of wall case to be minimum 600 mm long and contain doors and shelves.
- .4 Mock-up may form part of the Work if accepted by the Consultant.

1.06 DELIVERY, STORAGE, AND HANDLING

.1 Schedule delivery of casework and equipment so that spaces are sufficiently complete and material can be installed immediately following delivery.

.2 Protect finished surfaces from soiling or damage during handling and installation. Keep covered with polyethylene film or other protective coating.

.3 Protect all work surfaces throughout construction period with 6 mm corrugated cardboard completely covering the top and securely taped to edges. Mark cardboard in large lettering "No Standing".

1.07 SITE CONDITIONS

.1 Building shall be enclosed with all windows and doors sealed and weather-tight, and HVAC system is operational and able to maintain temperature and humidity at occupancy levels.

2 PRODUCTS

2.01 MANUFACTURERS

.1 Laboratory casework:
- .1 CiF Lab Solutions.
- .2 Hamilton Scientific.
- .3 Mott Manufacturing Ltd.

.2 Laboratory furniture:
- .1 Air Science.
- .2 Or approved equal.

2.02 PERFORMANCE CRITERIA

.1 Design laboratory furniture for durability, safety and structural integrity to the following standards:
- .1 Metal casework: SEFA 8-M.

.2 Countertops: SEFA 3.
.3 Fixtures: SEFA 7.

.2 Design laboratory casework and furniture for the following loading:
.1 Base cabinets: 500 lbs per linear foot up to 2000 lbs.
.2 Wall cases: 600 lbs.
.3 Shelves: 40 lbs per sq.ft. Up to 200 lbs.
.4 Mobile tables including drone tables: 300 lbs.
.5 Free standing tables: 600 lbs.
.6 Fixed tables: 2000 lbs.

.3 Flush construction: Surfaces of doors, drawers and panel faces shall align with cabinet fronts without overlap of case ends, top or bottom rails. Horizontal and vertical case shell members (panels, top rails and bottoms) shall meet in same plane without overlap, cracks or crevices.

.4 Self-supporting units: Completely welded shell assembly allowing cases to be used interchangeably or as single, standalone unit.

.5 Interior of case units: Easily cleanable with removable bottoms panned up. Base cabinets, 762 mm and wider, with double swinging doors shall provide full access to complete interior without centre vertical post.

.6 Drawers: Modular sizing to allow for interchange to meet varying storage needs, and designed to be easily removable in field without use of special tools.

.7 Case openings: Rabbeted joints sides and bottom of case opening for hinged doors and two sides for sliding doors to provide dust resistant case.

2.03 MATERIALS

.1 Galvanized steel sheet: commercial quality to ASTM A653/A653M with Z275 zinc coating.

.2 Stainless steel sheet: to ASTM A240/A240M, Type 316, with brushed finish.

.3 Stainless steel tubing: ASTM A269/A269M, Type 304, commercial grade, seamless welded, minimum 1.25 mm wall thickness.

.4 Sealant: Refer to Section 07 92 00.

.5 Solid epoxy resin: Monolithic thermosetting material composed of modified epoxy resin and fine filler material conforming to SEFA 3. Finished edges to be same material as work surface. Colour: To be selected by Consultant.

2.04 FABRICATION

.1 Fabricate steel laboratory casework of the following minimum thicknesses:
- .1 Solid door interior panels, door exterior panels, drawer fronts, back panels, drawer bodies, security panels and sloping tops; 0.9 mm (20 gauge).
- .2 Ends, bottoms, bases, vertical posts, shelves, access panels, table legs and frames, leg rails and stretchers; 1.2 mm (18 gauge).
- .3 Top front rails, top rear gussets, intermediate horizontal rails; 1.6 mm (16 gauge).
- .4 Door and case hinge reinforcements and front corner reinforcements; 1.8 mm (14 gauge).
- .5 Table leg corner brackets and gussets for leveling screws; 3.0 mm (11 gauge).

.2 Base Units and Cases:
- .1 Base units: End panels and back reinforced with internal reinforcing front and rear posts.
- .2 610 mm, 787 mm and 915 mm high wall cases and 2134 mm high cases: Formed end panels with front and rear reinforcing post channels; back shall be formed steel panel, recessed 19 mm for mounting purposes.
- .3 Posts: Front post fully formed. Shelf adjustment holes in front and rear posts shall be perfectly aligned for level setting.
- .4 Secure intersection of case members with spot and mig welds.
- .5 Base unit backs: Provide drawer units without backs and cupboard units with removable backs for access to services behind units.
- .6 Bottoms: Base units shall have one piece removable bottom with front edge formed into front rail, rabbeted for swinging doors and drawers.
- .7 Base for base units: 100 mm high x 75 mm deep with formed steel base and 3.0 mm (11 gauge) die formed steel gussets at corners. Provide 9.5 mm diameter leveling screw with integral bottom flange of minimum 360 sq. mm area at each corner, accessible through removable bottom.

.3 Drawers:
- .1 Drawer fronts: 19 mm thick, double wall construction, pre-painted prior to assembly and sound deadened.
- .2 Drawer bodies: Bottom and all sides formed into one piece with bottom and sides coved and formed top edges.
- .3 Drawer suspension: 100 lb. full extension drawer slides for full access and operation.

.4 Doors:
- .1 Solid panel doors: 19 mm thick, double wall, telescoping box steel construction with interior pre-painted and sound deadened.

.5 Shelves:
- .1 Form front and back edges down and back 19 mm. Form ends down 19 mm.
- .2 Reinforce shelves over 915 mm long with welded hat channel reinforcement the full width of shelf.
- .3 Pull out shelves: Same suspension as specified for drawers.

.6 Hardware:
- .1 Door and drawer pulls: 100 mm brushed aluminum, fastened from back with two screws.
- .2 Hinges: Institutional type, five knuckle projecting barrel hinges, minimum 2 12 mm long, type 302 or 304 stainless steel. Provide two hinges for doors up to 915 mm high; three hinges for doors over 915 mm high. Drill each leaf for three screw attachment to door and frame.
- .3 Door catches: Adjustable type, spring actuated nylon roller catches.
- .4 Shelf clips: Die formed steel, zinc plated, designed to engage in shelf adjustment holes.
- .5 Locks: Cam or half-mortise type lock with 5-disc or 5-pin tumbler, brass with chrome-plated finish; complying with BHMA A156.11. Locks to prevent removal when in locked position. Located where indicated on drawings.

.7 Epoxy countertops: Fabricated from flat 25 mm thick epoxy resin with blended radius corners.
- .1 Counters to have marine edges 6.4 mm high radius edge by 25 mm wide with drip grooves on underside of all exposed edges.
- .2 Fabricate splashbacks 100 mm high unless shown otherwise on drawings. Splahbacks and curbs to be 19 mm thick with cove junctions of splashbacks and curbs to top with 16 mm radius.
- .3 Curbs around special cutouts to be 25 mm thick and bonded to top to form square joint.

.8 Stainless steel countertops: Fabricated from stainless steel provided under Section 05 70 00 laminated to 25 mm thick solid plywood base.

.9 Acid Storage Cabinet: Fabricated as specified for metal casework, including hardware and locks and the following:
- .1 Provide 6 mm thick glass-fibre cement board or moulded one-piece white polypropylene lining on interior surfaces.
- .2 Provide 38 mm diameter indicators for field cut-outs for vent hose connection at rear of base cabinet. Vent hose to extend to appropriate laboratory exhaust system or fume hood.
- .3 Removable access back panel.
- .4 Provide one adjustable lined shelf, of similar material and thickness as interior liner and one 25 mm deep liquid tight drip pan covering entire floor area of cement board lined cabinet compartment. Pan to be fabricated of 6 mm thick white polypropylene with seams welded.

.5 Door catch to be non-metallic plunger and roller style.
.6 Provide signage in contrasting colour to cabinet doors indicating "CORROSIVE CHEMICALS."

.10 Flammables Storage Cabinet:
.1 Cabinets shall comply with NFPA 30, and FM 6050 and shall be listed and labelled to UL 1275.
.2 Cabinets shall be designed to limit internal temperature at centre, 25 mm from top to not more than 162 deg C when subjected to ten-minute fire test to NFPA 251.
.3 For cabinets required to be vented by local authorities, provide 38 mm diameter vented outlet with flame/fire arrestor. Opening provided by manufacturer shall be sealed with bungs.
.4 Casing: Bottom, top, back, door and sides of cabinet shall be constructed and finished as specified for metal casework. Bottom, top, door and sides of cabinet shall be minimum 1.2 mm (18 gauge) and double-walled with 38 mm air space. Joints shall be riveted or welded.
.5 Cabinet to be ground to structure and bond cabinet.
.6 Provide adjustable, full width, metal shelf supported with locking clips to hold shelf in place.
.7 Door: Self closing door with continuous piano hinge and three point locking mechanism. Door sill spacing shall be raised a minimum 50 mm above bottom of cabinet to retain spilled liquid within cabinet.
.8 Finish: Finish as specified for metal laboratory casework except interior and shelf finish shall be 3 mil thick.
.9 Provide signage in contrasting colour and in a conspicuous size to cabinet doors indicating "FLAMMABLE KEEP FIRE AWAY."

.11 Tables:
.1 Fabricate table tops as for bench tops and as indicated on Drawings. Provide steel tube legs and stretchers.
.2 Tables are to be fully adjustable at 25 mm increments between 750 and 915 mm in height.
.3 Manual lift table (barrier free) to be 1270 mm wide to suit fume hood.
.4 Movable tables shall have swivelling casters with plate mount and brake and 75 mm diameter wheels.
.5 Finish: Epoxy enamel in colour to be selected by Consultant from manufacturers full colour range.
.6 Basis of Design: Cart-P5-50 by Air Science or approved equal.

.12 Drainage pegboards:
.1 Fabricate from Type 304 stainless steel, brushed finish complete with manufacturers standard wall hanger and all accessories required for complete installation.
.2 Provide 100 mm deep integral drip trough with catch drain and clear plastic drain tube.

.3 Pegs shall be white polypropylene 150 mm long x 12 mm diameter, set and sealed into predrilled holes in face of pegboard at 45 degree angle. Pegs shall be removable without use of tools.

.4 Basis of Design: Victoria V1824 by Inter Dyne Systems or approved equal.

.13 Fume hood bench cabinets (teaching lab):

.1 Provide fume hood bench cabinets compatible with Owner supplied fume hoods.

.2 Basis of Design: Cart- MCC-P5-50 by Air Science or approved equal.

2.05 LABORATORY CASEWORK FITTINGS

.1 Undermount epoxy resin sinks: Fabricated from cast epoxy resins with powdered silicone filler:

.1 Support sinks with two painted 6 mm x 12 mm steel straps fixed to underside of countertop.

.2 Mount undermount sinks under top and seal joint with acid resistant sealant.

.3 Provide epoxy waste fittings.

.2 Gooseneck water faucet: Laboratory mixing faucet, deck mounted with 150 mm swing vacuum breaker gooseneck. Basis of Design:

.1 Model L412VB-BH, with TM 6020 thermostatic mixing valve by Watersaver or approved equal.

.3 De-ionized water faucet: Pure water single faucet, deck mounted with fixed gooseneck. Basis of Design:

.1 Model L681 by Watersaver or approved equal.

.4 Compressed air wall mounted outlet with pressure regulator: Panel mounted pressure regulator fixture. Basis of Design:

.1 Model CT3173-366-758WSA by Watersaver or approved equal.

2.06 FINISHES

.1 Spray clean metal with heated cleaner/phosphate solution, pre-treat with iron phosphate spray, water rinse, and neutral final seal. Immediately dry in heated ovens, gradually cooled, prior to application of finish.

.2 Electrostatically apply urethane powder coat of selected colour and bake in controlled high temperature oven. Surfaces shall have chemical resistant, high grade laboratory furniture quality finish of following thickness:

.1 Exterior and interior exposed surfaces: 1.5 mil average and 1.2 mil minimum.

.2 Backs of cabinets and other surfaces not exposed to view: 1.2 mil average.

3 EXECUTION

3.01 EXAMINATION

.1 Examine and verify previously installed Work upon which this Section depends. Report defects or unsatisfactory conditions to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.02 PREPARATION

.1 Take site measurements of construction to which work of this Section must conform, and through which access must be made, before work is delivered to site, to ensure that adaptation is not required which would result in construction delay.

3.03 INSTALLATION

.1 Set casework components plumb, square, and straight with no distortion and securely anchored to building structure. Shim as required using concealed shims.

.2 Bolt continuous cabinets together with joints flush, tight and uniform, and with alignment of adjacent units within 1.5 mm tolerance.

.3 Secure wall cabinets to solid supporting material, not to plaster, lath or gypsum board.

.4 Abut top edge surfaces in one true plane. Provide flush joints not to exceed 3 mm between top units.

.5 Provision of mechanical services and connection of equipment to mechanical work is specified in Division 22.

.6 Provision of electrical service and connections of equipment to the services is specified in Division 26.

3.04 ADJUSTING

.1 Repair or remove and replace defective work, as directed upon completion of installation.

.2 Adjust doors, drawers, hardware, fixtures and other moving or operating parts to function smoothly.

3.05 CLEANING

.1 Clean and polish all surfaces that are exposed to view from any location on completion of installation.

.2 Remove packaging materials and debris from installation from the site.

3.06 PROTECTION

.1 Provide all necessary protective measures to prevent exposure of equipment from exposure to other construction activity.

.2 Advise contractor of procedures and precautions for protection of material, installed laboratory casework and fixtures from damage by work of other trades.

END OF SECTION

HIDI

DIVISION 20 – GENERAL MECHANICAL

SPECIFICATIONS

FOR THE

UNIVERSITY OF TORONTO MISSISSAUGA

PRE-ENGINEERED BUILDING

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DISCIPLINES
MECHANICAL
ELECTRICAL
FIRE PROTECTION
LIGHTING DESIGN
COMMUNICATIONS & AV
SECURITY & RISK
COMMISSIONING
ENERGY SERVICES

Our Project No. 2023-0059

SEAL:

November 15, 2024

Project Name: *UNIVERSITY OF TORONTO MISSISSAUGA*
Project No.: *2023-0059*
Section Name: ***Table of Contents***
Section No.: ***Division 20 - General Mechanical***
Date: *November 15, 2024*

Project Name: *UNIVERSITY OF TORONTO MISSISSAUGA*
Project No.: *2023-0059*
Section Name: ***General Requirements***
Section No.: ***20 00 00***
Date: *November 15, 2024*

INDEX

1 GENERAL

1.1 GENERAL

1.1.1 Conform to the conditions stated in the Contract Form Document CCDC 2 – 2008, Supplementary Conditions and Division 01 - General Requirements of these Specifications.

1.1.2 The General Mechanical Requirements apply to all Sections of this Division and of Divisions 21, 22, 23 and 25.

1.1.3 The Specifications are arranged generally in accordance with the MasterFormat 2004 Edition. Sections of this Division are not intended to delegate functions or to delegate work to any specific Subcontractor(s).

1.2 DEFINITIONS

1.2.1 “Provide” means to supply and install the Products and services specified in the Contract Documents.

1.2.2 “The Work” means the total construction and related services required by the Contract, and it includes all labour, products, and services.

1.2.3 “Products” means all material, machinery, equipment, and fixtures forming part of the Work but does not include machinery and equipment used for preparation, fabrication, conveying and erection of the Work which is normally referred to as construction machinery and equipment.

1.2.4 “This Division” means all Subcontractors performing work under the Mechanical Contract, including Divisions 21, 22, 23 and 25.

1.2.5 “Other Divisions” means other Subcontractors not included in this Division.

1.2.6 “Balancing Subcontractor” means the Subcontractor responsible for the balancing work.

1.3 INTENT

1.3.1 Provide all work, including items, articles, materials, operations, and methods listed, mentioned, and scheduled in the Contract Documents. Include all labour, equipment, tools, scaffolds, and other incidentals necessary and required for the complete installation.

1.3.2 Consider the Specifications as an integral part of the Drawings, which accompany them. Do not use the Drawings or the Specifications alone. Consider any item or subject omitted from one, but mentioned or reasonably implied in the other, as properly and sufficiently specified and provided under the work of this Division.

1.3.3 This installation shall be made in strict accordance with the Drawings, Specifications, and all applicable codes, regulations, standards, bylaws, including the Ontario Building Code, requirements of local authorities having jurisdiction, Owner's Insurers', and NFPA regulations. Codes, standards, and regulations referenced by these Specifications shall be the latest edition as applicable at the time of building permit application unless noted otherwise or specifically defined under the OBC.

1.3.4 All equipment and devices used shall be UL/cUL listed and/or CSA certified where applicable.

1.3.5 Each Subcontractor is considered an expert in their field.

1.4 EXAMINATION OF SITE AND CONTRACT DOCUMENTS

1.4.1 Before tendering, visit the Site of the proposed Work and obtain all information as to existing conditions and limitations.

1.4.2 Examine the Specifications and all Drawings including the Specifications and Drawings of all other Divisions before commencing any portion of the work to this Division.

1.4.3 No allowance will be made for any consideration that may have been overlooked.

1.4.4 Unless exceptions are specifically noted in the Contract Documents at the time of Tender, the submission of a bid confirms that the Contract Documents and the Site conditions are accepted without qualification.

1.5 SCOPE

1.5.1 Major aspects of the work of this Division shall include, but not necessarily be limited to, the following items. Refer to Contract Drawings for the full scope of the Work included in the Contract.

1.5.1.1 Heating, Ventilation, and Air Conditioning (HVAC) systems, consisting of heat recovery air handling units supplemented by

Variable refrigerant flow system (VRF) and baseboard heaters on the perimeter, general exhaust and sanitary exhaust systems, associated ductwork, grilles, diffusers, humidifiers and controls. Air handling units, associated ductwork, grilles, diffusers, humidifiers and controls.

1.5.1.2 Service areas (electrical rooms, IT rooms, etc.) cooling systems, consisting of split AC unit, associated ductwork, grilles, diffusers and controls.

1.5.1.3 Supplementary heating systems, consisting of unit heaters, baseboard heaters, duct heaters

1.5.1.4 Garage ventilation system, consisting of exhaust fans, and associated CO/NOx detection system.

1.5.1.5 Laboratory fume hood exhaust system including fan and make-up air

1.5.1.6 Plumbing systems, including incoming water services with water meters, domestic cold water, sanitary drain and vent risers.

1.5.1.7 Central domestic hot water plant consisting of electric domestic hot water heater and recirculation pump.

1.5.1.8 Fire protection systems including wet sprinkler system throughout the building.

1.5.1.9 Water collection system from perimeter and U/F weeper systems (installed by others), including sump pumps, piping and controls.

1.5.1.10 Storm water drainage system, including drain piping and roof drains.

1.5.1.11 Noise control and vibration isolation systems.

1.5.1.12 DDC building automation system.

1.5.1.13 Testing, adjusting and balancing.

1.5.1.14 Commissioning of mechanical systems and equipment.

1.6 PERMITS, FEES AND INSPECTIONS

1.6.1 Apply for, obtain, and pay for all permits, licenses, inspections, examinations, and fees required.

1.6.2 Arrange for inspection of all work by the authorities having jurisdiction over the Work. On completion of the Work, present to the Owner the final unconditional certificate of approval of the Inspection Authorities.

1.6.3 Comply with requirements of the edition as applicable at the time of building permit application, of the relevant CSA standards, the requirements of the authorities, Federal, Provincial and Municipal codes, the applicable standards of the Underwriters' Association and all other authorities having jurisdiction. These codes and regulations constitute an integral part of these Specifications. In case of conflict between the Codes and the Contract Documents, the more stringent requirement shall apply.

1.6.4 In no instance reduce the standard established by the Drawings and Specifications by applying any of the codes referred to herein.

1.6.5 Before starting any work, submit the required number of copies of the Drawings and Specifications to the authorities for their approval and comments. Comply with any changes requested as part of the Contract, but notify the Owner immediately in writing of such changes for proper processing of these requirements. Prepare and furnish any additional drawings, details or information as may be required.

1.7 CONTRACT DRAWINGS

1.7.1 The Drawings for the mechanical work are diagrammatic performance drawings, intended to convey the scope of the Work, and indicate general arrangement and approximate location of apparatus, fixtures, and pipe runs. The Drawings do not intend to show architectural and structural details.

1.7.2 Do not scale drawings, but obtain information involving accurate dimensions to structure from dimensions shown on architectural and structural drawings, or by site measurements. Consult general construction Drawings as well as detail Drawings to become familiar with all conditions affecting the Work and verify spaces in which the Work will be installed.

1.7.3 Make, at no additional cost to the Owner, any changes or additions to materials and/or equipment necessary to accommodate structural conditions (runs around beams, columns, etc.).

1.7.4 Alter at no additional cost to the Owner, the location of materials and/or equipment as directed, provided that the changes are made

before installation and do not necessitate additional material.

1.7.5 Install all ceiling mounted components (diffusers, grilles, sprinklers) in accordance with reflected ceiling drawings reviewed by the Consultant.

1.7.6 Leave space clear and install all work to accommodate future materials and/or equipment as indicated and to accommodate equipment and/or material supplied by another Division of Work or Contract. Verify spaces in which Work is to be installed. Install all pipe runs, etc., to maintain headroom and clearances and to conserve space in shafts and ceiling spaces.

1.7.7 Confirm on the Site the exact location of outlets and fixtures. Confirm location of outlets for equipment supplied under other Divisions of Work or Contracts.

1.8 CONSTRUCTION DRAWINGS

1.8.1 Prepare dimensioned co-ordination drawings in conjunction with all Subcontractors concerned, showing sleeves, access door locations, and openings through structure and all insert sizes and locations. Show all weights on load points. Show all electrical systems, mechanical systems, conduit, and ductwork.

1.8.2 Prepare drawings of pump pits, equipment bases, anchors, inertia slabs, floor and roof curbs pertaining to the Mechanical Work. Base drawings upon reviewed Shop Drawings. Indicate all loads transferred to the structure.

1.8.3 Submit drawings approved by all trades, to the Consultant and include one complete set in each operating and maintenance instruction manual.

1.9 SHOP DRAWINGS

1.9.1 Submit Shop Drawings and samples for material and equipment as listed in the Specifications. Provide one (1) electronic pdf file. Each Shop Drawing shall have a clear margin equal to half of a 216 mm x 280 mm (8-1/2" x 11") size sheet for the application of all necessary approval stamps.

1.9.2 Contractor shall provide a shop drawing submission schedule at the start of the project. Schedule shall indicate the description of each shop drawing and the date of submission to the Consultant.

1.9.3 The Consultant will only consider Shop Drawings bearing the stamp of approval of the Contractor and all Sub-Contractors involved when applicable. Check for all pertinent information such as physical dimensions, make, performance, electrical characteristics, and indicate the intended use and location before stamping these drawings approved.

1.9.4 Assume responsibility for accuracy of equipment dimensions related to available space and accessibility for maintenance and service, and compliance with Codes and Inspection Authorities.

1.9.5 Submit Shop Drawings showing the following:

1.9.5.1 Project name.

1.9.5.2 Project tag number.

1.9.5.3 Manufacturer's name and model number.

1.9.5.4 Supplier's name.

1.9.5.5 Approval agencies.

1.9.5.6 Shipping and working weight.

1.9.5.7 Performance characteristics.

1.9.5.8 Dimensions including required clearances.

1.9.5.9 Electrical characteristics.

1.9.5.10 Materials used in manufacture and type of finish.

1.9.5.11 Time required to fabricate and to deliver.

1.9.5.12 All variations from Tender Documents.

1.9.5.13 Construction and field connection details.

1.9.5.14 Motor locations.

1.9.6 Shop Drawings for packaged equipment shall be submitted as complete packages, including all equipment components and details (wiring diagrams, control diagrams, etc.).

1.9.7 The Consultant's review shall not relieve the Contractor from responsibility for deviations from the Consultant's Drawings and

Specifications, unless they have in writing, called the Consultant's attention to such deviations at the time of submission of drawings. The Consultant's review shall be construed to apply to and only to general arrangement and shall not relieve the Contractor from the entire responsibility for correctness of details and dimensions. Any fabrication, erection, setting out or other work done in advance of the receipt of stamped drawings shall be done entirely at the Contractor's risk.

1.9.8 Shop Drawings will be marked by the Consultant for action by the Contractor as follows:

Consultant's Markings	Action by Contractor
Not reviewed	Product does not fall under this Division's scope and it does not affect this Division's Work in any way
Reviewed	Proceed with work
Reviewed as Noted	Proceed in accordance with mark-up. Resubmit revised drawings for record
Revise and Resubmit	Submit revised drawings for review before proceeding

1.10 SCHEDULING

1.10.1 Comply with the Contractor's construction schedule.

1.10.2 Provide in the tender price any costs for premium time outside of normal working hours to complete the work on schedule.

1.11 RECORD DRAWINGS

1.11.1 Obtain electronic copy of the Drawings, Specifications & Contract Documents in PDF format and AutoCAD/Revit drawing files from a central project management website. If such a website is not set-up for the project, obtain electronic copy of the Drawings, Specifications & Contract Documents in PDF format and

AutoCAD/Revit drawing files from the Consultant via email or other electronic file transfer tool used by the Consultant, after returning Consultant's waiver signed. As the job progresses, produce white prints of the relevant drawings and mark the prints to accurately indicate installed work. Have the white prints available for inspection at the site at all times, and present for scrutiny at job meeting. Transfer all information onto the AutoCAD drawing files/Revit model. Drawing files shall retain all original layering standards. Submit one (1) set of AutoCAD drawing files/Revit model files and one (1) set of pdf files, via email or other mutually agreed electronic file transfer tool, of final "Record" documents (drawings and specifications) to the Consultant for review. Note that the consultant's AutoCAD drawing files/Revit model files are copyrighted and may not be used for any other purpose other than that described above.

1.11.2 The drawing files shall be provided solely to assist the Subcontractor in the preparation of "Record" drawings. The Consultant assumes no liability for any errors, omissions, incomplete information, incorporation of latest changes, or other instructions.

1.11.3 While the Consultant takes precautions to ensure that no computer virus is transmitted, scanning for viruses upon receipt is recommended.

1.11.4 Prepare Record Drawings showing the following:

1.11.4.1 Inverts of all services entering and leaving the building and at property lines.

1.11.4.2 Dimensions of underground services in relation to building lines at key points of every run.

1.11.4.3 Elevations of underground services in relation to Ground floor level of the building.

1.11.4.4 Dimensioned location of all services embedded in the structure.

1.11.4.5 Dimensioned location of all services left for future Work.

1.11.4.6 All Addendum changes.

1.11.4.7 All changes to the work due to Change Orders.

1.11.4.8 All changes to the Work during construction.

1.11.4.9 Location and designation of all electrically supervised valves and smoke dampers.

1.11.4.10 Location and designation of all items requiring access or service in a hidden location.

1.11.4.11 All changes to Specifications, details and equipment schedules.

1.11.4.12 All duct traverse points and associated airflow rates as reported in final Air Balancing reports.

1.11.5 Identify each “Record” drawing as follows, “Record Drawing: This drawing has been revised to show all systems as installed. Remove references to the Consultant.

1.11.6 Prior to Testing, Adjusting and Balancing, provide print copies of all current record drawings to the Balancing Subcontractor and the Commissioning Agent.

1.12 PRODUCTS

1.12.1 Provide only new Products. Where manufacturer is not specified provide Products of high commercial standard and quality consistent with the standards of these Specifications.

1.12.2 All Products must bear the approval of the CSA or have special approval of the inspection authority having jurisdiction for their respective functions and environments.

1.12.3 Provide products of same manufacture for similar applications unless noted otherwise in the Contract Documents.

1.12.4 Refer to equipment performance schedules in the respective Specification Section and on the Drawings.

1.13 ALTERNATES AND SUBSTITUTIONS DURING PROGRESS OF WORK

1.13.1 Substitute Products will only be considered when Products specified in the Contract Documents become unobtainable.

1.13.2 Provide detailed Specifications and Shop Drawings with complete performance characteristics of the proposed alternate with the submission to the Consultant.

1.13.3 Assume responsibility and pay for any additional installation costs incurred by the work of all Divisions resulting from the substitution.

1.14 VALUATION OF CHANGES

1.14.1 For each change submit a complete itemized breakdown of labour and material.

1.14.2 Only the net difference between an extra and a credit will be subject to overhead and profit mark-up. Overhead and profit shall be as shown on the Tender Form.

1.15 APPLICATION FOR PAYMENT

1.15.1 Conform to the Consultant's method of submission of application for payment, which will be issued after the award of Contract.

1.16 SUPERINTENDENCE

1.16.1 The supervisory staff assigned to the project shall be fully competent to implement efficiently all requirements for scheduling, coordination, field engineering reviews, inspections and submittals defined in the Specifications.

1.17 INSTALLATION REQUIREMENTS

1.17.1 The Consultant's Drawings and instructions govern the general location of all items.

1.17.2 Install all equipment and apparatus to allow free access for maintenance, adjustment and replacement.

1.17.3 Install all Products and services in accordance with the manufacturer's requirements and/or recommendations.

1.17.4 Do not use explosive activated tools.

1.17.5 Install all services capped for future to allow easy access for future tie-in.

1.17.6 All equipment installed in parking structure floor slabs, ramps and driving areas shall meet all requirements of CAN/CSA-S413-07 with regard to corrosion protection:

1.17.6.1 The use of dissimilar materials shall be avoided, or if unavoidable, electric contact shall be prevented.

1.17.6.2 Embedded materials used for floor drains, pipes and other hardware shall be:

1.17.6.2.1 Non metallic, or;

1.17.6.2.2 A low copper aluminum alloy or an equally corrosion resistant metal, coated on surfaces in contact with concrete to prevent galvanic corrosion with steel reinforcing, or;

1.17.6.2.3 Protected against the corrosive effects of de-icing chemicals by an effective and durable coating.

1.17.7 Install equipment neatly to the satisfaction of the Consultant. Unless noted otherwise in the Contract Documents, install all Products and services to follow building planes. Installation shall permit free use of space and maximum headroom.

1.17.8 Cap off and seal all open ends of installed ductwork, piping and conduits to prevent entrance of foreign matter.

1.17.9 Do not install piping in a location or manner, which might result in freezing.

1.18 TEMPORARY SERVICE

1.18.1 Refer to Section 01 50 00 regarding temporary services, Contractor's shop, storage and other facilities.

1.18.2 Do not use any of the permanent mechanical systems during construction, unless specific written permission is obtained from the Consultant or unless allowed elsewhere in the Contract Documents.

1.18.3 The use of permanent facilities for temporary construction service shall not affect in any way the commencement of the warranty period. The warranty period shall commence as specified in the Contract Documents.

1.19 COOPERATION

1.19.1 Confer with all Subcontractors installing equipment that may affect the work of this Division, and arrange equipment in proper relation with equipment installed under other Divisions of the Contract.

1.19.2 Furnish all items to be built in, in time, complete with all pertinent information, commensurate with the progress of the work.

1.19.3 Store materials neatly and out of the way and clean up daily all refuse caused by the work.

1.19.4 Coordinate work with the work of all other Divisions. Relocate equipment and/or material installed, but not coordinated with the work of other Divisions, as directed by the Consultant, at no extra cost. Inform other Divisions of the locations of openings, chases, sleeves, supports, services, connections, etc. to be incorporated into the work.

1.20 PROTECTION

1.20.1 Protect building and structure from damage due to carrying out this work.

1.20.2 Protect all mechanical work from damage. Keep all equipment dry and clean at all times.

1.20.3 Cover all openings in equipment and materials.

1.20.4 Be responsible for and make good any damage caused directly or indirectly to any walls, floors, ceilings, woodwork, brickwork, finishes, etc.

1.21 FIELD REVIEW

1.21.1 The Consultants will make periodic visits to the Site during construction to ascertain reasonable conformity to plans and specifications. The Consultant is not responsible for quality control. Contractor shall maintain their own quality control and will be responsible for the execution of their work in conformity with the Contract Documents and with the requirements of authorities.

1.21.2 The Owner and Consultant shall have access to the Site at all times for periodic inspections. Maintain a complete set of contract documents on Site for field reference by the Consultant.

1.21.3 Provide all gauges, instruments, and other equipment necessary for field review by the Consultant.

1.21.4 Application for final review will be considered when the Work has been completed and written declarations submitted that all commissioning, adjustment, set up and documentation is complete. Final review shall be done when:

1.21.4.1 All reported deficiencies have been corrected.

1.21.4.2 All systems have been balanced, tested, commissioned and are operational.

1.21.4.3 The Owner has been instructed in the operation and maintenance of all equipment.

1.21.4.4 All reports have been submitted and reviewed.

1.21.4.5 All instruction manuals have been submitted and reviewed.

1.21.4.6 All tags and nameplates are in place and all data submitted and reviewed.

1.21.4.7 Cleaning up is finished in all respects.

1.21.4.8 All spare parts and replacement parts specified have been provided.

1.21.4.9 All record drawings have been submitted and reviewed.

1.22 SERVICES TO EQUIPMENT SUPPLIED BY OTHERS

1.22.1 Provide all necessary connections required for equipment supplied by the Owner and the work of other Divisions. Examine all the Drawings and Specifications and identify all requirements.

1.22.2 Provide valves, unions, caps, and vibration isolation for all services.

1.22.3 The Contractor shall be responsible to verify, adjust and coordinate the type, size and location of mechanical services required for all equipment supplied by the Owner and the work of other Divisions.

1.23 PROVISION FOR FUTURE EQUIPMENT AND CONSTRUCTION

1.23.1 Spaces designated for future equipment or building expansion shall be left clear.

1.23.2 Provide services for future extensions complete with Products necessary for present termination and to permit future extension.

1.23.3 Identify each service by a permanent marker at its termination point.

1.24 CUTTING AND PATCHING

1.24.1 Inform all other Divisions in time, concerning required openings. Where this requirement is not met, bear the cost of all cutting and patching, including layout, x-rays, ferroscanning at premium time. Obtain the permission of the Consultant before doing any cutting.

1.24.2 Do all necessary cutting and patching of existing work. X-ray all proposed floor-opening locations prior to core drilling. Refer to Section 20 00 55 – Work in Existing Buildings.

1.24.3 Obtain the Consultant's approval before doing any cutting and patching. Any structural modifications must not affect structural, fire barrier or vapor barrier integrity.

1.25 METALS

1.25.1 Metal construction required for the mechanical work and shown on the Structural Drawings will be carried out by Division 05 – Metals.

1.25.2 Provide all other metal work necessary for the mechanical work, such as, but not limited to, equipment bases, platforms, catwalks, supports, lintels, ladders, pit and trench covers. Have such work carried out in accordance with Division 05 – Metals.

1.25.3 Provide platforms and catwalks complete with safety rails, 6mm (¼") checkered plate or grating cover, suitable for minimum 750mm (30") wide. Provide removable sections where required for equipment removal.

1.25.4 Provide ladders using 13mm by 50mm (½" by 2") steel bar stringers and 19mm (¾") diameter steel bar rungs fastened through and welded to stringers at 300mm (12") on centers. Fabricate ladders 450mm (18") wide and locate 150mm (6") clear of wall face. Secure stringers at top and bottom and at minimum every 1.8m (6 ft) using welded steel brackets.

1.26 CONCRETE

1.26.1 Concrete work required for mechanical work and shown on the structural Drawings will be carried out by Division 03 – Concrete.

1.26.2 Provide all other concrete work specified but not shown on structural Drawings, necessary for the mechanical work including but not limited to inertia slabs, housekeeping pads, and pipe cradles. Have such work carried out in accordance with Division 03 – Concrete.

1.26.3 Ensure that the ultimate compressible strength after 28 Days shall not be less than:

1.26.4 13,790 kPa (2,000 psi) for pipe encasing and backfill or excessive excavations.

1.26.5 20,665 kPa (3,000 psi) for all other work.

1.27 EXCAVATION AND BACKFILLING

1.27.1 All excavation and backfilling required for the mechanical work will be done under Division 31 – Earthwork of the Specifications, except as noted below. Refer to soil report regarding the type of soil.

1.27.2 Ensure that bottom of pipe trench is graded as required.

1.27.3 In firm, undisturbed soil, excavation will be carried out under Division 31 – Earthwork, to within 150mm (6") of the bottom of pipes. Excavate under this Division to desired grade, lay pipes directly on the soil and shape soil to fit the lower $^1/_3$ segment of all pipes and pipe bells. Ensure even bearing along the barrels.

1.27.4 In rock and shale and where noted, excavation will be carried out under Division 31 – Earthwork, to 150mm (6") below and minimum 200mm (8") to either side of the pipe. Fill back under this Division, a bedding of 9mm ($^3/_8$") crushed stone or granular 'A' gravel.

1.27.5 In unstable soil, in fill and in all cases where pipe bedding has been removed in earlier excavation, particularly near perimeter walls of building and at catch basins, excavation will be carried out to 200mm (8") below the pipe under Division 31 – Earthwork. Compact to maximum possible density under this Division of Work and support the pipe by a 200mm (8") thick concrete cradle spanning full length, between firm supports. Install reinforcing steel in cradle or construct piers at maximum 2400mm (8 ft) spacing. Provide a minimum of one pier per length of pipe, down to solid load bearing strata. Use same method where pipes cross. Do all excavation for such piers.

1.27.6 Provide support over at least the bottom $^1/_3$ segment of the pipe in all bedding methods.

1.27.7 Before backfilling, obtain approval from Consultant.

1.27.8 Backfill trenches within the building to a compacted level of 300mm (12") above the top of pipes with clean, sharp sand in individual layers, maximum 150mm (6") thick, hand compacted to a density of 95% Modified Proctor.

1.27.9 Backfill trenches outside the building to a compacted level of 300mm (12") above the top of the pipes with individual layers of

material up to 150mm (6") thick, hand compacted to a density of 95% Modified Proctor, using Granular 'A' gravel.

1.27.10 Obtain written approval of all backfilling done under this Division from Consultant before work commences on additional backfilling under Division 31 – Earthwork.

1.28 PAINTING

1.28.1 Provide all exposed ferrous metal work and Products, except ductwork and piping, with at least one (1) factory prime coat or paint one prime coat on site. Clean up or wire brush all equipment before painting. Unless otherwise noted finish painting will be done under Division 09 – Finishes of these Specifications.

1.28.2 If not factory coated or galvanized, clean, wire brush and paint all ferrous supports and hangers concealed in ceiling spaces of kitchens or other similar high humidity areas.

1.28.3 Repaint or refinish all damaged factory applied finishes.

1.28.4 Provide oil-base red oxide primer applied as per manufacturer's recommendations.

1.29 ABBREVIATIONS

1.29.1 Abbreviations with respect to government agencies, testing agencies, technical societies, approval agencies and technical terminologies are as listed below:

AGA	American Gas Association
AHRI	Air-Conditioning, Heating, and Refrigeration Institute
AMCA	Air Moving and Conditioning Association
ANSI	American National Standards Institute
API	American Petroleum Institute
ARI	Air Conditioning and Refrigeration Institute
ASHRAE	American Society of Heating, Refrigerating, and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASSE	American Society of Safety Engineers

ASTM	American Society for Testing and Materials
AWS	American Welding Society
AWWA	American Water Works Association
BAS	Building Automation System
BC	National or State (US) Building Codes
CGA	Canadian Gas Association
CRN	Canadian Registration Number
CSA	Canadian Standards Association
DDC	Direct Digital Control
ECM	Electronically Commutated Motor
EEMAC	Electrical Equipment Manufacturers Association of Canada
FM	Factory Mutual
IAO	Insurers' Advisory Organization (CGI Information Systems and Management Consultants Inc.)
IEEE	Institute of Electrical and Electronics Engineers
ISTA	International Safe Transit Association
MERV	Minimum Efficiency Reporting Value
MICA	Midwest Insulation Contractors Association
MSS	Manufacturers Standardization Society of the Valve and Fittings Industry
NBC	National Building Code
NBFU	National Board of Fire Underwriters (currently American Insurance Association)
NC	Noise Criterion
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NPT	National Pipe Thread

OBC	Ontario Building Code
OESC	Ontario Electrical Safety Code
OSHA	Occupational Safety and Health Administration
PID	Proportional–Integral–Derivative
PSC	Permanent-Split Capacitor
PWM	Pulse-Width Modulation
SCR	Silicon Controlled Rectifier
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
TEMA	Tubular Exchanger Manufacturers Association
ULC/cUL	Underwriters' Laboratories of Canada
VAV	Variable Air Volume
VFD	Variable Frequency Drive

1.30 MANUFACTURER'S CERTIFICATION

1.30.1 Submit letters from the manufacturers of all equipment certifying that their technical representatives have inspected and tested their equipment, have approved the methods of installation and operation. Where existing systems are extended, provide letters covering both new and existing equipment and connections.

1.30.2 These letters shall state the names of persons present at the inspection and testing, methods used and a list of functions performed with location and room numbers where applicable.

1.30.3 Refer to the respective equipment sections for requirements for letters.

1.31 TRIAL USAGE

1.31.1 The Owner has the privilege of the trial usage of mechanical systems or parts thereof for the purpose of testing and learning the operational procedures.

1.31.2 Carry out the trial usage over a length of time as deemed reasonable by the Consultant, at no extra cost.

1.31.3 Carry out the operations only with the express knowledge and

under supervision of the Contractor and/or appropriate Subcontractors who shall not waive any responsibility because of trial usage.

1.31.4 Trial usage shall not be construed as acceptance by the Owner.

1.32 INSTRUCTION TO OWNER

1.32.1 Instruct the Owner's representatives in all aspects of the operation of systems and equipment. Refer to requirements for demonstration in respective equipment sections.

1.32.2 Arrange for, and pay for services of service engineers and other manufacturer's representatives required for instruction on specialized portions of the installation.

1.32.3 Submit to the Consultant at the time of final inspection a complete list of systems stating for each system:

1.32.3.1 Date instructions were given to the Owner's staff.

1.32.3.2 Duration of instruction.

1.32.3.3 Names of persons instructed.

1.32.3.4 Other parties present (manufacturer's representative, consultants, etc.).

1.32.3.5 Signatures of the Owner's staff stating that they properly understood the system installation, operation and maintenance requirements.

1.33 EARLY OCCUPANCY

1.33.1 The Owner will negotiate with the Contractor to occupy portions of the building before the Work is complete. Sufficient advance notice will be given to allow scheduling of the mechanical work to meet the Owner's requirements.

1.33.2 Notify the Contractor of any scheduling problems.

1.33.3 Schedule the Work and set construction priorities to satisfy the Owner's requirements.

1.33.4 Schedule the Work of this Division as follows:

1.33.4.1 Relevant equipment is ready for start-up as defined in these

Specification Sections.

1.33.4.2 Systems are balanced.

1.33.4.3 Safety controls are in place.

1.33.4.4 Automatic temperature controls are operational.

1.33.4.5 Primary equipment is tested and started-up.

1.33.4.6 All filters are in place.

1.33.5 The Owner will take over individual items of equipment used for Early Occupancy and the warranty period will start when:

1.33.5.1 Conditions of start-up (Item 1.33.4) have been complied with.

1.33.5.2 Air and fluid systems have been balanced.

1.33.6 The Consultant will issue a list of deficiencies covering the individual items of equipment used for Early Occupancy at the time of takeover by the Owner.

1.33.7 Early Occupancy and the Owner's takeover of individual items of equipment does not relieve the Contractor of their responsibility to test, adjust, balance, commission and demonstrate the systems in accordance with the Contract Documents.

1.34 <u>OPERATION AND MAINTENANCE MANUALS</u>

1.34.1 Assemble three (3) manuals, each containing data sheets, brochures, operating, maintenance, recommended spare parts, and lubricating instructions and a complete set of reviewed shop drawings and bind in hard cover. Identify cover "Operation and Maintenance Manual for _____". Manuals shall be separated with dividers in logical sections and volumes.

1.34.2 Present one (1) copy for review by Consultant. Make all corrections requested by the Consultant and forward the corrected review copy plus a duplicate to the Owner with a copy of transmittal to Consultant for their records. Include the following information in each manual:

1.34.2.1 Refrigeration Equipment

1.34.2.1.1 Operating instructions detailing the procedures to be followed for:

Charging

Start-up

Changeover from one season to another

Shutdown

Night operation

Maintenance instructions

1.34.2.1.2 Lubrication instruction for moving parts detailing type of lubricant to be used and the lubrication intervals in operation hours.

1.34.2.1.3 List of safety devices and instructions for their testing and adjusting.

1.34.2.1.4 Complete set of shop drawings showing:

Control sequence with description of the sequences of operation.

Detailed layout and sections indicating all maintenance, cleaning and lubrication points.

1.34.2.1.5 List of parts (bill of material) indicating the catalogue number and manufacturer, complete with drawings indicating the location of each part in the complete assembly.

1.34.2.1.6 Recommended chemical analysis of chilled water.

1.34.2.2 Heat Exchangers and Coils

1.34.2.2.1 Equipment layout (plans and section) giving all information on type of flanges, bolts, nuts, studs, tubes, etc.

1.34.2.2.2 Tube replacement instructions.

1.34.2.2.3 Cleaning instructions.

1.34.2.3 Pumps and Fans. Include for each different type and size:

1.34.2.3.1 Shop drawings indicating maintenance and lubrication points.

1.34.2.3.2 List of parts indicating the catalogue number and manufacturer, complete with drawings indicating the location of each part in the complete assembly.

1.34.2.3.3 Performance curves.

1.34.2.4 Valves and Fittings

1.34.2.4.1 Three (3) copies of framed valve charts for the project.

1.34.2.4.2 A list of valves as per the valve chart indicating size, type, catalogue number, make of each valve, strainer and steam trap.

1.34.2.5 Instrumentation and Control

1.34.2.5.1 Complete instrument list for all gauges, thermometers, gauge glasses and other instruments.

1.34.2.5.2 Sequence and description of operation for each control system.

1.34.2.5.3 Control diagram for each system complete with equipment summary giving system designation and catalogue number for each component.

1.34.2.5.4 Catalogue leaflet of each component used.

1.34.2.5.5 Applications programming information and programmer's manual.

1.34.2.5.6 Description of operating procedures, including required actions at each operator position, operation of computer peripherals, input and output formats and procedures, and emergency alarm and failure recovery procedures. Descriptions of system start-up, back-up equipment operation, and execution of all system functions and operating modes shall be provided.

1.34.2.5.7 Provide description of data communication, including data types and formats, data link components and interfaces, and operator test.

1.34.2.5.8 Instructions and schedules for inspections, cleaning, lubricating and calibration.

1.34.2.6 Other Equipment

1.34.2.6.1 Description of start-up and activating procedures, and commissioning procedures, as well as follow-up instructions to the Owner's operating staff to slowly break-in unit.

1.34.2.6.2 Maintenance instructions for all other equipment containing moving parts or requiring lubrication or chemical charging.

1.34.2.6.3 Include instruction list of parts indicating catalogue number and manufacturer, complete with drawings indicating the location of

each part in the complete assembly; performance curves.

1.34.2.7 A list of all motors serving mechanical equipment. Include in the list:

1.34.2.7.1 Location of motor.

1.34.2.7.2 Name of unit served by motor.

1.34.2.7.3 Motor serial number, manufacturer.

1.34.2.7.4 Power rating, voltage, full load current, service factor and rpm of motor (nameplate data), rating and catalogue number of motor starter thermal overload relays.

1.34.2.7.5 Serial number, rpm, airflow, manufacturer, static pressure (or head) of fan or pump.

1.34.2.7.6 Quantity, sizes and V-belt number of belts.

1.34.2.7.7 Sizes and types of drives used.

1.34.2.7.8 Type of oil or grease lubrication of gearbox, lubrication interval in hours of operation.

1.34.2.7.9 Type of grease lubrication for driven equipment, lubrication interval in hours of operation.

1.34.2.8 A copy of the following:

1.34.2.8.1 All reviewed sprinkler layouts and hydraulic calculations.

1.34.2.8.2 Final NFPA certification letter. Certification letter shall contain contractor's contact information, the building permit number, certification statement in regard to NFPA compliance and be stamped by a licensed professional engineer.

1.34.2.8.3 Certificates from all equipment manufacturers, duct-cleaning agents, pipe-cleaning agents, chemical treatment agents and local authorities having jurisdiction.

1.34.2.8.4 All pipe and duct pressure test reports.

1.34.2.8.5 Warranties and letters of guarantee from contractors and equipment manufacturers.

1.34.2.8.6 Copies of permits, licenses and certificates.

1.34.2.8.7 Start-up and activation and commissioning procedures and check sheets.

1.35 WARRANTY

1.35.1 Refer to General Conditions of the Contract and Specimen Warranty Form.

1.35.2 Furnish all extended warranty for equipment as required in the Specifications.

END OF SECTION

INDEX

1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 – General Requirements shall apply to and govern this Section.

1.2 SHOP DRAWINGS

1.2.1 Provide Shop Drawings for:

1.2.1.1 Access doors and panels.

1.3 MATERIALS AND EQUIPMENT

1.3.1 Use only new materials and equipment of Manufacturer as specified or shown on the Drawings. Ensure that equipment and materials for similar applications are of the same Manufacturer.

1.3.2 If the Subcontractor wishes to substitute materials of Manufacturers other than those named, they shall state in their Tender the name and a complete description of the materials to be substituted, along with the amount of change in the Contract Price.

1.3.3 Ensure that materials not specified to a specific Manufacturer are of high commercial standard and quality.

2 **PRODUCTS**

2.1 ACCESS DOORS AND PANELS

2.1.1 In plaster, gypsum board, tiled or masonry walls for exposed flush installation, provide 203mm by 203mm (8" x 8") prime coated 16 ga. access door with 18 ga. mounting frame, continuous concealed hinge, and screwdriver operated stainless steel cam latch, similar to Acudor UF-5000.

2.1.2 In plaster or tiled walls for recessed installation, provide 305mm by 305mm (12" x 12") 16 ga. access door recessed by 25mm (1"). Door to be complete with 14 ga. mounting frame, concealed pivoting rod type hinge, and flush-to-surface screwdriver operated stainless steel cam latch, similar to Acudor AT-5020.

2.1.3 In gypsum board surfaces or in acoustic tiles for recessed installation in public areas, provide 305mm by 305mm (12" x 12") bauco-plus architectural access door with concealed hardware and gypsum board inlay. Standard features include cam latch flush

with surface, aluminum frame and glass fibre-reinforced nylon hardware, fully hinged removable door panel and integrated safety catches, perimeter gasket installed onsite.

2.1.3.1 In areas not accessible by public, provide 305mm by 305mm (12" x 12") 16 ga. access door recessed by 25mm (1"). Door to be complete with 14 ga. mounting frame with drywall taping bead an all sides, concealed pivoting rod type hinge, and flush-to-surface screwdriver operated stainless steel cam latch, similar to Acudor DW-5015.

2.1.4 In fire rated walls, provide 305mm by 305mm (12" x 12") 16 ga. rated access door, ULC listed "B" label for 1-$^1/_2$ or 2 hours. Door to be complete with 16 ga. mounting frame, concealed hinge, spring closer, and knurled knob operated universal self-latching bolt, similar to Acudor FB-5060.

2.2 BEARINGS AND GEAR BOXES

2.2.1 Provide bearings suitable for application and environment, i.e., dust, corrosive atmospheres, high temperatures, etc. Bearings shall have a lifetime guarantee of not less than five (5) years.

3 EXECUTION

3.1 FLASHING

3.1.1 Provide galvanized or aluminum sleeves for piping through roof.

3.1.2 Ensure that the flashing suits roof and extends minimum 450mm (18") on all sides. Leave flashing as directed by the Contractor, to be built into roofing, rendering a watertight connection.

3.1.3 Provide counter flashing on diesel and boiler exhaust stacks, ducts, and pipes passing through roofs to fit over flashing or curb. Coordinate with the Subcontractor responsible for the roofing work of the Contractor.

3.1.4 Sleeve pipes through waterproof floors.

3.1.5 Pay special attention to the waterproofing conditions of basement walls and floors. Co-operate at all times with the water proofing trade and do not cut or destroy any waterproofing seal without the consent of the waterproofing trade. Provide piping sleeves passing through waterproof walls with asphalt roofing felt wrapped around to leave 25mm by 50mm (1" x 2") recess on both sides of the wall.

These recesses and the space between pipe and sleeve shall be caulked by this Division in accordance with the requirements of Division 07 – Thermal and Moisture Protection.

3.2 BEARINGS AND GEAR BOXES

3.2.1 Run-in all bearings, gearboxes and fluid couplings for a period recommended by the manufacturer. Flush out, and refill with new charge of recommended lubricant.

3.2.2 Provide all necessary lubricating materials and labour for all operating equipment until acceptable for operation and care by the Owner.

3.2.3 Provide oil-lubricated bearings and sumps with level gauge, in easily accessible location. Provide grease-lubricated bearings, if not readily accessible, with extended nipples.

3.3 BELT DRIVES, SHEAVES AND GUARDS

3.3.1 Provide all belt-driven equipment with V-belt drive, designed for at least 130 percent of motor nameplate power rating, and in accordance with manufacturer's recommendations for type of service intended. Belt drives to be at least 95 percent efficient. Balance and properly align drives. Provide matched sets of belts for multiple belt assemblies. Select belts to suit starting torque for driver. Use single belt drives only for motors 1.5kW (2.0 HP) and smaller.

3.4 INSERTS, SLEEVES, ESCUTCHEONS AND CURBS

3.4.1 Use only factory made, threaded, or toggle type inserts as required for supports and anchors, properly sized for the load to be carried. Place inserts only in portions of the main structure and not in any finishing material.

3.4.2 Use factory made expansion shields where inserts cannot be placed, but only where permission is given by the Consultant.

3.4.3 Do not use powder-activated tools except with written permission from the Consultant.

3.4.4 Supply and locate inserts, holes, anchor bolts, and sleeves in time when walls, floors and roof are erected.

3.4.5 Sleeves shall be concentric with pipe and be a minimum of 50mm (2") larger than pipe size.

3.4.6 Pass insulation unbroken where pipe or duct is insulated, except through fire rated walls and floors. Size sleeves to provide 13mm (½") clearance all around.

3.4.7 Use the following sleeving material for pipe sleeves:

3.4.7.1 Through interior walls use Schedule 10 steel pipes, machine cut, flush with finished structure. Check room-finish schedules.

3.4.7.2 Through exterior walls above grade use Schedule 10 steel pipes, machine cut, flush with finished structure inside and to suit flashing on outside.

3.4.7.3 Through exterior walls below grade and other waterproof walls use extra heavy weight cast iron or PVC sleeves, machine cut. Check flashing details for further information.

3.4.7.4 Through waterproof floors, through janitor's closets, mechanical rooms, compartment mechanical rooms, showers, kitchens, washrooms, and through roofs, use Schedule 40 sleeves, machine cut. As an alternative, copper DWV sleeves up to and including 150mm (6") sleeve size and rolled 32 ounce copper sleeves for larger than 150mm (6") sleeve size may be used. Extend sleeves 100mm (4") above finished floor upwards and cut flush with underside of floor. Refer to flashing details through waterproof floors.

3.4.7.5 Through other interior floors use Schedule 10 steel pipes, machine cut, flush with finished structure on both sides. Check room-finish schedules for further information.

3.4.7.6 Ensure that watertight concrete curbs, 100mm (4") high by 100mm (4") wide with 19mm (¾") chamfered edges, are furnished around pipes passing through waterproof floors except where furred in. Read Division 03 – Concrete for further information.

3.4.8 Pack spaces between the insulated pipe and the sleeve or where uninsulated, between the pipe and the sleeve, with ULC listed fire rated foam. Maintain vapour barrier on cold lines. Seal the annular space both sides as follows:

3.4.8.1 For horizontal sleeves in exposed areas, use a seal equal to or better fire rated than the wall to be sealed. Use "Fire barrier" as distributed by Double A/D Distributors Ltd. (UL No. 4 U 18.7 approved).

3.4.8.2 For horizontal concealed sleeves through firewalls and through walls separating areas of different air pressure, use a permanently resilient (silicone base or equal) sealing compound.

3.4.8.3 For vertical sleeves through roofs, janitor's closets, equipment rooms, and where required to provide fire rated separation, use permanently resilient (silicone base or equal) sealing compound, non-flammable and waterproof. Ensure that the seal is compatible with floor and ceiling finishes. Check the room-finish schedules for further information.

3.4.8.4 All fire stop materials and methods must be approved in accordance with CAN/ULC-S115-11, and be ULC listed.

3.4.8.5 Seal is not required for other sleeves.

3.4.9 Cover exposed floor and wall pipe sleeves in finished areas with satin finish chrome or nickel plated solid brass or with satin finish stainless steel escutcheons with non-ferrous set screws. Split cast plates of the screw locking type may be used. Do not use stamped steel friction type split plates.

3.4.10 Use the following sleeving for ducts:

3.4.10.1 Unless otherwise noted, use minimum 1.3mm (18 gauge) galvanized steel sleeves.

3.4.10.2 For rectangular duct openings through walls and floors provide a removable wood box-out of the required size.

3.4.10.3 Through firewalls, build fire dampers into wall.

3.4.10.4 Through floors where ducts are not furred in or enclosed in a duct-shaft, ensure the 100mm (4") high by 100mm (4") wide watertight concrete curbs are provided, with 19mm (¾") chamfered edges all around. Extend sleeves where used, flush to top of curb. Read Division 03 – Concrete, for further information.

3.4.10.5 Through floors where ducts are enclosed in a duct shaft or furred in, provide the watertight concrete curbs at the extreme top and bottom ends of the shaft only.

3.4.10.6 Through roofs, provide curbs and sleeves as shown on the detail drawings and to suit flashing requirements.

3.4.11 After ducts are installed, pack the opening and seal both sides as follows:

3.4.11.1 Use fiberglass insulation for packing, except through curbed concrete floors use “Fire barrier” as distributed by Double A/D Distributors Ltd. (UL No. 4 U 18.7 Approved).

3.4.11.2 Seal the packing in openings through floors with permanently resilient (Silicone base or equal) compound, non-flammable and waterproof. Press duct supports firmly into caulking before bolting down to curb.

3.4.11.3 Through all vertical walls seal the fibreglass packing using a permanently resilient (silicone base or equal) sealing compound.

3.4.11.4 All fire stop materials and methods must be approved in accordance with CAN/ULC-S115-11, and be ULC listed.

3.4.11.5 Seal is not required for other packings.

3.4.12 Brace duct sleeves and box-outs to retain their position and shape during the pouring of concrete and other work.

3.4.13 Provide bracing for each duct at every passing through structure to prevent sagging.

3.4.14 Cover exposed duct sleeves and openings in exposed areas only. Use 1.3mm (18 gauge) galvanized steel escutcheons in form of a duct collar. Over curbs extend the collar 25mm (1") down the side of the curb, similar to counter flashing. Fix collar in position with cadmium plated screws.

3.5 ACCESS DOORS AND PANELS

3.5.1 Install all concealed mechanical equipment requiring adjustment or maintenance in locations easily accessible through access panels or doors. Install systems and components to result in a minimum number of access panels. Indicate access panels on “As Built” drawings.

3.5.2 Provide the work of respective Division with panels, doors or the frames therefore; complete with all pertinent information for installation. Arrange with and deliver to the Subcontractor(s) in whose work they occur to install them. Ensure that access doors are installed in a manner to match the building material grids where applicable.

3.5.3 Prepare detailed and coordinated drawings showing location and type of all access doors. Submit these drawings to the Consultant

to review.

3.5.4 Size all access doors to provide adequate access and commensurate with the type of structure and architectural finish, minimum size 150mm (6") by 150mm (6). Should it be necessary for persons to enter, provide a minimum 600mm (24") by 450mm (18") size doors.

3.5.5 Ensure proper fire rating of access doors in fire separations, fire-rated walls and ceilings.

3.5.6 Lay-in type tiles, properly marked, may serve as access panels.

3.6 DRIP PANS

3.6.1 Construct drip pans of min. 1.0mm (20 gauge) galvanized steel sheet with sealed connections. Provide drain lines from drip pans to nearest hub drain, funnel floor drain, janitor's sink or appropriate approved location.

3.6.2 Provide drip pans at the following locations:

3.6.2.1 Beneath all pipes passing through electrical, battery, UPS, elevator machine, diesel generator, and telephone rooms, over horizontal runs of bus ducts, and in locations as indicated on the Drawings.

3.7 WORKMANSHIP

3.7.1 Install ducts and pipes parallel and perpendicular to the building planes and concealed in chases, behind furring or above ceiling, except in unfinished areas. Install all exposed systems neatly and group together, to present a neat appearance.

3.7.2 Install all equipment and apparatus requiring maintenance, adjustment, or replacement with sufficient clearance for servicing.

END OF SECTION

Project Name: *UNIVERSITY OF TORONTO MISSISSAUGA*
Project No.: *2023-0059*
Section Name: ***Electric Motors***
Section No.: ***20 05 13***
Date: *November 15, 2024*

INDEX

1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 – General Requirements, shall apply to and govern this Section.

2 **PRODUCTS**

2.1 MOTORS

2.1.1 Supply and install all motors for Mechanical Equipment.

2.1.2 All motors shall be 60 cycle, 1750 rpm, except where noted otherwise.

0.37kW ($^1/_2$ HP) and smaller: 120V, 1 Ph, 60 Hz.

0.56kW ($^3/_4$ HP) and larger: 575V, 3 Ph, 60 Hz.

2.1.3 Motors shall be squirrel-cage induction motors, built to CEMA and NEMA motor and generator standards. 2-speed motors shall be single winding variable torque.

2.1.4 The minimum requirement for three phase motors shall be CEMA Design B; Class B insulated for maximum 40°C (104°F) ambient.

2.1.5 Single-phase motors shall be capacitor types, for minimum 10 starts per hour.

2.1.6 Motors 44.7kW (60 HP) and over shall be with inherent overheat protection, consisting of thermistors embedded in each phase of the stator winding and wired to the motor conduit box.

2.1.7 Select motors for quiet, continuous operation to suit loads, which may be imposed by equipment. Recognize that motor powers specified and scheduled are minimum sizes. If larger motors are required, ensure that extra costs of larger motors, starters, power wiring, and additional control wiring are included in the work.

2.1.8 All motor 0.75kW (1 HP) to 373kW (500 HP), unless otherwise specified, shall be T-frame AC three phase, and equal or exceed the motor efficiency levels as tested to CSA-C390-M or the nominal efficiency noted in Tables 10.4.1.A.(a) or 10.4.1.A.(b) of SB-10 of the OBC (premium efficiency/energy efficient), whichever is the highest. Motors to be approved under Canadian Electrical Safety Code.

2.1.9 Motor enclosures shall be as follows:

2.1.9.1 If protected from the weather and entraining moisture, use open drip-proof, service factor 1.15.

2.1.9.2 Motors located in air streams shall be selected to operate satisfactorily at maximum temperature and moisture levels of surrounding air. Use drip-proof motors with encapsulated windings and weatherproof terminal box.

2.1.9.3 For all other locations, use totally enclosed fan-cooled, service factor 1.0.

2.1.9.4 Use explosion-proof motors where scheduled.

2.1.10 All motors shall be fitted with sealed for life bearing requiring no periodic lubrication.

2.1.11 Submit an accurate schedule of all motors. Include for each motor, the motor capacity, speed, nameplate current, equipment served, location, electrical characteristics, and identification number.

2.1.12 Provide each motor with a terminal box sized to accommodate the conductors connected thereto. Locate the terminal box to face the outside of the equipment assembly.

2.1.13 Provide EEMAC adjustable sliding bases for motors used with belt drives.

2.1.14 All motors driven by Variable Frequency Drives (VFD's) shall be NEMA31 design, have class F insulation, and be rated for inverter duty. Refer to Section 20 09 49 – Variable Frequency Drives.

3 EXECUTION

Not Used.

END OF SECTION

Project Name: *UNIVERSITY OF TORONTO MISSISSAUGA*
Project No.: *2023-0059*
Section Name: ***Electrical Wiring***
Section No.: ***20 05 14***
Date: *November 15, 2024*

INDEX

1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Division 26 - Electrical will do all line side power wiring for equipment provided by Division 21 – Fire Suppression, Division 22 – Plumbing, Division 23 – HVAC and Division 25 – Integrated Automation, up to the respective starter, motor control center, control panel, disconnect or VFD, also provided under Divisions 21, 22, 23 and 25. Load side power wiring shall be under Divisions 21, 22, 23 and 25.

1.2.2 Divisions 21, 22, 23 and 25 shall provide all disconnect switches for mechanical equipment as required by code. Provide weatherproof switches for all outdoor locations.

1.2.3 Field control wiring of local safeties and interlocks for packaged equipment shall be provided under the respective Sections unless otherwise specified.

1.2.4 Conduit and wiring materials and methods shall be in strict accordance with the requirements of Division 26 - Electrical.

1.2.5 Check all wiring diagrams and control diagrams submitted in shop drawing form. Before submitting these shop drawings to the Consultant, submit these drawings to Division 26 - Electrical Contractor for approval. Have these drawings stamped by Division 26 - Electrical Contractor as verification of their approval before forwarding to the Consultant. Co-operate in the commissioning of all electrically driven equipment with Division 26 - Electrical.

2 **PRODUCTS**

2.1 GENERAL

2.1.1 Conduit and wiring materials and methods shall be in strict accordance with the requirements of Division 26 - Electrical.

3 **EXECUTION**

3.1 GENERAL

3.1.1 Refer to Division 26 - Electrical.

END OF SECTION

INDEX

1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 – General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools equipment, training commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 Contactors and control devices.

1.3 SUBMITTALS

1.3.1 Submit Shop Drawings for:

1.3.1.1 Contactors and control devices.

1.4 ELECTRICAL EQUIPMENT AND WORK

1.4.1.1 Read together with Division 26 – Electrical and adhere to its requirements. Supply and install all electrical apparatus that is required and is not covered by Division 26 – Electrical.

2 **PRODUCTS**

Not Used.

3 **EXECUTION**

3.1 CONTACTORS AND CONTROL DEVICES

3.1.1 Install all automatic devices such as thermostats, controlling electrical equipment, supplied under this Division.

3.1.2 Disconnect switches, starters, push button stations, cable lugs, pilot lights, and control circuit transformers shall be supplied and installed by Division 26 – Electrical, except as noted below.

3.1.2.1 Division 21, 22 and 23 shall provide all starters, contactors, fuses, etc., for packaged equipment such as chillers, boilers, domestic hot water heaters, rooftop air conditioning and heating units, electric reheat coils, computer room air conditioning units, etc., as specified in the respective sections. Division 26 – Electrical shall

provide disconnect switches for these equipment as required by applicable code.

3.1.3 Provide Division 26 – Electrical Contractor with all details of the motors and electrical equipment supplied for selection of overload protection, etc.

END OF SECTION

Project Name: *UNIVERSITY OF TORONTO MISSISSAUGA*
Project No.: *2023-0059*
Section Name: ***Expansion Compensation***
Section No.: ***20 05 16***
Date: *November 15, 2024*

INDEX

1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools equipment, training commissioning and certification required to complete the work as shown on the Drawings and specified herein, including:

1.2.1.1 All necessary expansion compensation elements for piping and equipment.

1.2.2 Manufacturer of expansion compensation equipment shall guarantee specified isolation system deflection.

1.2.3 Manufacturer to provide installation instructions, drawings, and field supervision to assure proper installation and performance.

1.2.4 In addition to the work of this Section, comply with description of individual systems and general requirements of all other Specification Sections of this Division.

1.3 SUBMITTALS

1.3.1 Provide shop drawings for expansion compensation equipment.

1.3.2 As a minimum provide the following information:

1.3.2.1 Catalogue cuts and data sheets on specific compensators to be utilized showing compliance with the Specifications.

1.3.2.2 Drawings showing methods of suspension, support guides for piping and ductwork. Submittals must include the initial load, initial deflection, change in deflection, final load and change in load at all spring and anchor support locations, as well as guide spacing. Calculations shall include pipe stress at end conditions and branch off locations and the manufacturer must include installation instructions.

1.3.3 Submittal must be stamped and signed by a licensed professional engineer, either in the employ of the expansion compensation vendor or specialized to the field of expansion compensation system design, for at least 5 years.

1.3.4 Submit letter from manufacturer certifying that expansion compensation equipment have been installed in accordance with its recommendations and the Contract Documents, and that it operates to their satisfaction.

1.4 QUALITY ASSURANCE

1.4.1 All grooved joint couplings and specialties shall be the products of a single manufacturer.

2 **PRODUCTS**

2.1 GENERAL

2.1.1 All expansion compensation devices shall be the product of a single manufacturer.

2.2 EXPANSION COMPENSATORS

2.2.1 Provide manufactured expansion joints suitable for working and test conditions of the pipe in which they are installed, with adequate cyclic life to last through 25 years of normal operation. Select the joints for the expected movement in the temperature ranges from 4.4°C (40°F) to maximum operating temperature plus 25% for hot pipes and from 26.6°C (80°F) to minimum operating temperature plus 25% for cold pipes.

2.2.2 Rubber expansion joints shall be peroxide cured EPDM throughout with Kevlar tire cord reinforcement. Substitutions must have certifiable equal or superior characteristics. The raised face rubber flanges must encase solid steel rings to prevent pull out. Flexible cable wire is not acceptable. Sizes 40mm through 350mm (1-1/2" through 14") shall have a ductile iron external ring between the two spheres. Sizes 400mm to 600mm (16" through 24") may be single sphere. Sizes 20mm through 50mm (3/4" through 2”) may have one sphere, bolted threaded flange assemblies and cable retention.

2.2.2.1 Minimum ratings through 350mm (14”) shall be 1.72MPa at 77°C and 1.48MPa at 121°C (250psi at 170°F and 215psi at 250°F), 400mm (16”) through 600mm (24”) 1.24MPa at 77°C and 1.03 MPa at 121°C (180psi at 170°F and 150psi at 250°F). Higher published rated connectors may be used where required.

2.2.2.2 Control rods passing through 12mm (½”) thick Neoprene washer bushings large enough to take the thrust at 0.7 kg/mm2 (1000 psi)

of surface area may be used on unanchored piping where the manufacturer determines the condition exceeds the expansion joint rating without them.

2.2.2.3 Expansion joint to achieve a minimum reduction of 20 dB in vibration accelerations and 10 dB in sound pressure levels at typical blade passage frequencies.

2.2.2.4 Safety factors shall be a minimum of 3/1. All expansion joints must be factory tested to 150% of maximum pressure for 12 minutes before shipment.

2.2.2.5 Rubber expansion joint to be Mason Type SAFEFLEX SFDEJ, SFEJ, SFDCR or SFU, control rods Type CR.

2.2.3 Provide braided hose type connectors in accordance with the following schedule.

2.2.3.1 Low pressure service up to 121°C (250°F): bronze hose and copper sweat connection up to 65mm (2-½") dia., Mason Type CPSB; 304 stainless steel hose and carbon steel flanged connection 80mm (3”) dia and up, Mason Type FFL.

2.2.3.2 Medium pressure service up to 121°C (250°F): 304 stainless steel hose and carbon steel threaded nipple up to 65mm (2-½") dia., Mason Type MN, 304 stainless double-braided steel hose and carbon steel flanged connection 80mm (3”) dia and up, Mason Type FFL-2B300.

Size I.D. mm (in.)	**Operating Pressure Low** kPa (psi)	**Length** mm (in.)	**Max. Lateral Offset** mm (in.)	**Operating Pressure Medium** kPa (psi)	**Length** mm (in.)	**Max. Lateral Offset** mm (in.)
20 (¾")	1,793 (260)	450 (18”)	63 (2-½")	2,944 (427)	450 (18”)	88 (3-½")
25 (1")	1,717 (249)	450 (18”)	56 (2-¼“)	2,434 (353)	450 (18”)	75 (3")
32 (1-¼")	1,689 (245)	450 (18”)	44 (1-¾")	2,117 (307)	450 (18”)	56 (2-¼“)
40 (1-½")	1,413 (205)	600 (24”)	88 (3-½")	1,841 (267)	450 (18”)	50 (2”)
50 (2")	992 (144)	600 (24”)	81 (3-¼")	1,517 (220)	600 (24”)	94 (3-¾")
65 (2-½")	972 (141)	600 (24”)	50 (2")	1,241 (180)	600 (24”)	75 (3”)
80 (3")	1,193 (173)	450 (18”)	50 (2")	1,586 (230)	300 (12”)	19 (¾")
100 (4")	965 (140)	450 (18”)	38 (1-½")	1,586 (230)	450 (18”)	32 (1-¼")
150 (6")	875 (127)	600 (24”)	50 (2")	1,586 (230)	450 (18”)	22 ($^{7}/_{8}$”)

Size I.D. mm (in.)	**Operating Pressure Low** kPa (psi)	**Length** mm (in.)	**Max. Lateral Offset** mm (in.)	**Operating Pressure Medium** kPa (psi)	**Length** mm (in.)	**Max. Lateral Offset** mm (in.)
200 (8")	875 (127)	600 (24")	38 (1-½")	992 (144)	600 (24")	32 (1-¼")
250 (10")	738 (107)	600 (24")	32 (1-¼")	889 (129)	600 (24")	28 (1-$^{1}/_{8}$")
300 (12")	738 (107)	600 (24")	25 (1")	717 (104)	600 (24")	22 ($^{7}/_{8}$")

2.2.4 When bellows type expansion joints are used:

2.2.4.1 For pipes DN100 (4") and smaller provide two-ply stainless steel bellows type expansion compensator complete with anti-torque device, limit stops, internal guides with male IPT ends (Flexonics Type H). For copper pipes, two-ply bronze bellows (Flexonics Type HB) may be used.

2.2.4.2 For pipes DN150 (6") and larger provide single or double externally pressurized type expansion joints (Flexonics Type SX/NDX) with multiply 304 S.S. bellows, self-draining steel shell, integral guide ring, cover and liner. Expansion joint to be leakproof packless type, and maintenance-free. The joint shall be used to compensate for axial movement only.

2.2.5 Grooved end expansion joints:

2.2.5.1 For pipe sizes DN50 (2”) through DN150 (6”) provide a packless, gasketed, telescoping expansion joint consisting of a carbon steel body and slide section, and Victaulic couplings. Slide section to be coated with PTFE modified PPS coating. Joint shall be suitable for axial end movement up to 88.9mm (3”). Victaulic Mover Style 150.

2.2.5.2 For pipe sizes DN20 (3/4”) through DN300 (12”) provide a joint consisting of a series of grooved end pipe spools joined in tandem with Victaulic Style 77 couplings. (The number of nipples/couplings dependent on the movement required.) Victaulic Style 155.

2.2.6 All-directional acoustical pipe anchors shall consist of two sizes of steel tubing separated by a minimum 12mm (1/2") thickness of 60 duro or softer neoprene. Vertical restraint shall be provided by similar material arranged to prevent up or down vertical travel. Allowable loads on the isolation material shall not exceed 3.45

N/mm^2 (500 psi) and the design shall be balanced for equal resistance in any direction. All-directional anchors shall be Mason Type ADA.

2.2.7 Pipe guides shall consist of a telescopic arrangement of two sizes of steel tubing separated by a minimum 12mm (1/2") thickness of 60 durometer or softer neoprene. The height of the guides shall be preset with a shear pin to allow vertical motion due to pipe expansion or contraction. Guides shall be capable of ∀40mm (1-5/8") motion, or to meet location requirements. Pipe guides shall be Mason Type VSG.

2.2.8 Thrust restraint shall consist of a modified Type A spring mounting. Restraint springs shall have the same deflection as the isolator springs. The assembly shall be pre-set at the factory and fine-tuned in the field to allow for a maximum of 6mm (1/4") movement from stop to maximum thrust. The assemblies shall be furnished with rod and angle brackets for attachment to both the equipment and duct work or the equipment and the structure. Restraints shall be attached at the center line of thrust and symmetrically on both sides of the unit. Horizontal, vertical and diagonal thrust restraints shall be Mason Type WB.

2.2.9 Wall, floor and ceiling acoustical seals shall be split seals consisting of pipe halves with minimum 20mm (3/4") thick neoprene sponge cemented to the inner faces. The seal shall be tightened around the pipe to eliminate clearance between the inner sponge face and the piping. Concrete may be packed around the seal to make it integral with the floor, wall or ceiling if the seal is not in place prior to the construction of the building member. Seals shall project a minimum of 25mm (1") past either face of the wall. Where temperatures exceed 115°C (240°F), 160 kg/m3 (10 lb) density fiberglass may be used in lieu of the sponge. Seals shall be Mason Type SWS.

3 EXECUTION

3.1 GENERAL

3.1.1 Install compensators in accordance with manufacturer's written instructions. Compensators must not cause any change or position of equipment or piping resulting in piping stresses or misalignment.

3.2 EXPANSION COMPENSATION

3.2.1 Provide all necessary expansion joints or loops to control all piping movement without imposing undue stress onto structure, apparatus, or piping systems.

3.2.2 All compensators shall be installed on the equipment side of the shut off valves.

3.2.3 Where possible, use loops or swing joints. Where loops or swing joints cannot be used due to space limitations and where shown, provide a manufactured expansion joint in accordance with the manufacturer's instructions, complete with all the necessary anchors and guides.

3.2.4 For water systems with grooved joints, use adequate numbers of Victaulic Style 77 or 177H flexible couplings in header piping to accommodate thermal growth and contraction, and elimination or reduction of expansion loops. Where expansion loops are required, use Victaulic Style 77 or 177H couplings on the loops.

3.2.5 In all branch piping to radiation, perimeter units, booster coils, unit heaters, cabinet unit heaters and risers, provide swing joints or braided hose connectors. Provide braided hose type in all connection joints in all connections to equipment where shown in the Contract Documents.

3.2.5.1 Three (3) Victaulic Style 77 or 177H flexible couplings may be used in equipment drops in lieu of braided-hose flexible connectors for stress relief and vibration attenuation. The couplings shall be placed in close proximity to the source of the vibration.

3.2.6 Where braided hose type connectors are installed, anchor or guide pipes to eliminate all weight onto connectors. Use braided hose type joints for lateral movement only. Select the length of hose to manufacturer's instructions.

3.2.7 For bellows type expansion joints adjust end fittings to suit pipe application.

3.2.8 Until all pressure leakage tests are complete in all piping systems, install steel spools instead of flexible connections.

3.3 MANUFACTURER'S REVIEW

3.3.1 On completion of installation of all expansion compensation devices herein specified, the manufacturer shall inspect the completed system, and report in writing any installation error,

improperly selected devices, or other faults in the system that could affect the performance of the system. A written report shall be submitted outlining corrective work necessary to comply with the above specifications. Corrective work shall be the responsibility of the respective installing Subcontractor (Division 21, 22 or 23).

END OF SECTION

Project Name: *UNIVERSITY OF TORONTO MISSISSAUGA*
Project No.: *2023-0059*
Section Name: ***Meters and Gauges***
Section No.: ***20 05 19***
Date: *November 15, 2024*

INDEX

1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools, equipment, training, and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 Temperature gauges

1.2.1.2 Pressure gauges

1.3 SHOP DRAWINGS

1.3.1 Submit Shop Drawings for the following equipment:

1.3.1.1 Temperature gauges

1.3.1.2 Pressure gauges

2 **PRODUCTS**

2.1 TEMPERATURE GAUGES

2.1.1 Provide thermometers of 229mm (9") straight shank, immersion type, with red liquid fill and adjustable pivot, installed complete with non-ferrous separable well. Provide 150mm (6") long extension neck socket for insulated pipes. Thermometers with plastic case are not acceptable.

2.1.2 Select all thermometers to suit the expected range of temperatures of the medium and ensure that normal working temperature occurs approximately at mid scale.

2.2 GAUGE GLASSES

2.2.1 Provide gauge glasses on all liquid reservoirs, normally not completely filled.

2.2.2 Provide fail-safe type gauge glasses with shut off valve, ball check, flushing facilities, and white enamelled brass backplates, suitable for the intended service.

2.2.3 Provide gauge glasses complete with tri cocks. Extend tank gauge glasses the full tank height, if necessary through use of multiple gauge glasses in staggered arrangement.

2.3 PRESSURE GAUGES

2.3.1 Provide pressure gauges of the Bourdon type, minimum one percent accuracy through the entire range, complete with bronze Bourdon tube, brass socket, brass rotary movement, bronze bushings, tube and movement independently mounted from case, stainless steel case and ring, inherent shock protection. Furnish gauges having 114mm (4-½") dial, black graduations, black case, silver brazed joints, and adjustable black pointer.

2.3.2 Select gauges to suit fluid working pressure and, if possible, test pressure. If test pressure falls outside safe instrument range, attach a note to this effect on the installation instructions. Ensure that the normal working pressure occurs approximately at mid scale.

2.3.3 Install each gauge complete with DN6 (1/8") or DN8 (¼") bar stock valve, rated 150°C (300°F) and 6,895 kPa (1,000 psi). Provide pressure snubber on all pump services and coil syphon for steam, air, gas service. Install pressure gauges as noted.

2.3.4 Provide a valved and capped gauge connection at inlet and discharge of all coils and tube bundles in heat exchangers.

2.3.5 Submit a schedule in shop drawing form showing service, location, range, make, and catalogue number for gauges.

3 **EXECUTION**

3.1 PRESSURE GAUGES

3.1.1 Install pressure gauges in the following locations and where shown or specified in the Contract Documents.

3.1.1.1 Suction and discharge of all pumps.

3.1.1.2 High and low sides of all pressure reducing or regulating stations (water, steam, air).

3.1.1.3 Where shown

3.1.2 Provide valved and capped gauge connection at:

3.1.2.1 Entering and leaving side of heat exchangers.

3.1.2.2 Entering and leaving side of heating water coils in air supply units.

3.1.2.3 Supply and return lines of condenser, chilled, and heating water systems at each branch.

3.1.2.4 Where shown.

3.2 THERMOMETERS

3.2.1 Thermometers to be installed with thermal paste to ensure accurate reading.

3.2.2 Install thermometers in the following locations and where shown or specified:

3.2.2.1 Entering and leaving sides of all condenser, chilled, and hot water coils in air supply units.

3.2.2.2 Return lines of main branches of heating, chilled, and condenser water systems.

3.2.2.3 Entering and leaving sides of mixing valves.

3.2.2.4 Supply and return lines at hot water boilers.

3.2.2.5 Supply and return lines on primary heating water loops.

3.2.2.6 Entering and leaving lines of heat exchangers.

3.2.2.7 Where shown in the Contract Documents.

END OF SECTION

Project Name: *UNIVERSITY OF TORONTO MISSISSAUGA*
Project No.: *2023-0059*
Section Name: ***Bases, Hangers and Supports***
Section No.: ***20 05 29***
Date: *November 15, 2024*

INDEX

1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SHOP DRAWINGS

1.2.1 Provide Shop Drawings for:

1.2.1.1 Hangers and supports

2 **PRODUCTS**

2.1 PIPE ATTACHMENTS

2.1.1 For pipe attachments, review Specification Section 20 07 00 - Mechanical Insulation. Otherwise, adhere to the following:

2.1.1.1 For uninsulated fire servicing piping – ULC and FM approved -, use Taylor Fig. 41 swivel ring hanger.

2.1.1.2 For uninsulated steel pipes, use Taylor Fig. 22Z adjustable clevis up to and including 100mm (4") pipe size, and Taylor Fig. 24 adjustable clevis for sizes 125mm (5") and larger.

2.1.1.3 For uninsulated copper pipes, use Taylor Fig. 52 epoxy coated copper-gard clevis hanger up to and including 100mm (4") pipe size.

2.1.1.4 For uninsulated copper tubing, use Taylor Fig. 43 epoxy coated copper-gard swivel ring hanger up to and including 25mm (1") pipe size.

2.1.1.5 For insulated pipes where the insulation is around the hanger and continuous vapour barrier is not required, use the same hangers as for uninsulated pipes.

2.1.1.6 For insulated pipes where hanger is around insulation, provide galvanized sheet metal insulation shield minimum 250mm (10") long, 1.3mm (18 gauge), between covering and Taylor Fig. 22Z or Fig. 24 clevis, or Taylor Fig. 24L extended clevis, sized to include insulation.

2.2 UPPER ATTACHMENTS

2.2.1 Provide upper attachments as follows:

2.2.1.1 Standard beam clamp for normal service, Taylor Fig. 425.

2.2.1.2 Top beam clamp Taylor Fig. 407.

2.2.1.3 C clamp with locknut, Taylor Fig. 301.

2.2.1.4 Side beam bracket for light duty side mounting, Taylor Fig. 120.

2.3 PIPE SUPPORT

2.3.1 For vertical adjustment of hanger rods, provide Taylor Fig. 68 forged steel turnbuckle.

2.3.2 Where trapeze hanger is used for a group of pipes, use Taylor Fig. 14 U bolts, except where roller type hanger is indicated on the drawings or in the specifications.

2.3.3 For roller type hangers on both hot and cold pipes, provide Taylor Fig. 70 to 75 protection saddles to suit covering thickness. Use Taylor Fig. 93 adjustable roller hanger for pipe sizes up to and including 150mm (6") over insulation. For pipes 200mm (8") and larger over insulation, use Taylor Fig. 95 adjustable 2-rod roller hanger. On trapeze hangers and where pipe is supported from below, use Taylor Fig. 280S adjustable pipe roller stand.

2.3.4 For vertical pipe support, provide Taylor Fig. 82Z zinc plated steel riser clamp for steel pipe, and Taylor Fig. 85 epoxy coated copper-gard riser clamp for copper pipe.

2.3.5 For guides on vertical pipes, use manufactured pipe alignment guides (e.g. Flexonics). For horizontal pipes, use Taylor Fig. 255 pipe alignment guide. Field fabricated guides with rolled T-section welded to the pipe and guiding shoe, are also acceptable.

3 EXECUTION

3.1 GENERAL

3.1.1 Provide supports required for the erection and support of the mechanical work. Construct supports of steel, masonry or concrete, as noted or required. Ensure that steel supports in contact with water or high humidity are galvanized members bolted together using cadmium plated bolts, all others primed steel.

3.1.2 Ensure that housekeeping pads or concrete bases are provided for

floor mounted equipment. Make the minimum size, 100mm (4") high for bases or pads, keyed to the floor slab, extending at least 100mm (4") all around the equipment, with 19mm (¾) chamfered edges. Where concrete is provided by Division 03 – Concrete, provide all anchor bolts and setting templates to Division 03 – Concrete.

3.1.3 Support suspended equipment from the bottom. Support tanks and other equipment with cast or welded steel saddles having proper curvature and inherent beam strength. Support plenums and sheet metal type air-handling units from auxiliary frames or beams under equipment. Support fans from structural steel frames with steel base plate. Read Division 05 – Metals, for further information.

3.1.4 Provide supports and suspended bases having ample strength to safely carry the load under all operating conditions and during testing. Submit support and base details to the Consultant for review. Design supports except springs with a minimum factor of safety of five (5) based on ultimate tensile strength at operating temperature.

3.1.5 Ensure that the load onto structures does not exceed the maximum loading as shown on structural drawings or as directed by the Consultant.

3.1.6 Take special care in locating hangers and supports to avoid introduction of undue reaction forces onto the structure of the building, to flanges of pumps and equipment, to expansion joints and to the pipe.

3.1.7 Install all piping supported from hangers or supports in a manner to ensure that building construction is not weakened or over-stressed, that pipes are secure, vibration free, free to expand and contract and properly graded, and that vertical adjustment of horizontal piping is possible after erection.

3.2 <u>HANGERS</u>

3.2.1 For structure attachments, adhere to the following:

3.2.1.1 Support hangers directly from the structure only. Do not support pipes or equipment from other pipes, ducts, equipment, suspended ceiling, etc.

3.2.1.2 Suspend hanger rods generally from certified inserts in concrete or

by beam clamps. Before welding to steel structure members obtain prior permission of welding method from the Consultant and ensure that loads do not exceed the limit set by the Consultant. Ensure that hanging from floors and roofs made from pre-cast concrete members is from inserts originally cast into the members and provided by this contractor, or by rods passing between the members connected to a steel plate resting on the upper surface.

3.2.2 Sliding guides must have sliding surfaces cleaned of all dirt, paint or corrosion and, except for Teflon, have coating of graphite paste added during erection. Adjust guides to allow for free sliding at operating conditions. After assembly, provide these guides with temporary protective cover or wrapping added to keep them free of debris during extent of construction work. When piping is ready to be put into service, remove this protective covering, blow out guides clean of all debris and add paste where applicable. Care must be taken that ample clearance is provided so as not to obstruct free sliding of guide.

3.2.3 Install copper, brass, and stainless steel pipes with 3mm ($^1/_8$") thickness of di-electric packing between the pipe and the pipe attachment or use Taylor plastic coated pipe attachments.

3.2.4 Install guides on pipes with expansion movement next to expansion joints. Consult expansion joint manufacturer's recommendations and follow their instructions for number and spacing of guides. Use a minimum of two guides on each side of expansion joints.

3.2.5 Set hanger rods on steel and copper lines with expansion movement out of plumb in ambient temperature position, a distance equal to one-half pipe movement calculated from anchor point. Base movement on 25mm (1") expansion per 30m (100 ft) of pipe length and 37°C (67°F) temperature difference. Use toggle type insert of beam clamp for such locations.

3.2.6 Use roller type hanger only where shown on the drawings.

3.2.7 Install all hangers close to points where pipes change direction or where branch piping drops or rises from main.

3.2.8 Install vertical riser suitably anchored and guided with manufactured or fabricated guides to maintain accurate vertical position. Protect insulated pipes with 2.2mm (12 gauge) galvanized steel jacket at guides. Guide pipes with expansion movement and definite anchor points up to and including 100mm

(4") sizes, at every floor or 3m (10 ft). Guide larger pipes and vertical cast iron pipes at every second floor or 7.5m (25 ft).

3.2.9 For horizontal cast iron, glass, or polypropylene pipes where packed or friction type mechanical joints are used, provide a support at every joint in straight runs with maximum 1.5m (5 ft) between supports. Where fittings are joined together (elbows, wyes, etc.) provide a separate support for a minimum of every second fitting.

3.2.10 For horizontal cast iron, pipes where screwed or bolted type joints are used, the spacing or supports may be increased not to exceed 2.4m (8 ft) between supports, but provide a support for every joint and every second fitting as described above.

3.2.11 Use lockwasher with single nut on all bolted connections for pipe supports, anchors, guides and support steel, or use double nuts.

3.2.12 During hydrostatic test on all air and vapour piping supported by springs or counterweights, install temporary rigid supports, blocking, etc., or lock the spring against movement to prevent excessive strain on piping or equipment.

3.2.13 Use spring hangers where vertical movement of the horizontal pipes may occur due to expansion or contraction. Refer to Sections 20 05 16 – Expansion Compensation and 20 05 48 – Vibration Isolation, for further information.

3.2.14 For rod hangers use round steel threaded rod supports on horizontal pipes, spaced at the following maximum intervals and having the minimum diameter as directed.

3.2.14.1 For Steel Pipes:

Pipe Diameter mm (in)	**Horizontal Spacing of Supports mm (ft)**	**Single Rod Diameter mm (in)**	**Double Rod Diameter mm (in)**
DN15 (½)	1,524 (5)	9 (3/8)	9 (3/8)
DN20 (¾)	1,829 (6)	9 (3/8)	9 (3/8)
DN25 (1)	2,134 (7)	9 (3/8)	9 (3/8)

Pipe Diameter mm (in)	Horizontal Spacing of Supports mm (ft)	Single Rod Diameter mm (in)	Double Rod Diameter mm (in)
DN32 (1-¼)	2,438 (8)	9 (3/8)	9 (3/8)
DN40 (1-½)	2,743 (9)	9 (3/8)	9 (3/8)
DN50 (2)	3,048 (10)	9 (3/8)	9 (3/8)
DN65 (2-½)	3,048 (10)	13 (½)	9 (3/8)
DN80 (3)	3,658 (12)	13 (½)	9 (3/8)
DN100 (4)	4,268 (14)	16 (5/8)	13 (½)
DN125 (5)	4,877 (16)	16 (5/8)	13 (½)
DN150 (6)	5,182 (17)	19 (¾)	16 (5/8)
DN200 (8)	5,791 (19)	22 (7/8)	19 (¾)
DN250 (10)	6,706 (22)	22 (7/8)	19 (¾)
DN300 (12)	7,010 (23)	22 (7/8)	19 (¾)
DN375 (15) and over	max. 7,620 (25)	to suit weight	to suit weight

3.2.14.2 For Copper or Stainless Steel Tubing:

Pipe Diameter mm (in)	Horizontal Spacing of Supports mm (ft)	Single Rod Diameter mm (in)	Double Rod Diameter mm (in)
DN15 (½)	1,524 (5)	9 (3/8)	9 (3/8)
DN20 (¾)	1,829 (6)	9 (3/8)	9 (3/8)
DN25 (1)	1,829 (6)	9 (3/8)	9 (3/8)
DN32 (1-¼)	2,134 (7)	9 (3/8)	9 (3/8)
DN40 (1-½)	2,438 (8)	9 (3/8)	9 (3/8)
DN50 (2)	2,743 (9)	9 (3/8)	9 (3/8)

Pipe Diameter mm (in)	Horizontal Spacing of Supports mm (ft)	Single Rod Diameter mm (in)	Double Rod Diameter mm (in)
DN65 (2-½)	3,048 (10)	13 (½)	9 (3/8)
DN80 (3)	3,048 (10)	13 (½)	9 (3/8)
DN100 (4)	3,658 (12)	16 (5/8)	13 (½)

3.2.15 Do not use pipe hooks, chains, or perforated straps.

3.2.16 Use angle or channel iron welded frames for trapeze hangers.

3.2.17 For all drain pipe installed under structural slab on disturbed soil (up fill), suspend piping via galvanized clevis hangers embedded in structural slab. Hanger spacing shall be per pipe manufacturer recommendations, with minimum of two (2) hangers per pipe length.

3.3 ANCHORS

3.3.1 Design pipe anchors to restrain the movement of pipes in all directions.

3.3.2 Take special care in locating anchors to avoid introduction of undue reaction forces into the structure of the building, to flanges of pumps and equipment, to expansion joints and to the pipe.

3.3.3 Fabricate anchors and guides of structural steel channels, angles or plates secured to building structure. Size cylindrical type guides for full pipe insulation.

3.3.4 Submit for review by the Consultant prior to installation, a detailed design prepared in conjunction with the expansion joint manufacturer for anchors, guides, and their proposed connection to the structure, including reaction forces and loads imposed on structure. All Drawings must be signed by a Professional Engineer registered in the Province of Ontario. Do not proceed with installation until after receipt of reviewed drawings.

3.4 DUCT SUPPORT

3.4.1 Provide all foundations and supports required for the proper

erection of the ductwork. Use concrete, masonry, and steel as specified, shown or required. Provide lightweight concrete fill around buried ductwork.

3.4.2 Co-operate with Division 03 – Concrete and Division 05 – Metals, and co-ordinate the work under this Division with those Divisions to ensure that opening required in floors, walls and partitions for the ducts are provided in the exact location required.

3.4.3 Where possible, use beam clamps, pre-set sleeves, and inserts for attachment to or passage through work under other Divisions. Do not weld to or cut into the work of other Specification Sections unless with the special permission of the Consultant.

3.4.4 Where vibration mountings are required, make necessary provisions in accordance with the recommendations of the equipment manufacturer. Refer to Sections 20 05 16 – Expansion Compensation and 20 05 48 – Vibration Isolation, for further information.

3.4.5 Install ducts securely supported from hangers or supports, in a manner to ensure that building construction is not weakened or over-stressed, that ducts are secure, free of vibration, free to expand and contract and properly graded.

3.4.6 Bolt steel frames to galvanized steel ducts. Rivet aluminum frames to aluminum ducts. Bolt steel frames to soldered lugs on copper ducts. Use di-electric gaskets. Bolt steel frames to welded lugs on stainless steel ducts.

3.4.7 Extend angles 50mm (2") to either side of ducts. For no-ferrous ducts, use di-electric gasket between duct and support. For additional stainless steel ducts use supports not directly attached to the duct. For watertight ducts, use supports not attached to the duct.

3.4.8 Support vertical ducts as follows:

3.4.8.1 Support vertical ducts in duct shafts at the top and the bottom of the shafts and at every floor in between. Supply auxiliary steel structural steel, sized as required.

3.4.8.2 Support other vertical ducts at the passage through every floor.

3.4.9 Support round and oval ducts using a 38mm by 3mm (1-½" x $^{1}/_{8}$") split ring bolted at each end, extending minimum 75mm (3") on

each side.

3.4.10 Support rectangular ducts using a bolted or tack welded frame on 38mm by 38mm by 3mm (1-½" x 1-½" x $^{1}/_{8}$") angle steel.

3.4.11 In T-bar ceilings, attach diffusers connected to flexible duct directly to the ceiling suspension system main runners. Use this method for diffusers or mechanical items weighing less than 9 kg (20 lbs.). Support diffusers or equipment weighing more than 9 kg (20 lbs.) directly from the roof or floor.

3.5 EQUIPMENT SUPPORT

3.5.1 Place all suspended equipment on welded steel bases of up to 150mm (6") profile steel, stiffened with 3mm ($^{1}/_{8}$") checkered steel plate. Co-ordinate with Division 05 – Metals.

3.5.2 Place floor plates on 100mm (4") concrete housekeeping pads. Ensure that the load on the structure does not exceed 488 kg per square meter (100 lbs. per square feet) projected floor area within the perimeter of the supports.

END OF SECTION

INDEX

1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools equipment, training commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 All necessary vibration isolation elements for piping and equipment, and vibration isolation bases for equipment to prevent noise levels from exceeding the room criteria listed in Table 1, Chapter 48 of the ASHRAE 2011 HVAC Applications Handbook.

1.2.2 Manufacturer of vibration isolation equipment shall have the following responsibilities:

1.2.2.1 Determine vibration isolation sizes and locations.

1.2.2.2 Provide piping and equipment isolation systems as scheduled or specified in the Contract Documents.

1.2.2.3 Guarantee specified isolation system deflection.

1.2.2.4 Provide installation instructions, drawings, and field supervision to assure proper installation and performance.

1.2.3 In addition to the work of this Section, comply with description of individual systems and general requirements of all other Specification Sections of this Division.

1.3 SUBMITTALS

1.3.1 The Contractor shall supply to the manufacturer approved drawings of all equipment to be isolated.

1.3.2 The manufacturer shall supply shop drawings of all vibration control components to be used on the project.

1.3.3 As a minimum provide the following information:

1.3.3.1 Catalogue cuts and data sheets on specific vibration isolators to be utilized showing compliance with the specifications.

1.3.3.2 An itemized list showing the items of equipment or piping to be isolated, the isolator type of model number selected, isolator loading and deflection, and reference to specific drawings showing base and construction where applicable.

1.3.3.3 Grooved joint couplings and fittings shall be shown on drawings and product submittals, and shall be specifically identified with the applicable style or series designation.

1.3.3.4 Written approval of the base design to be used, obtained from the equipment manufacturer.

1.3.3.5 Drawings showing equipment base constructions for each machine, including dimensions, structural member sizes and support point locations.

1.3.3.6 Drawings showing methods for isolation of pipes and ductwork piercing walls and slabs.

1.3.4 Submit letter from manufacturer certifying that vibration isolation equipment have been installed in accordance with their recommendations and the Contract Documents, and that it operates to their satisfaction.

1.4 QUALITY ASSURANCE

1.4.1 It is the objective of this Specification Section to provide the necessary design for the control of excessive noise and vibration in the Building due to the operation of machinery or equipment, and/or due to interconnected piping, ductwork, or conduit. The installation of all vibration isolation units, and associated hangers and bases, shall be under the direct supervision of the vibration isolation manufacturer's representative.

1.4.2 All vibration isolators shall have either known undeflected heights or calibration markings so that, after adjustment, when carrying their load, the deflection under load can be verified, thus determining that the load is within the proper range of the device and that the correct degree of vibration isolation is being provided according to the design.

1.4.3 All isolators shall operate in the linear portion of their load versus deflection curve. Load versus deflection curves shall be furnished by the manufacturer and must be linear over a deflection range of not less than 50% above the design deflection.

1.4.4 The theoretical vertical natural frequency for each support point, based upon load per isolator and isolator stiffness, shall not differ from the design objectives for the equipment as a whole by more than "10%.

1.4.5 All neoprene mountings shall have a Shore hardness of 30 to 60 "5, after minimum aging of 20 days or corresponding oven-aging.

1.4.6 All grooved joint couplings and specialties shall be the products of a single manufacturer.

2 PRODUCTS

2.1 GENERAL

2.1.1 All vibration isolation devices shall be the product of a single manufacturer.

2.2 TYPE A SPRING ISOLATORS

2.2.1 Spring isolators shall be free standing and laterally stable without any housing and complete with a molded neoprene cup or 6mm (1/4") neoprene acoustical friction pad between the baseplate and the support. All mountings shall have leveling bolts that must be rigidly bolted to the equipment. Installed and operating heights shall be equal. The ratio of the spring diameter divided by the compressed spring height shall be no less than 0.8. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection.

2.2.2 Corrosion resistance where exposed to corrosive/outdoor environment shall be with:

2.2.2.1 Springs neoprene coated.

2.2.2.2 Hardware cadmium plated.

2.2.2.3 All other metal parts hot-dip galvanized.

2.2.3 Designed and installed so that ends of springs remain parallel.

2.2.4 Non-resonant with equipment forcing frequencies or support structure natural frequencies.

2.2.5 Submittals shall include spring diameters, deflection, compressed spring height and solid spring height.

2.2.6 Type A spring isolators to be Mason Type SLF.

2.3 TYPE B SPRING ISOLATORS

2.3.1 Isolators shall be same as Type A, except:

2.3.1.1 Provide built-in resilient vertical limit stops.

2.3.1.2 All restraining bolts shall have large rubber grommets to provide cushioning in the vertical as well as horizontal modes. The hole through the bushing shall be a minimum of 20mm (0.75") larger in diameter than the restraining bolt. Horizontal clearance on the sides between the spring assembly and the housing shall be a minimum of 12mm (0.5") to avoid bumping and interfering with the spring action. Vertical limit stops shall be out of contact during normal operation.

2.3.1.3 Provide tapped holes in top plate for bolting to equipment.

2.3.1.4 Isolators shall be capable of supporting equipment at a fixed elevation during equipment erection.

2.3.2 Housings and springs shall be powder coated and hardware electro-galvanized.

2.3.3 Type B spring isolators to be Mason Type SLR.

2.4 TYPE C SPRING HANGER ROD ISOLATORS

2.4.1 Hangers shall be manufactured with minimum characteristics as Type A isolators, but without the neoprene element:

2.4.1.1 Springs are seated in a steel washer reinforced neoprene cup that has a neoprene bushing projecting through the bottom hole to prevent rod to hanger contact.

2.4.1.2 Spring diameters and the lower hole sizes shall be large enough to allow the hanger rod to swing through a 30° arc from side to side before contacting the cup bushing.

2.4.1.3 If ducts are suspended by flat strap iron, the hanger assembly shall be modified by the manufacturer with an eye on top of the box and on the bottom of the spring hanger rod to allow for bolting to the hanger straps.

2.4.2 Submittals on either of the above hangers shall include a scaled drawing of the hanger showing the 30° capability.

2.4.3 Where operating weight differs from installed weight provide built-in adjustable limit stops to prevent equipment rising when weight is removed. Stops shall not be in contact during normal operation.

2.4.4 Type C spring hanger rod isolators to be Mason Type 30 or for straps W30.

2.5 TYPE D ELASTOMETER MOUNTING TYPES

2.5.1 Neoprene mountings shall have a minimum static deflection of 9mm (0.35"). All metal surfaces shall be oil-resistant neoprene covered and have friction pads both top and bottom. Bolt holes shall be provided on the bottom and a tapped hole and cap screw on top. Steel rails shall be used above the mountings under equipment such as small vent sets to compensate for the overhang.

2.5.2 Neoprene to be compounded to hardness no greater than 70 durometer.

2.5.3 Mounts to have straight line deflection curve.

2.5.4 Type D elastomer isolators to be Mason Type ND.

2.6 TYPE E ELASTOMETER HANGER ROD ISOLATORS

2.6.1 Isolators shall incorporate a moulded unit type neoprene element and steel retainer box encasing the neoprene mounting.

2.6.2 Neoprene to be compounded to hardness no greater than 70 durometer.

2.6.3 Isolator to have sufficient clearance between mounting hanger rod and steel retainer box.

2.6.4 Type E hanger rod isolators to be Mason Type HD.

2.7 TYPE F PAD TYPE ELASTOMETER MOUNTINGS

2.7.1 Elastomer pads to incorporate the following:

2.7.1.1 20mm ($^3/_4$") minimum thickness per layer of pad.

2.7.1.2 Suitable top bearing plate provided to uniformly distribute load.

2.7.1.3 Ribbed or waffled design.

2.7.1.4 15% deflection.

2.7.1.5 Standard neoprene with moderate oil-resistance, compounded to hardness no greater than 70 durometer.

2.7.1.6 1.6mm (16 ga.) galvanized steel plate between multiple layers of pad thickness.

2.7.1.7 Bolts through equipment and pad shall be oversized and provided with resilient washers and bushings.

2.7.2 Type F pad to be Mason Type Super W.

2.8 TYPE G PAD TYPE ELASTOMETER MOUNTINGS

2.8.1 Elastomer pads to incorporate the following:

2.8.1.1 High quality bridge bearing neoprene.

2.8.1.2 3mm ($^1/_8$") deflection.

2.8.1.3 Maximum loading 6,895 kPa (1000 psi).

2.8.1.4 Suitable bearing plate to distribute load.

2.8.1.5 Minimum thickness 25mm (1").

2.8.2 Type G pad to be Mason Type BBNR.

2.9 TYPE H COMBINATION SPRING/ELASTOMETER HANGER ROD ISOLATORS

2.9.1 Hangers shall consist of rigid steel frames containing minimum 32mm (1-1/4") thick neoprene elements at the top and a steel spring with general characteristics as described in Type C, seated in a steel washer reinforced neoprene cup on the bottom. The neoprene element and the cup shall have neoprene bushings projecting through the steel box. In order to maintain stability the boxes shall not be articulated as clevis hangers nor the neoprene element stacked on top of the spring. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30° arc from side to side before contacting the cup bushing and short circuiting the spring.

2.9.2 Neoprene to be compounded to hardness no greater than 70 durometer.

2.9.3 Submittals shall include a hanger drawing showing the 30° capability.

2.9.4 Type H isolator to be Mason Type 30N.

2.10 INTEGRAL STRUCTURAL STEEL BASE, TYPE B-1

2.10.1 Base to be reinforced as required to prevent base flexure at start-up and misalignment of drive and driven units. Rectangular bases are preferred for all equipment. Centrifugal refrigeration machines and pump bases may be T or L shaped. Pump bases for split case pumps shall be large enough to support suction and discharge elbows. Centrifugal fan bases to be complete with motor slide rails, drilled for drive and driven unit mounting template.

2.10.2 All perimeter members shall be steel beams with a minimum depth equal to 1/10 of the longest dimension of the base. Base depth need not exceed 350mm (14") provided that the deflection and misalignment is kept within acceptable limits as determined by the manufacturer. Height saving brackets shall be employed in all mounting locations to provide a base clearance of 25mm (1").

2.10.3 Type B-1 base to be Mason Type WF.

2.11 CONCRETE INERTIA BASE, TYPE B-2

2.11.1 Concrete inertia bases shall be formed in a structural steel perimeter base, reinforced as required to prevent flexure, misalignment of drive and driven unit or stress transferal into equipment.

2.11.2 The base shall be complete with motor slide rails, pump base elbow supports, and complete with equipment bolting provisions and isolators. Bases shall be a minimum of 1/12 of the longest dimension of the base but not less than 150mm (6"). The base depth need not exceed 300mm (12") unless specifically recommended by the base manufacturer for mass or rigidity. Forms shall include minimum concrete reinforcing consisting of 12mm (1/2") bars welded in place on 150mm (6") centers running both ways in a layer 40mm (1-1/2") above the bottom. Forms shall be furnished with steel templates to hold the anchor bolt sleeves and anchor bolts while concrete is being poured. Height saving brackets shall be employed in all mounting locations to maintain a 25mm (1") minimum clearance between base and housekeeping pad. Wooden formed bases leaving a concrete rather than a steel finish are not acceptable.

2.11.3 Minimum thickness of the inertia base shall be according to the following tabulation:

Motor Size kW (hp)	Min. Thickness mm (inches)
up to 11 (15)	150 (6)
15-37 (20-50)	200 (8)
45-55 (60-75)	250 (10)
75-185 (100-250)	300 (12)
225-375 (300-500)	400 (16)

2.11.4 Type B-2 inertia base to be Mason Type BMK or K.

2.12 SPRING ISOLATED ROOF CURB, TYPE B-3

2.12.1 Structural roof curb assembly to have a top and bottom frame resiliently connected by spring isolator complying with specification Type A.

2.12.2 The lower member shall consist of a sheet metal Z section containing adjustable and removable steel springs that support the upper floating section. The upper frame must provide continuous support for the equipment and must be captive so as to resiliently resist wind forces. All directional neoprene snubber bushings shall be a minimum of 6mm (1/4") thick. Steel springs shall be laterally stable and rest on 6mm (1/4") thick neoprene acoustical pads. Hardware must be plated and the springs provided with a rust resistant finish. The curb's waterproofing shall consist of a continuous galvanized flexible counter flashing nailed over the lower curb's waterproofing and joined at the corners by EPDM bellows. All spring locations shall have access ports with removable waterproof covers. Lower curbs shall have provision for 50mm (2") of insulation.

2.12.3 Type B-3 curb to be Mason Type RSC.

2.13 MOUNTING TYPES AND STATIC DEFLECTION SCHEDULE

Equipment	Slab on Grade	Suspended Slabs

Type	Category	HP or Other	RPM	Base Type	Isolator Type	Min. Defl. mm (in.)	Base Type	Isolator Type	Min. Defl. mm (in.)
Refrigeration Machines and Chillers	Reciprocating	All	All	(1)	D	6 (¼")	(1)	B	38 (1-½")
	Centrifugal scroll	All	All	(1)	F	6 (¼")	(1)	B	38 (1-½")
	Screw	All	All	(1)	F	25 (1")	(1)	B	64 (2-½")
	Absorption	All	All	(1)	F	6 (¼")	(1)	B	38 (1-½")
	Air-cooled recip, scroll	All	All	(1)	D	6 (¼")	(1)	B	38 (1-½")
	Air-cooled screw	All	All	(1)	B	25 (1")	B-1	B	64 (2-½")
Air Compressors and Vacuum Pumps	Tank-mtd horiz.	≤10	All	(1)	A	19 (¾")	(1)	A	38 (1-½")
		≥15	All	B-2	A	19 (¾")	B-2	A	38 (1-½")
	Tank-mtd vert.	All	All	B-2	A	19 (¾")	B-2	A	38 (1-½")
	Base-mtd	All	All	B-2	A	19 (¾")	B-2	A	38 (1-½")
	Large recip	All	All	B-2	A	19 (¾")	B-2	A	38 (1-½")
Pumps	Close coupled	≤7.5	All	B-1	D	6 (¼")	B-2	A	19 (¾")
		≥10	All	B-2	A	19 (¾")	B-2	A	38 (1-½")
	Inline	5 to 25	All	(1)	A	19 (¾")	(1)	A	38 (1-½")
		≥30	All	(1)	A	38 (1-½")	(1)	A	38 (1-½")
	End suction,	≤40	All	B-2	A	19 (¾")	B-2	A	38 (1-½")
	double suction	50 to 125	All	B-2	A	19 (¾")	B-2	A	38 (1-½")
	split case	≥150	All	B-2	A	19 (¾")	B-2	A	64 (2-½")
	Packaged pump	All	All	(1)	A	19 (¾")	B-2	A	38 (1-½")
Cooling towers	All	All	≤300	(1)	G	6 (¼")	(1)	B	89 (3-½")
			301to500	(1)	G	6 (¼")	(1)	B	64 (2-½")
			≥501	(1)	G	6 (¼")	(1)	B	19 (¾")
Boilers	Fire-tube	All	All	(1)	F	6 (¼")	B-1	B	38 (1-½")
	Water-tube	All	All	(1)	F	3 (1/8")	(1)	F	3 (1/8")
	Steam	All	All	(1)	F	6 (¼")	B-1	B	38 (1-½")
Fans: axial, plenum, cabinet, inline	≤ 22 in dia.	All	All	(1)	D	6 (¼")	B-2	A	19 (¾")
	≥ 24 in dia.	≤2 in SP	≤300	B-1	A	64 (2-½")	B-2	A	89 (3-½")
			301to500	B-1	A	19 (¾")	B-2	A	64 (2-½")
			≥501	B-1	A	19 (¾")	B-1	A	38 (1-½")
		>2 in SP	≤300	B-2	A	64 (2-½")	B-2	A	89 (3-½")
			301to500	B-2	A	38 (1-½")	B-2	A	64 (2-½")
			≥501	B-2	A	19 (¾")	B-2	A	38 (1-½")
Centrifugal fans	≤ 22 in dia.	All	All	B-1	D	6 (¼")	B-1	A	19 (¾")
	≥ 24 in dia.	≤40	≤300	B-1	A	64 (2-½")	B-1	A	89 (3-½")
			301to500	B-1	A	38 (1-½")	B-1	A	64 (2-½")
			≥501	B-1	A	19 (¾")	B-1	A	19 (¾")
		≥50	≤300	B-2	A	64 (2-½")	B-2	A	89 (3-½")
			301to500	B-2	A	38 (1-½")	B-2	A	64 (2-½")
			≥501	B-2	A	25 (1")	B-2	A	38 (1-½")
Propeller	Wall-mounted	All	All	(1)	F	6 (¼")	(1)	F	6 (¼")

fans	Roof-exhauster	All	All	(1)	F	6 (¼")	B-3	B	38 (1-½")
Heat pumps, fan coils, CRAC units	All	All	All	(1)	A	19 (¾")	(1)	A	19 (¾")
Condensing units	All	All	All	(1)	F	6 (¼")	(1)	B	38 (1-½")
AHUs, AC, heating and ventilation units	All All	≤10 ≤15, ≤4 in SP >15, >4 in SP	All ≤300 301to500 ≥501 ≤300 301to500 ≥501	(1) (1) (1) (1) B-1 B-1 B-1	A A A A A A A	19 (¾") 19 (¾") 19 (¾") 19 (¾") 19 (¾") 19 (¾") 19 (¾")	(1) B-2 (1) (1) B-2 B-2 B-2	A A A A A A A	19 (¾") 89 (3-½") 64 (2-½") 38 (1-½") 89 (3-½") 64 (2-½") 38 (1-½")
Packaged RTUs	All	All	All	(1)	G	6 (¼")	B-3	A	19 (¾")
Ducted rotating equipment	Small fans, fan powered boxes	≤600 cfm >600 cfm		(1) (1)	A A	13 (½") 19 (¾")	(1) (1)	A A	13 (½") 19 (¾")
Generators	All	All	All	(1)	A	19 (¾")	B-2	A	64 (2-½")
Heat exchangers, tanks	Plate and frame			(2)	F	3 (1/8")	(2)	F	3 (1/8")
Piping (see specs)	Floor supported Suspended			-	B	25 (1")	- -	B H	25 (1") 32 (1-¼")
Transformer, dry type	Floor mounted Suspended Wall mounted			(2)	D	6 (¼")	(2) (2) (2)	D E D	6 (¼") 6 (¼") 6 (¼")

2.13.1 Notes:

(1) No base, isolator directly attached to equipment.
(2) Base as recommended and/or provided by manufacturer.

3 EXECUTION

3.1 GENERAL

3.1.1 Have all materials and systems for vibration isolation designed and supplied by one company, referred to in this Section as the 'manufacturer'.

3.1.2 Install all products in accordance with manufacturer's written instructions. Vibration isolators must not cause any change or position of equipment or piping resulting in piping stresses or misalignment.

3.1.3 Provide through the manufacturer all vibration isolation equipment work and measures to prevent the transmission of objectionable vibration to the building structure and from one area to another area. Provide all necessary drawings indicating isolator locations and base dimensions. Have the installation directed and supervised by the manufacturer. Supply to the manufacturer the necessary copies of all drawings of equipment to be isolated.

3.1.4 Consider the areas classified as follows for selection of vibration control devices:

3.1.4.1 Mechanical rooms or equipment locations in basement or sub-basement areas only and not bordering areas regularly occupied are ‘non-critical’.

3.1.4.2 Mechanical rooms or equipment locations bordering habitable suites, boardrooms, conference rooms, private offices are ‘ultra-critical’. This shall include all mechanical penthouses and all mechanical compartment rooms.

3.1.5 Vibration isolation is not required for the following equipment between equipment and building only, but provide isolated connection to these for pipes and ducts:

3.1.5.1 Fire pumps

3.1.5.2 Sump pumps, sewage pumps

3.1.6 All piping and ductwork to be isolated shall freely pass through walls and floors without rigid connections. Penetration points shall be sleeved using acoustical sleeves, or otherwise formed to allow passage of piping or ductwork, and maintain 20mm (¾") to 32mm (1-¼") clearance around the outside surfaces. This clearance space shall be tightly packed with fiberglass, and caulked airtight after installation of piping or ductwork.

3.1.7 No rigid connections between equipment and building structure shall be made that degrades the noise and vibration isolation system specified in this Section.

3.1.8 Electrical conduit connections to isolated equipment shall be

flexible to allow free motion of isolated equipment.

3.1.9 Do not install any equipment, piping, or conduit, which makes rigid contact with the building unless permitted in this Specification. Building includes, but is not limited to, slabs, beams, columns, studs, and walls.

3.1.10 Coordinate work with other trades to avoid rigid contact with the building. Inform other trades following work, such as plastering or electrical, to avoid any contact which would reduce the vibration isolation.

3.1.11 Bring to the Consultant's attention prior to installation any conflicts with other trades, which will result in unavoidable rigid contact with equipment or piping as described herein, due to inadequate space or other unforeseen conditions. Corrective work necessitated by conflicts after installation shall be at the responsible contractor's expense.

3.1.12 Obtain inspection and approval of any installation to be covered or enclosed, prior to such closure.

3.1.13 Diagonal restraints shall be attached at the centerline of thrust.

3.1.14 Vertical piping loads, including water strainers, valves between pump base elbow supports and the suction and discharge header piping, shall be supported by the pump base spring isolators without stress or strain to the pump housing.

3.1.15 Correct, at no additional cost, all installations, which are deemed defective in workmanship or materials.

3.2 <u>EQUIPMENT ISOLATORS</u>

3.2.1 Mount floor mounted equipment on 100mm (4") concrete housekeeping pads over complete floor area of equipment. Mount vibration isolating devices and related inertia blocks on concrete pad.

3.2.2 Each fan and motor assembly shall be supported on a single structural steel frame. Provide all ductwork connected to vibration-isolated equipment at both inlet and outlet with flexible connectors having sufficient length and flexibility to eliminate vibration transmission and to not short circuit the effectiveness of the vibration isolation. Make flexible connections of glass fibreglass cloth sleeves, sealed to prevent air leakage. Install a minimum

length of flexible connection on both sides equal to static pressure of the fan in inches but not less than 150mm (6").

3.2.3 The machine to be isolated shall be supported by a structural steel frame or concrete inertia base.

3.2.4 Brackets shall be provided to accommodate the isolator. The vertical position and size of the bracket shall be specified by the isolation manufacturer.

3.2.5 The minimum operating clearance between the equipment frame or rigid steel base frame and the housekeeping pad or floor shall be 25mm (1"). Minimum operating clearance between concrete inertia and base and housekeeping pad or floor shall be 50mm (2").

3.2.6 The equipment structural steel or concrete inertia base shall be placed in position and supported temporarily by blocks or shims, as appropriate, prior to the installation of the machine or isolators.

3.2.7 The isolators shall be installed without raising the machine and frame assembly.

3.2.8 After the entire installation is complete and under full operational load, the isolators shall be adjusted so that the load is transferred from the blocks to the isolators. When all isolators are properly adjusted, the blocks or shims shall be barely free and shall be removed.

3.2.9 Air handling equipment and centrifugal fans shall be protected using horizontal thrust restraints against excessive displacement weight which results from high air thrust when thrust forces exceed 10% of the equipment.

3.2.10 Rooftop equipment isolators must be bolted to the equipment and structure. Mountings must be designed to resist 160 km/h (100mph) wind loads.

3.2.11 Isolation mounting deflection shall be the minimum as specified or scheduled on the Drawings.

3.2.12 Verify that all installed isolator and mounting systems permit equipment motion in all directions. Adjust or provide additional resilient restraints to flexibly limit start-up equipment lateral motion to 6mm (¼").

3.2.13 Prior to start-up, clean out all foreign matter between bases and equipment. Verify that there are no isolation short circuits in the base or isolators.

3.3 PIPING ISOLATORS

3.3.1 All piping isolators are included under this Section.

3.3.2 Where piping connects to mechanical equipment install expansion joints, or stainless hoses if expansion joints are not suitable for the service. All piping passing through the equipment walls, floors or ceilings shall be protected against sound leakage by means of an acoustical seal.

3.3.3 Isolate piping outside the shafts as follows:

3.3.3.1 All water piping in machine rooms, including strainers, filters, valves and associated equipment with water systems.

3.3.3.2 Piping and associated equipment where exposed on roof.

3.3.3.3 Water piping within 12.2m (40 ft) or 100 x pipe diameters, whichever is greater, from connected rotating equipment, using Type H hangers with the same static deflection as specified for the equipment. If piping is connected to equipment located beneath occupied spaces and hangs from ceilings under occupied spaces, the first four hangers shall have a minimum deflection of 20mm (¾") for pipe sizes up to and including 75mm (3"), 40mm (1-1/2") deflection for pipe sizes over 75mm (3") and up to and including 150mm (6”), and 65mm (2-1/2") deflection thereafter.

3.3.4 The isolators shall be installed with the isolator hanger box attached to, or hung as close as possible to, the main structural elements of the building.

3.3.5 The isolators shall be suspended from substantial structural members, not from slab diaphragm unless specifically permitted.

3.3.6 Hanger rods shall be aligned to clear the hanger box.

3.3.7 Horizontal suspended pipe 50mm (2") and smaller and all steam piping shall be suspended by Type E isolator with a minimum 6mm (¼") deflection. Water pipe larger than 50mm (2") shall be supported by Type H isolator with a minimum 32mm (1-½") static deflection.

3.3.8 Horizontal pipe floor supported at slab shall be supported via Type

A or B, with a minimum static deflection of 25mm (1") or same deflection as isolated equipment to which pipe connects whichever is the greater.

3.3.9 All vertical risers shall be supported by spring isolators designed to support the riser filled with water, if it is a water line. Assigned loads must be within the building design limits at the support points. Neutral central resilient anchors shall direct movement up and down. The anchors shall be capable of holding an upward force equal to the water weight when the system is drained. If one level cannot accommodate this force, anchors can be located on two or three adjacent floors. Resilient guides shall be spaced and sized properly depending on the pipe diameter. The initial spring deflection shall be a minimum of 20mm (¾") or four times the thermal movement at the isolator location, whichever is greater. Proper provision shall be made for seismic protection in seismic zones. Support spring mountings shall be Type A, anchors and telescoping guides as described under the Products section.

3.3.10 Pipe sway braces, where required, shall utilize two (2) neoprene elements (type D to accommodate tension and compression forces).

3.3.11 Pipe extension and alignment connectors: Provide connector at riser takeoffs, cooling and heating coils, and elsewhere as required to accommodate thermal expansion and misalignment.

3.4 DUCT ISOLATORS

3.4.1 All air ducts with a cross section of 0.19m^2 (2ft^2) or larger shall be isolated from the building structure by Type C hangers or Type A floor supports with a minimum deflection of 20mm (¾"). Isolators shall continue for minimum 15m (50 ft) from the equipment. If air velocity exceeds 5.3 mps (1000 fpm), hangers or supports shall continue for an additional 15m (50 ft) or as shown on the Drawings

3.5 ISOLATOR POSITION

3.5.1 Close to building structure.

3.5.2 Between building structure and supplementary steel if required.

3.5.3 Suspend isolators from rigid and massive support points.

3.5.4 Supplementary steel to be sized for a maximum deflection of 1.6mm ($^1/_{16}$") at center span.

3.5.5 Support piping in shafts and floor supports entering shaft with Type B isolators or Type H hangers depending on piping loads and support point space conditions within shafts.

3.5.6 Guide piping in shafts as required with approved mounting designs incorporating Mason Type ADA mountings to building. Prevent direct contact of piping with building structure.

3.6 MANUFACTURER'S REVIEW

3.6.1 On completion of installation of all vibration isolation and expansion compensation devices specified in this Section, the manufacturer shall inspect the completed system; check the vibration levels in the areas as requested by the Consultant, and report in writing any installation error, improperly selected isolation devices, or other faults in the system that could affect the performance of the system. A written report shall be submitted outlining corrective work necessary to comply with the above specifications. Corrective work shall be the responsibility of the installing Subcontractor.

END OF SECTION

INDEX

1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

2 **PRODUCTS**

Not Used

3 **EXECUTION**

3.1 PIPE SYSTEMS

3.1.1 After finished painting is complete, identify each pipe with SMS Coil-Mark or adhesive style building service pipe markers.

3.1.2 Use capital letters minimum 51mm (2") high for DN80 (3") diameter piping or larger, including insulation, and 19mm (¾") size capital letters on smaller diameters.

3.1.3 Use flow arrows to indicate direction of flow. Use double arrow where flow is reversible. Arrow shall be solid black or white; minimum 152mm (6") long by 51mm (2") wide for DN80 (3") diameter piping or larger, including insulation, and 102mm (4") long by 19mm (¾") wide on smaller diameters.

3.1.4 Locate identification and flow arrows as follows:

3.1.4.1 Behind each access door.

3.1.4.2 At each change of direction and take-off.

3.1.4.3 Not more than 12.2m (40 ft) apart on all pipes exposed and/or located behind accessible ceiling.

3.1.4.4 On both sides of sleeves.

3.1.4.5 Adjacent to valves.

3.1.4.6 Above each floor or platform for vertical exposed pipes approximately 1,524mm (5 ft.) above floor.

3.1.5 SMS Coil-Mark or adhesive style building service pipe markers shall be mounted in a visible neat, durable manner. Upon completion of project, provide one complete set of markers used

for the Owner.

3.1.6 Use wording shown on the Legend on the Drawings or as instructed by the Consultant. Special system designations and abbreviations shall be submitted to Consultant for approval prior to use.

3.1.7 Colour coding to be as per the following schedule. For all other services, provide colour coding in conformance with CAN/CGSB-24.3 and ANSI A131.

MARKER LEGEND	**CLASSIFICATION COLOUR**	
Description and Service	**Primary**	**Secondary**
City Water	Green	
Cold Water	Green	
Cooling Tower Water	Green	
Chilled Water	Green	
Ice Water	Green	
Domestic Hot Water	Green	
Domestic Hot Water Recirculation	Green	
Low Temp. Heating Water (Up To 121°C / 250°F)	Yellow	Black
High Temp. Heating Water (Over 121°C / 250°F)	Yellow	Black
Make-Up Water	Yellow	Black
Boiler Feed Water	Yellow	Black
Condensate	Yellow	Black
Blow-Off Water	Yellow	Black
Treated Water	Green	
Brine	Green	
Waste Water	Green	

MARKER LEGEND	**CLASSIFICATION COLOUR**	
Description and Service	**Primary**	**Secondary**
Storm Water	Green	
Acid Drain	Yellow	Black
Fire Protection Water	Red	White
Sprinkler Water	Red	White
Carbon Dioxide (Fire Protection)	Red	White
Plumbing Vent	Green	
Heating Vent	Yellow	Black
Low Pressure Steam (103 kPa / 15 psi Or Less)	Yellow	Black
High Pressure Steam (Above 103 kPa / 15 psi)	Yellow	Black
Hydraulic Oil	Yellow	Black
Instrument Air	Green	
Diesel Exhaust	Yellow	Black
Fuel Oil	Yellow	Orange
LP Gas	Yellow	Orange
Natural Gas	Yellow	Orange
Chlorine	Yellow	Black
Nitrogen	Blue	Yellow
Vacuum	Green	
Compressed Air (690 kPa / 100 psi Or Less)	Green	
Compressed Air (Above 690 kPa / 100 psi)	Yellow	Black

3.1.8 Use primary colours for full length of piping or in minimum 914mm (36") long sections; use minimum 457mm (18") long sections on each side of valves. Use secondary colours in min. 51mm (2") wide bands.

3.1.9 Install pipe identification in accordance with the manufacturer's recommendations.

3.2 VALVES

3.2.1 Supply and attach to each valve (except fixture stops) a lamacoid tag 32mm (1-¼") in diameter or 38mm (1-½") square, similar to SMS RP/SP-1500 series. The system code to be 5mm ($^{3}/_{16}$") high characters on the top line, valve numbers to be 9mm ($^{3}/_{8}$") high on the bottom line. Tags to be colour coded in conformance with piping system colours as per CAN/CGSB-24.3.

3.2.2 Attach tag to valve with a brass chain.

3.2.3 Schedule the valve numbers using a sequential numbering system. For fire protection valves, co-ordinate valve numbers with the annunciator panel numbering system.

3.2.4 Prepare and submit valve directories and charts giving number, size, location, purpose, and normal position (opened or closed) for each valve.

3.2.5 Provide two (2) framed copies of the valve charts and locate where directed by the Consultant.

3.2.6 All control, drain, and test connection valves shall be provided with signs indicating their purpose.

3.3 EQUIPMENT

3.3.1 Identify all fans, pumps, controls, starters, switches, pushbuttons, and all other equipment as to service by a white lamacoid engraved nameplate on black background. Submit sample plates and lettering to the Consultant. Attach plates only after all painting work is completed. Use mechanical fastening devices acceptable to the Consultant.

3.3.2 Manufacturer’s nameplates shall be affixed to all equipment, serial number and all information usually provided, including voltage, cycle, phase, motor power, etc., name of the manufacturer and their address. All stamped etched or engraved lettering on plates

shall be perfectly legible. Do not paint over nameplates and, where apparatus is to be concealed, attach the nameplates in an approved location on the equipment support or frame.

3.3.3 Identify all equipment with the corresponding remote controls.

3.3.4 Equipment plates shall have 9mm ($^3/_8$") capital letters; starter plates shall have 3mm ($^1/_8$") capital letters. All plates shall be sized to accommodate required description. Locate plates conspicuously and secure with self-tapping sheet metal screws where possible, or with double sided adhesive tape. Recognizable abbreviations will be acceptable, other proposed abbreviations to be approved by Consultant.

3.4 DUCTWORK

3.4.1 Identify all ductwork with duct markers using black or white text to contrast surface being identified.

3.4.2 Identification location shall conform to guidelines for duct systems, and shall indicate flow medium, function, and direction.

3.4.3 SMS Coil-Mark or adhesive style building service duct markers, or equal, shall be mounted in a visible neat, durable manner. Upon completion of project, provide one complete set of markers used for the Owner.

END OF SECTION

INDEX

1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 GENERAL REQUIREMENTS

1.2.1 Test, balance and adjust all systems to the Drawings and Specifications, in accordance with the intent and requirements of the ASHRAE Guide - Testing, Adjusting and Balancing (TAB) (Chapter 38, 2011 ASHRAE Application Handbook).

1.3 QUALIFICATION

1.3.1 The Testing, Balancing and Adjusting (TAB) Contractor must be a member in good standing with the National Environmental Balancing Bureau (NEBB), the Canadian Associated Air Balance Council (CAABC) or the National Building Comfort Testing Association (NBCTA).

1.4 SCOPE OF WORK

1.4.1 The TAB Contractor shall:

1.4.1.1 Within fourteen (14) days after award of contract, submit proof of certification for CAABC / NBCTA / NEBB.

1.4.1.2 Within thirty (30) days after award of contract, submit a report to the consultant summarizing the TAB Contractor's comments and recommendations regarding their review of the contract documents. Meet with the Contractor, Owner and Consultant as necessary to discuss.

1.4.1.3 Within thirty (30) days after Contract award, submit an outline of proposed TAB procedures, or alternatively, provide a copy of the latest edition of CAABC / NBCTA / NEBB Procedural Standards.

1.4.1.4 Conduct ongoing reviews of all related construction documentation, including co-ordination Drawings and shop drawings.

1.4.1.5 Visit the Site a minimum of once per month during construction, commencing when the pipe and/or duct installation starts. Submit a written report to the Consultant, including date of visit, areas observed, and any anticipated problems, which could adversely affect the TAB work.

1.4.1.6 Prior to commencing the TAB work, the TAB Subcontractor shall submit the list of instruments they will use on the project, together with a record of calibration dates and procedures.

1.4.1.7 Perform all prebalancing work as specified in respective procedures.

1.4.1.8 Furnish all TAB labour, instruments and services necessary to complete the TAB work for air systems and water systems to achieve the required air and water flow rates. For fans with fixed drives, provide preliminary balance for first set of sheaves, advise the Division 23 - HVAC Subcontractor of results, install new sheaves, and rebalance system following installation of second set of sheaves. Adjust adjustable drives for required rpm and airflow. Adjust VAV box minimum and maximum airflows. Adjust and set all volume control devices to achieve proper air distribution, pressures and patterns in all parts of supply return and exhaust air systems. Adjust and set all pumps, balancing valves and other flow devices to achieve optimum water distribution in all parts of the circulating water systems.

1.4.1.9 Document any deficiencies that prevent the system from being properly balanced and advise the respective installing Subcontractor (Division 21, 22 or 23). Rebalance all affected systems following correction by the respective installing Subcontractor (Division 21, 22 or 23) at no additional cost to the Owner.

1.4.1.10 Report on any noise and vibration problems that are discovered during the course of balancing.

1.4.1.11 Submit a Balancing Report to the Consultant.

1.4.1.12 Repeat the balancing procedures for up to 10% of the system at the request of the Consultant. Should the retest data differ by more than ± 5% from the originally reported values, the TAB Contractor shall be obligated to repeat the balancing of the entire system or systems at no additional cost to the Owner, if so requested by the Consultant.

1.4.1.13 Include for premium time where schedule requires that TAB work be undertaken after hours.

1.5 <u>CO-ORDINATION</u>

1.5.1 The respective installing Subcontractor (Division 21, 22 or 23) shall

be responsible to ensure that all systems are complete and ready for testing, balancing and adjusting by the TAB Contractor. The respective installing Subcontractor (Division 21, 22 or 23) shall:

1.5.1.1 Confirm the complete operational readiness of the building, including sealed walls, doors, and ceilings to allow the balancing to be performed and required pressures to be set and maintained.

1.5.1.2 Allow access to all components requiring testing, balancing, and servicing. This includes permanently installed ladders and catwalks.

1.5.1.3 Maintain a construction schedule that allows the test and balance (TAB) firm to complete contract work prior to occupancy.

1.5.1.4 Verify the installation conformity to the design drawings and specifications.

1.5.1.5 Promptly correct deficiencies of materials and work that may delay completion of the TAB work.

1.5.1.6 Provide operation and maintenance manuals. Manuals must include the following:

1.5.1.6.1 The manufacturers' method for adjusting and setting components for correct operation under actual load conditions.

1.5.1.6.2 The manufacturers' recommended tolerance for maximum and minimum operating conditions.

1.5.1.6.3 The recommended correction or A_k factors, to allow adjustment of flow, rpm, etc.

1.5.1.6.4 A list of spare parts, identification numbers, and diagrams of their proper locations.

1.5.1.6.5 Pressure drops for air and hydronic flows through the component or unit at design flow rate.

1.5.1.7 Start up all HVAC systems, according to the following conditions:

1.5.1.7.1 Proper lubrication of rotating or sliding parts is verified.

1.5.1.7.2 Motors, fans, and all HVAC equipment have the correct rotation.

1.5.1.7.3 Installation of the correct drive (package) is checked.

1.5.1.7.4 Belt tension is appropriate for the type of drive.

1.5.1.7.5 Vibration isolators and bases are properly installed and are the correct type.

1.5.1.7.6 Smoke and fire damper operation (left in full open position) is correct.

1.5.1.7.7 Volume and control dampers (left in a neutral or wide-open position) function properly.

1.5.1.7.8 Verification that duct-leakage test has been performed and ducts are sealed to the minimum tolerance specified in the Contract Documents.

1.5.1.7.9 Verification that all registers, grilles, and diffusers are of the correct type, are properly installed, and are in the open position.

1.5.1.7.10 Verification that all terminal boxes are the correct type and are properly installed according to the manufacturer's recommendations.

1.5.1.7.11 Verification that motors, starters, and variable speed controllers with overload safety devices are the correct size and are operating properly.

1.5.1.7.12 Verification that automatic controls are installed correctly and include all components specified, including interlocks, freeze stats, damper controllers, minimum positioning switches, control valves, actuators, and sensors.

1.5.1.7.13 Verification that hydronic pumps and related components are properly installed and operate correctly.

1.5.1.7.14 Verification that strainers are clean and that the system is vented and free of air.

1.5.1.7.15 Verification that expansion tanks are properly installed and working.

1.5.1.7.16 Verification that coils are piped correctly and are clean.

1.5.1.7.17 The motor, amps, volts, and rpm, are compared with nameplate data and are adjusted within a motor-rated hp or amperes.

1.5.1.7.18 Verification that fan and pump power and speed are within design range.

1.5.1.7.19 Verification that the controls are complete and operational.

1.5.1.7.20 Verification of the correct type, quantity, and cleanliness of installed filters.

1.5.2 During testing and balancing; the respective installing Subcontractor (Division 21, 22 or 23) shall:

1.5.2.1 Operate and maintain all systems requiring balancing during the balancing period.

1.5.2.2 Ensure that the control system responds to the testing and balancing requirements. Provide all necessary personnel, equipment and software to make adjustments to controls as required to achieve design condition.

1.5.2.3 Furnish and install drives and motors as required to accomplish design requirements.

1.5.2.4 Provide all equipment, labour, instruments and incidentals and pay for all power and fuel to carry out the tests.

1.5.3 Start-Up Report:

1.5.3.1 The Contractor shall provide a copy of a detailed start-up report, including initial tabulated data required for the start-up of systems, to the test and balance agency for reference in the balancing work.

1.5.4 Joint effort of Contractors:

1.5.4.1 Upon completion of balancing, the TAB Subcontractor shall provide flows, pressures, and temperatures to the control contractor for final calibration of the automatic control system. The Division 25 – Integrated Automation Subcontractor shall provide access to computerized data and equipment and/or provide operating personnel.

1.5.4.2 After balancing, the TAB Subcontractor shall provide water flow rates, etc. to the chiller, cooling tower, and boiler suppliers for final setup and performance verification.

2 PRODUCTS

Not Used

3 EXECUTION

3.1 GENERAL

3.1.1 TAB work shall be undertaken in accordance with the following descriptions. Procedures not specifically described herein or requiring amplification shall be in accordance with CAABC / NBCTA / NEBB standards, as applicable.

3.2 AIR SYSTEM BALANCING

3.2.1 Air quantities in main ducts shall be measured by Pitot tube traverses of the entire cross section area of the duct. Openings in ducts for Pitot tube insertion shall be sealed with approved plugs. Outlet and inlet air quantities shall be determined in accordance with CAABC / NBCTA / NEBB procedures.

3.2.2 Total air quantities shall be obtained by adjustment of fan speeds. Branch duct air quantities shall be adjusted by volume dampers. Damper positions shall be permanently marked after TAB work is complete.

3.2.3 For systems handling outdoor air, the system shall be balanced at the normal minimum outdoor air condition. Where the system is designed to deliver 100% return air or a variable amount of outdoor air, the total airflow tests shall be repeated for 100% maximum outdoor air and shall agree with conditions measured under minimum outdoor air operation before the system is considered to be in balance.

3.2.4 Adjusting of individual outlets shall be performed as per CAABC / NBCTA / NEBB procedures or as otherwise approved by the Consultant. Outlets shall be set for the air pattern required and all main supply air dampers shall be adjusted and set for the design indicated. All required changes in air patterns or setting necessary to achieve correct air balance and to minimize drafts shall be performed by the TAB Subcontractor.

3.2.5 All measured air quantities shall be within ± 5% of design air quantities where achievable.

3.2.6 Each Variable Air Volume (VAV), and Constant Volume (CV) supply, return air and exhaust terminal unit shall be adjusted to deliver the maximum and minimum air quantities specified in all specified modes of operation. (Use the prescribed procedures for each type terminal device). The individual supply outlets for each zone shall be adjusted after the respective control unit is manually set (Pneumatic and/or Direct Digital Control (DDC)) to design

airflow settings (Minimum and Maximum). Factory calibration of all types of VAV and High Velocity Fan Powered/Reheat Units shall be verified and reset as required by the TAB Subcontractor.

3.2.7 The TAB Subcontractor shall perform the test and compile the data required. In addition to the tabulation forms, the TAB Subcontractor shall provide schematic diagrams showing all system components cross-referenced to form tabulations. The lists provided hereinafter shall be considered minimum requirements. All information required to prove system balance shall be provided by the TAB Subcontractor.

3.2.8 Air Handling Equipment Tests and Data

3.2.8.1 Tabulate design conditions from documents and installed conditions from shop drawings:

3.2.8.1.1 Fan, unit or system number.

3.2.8.1.2 Location.

3.2.8.1.3 Area served.

3.2.8.1.4 Manufacturer, model and serial number of air unit, motor(s), pulley and belts.

3.2.8.1.5 Motor nameplate power (kilowatts), amperage, voltage, phase, hertz, frame type, and service factor.

3.2.8.1.6 Sheave Manufacturer, model number, grooves, and pitch diameter, adjustable or fixed. Include pitch diameter settings on adjustable sheaves.

3.2.8.1.7 Fan and motor rpm.

3.2.8.1.8 Fan or unit static pressure profile. Measure and record pressure differentials across coils, filters, dampers, etc.

3.2.8.1.9 Total airflow, Outdoor Air, Return Air, Exhaust Air, Relief Air, and Outlet Air (Maximum and Minimum).

3.2.8.1.10 Terminal Manufacturer and type.

3.2.8.1.11 Outlet or inlet size, effective area and A_k Factor, except when using a direct reading flow hood.

3.2.8.1.12 Design temperature differences.

3.2.8.1.13 Design brake horsepower (kilowatts).

3.2.8.1.14 Check that stratification has been eliminated before taking measurements. Make temperature traverse readings after each mixing compartment. Advise the Division 23 – HVAC Subcontractor if any stratification is present.

3.2.8.2 Tabulate from equipment field tests.

3.2.8.2.1 Fan and motor rpm.

3.2.8.2.2 Motor amperage for each phase.

3.2.8.2.3 Voltage for each phase.

3.2.8.3 Tabulate from air data from field test (for each required condition).

3.2.8.3.1 Total air quantity for each outlet or inlet and for Supply air, Return Air, Exhaust Air, Relief Air and Outdoor Air for each system.

3.2.8.3.2 Pressure reading at most distant point of system (Pa / mm w.g. for VAV systems only).

3.2.8.3.3 Pressure drops across filters, boxes, coils and air-to-air heat exchangers.

3.2.8.3.4 Supply, Return and Exhaust fan pressure differentials.

3.2.8.3.5 Temperature differences across coils and air-to-air heat exchangers.

3.2.8.3.6 Traverse locations and grid with actual velocities. Record duct static pressure at each traverse location. Provide traverses at all points necessary for balancing.

3.3 <u>WATER SYSTEM BALANCING</u>

3.3.1 Water flows shall be balanced by venturi and calibrated orifices with portable type flow meters, where provided by the respective installing Subcontractor (Division 21, 22 or 23), or calibrated meters provided by the TAB Subcontractor.

3.3.2 Pump flow capacities shall be determined by venturies, orifices, or multi-duty valves. All settings of balancing valves shall be permanently marked after balance is complete.

3.3.3 The TAB Subcontractor shall compare design documents with the

shop drawings. If discrepancies are found, TAB Subcontractor shall submit a request for information to resolve the discrepancies.

3.3.4 Pump Test and Data.

3.3.4.1 Tabulate tests and data: (Confirm in field)

3.3.4.1.1 Pump number and service.

3.3.4.1.2 Location.

3.3.4.1.3 Area served and type of system served.

3.3.4.1.4 Manufacturer, model, serial number of pump.

3.3.4.1.5 Motor nameplate power (watts), amperage, voltage, phase, Hertz, frame type and service factor.

3.3.4.1.6 Pump and motor rpm.

3.3.4.1.7 Pump suction and discharge pressure at operating conditions.

3.3.4.1.8 System flow.

3.3.4.2 Tabulate from field tests:

3.3.4.2.1 Pump and motor rpm.

3.3.4.2.2 Motor amperage for each phase.

3.3.4.2.3 Voltage for each phase.

3.3.4.3 Tabulate from pump field test:

3.3.4.3.1 Total flow.

3.3.4.3.2 Discharge and suction pressure for operating and shut off conditions.

3.3.5 Heat Transfer Equipment Tests and Data

3.3.5.1 Tabulate design conditions from documents and installed conditions from shop drawings.

3.3.5.1.1 Identification, location and service.

3.3.5.1.2 Transferred heat (kW).

3.3.5.1.3 Manufacturer.

3.3.5.1.4 Model and serial number.

3.3.5.1.5 Pipe size (mm).

3.3.5.1.6 Design pressure differential (kPa / psi) and flow rates (L/s / USgpm).

3.3.5.1.7 Design leaving and entering conditions.

3.3.5.1.8 Type motor used.

3.3.5.2 Tabulate from field tests:

3.3.5.2.1 Pressure differential (kPa / psi).

3.3.5.2.2 Total flow (L/s / USgpm).

3.3.5.2.3 Entering and leaving temperature and conditions.

3.3.5.3 For heating systems where automatic control valves are not used for each radiator or convector, adjust to equal temperature drop through each unit. Submit the temperature readings taken by contact pyrometer on inlet and outlet pipes to the top and bottom units on each riser.

3.3.6 Cooling Tower Test and Tabulations:

3.3.6.1 The tower water distribution system shall be balanced to ensure an even water flow to each tower cell. The fan(s) speed, rotation, motor voltage and amperage shall be checked and recorded.

3.3.6.2 The TAB Subcontractor shall perform tests on cooling towers in accordance with CAABC / NBCTA / NEBB procedures and shall provide the following information:

3.3.6.2.1 Pump and cooling tower nomenclature.

3.3.6.2.2 Size and capacities.

3.3.6.2.3 Pump motor and fan motor operating information and characteristics.

3.3.6.2.4 Pump flows, discharge head, and Total Dynamic Head (TDH).

3.3.6.2.5 Fan airflow and velocities if applicable.

3.3.6.2.6 Wet and dry bulb air temperatures of inlet and outlet.

3.3.6.2.7 Water temperature of hot water, cold water and make-up water.

3.3.7 Boilers and Furnaces

3.3.7.1 For boilers and furnaces, test flue gas using Orsat flue gas analyzer for carbon dioxide, oxygen and carbon monoxide. Measure and record fuel consumption. Perform test at each firing rate.

3.3.8 Systems installed with pressure independent control valves shall not require terminal level hydronic system balancing. Total system flow shall be verified to be within +/-10% of system design. 10% of the total installed product shall be randomly checked for individual conformance. Exact locations of tested product to be coordinated with the design engineer. Any individual adjustments for the pressure independent valve assembly (valve and actuator combination) for field conditions shall be performed using the pressure independent control valve manufacturer's documented procedure following the guidelines of CAABC / NBCTA / NEBB.

3.4 DEMONSTRATION

3.4.1 At the request of the Consultant, the TAB Subcontractor shall repeat the balancing procedure for any system or portion of a system. The TAB Subcontractor shall repeat the balancing procedure on 10% (as selected by the Consultant) of systems. If the data is within ± 5% of the reported data, the system shall be considered acceptable and the report accepted. If the data is not within ± 5% of the reported data, the Consultant can request that the entire system or systems be rebalanced.

3.5 REPORTS

3.5.1 Submit written reports, during the course of construction, of potential developing problems relating to the work being provided under other sections of the specifications where such problems may adversely affect the proper balancing of the equipment or systems.

3.5.2 Submit written reports for review upon completion of each major phase of the balancing work.

3.5.3 The TAB Subcontractor shall prepare and submit three (3) copies of the Balancing Report to the Consultant for review and evaluation

prior to final acceptance of the project. The Balancing Report shall include the data outlined above, but may be expanded or modified to be compatible with the requirements of the installed equipment and systems.

3.5.3.1 The cover of the TAB Report must show the "CAABC / NBCTA / NEBB" Logo, Name and Address of the project, Architect, Mechanical Engineer, Installing Contractor, Date the report is issued, Address and Phone Number of the TAB Subcontractor. The CAABC / NBCTA / NEBB Seal and Signature of the TAB Supervisor who is in charge of the reported project must be submitted on the "Certification" Report Form (TAB 2-98)

3.5.3.2 Identification of all types of instruments used and their last dates of calibration shall be submitted with the Final Report.

3.5.3.3 Once the Consultant's comments have been incorporated in the report, submit four (4) copies of the Final Report to the Consultant.

3.6 QUALITY ASSURANCE

3.6.1 The Tab Subcontractor shall guarantee that all work will be performed in accordance with the applicable CAABC / NBCTA / NEBB Standards and Procedures. The TAB Subcontractor's Certification Number must be provided to the Consultant.

END OF SECTION

INDEX

1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 – General Requirements, shall apply to and govern this Section.

1.1.2 All insulation shall comply with minimum R-value requirements listed in ASHRAE Energy Standard 90.1, 2013 edition.

1.1.3 All insulation materials and installation must meet the requirements of applicable codes and standards, and be appropriately labeled.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools, equipment, training, commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 Piping insulation.

1.2.1.2 Equipment insulation, including tanks.

1.2.1.3 Thermal duct insulation.

1.2.1.4 Adhesives, tie wires, tapes.

1.2.1.5 Recovery jackets.

1.3 SUBMITTALS

1.3.1 Submit Shop Drawings for:

1.3.1.1 Insulation products.

1.3.1.2 Recovery jackets.

1.3.1.3 Adhesives and sealants.

1.3.2 Submittal to include product description, manufacturer's installation instructions, and appropriate specification compliance.

1.3.3 Submit samples of all insulation materials to the Consultant mounted on a board, and labeled for intended services, including ‘k’ factors. Obtain the Consultant’s comments prior to ordering insulation and proceeding with the installation.

1.4 QUALITY ASSURANCE

1.4.1 Glass mineral wool insulation products to have UL GREENGUARD Gold Certification and be formaldehyde free as certified by UL Environment; whenever possible.

1.4.2 Products shall contain no polybrominated diphenyl ethers (PBDE) such as Penta-BDE, Octa-BDE or Deca-BDE fire retardants.

1.4.3 The Contractor shall take precaution to protect insulation materials from moisture exposure or physical damage. Any glass mineral wool insulation that becomes wet or damaged shall be replaced at no additional cost.

1.4.3.1 HVAC ductwork insulation used in the air stream must be discarded if exposed to liquid water.

1.4.3.2 Pipe insulation with factory applied all service jacket with self-sealing lap (ASJ+) facing having been installed per manufacturer's installation recommendation which may experience intermittent exposure to liquid water after installation may be exempted from removal and replacement requirements.

2 **PRODUCTS**

2.1 INSULATION MATERIAL

2.1.1 Unless otherwise noted, insulating materials are based on Knauf Fiber Glass GmbH.

2.1.2 All insulation materials, adhesive sealants and coatings, shall be ULC listed, non-hygroscopic, and mould-proof. Insulation products shall not contain asbestos, lead, mercury, mercury compounds, or formaldehyde.

2.1.3 All insulation system materials inside the building must meet the requirements of NFPA 90A, with a flame spread rating of less than 25, and smoke developed rating of less than 50, when tested in accordance with CAN/ULC-S102. Insulation materials shall not flame, smolder, glow or smoke at their service temperatures.

2.1.4 Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795. Insulation materials applied to carbon steel shall be Mass Load Corrosion Rate (MLCR) tested per ASTM C 1617.

2.1.5 Pipe insulation: Knauf Earthwool™ 1000° glass mineral wool pipe

insulation, UL/ULc classified, rigid, molded, k value: 0.033 (0.23) at 24°C (75°F) mean temperature; 0.049 (0.34) at 149°C (300°F) mean temperature. Maximum service temperature 538°C (1000°F). Vapor retarder jacket: ASJ+ conforming to ASTM C 1136 Type I, II, III, IV, & VIII secured with self-sealing longitudinal laps and matching ASJ+ butt strips.

2.1.6 Semi-rigid pipe and tank insulation: Knauf Pipe & Tank galss mineral wool insulation, limited combustible, k value: 0.036 (0.25) at 24°C (75°F) mean temperature. Maximum service temperature 454°C (850°F). Compressive strength: not less than 5.75 kPa (120 PSF) @ 10% deformation per ASTM C 165. Vapor retarder jacket: ASJ conforming to ASTM C 1136 Type II.

2.1.7 Semi-rigid blanket for equipment: Knauf KwikFlex™ glass mineral wool; in roll form, k value: 0.035 (0.24) at 24°C (75°F) mean temperature; 0.056 (0.39) at 149°C (300°F) mean temperature. Maximum service temperature 454°C (850°F), maximum surface temperature for faced product: 66°C (150°F), maximum thickness @ 454°C (850°F): 102mm (4”). Compressive strength: not less than 1.2 kPa (25 PSF) @ 10% deformation per ASTM C 165. Vapor retarder jacket: ASJ, FSK or PSK conforming to ASTM E 96, Procedure A.

2.1.8 Fitting insulation: insulate using pre-formed PVC fitting covers with glass mineral wool inserts. Alternatively, preformed molded, formaldehyde free glass mineral wool; minimum 50% post-consumer recycled glass content, or mitered glass mineral wool pipe insulation sections. These fittings shall be further protected by field-applied PVC fitting covers, metal fitting covers, or glass fabric and mastic sealed as necessary.

2.1.9 Duct wrap: Knauf Friendly Feel® glass mineral wool blanket; flexible, limited combustible, k value: 0.042 (0.29) at 24°C (75°F) mean temperature. Maximum service temperature: faced 121°C (250°F), unfaced 177°C (350°F). Maximum allowable compression is 25%. Density: concealed areas: minimum 12 kg/m3 (0.75 PCF); exposed areas: minimum 16 kg/m3 (1.0 PCF). Vapor retarder jacket: FSK or PSK conforming to ASTM C 1136 Type II.

2.1.10 Rigid duct insulation: Knauf Insulation Board, rigid glass mineral wool board. Maximum service temperature 232°C (450°F). Concealed areas: Density: Minimum 48 kg/m3 (3 PCF). k value: 0.033 (0.23) at 24°C (75°F) mean temperature. Vapor retarder jacket: ASJ conforming to ASTM C 1136 Type I, or FSK or PSK conforming to ASTM C 1136 Type II.

Exposed Areas: Density: Minimum 96 kg/m3 (6 PCF). k value: 0.032 (0.22) at 24°C (75°F) mean temperature. Vapor retarder jacket: ASJ conforming to ASTM C 1136 Type I, or FSK or PSK conforming to ASTM C 1136 Type II in combination with protective jacket where necessary.

2.1.11 Factory applied jackets:

2.1.11.1 All service jacket with advanced closure system self-sealing lap (ASJ+). All service jacket composed of aluminum foil reinforced with glass scrim bonded to a kraft paper interleaving with an outer film layer leaving no paper exposed.; conforming to ASTM C 1136 Type I, II, III, IV, and VIII; vapor retarder; with a self-sealing adhesive.

2.1.11.2 All service jacket (ASJ). White kraft paper bonded to aluminum foil and reinforced with glass fibers; conforming to ASTM C 1136; vapor retarder.

2.1.11.3 Foil scrim kraft (FSK). Aluminum foil, fiberglass reinforced scrim with kraft backing; conforming to ASTM C 1136 Type 1; vapor retarder.

2.1.11.4 Poly scrim kraft (PSK). Metalized polypropylene, fiberglass reinforced scrim with kraft backing; conforming to ASTM C 1136 Type 1; vapor retarder.

2.1.11.5 Redi-Klad Jacket: VentureClad 5-ply weather and abuse resistant with self-seal lap, zero permeability per ASTM E 96-05; puncture resistance 35.4 kg (189.3 N) per ASTM D 1000; tear strength 19.4 N (4.3 lbs) per ASTM D 624; thickness 14.5 mils (0.0145"); tensile strength 306 N (31 kg)/25 mm (68.0 lb./inch) width.

2.1.12 Field applied jackets:

2.1.12.1 PVC: Proto Corporation 25/50 or Indoor/Outdoor, UV resistant fittings, jacketing and accessories, white or colored. Fitting cover system consists of pre-molded, high-impact PVC materials with glass mineral wool inserts. Glass mineral wool insert has a thermal conductivity (k value) of 0.037 (0.26) at 24°C (75°F) mean temperature. Closures: stainless steel tacks, matching PVC tape, or PVC adhesive per manufacturer's recommendations.

2.1.12.2 Aluminum Jacket: Alloy 3003 or 3105, minimum thickness per ASTM C 1729, smooth, corrugated or stucco embossed with factory-applied moisture barrier. Overlap shall be 50mm (2 inch)

minimum. Jacket shall be banded in place with 12mm x 5mm (½" x 0.20") aluminum strapping fastened with aluminum wing seals.

2.1.12.3 Stainless Steel Jacket: T-304, minimum per ASTM C 1729, smooth, corrugated or embossed with factory-applied moisture barrier. Overlap shall be 50mm (2 inch) minimum. Jacket shall be banded in place with 10mm x 5mm (⅜" x 0.20") aluminum strapping fastened with stainless steel wing seals.

2.1.12.4 Laminated Self-Adhesive Water and Weather Seals: permanent acrylic self-adhesive system; weather resistant, high puncture and tear resistance; meeting or exceeding requirements of UL 723; and applied in strict accordance with manufacturers' recommendations.

2.1.12.5 Canvas jackets: 1.83kg/m2 (6oz./sq.ft) plain weave cotton fabric sealed with dilute fire retardant, waterproof, ULC listed lagging adhesive.

2.1.13 Jacketing for outdoor ductwork

2.1.13.1 Aluminum Jacket: 0.406mm (0.016 inch) thick in smooth, corrugated, or embossed finish with factory applied moisture barrier. Overlap shall be 50mm (2 inch) minimum.

2.1.13.2 PVC Jacket: Proto Corporation Indoor/Outdoor, UV resistant, white. Closure shall be solvent weld adhesive or per manufacturers' recommendations.

2.1.13.3 Laminated Self-Adhesive Water and Weather Seals: applied per manufacturer's recommendations.

2.1.14 Mastics:

2.1.14.1 Vapor Retarder Mastics: Knauf Insulation EXPERT Mastics: KI-900 ASJ or KI-905 ASJ+; water vapor permeance:, 0.026 metric perm (0.04 perm) at 40 mil dry film thickness. Service Temperature Range: -29°C to 82.2°C (-20°F to 180°F). Color: White

2.1.15 Weather Barrier Mastics: Knauf Insulation EXPERT Mastics: KI-700 ASJ or KI-705 ASJ+; water vapor permeance:, 1.2 metric perm (1.8 perm). Service Temperature: -17.8°C to 82.2°C (0°F to 180°F) constant; -29°C to 93°C (-20°F to 200°F) intermittent. Solids: 58% by weight; 50% by volume. Color: White

2.1.16 Tapes:

2.1.16.1 ASJ Tape: Knauf Insulation EXPERT ASJ Tape or ASJ+ Tape. Width: 75mm (3 inches) or 102mm (4 inches). Thickness (Total): 0.36 mm (14.3 mil) – ASJ; 0.34mm (13.3 mil) – ASJ+. Adhesion: >840 N/m (4.8 Lbf / in.)

2.1.16.2 FSK Tape: Knauf Insulation EXPERT FSK Tape. Width: 75mm (3 inches) or 102mm (4 inches). Thickness (Total): 0.34mm (13.3 mil). Adhesion: 1,138 N/m (6.5 Lbf / in.)

2.1.16.3 Aluminum Foil Tape: Knauf Insulation EXPERT 2 Mil Foil Tape. Width: 75mm (3 inches) or 102mm (4 inches). Thickness (Total): 0.19mm (7.3 mil). Adhesion: 700 N/m (4.0 Lbf / in.)

2.2 APPLICATION

2.2.1 The following areas are designated as “exposed” where the term is applied to covering:

2.2.1.1 Mechanical and electrical equipment rooms, penthouses, parking garage, loading dock, shipping/receiving areas.

2.2.1.2 Mechanical plenum spaces.

2.2.1.3 Below suspended ceiling level in occupied areas or below slab where no ceiling occurs.

2.2.1.4 Duct shafts and/or pipe shafts serviced via “walk-in” type access doors.

2.2.1.5 Crawl spaces, tunnels.

2.2.2 Cover duct and pipes exposed to weather or dampness with 75mm (3") thick insulation and a final application of tape adequately overlapped to render it water tight. The following areas are designated as “exposed to weather or dampness” and are applicable for this treatment:

2.2.2.1 Air intake, relief, and exhaust plenums directly connected to the outside of the building.

2.2.2.2 Underground service trenches.

2.2.2.3 Buried below ground level.

2.2.2.4 Areas subject to high humidity.

2.2.2.5 Ductwork and piping exposed on the roof.

2.3 COLD PIPING

2.3.1 Cover 'cold' piping (operating temperature below 16°C/61°F) with rigid pipe insulation with factory applied vapour barrier jacket and aluminum foil vapour barrier with self-sealed lap. Butt joints sealed with butt strips or aluminum tape. Recover pipe in exposed areas with field applied jacket.

2.3.2 Insulation thickness shall be as follows:

2.3.2.1 25mm (1")

- unburied domestic cold water piping
- chilled drinking water
- unburied apparatus drains
- horizontal unburied rain water piping, including the piping up to and including roof hoppers or drain fixtures
- horizontal unburied sanitary drains
- cast iron fittings on transite rainwater piping
- gray water piping
- fire standpipe, wet sprinkler and drainage piping in loading dock, parking garage and other unheated areas
- refrigerant suction piping
- auxiliary water piping on refrigeration compressors
- cooling tower make-up water, overflow, bleed and drain pipes inside and outside building
- chilled water/glycol supply and return at 5°C (41°F) and above
- condenser water used for low temperature cooling (water side free cooling) inside building

2.3.2.2 50mm (2")

- electrically traced piping, including drum drips of

dry sprinkler system

2.3.3 Cover 'cold' piping running outside the building envelope with insulation thickness as follows:

2.3.3.1 65mm (2-½") - pipes up to and including DN50 (2") dia.

2.3.3.2 80mm (3") - pipes DN65 (2-½") up to and including DN100 (4") dia.

2.3.3.3 90mm (3-½") - pipes above DN100 (4") dia.

2.3.4 In lieu of the above specified insulation, Armstrong AP/Armaflex flexible elastomeric expanded closed-cell insulation with same thickness may be substituted for the following services:

- horizontal unburied rain water piping, including the piping up to and including roof hoppers or drain fixtures
- horizontal unburied sanitary drains
- refrigerant suction piping, 16mm ($^{5}/_{8}$") thickness
- auxiliary water piping on refrigeration compressors

2.4 <u>HOT PIPING</u>

2.4.1 Cover 'hot' piping – heating water/glycol, domestic hot water supply and recirculation, condenser water, hot-gas bypass, drip and blowdown lines, steam and condensate, at operating temperatures above 41°C/106°F – with rigid pipe insulation with factory applied kraft paper jacket bonded to aluminum foil vapour barrier with self-sealed lap. Hold insulation in place with flare type staples. Recover pipe in exposed areas with field applied jacket.

2.4.2 Insulation thickness shall be as follows:

2.4.2.1 25mm (1") - 'hot' piping up to 60°C (140°F) operating temperature, for pipes less than 40mm (1-1/2") dia.

2.4.2.2 40mm (1-½") - 'hot' piping up to 60°C (140°F) operating temperature, for pipes equal to or greater than

40mm (1-1/2") dia.

- electrically traced piping

2.5 DUCTS

2.5.1 Insulate round supply ducts up to 750mm (30") diameter and rectangular supply ducts up to 750mm (30") width with 25mm (1") thick flexible duct insulation. Adhere insulation to duct surface with adhesive applied in strips 150mm (6") wide on 300mm (12") centres. Use fiberglass tying cord or 16 gauge annealed wire until the adhesive sets. Butt edges of insulation tightly together, and seal all breaks and joints with self-adhering aluminum tape.

2.5.2 Insulate round supply ducts over 750mm (30") diameter and rectangular supply ducts over 750mm (30") width with 25mm (1") thick rigid duct insulation board. Fasten the insulation with welded pins and speed washers on maximum 300mm (12") centres. Use a minimum of two (2) rows of fasteners per side. Butt edges of insulation tightly together, and seal all breaks and joints with self-adhering aluminum tape.

2.5.3 Where angles or standing seams extend beyond the insulation and before the final finish, apply a compressed layer of 25mm (1") flexible duct insulation over the angles and standing seams. Extend the insulation 75mm (3") on each side of the angle and place tightly around the projecting leg of the angle. Apply the insulation overlapping the edge so that the vertical part of the insulated angle will project throughout the work.

2.5.4 Where interior acoustic insulation is required, decrease the exterior insulation by equal thickness. Overlap the exterior insulation by at least 300mm (12"), upstream and downstream.

2.5.5 Apply vapour barrier over insulation on cold and dual temperature ducts.

2.5.6 Insulate all ductwork running outside the building with 75mm (3") rigid board insulation and weatherproof jacket.

2.5.7 Insulate the following duct:

2.5.7.1 Air conditioning supply ducts from apparatus casings to air terminal control units, reheat coils, or duct termination.

2.5.7.2 Tempered air supply ducts in unheated space.

2.5.7.3 Air supply duct downstream of energy/heat recovery ventilators.

2.5.7.4 All rigid supply ducts downstream from air terminal control units, reheat coils and hydronic terminal units.

2.5.8 Air intakes and exhaust:

2.5.8.1 Insulate with rigid vapour seal insulation board.

2.5.8.2 Impale the insulation in place with suitable speed washers or clips. Where angles or standing seams extend beyond the insulation, apply a compressed layer of 25mm (1") flexible duct wrap over the angles and standing seams. The wrap shall extend 75mm (3") on each side of the angle and placed tightly around the projecting leg of the angle. Apply the insulation overlapping the edge of the wrap on the angle so that the vertical part of the insulated angle will project throughout the work.

2.5.8.3 Seal all breaks and joints by adhering a 75mm (3") aluminum foil vapour barrier tape with fire retardant adhesive. Cover with canvas adhered with resin base lagging adhesive. Finish with one coat of the same lagging adhesive.

2.5.8.4 Insulate the following intakes and exhaust:

2.5.8.4.1 All outdoor air intake ductwork from outside louvres to air handling units.

2.5.8.4.2 All exhaust and relief ductwork from outside louvres to 1.5m (5 ft) upstream of motorized dampers or where there are no motorized dampers, from louvre to fan discharge in 50mm (2") thickness.

2.5.8.4.3 All exhaust and relief ductwork from outside louvres to heat recovery units located inside mechanical spaces/rooms in 50mm (2") thickness.

2.5.8.4.4 All exhaust and relief ductwork from outside louvres to energy/heat recovery ventilators inside ceiling bulkheads and spaces in 40mm (1-½") thickness.

2.5.8.4.5 Mixed air plenums in 50mm (2") thickness.

2.5.8.4.6 Behind unused portion of louvers in 50mm (2") thickness.

2.5.9 Ensure that access doors of casings and plenums are supplied pre-insulated. Do not apply additional insulation.

2.6 COLD EQUIPMENT

2.6.1 Cover ‘cold’ equipment with 25mm (1") thick Armstrong AP/Armaflex flexible elastomeric expanded closed-cell insulation. Apply to clean and dry surfaces, using 100% Armstrong 520 adhesive coverage on both surfaces to be joined. Use manufacturer's compression fit method of butt joining sheets.

2.6.2 Insulate the following equipment as ‘cold’ equipment. Finish insulation with two coats of Armaflex Finish. Color selection to be determined.

2.6.2.1 Refrigeration machine evaporators, suction lines, chiller shells, shell ends and sumps, except pre-insulated units

2.6.2.2 Water meters and irregular shapes.

2.6.2.3 Strainer heads in cold lines.

2.6.2.4 Cold water booster pumps.

2.6.2.5 Condensation trays.

2.6.2.6 Spray pumps, piping, valves, and fittings.

2.6.2.7 Flat plate heat exchangers.

2.6.3 Provide removable 1.3mm (16 ga.) aluminum sheet metal enclosure with insulation applied as above to inside of cover, for the following 'cold' equipment:

2.6.3.1 Chilled water pumps

2.6.3.2 Chilled water pump suction and discharge guides

2.6.3.3 Condenser water pumps

2.6.3.4 Condenser water pump suction and discharge guides

2.6.4 Cover cooling tower sumps (if electrically traced) with 50mm (2") thick semi-rigid fiberglass board insulation with factory applied vapour barrier. Cut and mitre insulation to suit surface contours. Impale insulation on mechanically fastened pins, located at not greater than 300mm (12") centres. Apply expanded metal lath and lace edges with 1.63mm (16 ga.) galvanized annealed wire. Secure insulation and metal lath with speed washers.

2.6.4.1 Recover sumps with 0.5mm (24 ga.) thick sheet aluminum fabricated to the shape of the sump. Mechanically fasten in place with bands, sheet metal screws or pop rivets. All corners shall be square and raw metal edges concealed.

2.6.5 Under each dehumidifier and cooling cool drip pan, place 50mm (2") thick foam glass with all joints sealed with cold adhesive cement.

2.6.6 Cover chilled water storage tanks with 50mm (2") thick rigid fiberglass board insulation, scored to suit curved surface. Impale insulation on suitable welded fasteners on 300mm (12") centres secured in place with speed washers. Recover with field applied jacket.

2.7 HOT EQUIPMENT

2.7.1 Cover 'hot' equipment (for temperatures not exceeding 232°C/450°F) with 50mm (2") thick semi-rigid fiberglass board insulation. The insulation shall be held in place with 19mm (¾") metal bands on maximum 450mm (18") centres. For large, flat or irregular surfaces, impale the insulation over suitable welded fasteners on 300mm (12") centres secured in place with speed washers. Lace the metal edges that butt together with 1.63mm (16 ga.) galvanized annealed wire. Insulation shall not be compressed beyond a maximum of 5% at any point. Recover with field applied jacket.

2.7.2 Insulate the following equipment as 'hot' equipment:

2.7.2.1 Converters, shell and tube heat exchangers (including glycol).

2.7.2.2 Domestic hot water tanks and water heaters except pre-insulated units.

2.7.2.3 Refrigeration condensers, except pre-insulated units.

2.7.2.4 Steam ancillaries.

2.7.3 Insulate flat plate heat exchangers with 25mm (1") thick Armaflex insulation. Refer to Paragraph 2.6.1 for details.

3 **EXECUTION**

3.1 APPLICATION

3.1.1 Do not apply insulation before piping ductwork and equipment has

been tested and accepted.

3.1.2 All insulation shall be supplied and installed by a qualified insulation applicator in accordance with the latest MICA Commercial and Industrial Insulation Standard.

3.1.3 All insulation shall be applied in full accordance with the insulation manufacturer's recommendations, and shall present a neat professional appearance upon completion.

3.1.4 Apply all insulation in a manner to facilitate replacing and/or servicing of equipment. All insulation for equipment shall be removable and reusable.

3.1.5 Use insulation, wrapping, vapour barriers and adhesive materials having flame spread, fuel contributed and smoke developed ratings in accordance with rulings and regulations of authorities. Follow all rules, regulations, and instructions of the Fire Marshall's office and all authorities having jurisdiction.

3.1.6 Do not apply any insulation or finishing when the ambient temperature in the space is less than 10°C (50°F).

3.1.7 Apply insulation only on clean and dry surfaces.

3.1.8 On cold surfaces where a vapor seal must be maintained, insulation shall be applied with a continuous, unbroken moisture and vapor retarder. All hangers, supports, anchors, or other projections secured to cold surfaces shall be insulated and vapor sealed to prevent condensation. Wheatpaste must not be used.

3.1.9 All pipe insulation shall be continuous through walls, ceiling or floor openings or sleeves except where firestop materials are required.

3.1.10 Install multiple layers of insulation with longitudinal and circumferential joints staggered.

3.1.11 Galvanized sheet metal shields, minimum 250mm (10") long and 1.3mm (18 gauge) thickness, shall be installed between hangers or supports and the piping insulation. Rigid insulation inserts shall be installed as required between the pipe and the insulation shields. Inserts shall be of equal thickness to the adjacent insulation and shall be vapor sealed as required. Inserts made of wood are not acceptable. Insulation inserts shall be no less than the following lengths:

3.1.11.1	40mm (1½″) to 65mm (2½″) IPS	250mm (10″) long
3.1.11.2	75mm (3″) to 150mm (6″) IPS	300mm (12″) long
3.1.11.3	200mm (8″) to 250mm (10″) IPS	400mm (16″) long
3.1.11.4	300mm (12″) and over IPS	550mm (22″) long

3.1.12 For piping, ductwork or equipment exposed in mechanical rooms or high traffic areas, insulation shall be protected from abuse by the use of appropriate thickness of PVC jacketing, metal jacketing or laminated self-adhesive water and weather seals.

3.1.13 On boiler breeching, generator exhaust pipes and mufflers stagger half sections and butt one-piece sections firmly together. Recover insulation with glassfiber cloth, adhered with fire retardant and high temperature rated adhesive. Insulation shall be banded securely in place with 20mm x 0.5mm (¾" x 0.02") stainless steel bands on maximum 300mm (12") centres and recovered with metal jacketing secured using additional banding or sheet metal screws. Position bands at butt joint overlaps and in between joints to secure jacket.

3.1.14 Insulate over flanges and mechanical couplings with specified insulation and thickness, sized to suit flange diameters. Fill spaces between insulation and adjoining pipe insulation with similar material. Recover in exposed areas with canvas or PVC jackets.

3.1.15 If not using preformed insulation, wrap all valves and inline components in cold piping and in hot piping above 60°C (140°F) operating temperature with flexible duct insulation, under compression at 2 to 1 ratio. Recover in exposed areas with field applied jackets.

3.1.16 Cover the first 150mm (6") of hanger rods directly connected to cold piping, with block or sectional insulation. Finish to match jacket on piping. Recover in exposed areas with canvas jacket.

3.1.17 Cover all insulated electrically traced piping, and all insulated piping, ductwork or equipment exposed to the outside with weatherproof field applied jacket.

3.1.18 Insulate all silencer casings where no internal media contacts wall.

3.1.19 All aluminum and PVC recovery jackets shall be removable and reusable.

3.1.20 Dampers, supports, anchors, etc. that are secured directly to cold

surfaces must be adequately insulated and vapour sealed to prevent condensation.

3.1.21 Cover expansion joints first with a 0.7mm (24 gauge) galvanized metal sleeve and then insulate to provide equivalent thickness to that on adjoining pipe.

3.1.22 Ensure insulation is continuous through non-fire rated walls and floors. Terminate insulation neatly on either side of a fire rated barrier. Fill space between pipe and construction with fire retardant sealant. Insulation or recovery jacket shall not penetrate fire-rated construction.

3.1.22.1 Outdoor ductwork or insulation shall be installed so as to shed water and not allow standing water.

3.1.23 Insulate electrically traced piping and equipment only after pipe tracing has been installed and tested.

3.1.24 Repair/replace all insulation damaged during construction with the thickness, quality, and finish of original insulation.

3.1.25 Make good and refinish cracks, undulation or any other deficiencies occurring in the insulation or vapour barrier. Priming or painting of insulation will be done under Division 9 – Finishes.

END OF SECTION

Project Name: *UNIVERSITY OF TORONTO MISSISSAUGA*
Project No.: *2023-0059*
Section Name: ***Commissioning***
Section No.: ***20 08 00***
Date: *November 15, 2024*

INDEX

1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this section.

1.1.2 This Section of the specification shall be read in conjunction with all other Sections of the Division 21, 22, 23 and 25 Specifications, which include details of specific tests / inspections to be performed on various equipment / systems in addition to those specified in this Section.

1.1.3 The Appendix A to this Section details Owner's requirements for training of their Operation and Maintenance (O&M) personnel. The Appendix B to this section details Owner's requirements for O&M Manuals. The Contractor shall meet the requirements of these Appendices, which are to be read in conjunction with the Division 21, 22, 23 and 25 Specifications. In the even of a conflict between Division 21, 22, 23 and 25 Specifications and the Appendices, the more stringent shall apply and the Commissioning Coordinator's decision shall be final. The scope and responsibilities of various parties mentioned in the Appendices do not in any way reduce the Contractors' scope or responsibilities as defined in the Division 21, 22, 23 and 25 Specifications.

1.2 COMMISSIONING COORDINATOR

1.2.1 The Owner shall directly employ the services of a Commissioning Coordinator (who will act on behalf of the Owner as the Commissioning Authority) whose responsibilities include:

1.2.1.1 Organize all necessary meetings of the commissioning team, act as chairperson at all commissioning meetings and events, prepare agenda for the events, and issue minutes of meeting.

1.2.1.2 Report to the Owner and Construction Manager on the status, integration, and performance of mechanical systems provided as a part of the Works.

1.2.1.3 Review Contractor's Commissioning Plan.

1.2.1.4 Review shop drawings approved by the Consultants for compatibility with commissioning requirements.

1.2.1.5 Review Commissioning Schedule, prepared, coordinated, and

submitted by the Contractor.

1.2.1.6 Ensure that the Contractor successfully conducts all specified and/or necessary tests on systems, equipment, and components during construction and that all tests are recorded by the Contractor for retention as part of Commissioning Documents. Witness or verify tests as appropriate.

1.2.1.7 Review and approve all Commissioning Report Forms, record sheets etc. proposed by the Contractor.

1.2.1.8 Periodically monitor assembly of material for O&M Manuals by the Contractor to ensure timely completion of manuals.

1.2.1.9 Periodically monitor preparation of Record Drawings by the Contractor to ensure timely completion of drawings.

1.2.1.10 Monitor progress of commissioning relative to the Commissioning Schedule and periodically report the status, pending problems and/or disputes to the Owner and Construction Manager.

1.2.1.11 Witness, check, and verify a percentage of all reported results of commissioning tests and procedures including Testing Adjusting and Balancing (TAB), start-up, verification and Functional Performance Tests (FPT).

1.2.1.12 Examine all deviations in test results and in performance, confirm as acceptable or otherwise, and advise Owner and Construction Manager of corrective action required from the Contractor.

1.2.1.13 Ensure that all deficiencies discovered during commissioning testing are identified, documented and assessed for their severity and impact on proper system performance and forwarded to the Owner and Construction Manager.

1.2.1.14 Review of Final Commissioning Report prepared by the Contractor for completeness including identification of all problems encountered during commissioning and operation phases.

1.2.1.15 Review of O&M Manuals prepared by Contractor for completeness and submission to Consultant for approval.

1.2.1.16 Review of Record Drawings to ensure that they reflect the approved results of commissioning and submission to Consultant for approval.

1.2.1.17 Assist in the scheduling of training for Owner’s O&M personnel.

1.2.1.18 Ensure completion and documentation of commissioning activities not concluded during the commissioning phase due to seasonal operation constraints or testing which requires long term monitoring and analysis.

1.3 COMMISSIONING CONTRACTOR

1.3.1 The Division 21, 22, 23 and 25 Contractors shall be the Commissioning Contractors (Contractors) for all systems and equipment provided under their respective Divisions.

1.3.2 Division 21, 22, 23 and 25 each shall provide a single person to act as a Commissioning Manager for their respective Division. The Commissioning Managers shall be responsible for progressing the activities of each Division trade, and report to the Commissioning Coordinator.

1.3.3 Supply the name, qualifications, and experience of the proposed Commissioning Manager to the Commissioning Coordinator prior to commencement of the work. Selection shall be subject to the review and approval of the Commissioning Coordinator. Supply alternate person(s) when requested by the Commissioning Coordinator.

1.4 SCOPE OF WORK

1.4.1 The Contractor shall provide all labour, materials, tools, equipment, documentation, training, and certification required to commission all mechanical systems provided for the Works including, but not limited to, the following:

1.4.1.1 HVAC terminals including VRF system, heat pump units, VAV boxes, and perimeter radiation.

1.4.1.2 Air handling / air distribution systems.

1.4.1.3 Laboratory Exhaust, Washroom exhaust, and General exhaust systems.

1.4.1.4 Water treatment systems.

1.4.1.5 Building Automation System (BAS) and controls.

1.4.1.6 Domestic cold water system.

1.4.1.7 Domestic hot water system.

1.4.1.8	Sanitary drainage system.
1.4.1.9	Storm water drainage system.
1.4.1.10	Sprinkler system.
1.4.1.11	Fire standpipe system.
1.4.1.12	Motor Control Centres.
1.4.1.13	Variable Frequency Drives.
1.4.1.14	Electric power supplies included under Division 21, 22, 23 and 25's scope.
1.4.1.15	Site services.
1.4.2	Commissioning work shall include, but not be limited to:
1.4.2.1	Attendance at all Commissioning Meetings.
1.4.2.2	Preparation of Commissioning Plan.
1.4.2.3	Preparation of Commissioning Schedule.
1.4.2.4	Development and completion of Commissioning Report forms and check sheets for each system and piece of equipment.
1.4.2.5	Demonstration to the Owner and Consultant(s) that the equipment/system have been installed per contract documents.
1.4.2.6	Preparation of O&M Manual.
1.4.2.7	Preparation of Record Drawings.
1.4.2.8	Start-up and verification of systems and equipment.
1.4.2.9	Performance testing of equipment.
1.4.2.10	Review and verification of Testing, Adjusting and Balancing work and report.
1.4.2.11	Correction of all deficiencies and performance deviations.
1.4.2.12	Demonstration and training to Owner and Consultant of all systems and equipment provided in this Division.
1.4.2.13	Preparation and assembly of Commissioning Documentation.

1.4.2.14 Coordination of Division 21, 22, 23 and 25 commissioning activities with all other trades.

1.4.2.15 Coordinate with and assist Division 26 – Electrical for Commissioning of Division 26 – Electrical works.

1.4.3 Provide qualified personnel and all necessary equipment / measuring / recording instruments etc. to perform commissioning tests (including seasonal testing required after the initial testing) and their verification / witnessing by the Commissioning Coordinator.

1.4.4 Provide equipment, materials, and labour as necessary to correct construction and/or equipment deficiencies found during the commissioning process. Repeat the necessary tests to the satisfaction of Consultants and the Commissioning Coordinator.

1.4.5 Perform detailed testing on all installed equipment and systems to ensure that operation and performance conform to Contract Documents. All tests shall be offered for witnessing by the Commissioning Coordinator and Consultant. Apart from tests and inspections specified elsewhere in this division, perform the following tests as part of the commissioning process:

1.4.5.1 Verification tests including a full range of checks and tests to determine that all components, equipment, systems, and interfaces between systems are installed and operate in accordance with Contract Documents. This includes all operating modes, interlocks, control responses, and specific responses to abnormal or emergency conditions.

1.4.5.2 Functional Performance Tests (FPT) to determine if the Mechanical systems provide the required services in accordance with the finalized design intent.

1.4.6 Comprehensive training of Owner's O&M personnel shall be performed by the Contractor, and where appropriate, by other sub-contractors, and vendors prior to turnover of building to the Owner. The training shall include on-site familiarization, classroom instruction and with hands-on instruction on the installed equipment and systems. The Contractor shall provide all necessary training material and documents.

1.4.7 Provide attendance at the site at minimum once each month from Substantial Completion up to one (1) month after the first year warranty review, at a date and time to be arranged by the

Consultant or Commissioning Coordinator. Follow up and rectify deficiencies and other issues raised during this site review.

1.4.8 Attend all commissioning meetings organized by the Commissioning Coordinator or Consultant. The meetings will commence no later than two (2) months after award of contract, will be held (as a minimum) once a month during the first half of the construction period, and thereafter, the frequency will increase as deemed necessary by the Commissioning Coordinator or Consultant to accomplish timely commissioning.

1.4.9 Ensure and pay for attendance at all commissioning meetings by the sub-contractors (including, but not limited to, the sheet metal, piping, sprinkler, BAS and controls, water treatment, TAB sub-contractors) and major equipment suppliers as required by the Commissioning Coordinator or Consultant.

1.4.10 Prepare a detailed Commissioning Schedule for commissioning of all mechanical systems and equipment in coordination with the General Contractor's / Construction Manager's schedule and to the approval of Commissioning Contractor. Update the schedule as appropriate through the construction period.

1.4.11 Prepare all documents related to commissioning of the mechanical systems. Documentation required as part of the Commissioning process shall include, but not limited to:

1.4.11.1 Commissioning Plan.

1.4.11.2 Commissioning Schedule.

1.4.11.3 Design intent narrative, systems descriptions, Basis of Design including the design criteria, setpoints, design conditions, etc. These documents shall be based, where appropriate, on Division 21, 22, 23 and 25 Specifications, Drawings, approved shop drawings, and input from the Consultant.

1.4.11.4 Completed commissioning check sheets.

1.4.11.5 Independent test reports, including Testing, Adjusting and Balancing (TAB), equipment manufacturers' certification letters, reports from Authorities having jurisdiction (AHJ), etc.

1.4.11.6 Inspection and performance test reports.

1.4.11.7 Operation and Maintenance Manuals.

1.4.11.8 User and Operator Training Manuals.

1.4.11.9 Tender drawing and specifications.

1.4.11.10 Change orders.

1.4.11.11 Record drawings.

1.4.11.12 Permits and licenses.

1.4.11.13 Warranties.

1.4.11.14 Post occupancy optimization reports.

1.4.11.15 Other documents as required.

1.4.12 The Commissioning Coordinator may, at their discretion, advise in the commissioning process. Meet all requirements of the Commissioning Coordinator and provide cooperation.

1.5 COORDINATION

1.5.1 Coordinate the work of this Section with all other Divisions to ensure complete and operational mechanical systems at completion of this work.

1.5.2 Review the design intent of the project and the intended operation of systems with the Commissioning Coordinator and Consultant before proceeding with commissioning.

1.6 QUALITY ASSURANCE

1.6.1 The commissioning process shall meet the requirements of CAN/CSA Z31 series, the Code of Practice for Commissioning Mechanical Systems in Buildings and ASHRAE Guideline 1.1 - 2007 The HVAC Commissioning Process except as specifically modified by this specification.

1.7 SPECIALIST COMMISSIONING COMPANY

1.7.1 Division 21, 22, 23 and 25 may elect to source start-up and handover by a specialist commissioning company. Supply to the Commissioning Coordinator, the following details regarding the proposed firm:

1.7.1.1 Principle representative and qualifications.

1.7.1.2 Proposed personnel and relevant project experience.

1.7.1.3 Previous similar assignments and references.

1.7.1.4 Scope of work to be undertaken.

1.7.1.5 Company resources and equipment.

1.7.2 Use of a commissioning specialist shall not relieve Division 21, 22, 23 and 25 Contractors of the obligation to name one of their own employees as the person responsible for progressing commissioning, i.e. the Commissioning Manager.

2 PRODUCTS

2.1 INSTRUMENTS

2.1.1 Prior to commencing commissioning activities on site, the contractor shall submit list of all measuring / recording instruments to be used on the project, along with calibration certificates, for Commissioning Coordinator's approval.

3 EXECUTION

3.1 SCHEDULE AND COMPLETION OF INSTALLATION OF SYSTEMS

3.1.1 Submit to the Commissioning Coordinator, within 90 days of award of contract, a detailed and comprehensive installation completion / start-up / testing schedule, identifying all trades and suppliers to be involved. Coordinate the schedule with General Contractor's / Construction Manager's overall Construction schedule. Update the schedule and resubmit for review, periodically as required, and on a biweekly basis during the course of commissioning. If found to be unacceptable, revise the schedule and the construction forces to suit the reviewed schedule. This schedule shall include, but is not limited to the following items:

3.1.1.1 Installation and testing of pipe systems.

3.1.1.2 Installation, leak testing, and cleaning of duct systems.

3.1.1.3 Chemical clean out and treatment of pipe systems, including disinfection of domestic water piping.

3.1.1.4 Control system wiring (by Controls Contractor).

3.1.1.5 Electrical works under Scope of Division 21, 22, 23 and 25 Contractors.

3.1.1.6 Air and water balancing (by Balancing Contractor).

3.1.1.7 Electrical service connections (by Electrical Contractor).

3.1.1.8 Equipment suppliers' prestart checkout and certification of the equipment installations, including controls.

3.1.1.9 Start up of various pieces of equipment and systems.

3.1.1.10 Operational testing of system components.

3.1.1.11 Performance testing of equipment and systems.

3.1.1.12 Acceptance testing of equipment installations and system including fire and sprinkler systems, by authorities having jurisdiction and Owner’s insurance company.

3.1.1.13 Troubleshooting.

3.1.1.14 Calibration of controls and point checkout (by Division 25 Contractor).

3.1.1.15 Control software setup and checkout including seasonal and response checkout or operating sequences, PID optimization (By Division 25 Contractor).

3.1.1.16 Emergency system checkout.

3.1.1.17 Fire alarm and control system interfacing (by Division 25 Contractor & Division 26 - Electrical).

3.1.1.18 Submittal of completed equipment and system check sheets.

3.1.1.19 Demonstration of systems and equipment.

3.1.1.20 Record Drawing preparation and submittal.

3.1.1.21 O&M manual preparation and submittal.

3.1.1.22 O&M personnel training program.

3.1.1.23 Stair pressurization testing.

3.1.1.24 Verification / witnessing of commissioning tests and TAB by the Commissioning Coordinator and/or Consultant.

3.2 RECORD DOCUMENTATION

3.2.1 Prepare record documentation for each equipment installation covering:

3.2.1.1 Equipment identification and supplier.

3.2.1.2 Shop Drawing submittal, review, production release, and delivery dates.

3.2.1.3 Dates for completion of all work required preparing for equipment installation.

3.2.1.4 Dates for equipment installation, supplier prestart checkout, and system availability for start-up.

3.2.1.5 Dates for equipment start-up, performance testing, proposal for temporary use, acceptance testing, demonstration, turnover and warranty start / finish.

3.2.2 Submit proposed record sheets and procedures to Commissioning Coordinator for review, when requested.

3.2.3 List all specialist personnel and equipment required for the tests, and ensure that these are available by the test dates.

3.2.4 Provide documentation of the commissioning process and include in maintenance manuals. These are to include check sheets, equipment data sheets, start-up certificates from suppliers involved in start-up, and documentation concerning demonstration to the Owner's O&M Personnel. Include all record and result sheets from commissioning tests.

3.2.5 Maintain a log of key operating parameters, problems encountered, solutions employed and verification of effectiveness of solutions. Include log in maintenance manuals.

3.2.6 Submit templates for all documentation including record sheets, check sheets, commissioning reports etc to Commissioning Coordinator for approval. Meet Commissioning Coordinator's requirements for level of reporting.

3.3 START-UP

3.3.1 Coordinate and supervise the start-up of the various pieces of equipment and systems. Utilize the start-up services of the manufacturer's representative. Ensure that the equipment is

operating in a satisfactory manner. Check the following items:

3.3.1.1 Direction of rotation.

3.3.1.2 Grease and lubricants.

3.3.1.3 Noise, if deemed to be a problem.

3.3.1.4 Seals.

3.3.1.5 Alignment of pump and fan drives by a millwright.

3.3.1.6 Piping connections and safeties.

3.3.1.7 Electrical amp draw, starting inrush current and trip / heater settings.

3.3.2 Meet Section 20 00 00 - General Requirements criteria for Temporary Services, Trial Use, and Early Occupancy.

3.4 TROUBLESHOOTING

3.4.1 Resolve inter-division coordination problems.

3.4.2 Where problems become apparent during the commissioning process, identify and resolve these problems. The basic functions in troubleshooting shall include:

3.4.2.1 What – identification and definition of the problem.

3.4.2.2 Why – determination and evaluation of the causes.

3.4.2.3 When – determine the time available to resolve the problem.

3.4.2.4 Involve the Consultant in the review of the problem and proposed resolution, and keep Commissioning Coordinator informed.

3.4.2.5 Coordinate remedial action with the appropriate parties.

3.4.2.6 Evaluate the effectiveness of the remedial action.

3.4.2.7 Record the problem, cause, remedial action, and result.

3.5 OPERATION AND TESTING

3.5.1 Meet Section 20 00 00 – General Requirements and 20 05 93 – Testing, Balancing and Adjusting requirements for inspection, testing and certificates.

3.5.2 Test the operation of the individual components and systems. Go through each step of the sequence of operation and verify that each component operates correctly. Direct and ensure that all trades involved make the required changes and adjustments to effect the proper operation of all components and systems. Meet commissioning test requirements.

3.5.3 Document operation and testing.

3.5.4 Carry out operational tests for the current season and simulate operation of summer, winter, and intermediate seasons.

3.6 DEMONSTRATION

3.6.1 Demonstrate to the Owner the proper operation of all equipment and systems supplied under this Division. Demonstrations shall occur only after the operation and testing has been successfully completed. Ensure that Trade Contractor and equipment suppliers participate in the demonstration as required.

3.6.2 Meet Section 20 00 00 – General Requirements criteria for instruction to Owners and requirements of Appendix A to this section.

3.7 TRAINING

3.7.1 Organize and provide comprehensive training to the Owner's O&M Personnel on all mechanical equipment, systems and components provided for the Works. Training shall be carried out by the Contractor (and vendors / suppliers where appropriate) to meet the requirements of Appendix A and this Specification.

3.7.2 Secure and pay for the services of all manufacturer's of major equipment / systems for providing training on their respective systems. Such equipment / systems include:

3.7.2.1 Domestic water boilers

3.7.2.2 BAS and controls.

3.7.2.3 Air handling and make-up air units

3.7.2.4 Variable Refrigerant Flow System

3.7.3 The training shall include:

3.7.3.1 Familiarization sessions organized during the construction and

commissioning stages as necessary. The intent of these sessions is to fully familiarize the O&M personnel with the installation.

3.7.3.2 Hands-on training shall be provided on all systems, components and equipment and all commissioning procedures explained. This training shall be provided during the commissioning stage.

3.7.3.3 Classroom sessions during the commissioning stage to instruct the O&M personnel in the use of O&M Manuals and other commissioning documentation.

3.7.3.4 All classroom training, field training and demonstrations shall be video recorded for future reference. All recordings shall be delivered to the Commissioning Coordinator on DVD format for review with seven (7) days of the session. All recordings shall be formatted to be played on a standard DVD player and include electronic copies of all classroom materials used throughout the training.

3.7.4 The Contractor shall prepare all necessary system descriptions, sequence of operation documents, schematic diagrams, control schematics, catalogue cuts, wiring diagrams and similar documents as required for imparting training. As far as practical, the documents should be same as those intended for use in O&M manuals. The Contractor shall compile all training documents and make them available to O&M personnel prior to training and for retention throughout training period.

3.7.5 Contractor shall pay for all audio / visual training aids (such as video presentations, slides, projectors and similar equipment) and space for imparting training.

3.7.6 The training shall be imparted during normal working hours and the duration shall be as necessary to meet the Owner's requirements, but in any case not less than 15 hours for familiarization and 35 hours for classroom and hands-on sessions.

3.7.7 Training for Mechanical Services shall be imparted to up to ten (10) O&M Personnel.

3.8 <u>OPERATING AND MAINTENANCE MANUALS</u>

3.8.1 Meet requirements of Section 20 00 00 – General Requirements, of this Section, and of Appendix B. Documents such as system description, sequence of operation (including start-up and shut-down procedures) shall be compiled by the Contractor from the

specification, drawings and approved shop drawings and included in the manuals after Consultant's approval.

3.9 RECORD DRAWINGS

3.9.1 Meet requirements of Section 20 00 00 – General Requirements and of this Section.

3.10 SPARE PARTS

3.10.1 Provide a list of spare parts, special tools, lubricants, etc. for each item of equipment, which has been purchased as part of the Contract.

3.10.2 Provide a listing of recommended spare parts for all equipment installed under Division 21, 22, 23 and 25, to cover a period from Substantial Completion to Warranty end.

3.10.3 Provide at minimum, the following information for recommended spare parts:

3.10.3.1 Manufacturer's name, address, phone and fax numbers.

3.10.3.2 Manufacturer's part name, part number, unit price, lead time, shelf life.

3.10.3.3 Quantity recommended for one (1) year.

3.10.3.4 Alternative suppliers of compatible parts, including local supplier name, address, phone and fax numbers.

3.10.4 Submit preliminary list of spare parts and tools to Owner to least 30 days prior to intended system handover to Owner. The Owner reserves the right to add to, reduce, or omit entirely, the recommendations contained on these lists.

3.10.5 Meet requirements of Appendix B.

3.11 COMMISSIONING TESTS

3.11.1 Verify readings, calibration and setup of sensors and equipment, including, but not limited to, the following:

3.11.1.1 Temperature sensors.

3.11.1.2 Freeze protection devices.

3.11.1.3 Flow switches.

3.11.1.4 Status switches.

3.11.1.5 Temperature and pressure gauges and gauge connection utilization.

3.11.1.6 Control damper positioning, including tightness when closed and full open / balance position.

3.11.1.7 Alarm contacts.

3.11.1.8 Pressure sensors.

3.11.1.9 Refrigerant sensors.

3.11.2 Verify correct sensors are reporting accurately to the distributed field panels and operator workstation.

3.11.3 Operate chiller and verify operation including, but not limited to, the following:

3.11.3.1 Full checkout by manufacturer's start-up representative.

3.11.3.2 Start / stop from local MCC and from BAS.

3.11.3.3 Chilled water temperature control.

3.11.3.4 Safety interlocks.

3.11.4 Operate each air handling unit. Verify operation with respect to sequence of operation. As a minimum, verify the following:

3.11.4.1 Start / stop from local panel and BAS terminal.

3.11.4.2 Correct open / close and modulation procedures with valves and dampers.

3.11.4.3 Stable operation of controls under normal conditions and with changes in air / water / on / off conditions.

3.11.4.4 Trend logs operation indication.

3.11.4.5 Piping, sensor, and unit installation.

3.11.4.6 Filters.

3.11.4.7 Drain pan operation and trap priming.

3.11.4.8 Alarm indications.

3.11.5 Verify operation of condenser water system and support systems, including, but not limited to, the following:

3.11.5.1 Full checkout by manufacturer's start-up representatives.

3.11.5.2 Makeup water system.

3.11.5.3 Condenser water pumps with sequence of operation and flow rates.

3.11.6 Verify operation of heated water and chilled water pumps and support systems, including, but not limited to, the following:

3.11.6.1 Full checkout by manufacturer's start-up representative.

3.11.6.2 Heat exchanger operation.

3.11.6.3 Temperature control stability.

3.11.6.4 Strainer and filter performance.

3.11.6.5 Pumping.

3.11.7 Verify pipe cleaning and chemical treatment condition for all systems.

3.11.8 Verify duct cleaning, air and water balancing and air pattern adjustments.

3.11.9 Verify access to each fire damper.

3.11.10 Verify that all cooling coil drain pans and condensate piping operate.

3.11.11 Verify backflow preventer operation.

3.11.12 Verify operation of fire protection system including flow switches and supervisory switches.

3.11.13 Demonstrate access to all valves, equipment, and components for servicing.

3.11.14 Coordinate with Division 26 - Electrical, a power failure test with emergency generator start-up. Verify the following (as a minimum):

3.11.14.1 Miscellaneous equipment on emergency power, with Division 26 - Electrical.

3.11.14.2 Stability of control equipment with start-up power surge.

3.11.14.3 Controls systems recovery.

3.11.14.4 Generator cooling air intake, exhaust, and re-circulation system.

3.11.14.5 Division 23 – HVAC to refill fuel oil system following the completion of mechanical tests.

3.11.15 Verify operation of domestic cold water system including full checkout by booster pump manufacturer's start-up representative. Verify flow at sanitary fixtures.

3.11.16 Verify operation of domestic hot water system including temperature control stability and flow at sanitary fixtures.

3.11.17 Verify the operation of all other equipment provided under Division 21, 22, 23 and 25.

3.11.18 Verify that interfacing to the work of other Divisions results in complete and operational systems.

3.11.19 Test all individual equipment and system responses to power fluctuations and interruptions.

3.11.20 Test the ability of the BAS system to perform a power fail restart of the systems effectively and in coordination with the electrical system to prevent electrical system overloading. (This depends on the electrical system response and degree of BAS monitoring.)

3.11.21 Test redundant systems to ensure they provide the required back-up in the event of a primary system failure.

3.11.22 Test the system response to the loss of communication between the various levels of control system architecture.

3.11.23 Test the system response to the loss of cooling.

3.11.24 Test the system response to the loss of heating.

3.12 FUNCTIONAL PERFORMANCE TESTS

3.12.1 Carry out, record, document and offer for witnessing all measurements necessary to determine the capacity of all heating /

cooling equipment and heat exchangers provided for the works including, but not limited to, the following:

3.12.1.1 Domestic hot water heaters

3.12.1.2 VRF indoor units and condenser units.

3.12.1.3 Cooling and heating coils of air handling units.

3.12.1.4 Cooling coils of each type and model of fan coil units.

3.12.2 Contractor shall include for all costs related with simulating the internal loads if necessary and/or for deferring the tests to the appropriate season. However all tests must be completed satisfactorily within twelve (12) months of substantial completion.

3.12.3 Measure and record the temperature in all occupied spaces of the Works. Also record the setpoint temperatures. Measurements shall be carried out on two occasions within the first year of operation at times to be determined by the Commissioning Coordinator; once during summer and once during winter.

3.12.4 Rectify any deficiencies noted in the above tests and include comprehensive report in the commissioning documents.

3.12.5 Contractor shall employ the services of the TAB contractor to carry out the FPT's. TAB contractors scope as defined in Section 20 05 93 - Testing, Balancing and Adjusting shall be extended to include these works.

3.12.6 Ensure all other performance tests specified elsewhere in the specifications (including, but not limited to, sound levels and vibrations) are carried out at this stage, offered for witnessing and all test sheets are included in the commissioning documents.

3.13 <u>SITE ACCEPTANCE TESTING FOR BAS & CONTROLS</u>

3.13.1 In addition to the tests / demolition specified under Division 25 and elsewhere in this Section, the following requirements apply for BAS and Control system:

3.13.1.1 Perform a complete demonstration of the BAS real-time responsibilities of surveillance and command prior to online operation.

3.13.1.2 Advise the Commissioning Coordinator, Consultant, and Owner, in writing, at least two (2) weeks in advance of readiness to perform

tests.

3.13.1.3 Note deficiencies and correct starting and continuing tests. Perform calibration and operational checks prior to the commencement of final acceptance testing for all relevant system parts.

3.13.1.4 Perform final acceptance testing at the following defined levels:

3.13.1.4.1 Per point basis.

3.13.1.4.2 Per system basis.

3.13.1.4.3 Software functions and packages basis.

3.13.1.4.4 Per building basis.

3.13.1.4.5 Total BAS basis.

3.13.1.5 Make available on site for the duration of these tests, all installation, engineering, software, system and personnel, required to enable test completion.

3.13.1.6 Demonstrate the specified performance of the BAS software and hardware, at all levels from individual end devices through to total system operation and the proper operation / undertaking of all other items of work performed under this Contract.

3.13.1.7 Specifically orient acceptance test procedures to demonstrate the satisfactory operation of aspects of the operator interface terminals.

3.13.1.8 Perform and complete and detailed calibration and operational check for each individual BAS point and control function contained within the supplied system. Check to ensure that all equipment, software, network elements, modules and circuits provided are functioning to meet the Specification and record on long sheets.

3.13.1.9 Randomly test the response to the following sensor failures:

3.13.1.9.1 Space temperature.

3.13.1.9.2 Fluid temperature (air and water).

3.13.1.9.3 Flow sensor (air and water).

3.13.1.9.4 Pressure sensor (air and water).

3.13.1.10 Repeat acceptance testing until acceptance performance has been established.

3.14 POST SUBSTANTIAL PERFORMANCE VISITS

3.14.1 Visit the site and the Owner's representative with the Consultant each month after Substantial Completion up to one (1) month after the first year warranty review.

3.14.2 Review the operation of the system.

3.14.3 Correct any operating problems, if problem is related to warranty issues, and follow up on deficiencies and other issues raised.

3.14.4 Prepare a report for the Consultant and Construction Manager for inclusion in the Operating Manuals of the problems and issues that have arisen and the corrective action(s) recommended and implement.

END OF SECTION

INDEX

1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 – General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools equipment, training commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 Variable frequency drives (VFDs).

1.2.1.2 Line filters

1.2.2 Power wiring from power supply to each VFD shall be by Division 26 - Electrical. Power wiring from the VFDs to the motors shall be provided under this Division, by the Subcontractor responsible for the provision of the respective motor.

1.3 SUBMITTALS

1.3.1 Provide shop drawings for VFDs, including performance data, dimensions, shipping section dimensions, weight, control schematics, external connection diagram showing function and identification of all terminals requiring field connections.

1.3.2 Provide operating and maintenance information and commissioning report prepared by authorized manufacturer's representative.

1.3.3 Manufacturer shall submit a computerized harmonics analysis of the facility system based on the most recent single line diagram. Analysis shall illustrate the effect of VFDs on system harmonics.

1.4 ELECTRICAL EQUIPMENT AND WORK

1.4.1 Read together with Division 26 - Electrical and adhere to its requirements. Supply and install all electrical apparatus, which is required and is not covered by Division 26 - Electrical.

1.4.2 All VFDs shall be cUL or CSA/UL approved.

2 **PRODUCTS**

2.1 DESIGN

2.1.1 Manufacturer shall provide passive matrix-type line filters at the input of each VFD, for motors over 15HP, to reduce the total harmonic current level (THID) to less than 5% at the VFD input where the analysis has shown that the incremental effect of the addition of the VFDs would cause the THID to exceed the allowable values per IEEE 519-2014.

2.1.2 The VFD shall convert incoming fixed frequency three-phase AC power into an adjustable frequency and voltage for controlling the speed of three-phase AC induction motors. The motor current shall closely approximate a sine wave.

2.1.3 The VFD shall be UL listed for a short circuit current rating (SCCR) of 100 kA and labeled with this rating.

2.1.4 The VFD shall have a dual 5% impedance DC link reactor on the positive and negative rails of the DC bus to minimize power line harmonics and protect the VFD from power line transients. The chokes shall be non-saturating. Swinging chokes that do not provide full harmonic filtering throughout the entire load range are not acceptable. VFDs that do not include 5% DC link impedance shall include 5% AC line reactors in the options enclosure.

2.1.5 The VFD must be able to produce full torque at low speed to operate direct drive fans.

2.1.6 The VFD must be capable of connection and disconnection to motor while the VFD is under load. This switching shall be accomplished without interlocks or damage to the VFD.

2.1.7 All VFDs shall contain integral electromagnetic interference (EMI) filters to attenuate radio frequency interference conducted to the AC power line.

2.1.8 Provide sine wave output filters on all 460 Volt and 575 Volt VFDs to limit the dV/dt to 1,000 Volts/0.5 micro seconds at the motor terminals where the developed wiring length between the VFD and the motor exceeds 30m (100 ft).

2.1.9 Provide incoming, horsepower rated, disconnect switch with an operating mechanism, door interlocked and padlockable in the open position.

2.1.10 AC line voltage variation, -10 to +10% of nominal with full output

2.1.11 All VFDs shall be plenum rated.

2.2 PROTECTION

2.2.1 Provide the following VFD protection features as a minimum:

2.2.1.1 Line over and under voltage protection.

2.2.1.2 Phase loss and unbalance protection.

2.2.1.3 Short circuit protection for line to line and line to ground faults.

2.2.1.4 Electronic instantaneous overcurrent protection.

2.2.1.5 Current sensors on all three output phases to accurately measure motor current, protect the VFD from output short circuits, output ground faults, and act as a motor overload.

2.2.1.6 Motor preheat feature to keep the motor warm and prevent condensation build up in the motor when it is stopped in a damp environment by providing the motor stator with a controlled level of current.

2.2.1.7 Internal over temperature protection.

2.2.1.8 Electronic motor stall protection to trip the VFD off should a motor overload or stall occur.

2.2.1.9 VFD shall catch a rotating motor operating forward or reverse up to full speed without VFD fault or component damage.

2.2.1.10 The VFD shall store in memory the last 10 alarms. A description of the alarm, and the date and time of the alarm shall be recorded. The VFD shall include graphing capability for the last 2 alarms to provide additional diagnostic analysis.

2.2.1.11 When used with a pumping system, the VFD shall be able to detect no-flow situations, dry pump conditions, and operation off the end of the pump curve. It shall be programmable to take appropriate protective action when one of the above situations is detected.

2.2.1.12 The VFD shall be able to provide full rated output current continuously, 110% of rated current for 60 seconds and 135% of rated torque for up to 0.5 second while starting.

2.3 ENVIRONMENT

2.3.1 The VFD shall have the following minimum environmental tolerances.

2.3.1.1 Ambient temperature range of 0ºC to 45ºC (32ºF to 113ºF). Units located in non-heated areas shall be provided with thermostatically controlled heater weather enclosure.

2.3.1.2 Maximum humidity of 95% non-condensing.

2.3.1.3 Maximum altitude of 1,000m (3,300ft) for rated output.

2.4 PERFORMANCE

2.4.1 The VFD shall have the following performance features as a minimum:

2.4.1.1 Minimum line side displacement power factor of 0.96 at all speeds and loads.

2.4.1.2 Adjustable minimum and maximum motor frequency of 0 to 120 Hz.

2.4.1.3 Separately adjustable acceleration and deceleration ramps from 0.1 to 3,600 seconds with damping and smoothing parameters for (0% to 100% speed).

2.4.1.4 DC Injection Braking.

2.4.1.5 Automatic restart after an inverter fault trip. The VFD shall attempt to restart automatically 5 times with Lock-Out after the fifth attempt if a restart has not occurred.

2.4.1.6 The VFD shall restart the motor at the speed at which it is rotating and then re-accelerate to the speed called for by the speed reference signal.

2.4.1.7 Capable of running without a motor connected for setup and testing.

2.4.1.8 Capable of accepting the opening of a remote motor disconnect while running without causing damage to the VFD.

2.4.1.9 Auto restart after power outage.

2.4.1.10 Skip frequency reject point to prevent the fan/pump from operating at a resonant speed. Adjustable centre frequency with a band width of 0 - 10 Hz.

2.4.1.11 Automatic/manual signal follower for 4-20 mA, 0-20mA, 0-10 VDC or 2-10 VDC reference.

2.5 OPERATOR INTERFACE

2.5.1 Provide a door mounted keypad with an Alpha-numeric high resolution display to allow the operations personnel to set up and monitor the VFD parameters, observe output speed, load or other programmable values and monitor status and fault information, complete with tactile keys and backlit display.

2.5.2 The VFD shall be programmable to provide a digital output signal to indicate whether the VFD is in Hand or Auto mode. This is to alert the Building Automation System whether the VFD is being controlled locally or by the Building Automation System

2.5.3 Provide maintenance monitoring to display the time since starting, total elapsed run time and total power consumed in kWh. Also provide maintenance target alarm to alert the operator with a displayed message.

2.5.4 Provide the following control functions on the door mounted keypad:

2.5.4.1 Run (Hand and Auto Mode)

2.5.4.2 Stop (Hand and Auto Mode)

2.5.4.3 Parameterization button (to toggle between parameters)

2.5.5 Provide a selectable display to observe the following parameters:

2.5.5.1 Frequency

2.5.5.2 Motor Current

2.5.5.3 Motor Voltage

2.5.5.4 VFD Output Power

2.5.5.5 VFD Output Energy

2.5.5.6 VFD Temperature

2.5.6 Controller shall accept up to three feedback signals. It shall be programmable to compare the feedback signals to a common setpoint or to individual setpoints and to automatically select either

the maximum or the feedback signal as the controlling signal. It shall also be possible to calculate the controlling feedback signal as the average of all feedback signals or the difference between a pair of feedback signals.

2.5.7 The VFD shall have three additional PID controllers which can be used to control damper and valve positioners in the system and to provide setpoint reset. Floating point control interface shall be provided to increase/decrease speed in response to contact closures.

2.5.8 A run permissive circuit shall be provided to accept a “system ready” signal to ensure that the VFD does not start until dampers or other auxiliary equipment are in the proper state for VFD operation. The run permissive circuit shall also be capable of initiating an output “run request” signal to indicate to the external equipment that the VFD has received a request to run.

2.5.9 VFD shall be programmable to display feedback signals in appropriate units, such as inches of water column (in-wg), pressure per square inch (psi) or temperature (°F).

2.5.10 VFD shall be programmable to sense the loss of load. The VFD shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communications bus. To ensure against nuisance indications, this feature must be based on motor torque, not current, and must include a proof timer to keep brief periods of no load from falsely triggering this indication.

2.6 <u>BYPASS</u>

2.6.1 Provide components and circuitry necessary to safely bypass the motor from the VFD to line, or from the line to the VFD at zero speed.

2.6.2 Provide a door interlocked input circuit breaker to ensure positive shutdown of all input power to both the VFD and bypass. Motor protection to be provided in both modes of operation by a common thermal motor overload relay.

2.6.3 Provide mechanically interlocked contactors on the output of the VFD and in the bypass circuit.

2.6.4 Protective features:

2.6.4.1 Main input disconnect shall be provided that removes power from

both the bypass and VFD.

2.6.4.2 Main input motor rated fuses that protect the entire package.

2.6.4.3 VFD only fast acting input fuses shall be provided. Packages that include only main input motor rated fusing or circuit breaker are not acceptable.

2.6.4.4 Overload protection shall be supplied in bypass mode.

2.6.4.5 This overload shall supply minimum class 20 protection as well as wide adjustable current setting for complete motor protection when operating on line power. Those overloads that are not class 20 or current selectable will not be acceptable.

2.6.4.6 Overload protection shall include phase loss and phase imbalance protection.

2.6.4.7 For 600V units 75 HP and below and 208V/230V units 40 HP and below, low voltage contactor operation shall be maintained down to 70% of the unit's nominally rated voltage, to ensure VFD operation.

2.6.4.8 For 600V units 75 HP and below and 208V/230V units 40 HP and below, the VFD shall be able to operate the motor at a reduced load with the loss of any one of the three phases of power. Contactors shall remain closed regardless of which phase is lost to ensure VFD operation.

2.7 COMMUNICATION AND CONTROL

2.7.1 Four dedicated, programmable digital inputs shall be provided for interfacing with the systems control and safety interlock circuitry.

2.7.2 Two terminals shall be programmable to act as either as digital outputs or additional digital inputs.

2.7.3 Two programmable relay outputs, Form C 240 V AC, 2 A, shall be provided for remote indication of VFD status.

2.7.4 Two programmable analog inputs shall be provided that can be either direct-or-reverse acting.

2.7.4.1 Each shall be independently selectable to be used with either an analog voltage or current signal.

2.7.4.2 The maximum and minimum range of each shall be able to be independently scalable from 0 to 10 V dc and 0 to 20 mA.

2.7.4.3 A programmable low-pass filter for either or both of the analog inputs must be included to compensate for noise.

2.7.4.4 The VFD shall provide front panel meter displays programmable to show the value of each analog input signal for system set-up and troubleshooting,

2.7.5 One programmable analog current output (0 to 20 mA) shall be provided for indication of VFD status. This output shall be programmable to show the reference or feedback signal supplied to the VFD and for VFD output frequency, current and power. It shall be possible to scale the minimum and maximum values of this output.

2.7.6 It shall be possible through serial bus communications to read the status of all analog and digital inputs of the VFD.

2.7.7 Standard programmable firefighter's override mode allows a digital input to control the VFD and override all other local or remote commands. It shall be possible to program the VFD so that it will ignore most normal VFD safety circuits including motor overload. The VFD shall display FIREMODE whenever in firefighter's override mode. Fire-mode shall allow selection of forward or reverse operation and the selection of a speed source or preset speed, as required to accommodate local fire codes, standards and conditions.

2.7.8 The VFD shall include a standard EIA-485 communications port and capabilities to be connected to the following serial communication protocols at no additional cost and without a need to install any additional hardware or software in the VFD:

2.7.8.1 Johnson Controls Metasys N2

2.7.8.2 Modbus RTU

2.7.8.3 Siemens FLN

2.7.8.4 BACnet MS/TP

2.7.9 Option boards for the following protocols shall be available:

2.7.9.1 BACnet

2.7.9.2 Ethernet

2.7.9.3 DeviceNet

2.7.9.4 Profibus DP V1

2.7.9.5 Profinet SRT

2.7.9.6 Modbus TCP

2.7.9.7 LonWorks Free Topology (FTP) certified to LonMark standard 3.3

2.7.10 VFD shall have standard USB port for direct connection of Personal Computer (PC) to the VFD. The manufacturer shall provide no-charge PC software to allow complete setup and access of the VFD and logs of VFD operation through the USB port. It shall be possible to communicate to the VFD through this USB port without interrupting VFD communications to the building management system.

2.7.11 The VFD shall have provisions for an optional 24 V DC back-up power interface to power the VFD's control card. This is to allow the VFD to continue to communicate to the building automation system even if power to the VFD is lost.

2.8 SYSTEM OPERATION

2.8.1 If "Manual" mode is selected the VFD/motor shall start when the run key is depressed. The speed shall be controlled by depressing the Accelerate or Decelerate keys on the keypad or by the direct speed set mode.

2.8.2 If "Auto" mode is selected the VFD/motor shall start when a contact closure run command is received from the BAS. The speed shall be controlled by a speed reference signal from the BAS.

2.8.3 In the event of a power outage the VFD shall automatically restart when the power returns provided the run command is maintained.

2.8.4 In the event of an inverter fault trip, the VFD shall attempt to restart automatically up to maximum of five attempts. If, after five attempts, restart does not occur, the VFD shall lock out.

2.9 WARRANTY

2.9.1 The complete VFD shall be warranted by the manufacturer for a period of 12 months from the date of start-up. The warranty shall be provided by the VFD manufacturer and not a third party. A written warranty statement shall be provided with the submittals.

2.9.2 (Optional) The manufacturer shall offer an optional, extended

warranty allowing the VFD warranty to be extended to up to 6 years.

3 **EXECUTION**

3.1 INSTALLATION

3.1.1 Install each VFD in accordance with manufacturer's recommendations and local, provincial and national safety codes.

3.1.2 Use motors with a minimum of class F insulation. Motor shall meet NEMA MG-1 Part 31. Motor shall be rated for inverter duty.

3.1.3 Provide on-site commissioning (start-up) of the VFDs by a factory-authorized technician. Allow a minimum of 1/2 day per system. Also, include an allowance for a second visit to site of one-day duration to train operating personnel in the operation and maintenance of the VFDs.

3.1.4 Upon completion of the installation, the supplier of VFDs shall supply four complete sets of operation and maintenance manuals including wiring and connection diagrams.

3.1.5 Upon completion of the start-up, the supplier of VFDs shall supply four compete sets of typed report and one USB drive with parameters ready for uploading for future use.

END OF SECTION

DIVISION 22 – PLUMBING

SPECIFICATIONS

FOR THE

UNIVERSITY OF TORONTO MISSISSAUGA

PRE-ENGINEERED BUILDING

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DISCIPLINES
MECHANICAL
ELECTRICAL
FIRE PROTECTION
LIGHTING DESIGN
COMMUNICATIONS & AV
SECURITY & RISK
COMMISSIONING
ENERGY SERVICES

Our Project No. 2023-0059

SEAL:

November 15, 2024

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1.1 GENERAL

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1.2.1.1 All plumbing valves.

2 **PRODUCTS**

2.1 GENERAL

2.1.1 All valves shall be of one manufacture unless stated otherwise and should have the manufacturer's name and pressure ratings clearly marked on body. Valves to conform to the current of ANSI, ASTM, ASME standards, and to the applicable MSS.

2.1.2 Bronze valves up to and including 1034kPa (150 psi) steam pressure to be manufactured to ASTM B62-93 standard. Bronze valves up to 1379kPa (200 psi) and 2068kPa (300 psi) steam pressure to be manufactured to ASTM B61-93 standard. Bronze valves used in water systems may be cast bronze to ASTM B584-87 alloy CDA-836.

2.1.3 Iron body valves shall be ductile iron manufactured to ASTM A536-84 Grade 65-45-12 or cast iron ASTM A126-95 Class B standard where ductile iron is not available.

2.1.4 All valves shall have a CRN registration number.

2.1.5 Valve Materials

2.1.5.1 Bronze: to ASTM B62 or B61 as applicable

2.1.5.2 Brass: to ASTM B283 C3770

2.1.5.3 Cast Iron: to ASTM A126, Class B

2.1.5.4 Forge Steel: to ASTM A105N

2.1.5.5 Cast Steel: to ASTM A216WCB

2.1.6 Valve Markings

2.1.6.1 All pressure ratings, manufacturers' trademark and size to conform as per MSS-SP-25.

2.1.7 End Connections

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SPEC NOTE:		The following table shows the maximum operating pressure at 100°F, corresponding to the valve ANSI class rating:					
ANSI Class	125	150	300	400	600	800	900

Pressure (psi)	200	285	740	990	1480	1975	2220

2.2 VALVES FOR LOW PRESSURE SERVICE

2.2.1 This section applies to valves used in domestic cold water, domestic hot water and natural gas systems up to 1,034 kPa (150 psi) system operating pressure.

2.2.2 Gate Valves

2.2.2.1 50mm (2") dia. or less - shall be Class 125, all bronze, with solid wedge disc, non-rising stem, lead-free (NSF-61).

Threaded ends
- Kitz 827
- Toyo 206A-LF
- Crane LF-438
- Apollo 102TLF

Soldered ends
- Kitz 828
- Toyo 207A-LF
- Crane LF-1320
- Apollo 102SLF

2.2.3 Globe Valves

2.2.3.1 50mm (2") dia. or less - shall be Class 125, all bronze, with rising stem, fitted with PTFE disc, lead-free (NSF-61).

Threaded ends
- Kitz 811
- Toyo 211A-LF
- Apollo 120TLF

Soldered ends
- Kitz 812
- Toyo 212A-LF
- Apollo 120SLF

2.2.4 Butterfly Valves

2.2.4.1 65mm (2-½") dia. and over - shall be Class 125, ductile iron full lug body with aluminum bronze or stainless steel disk, stainless steel stems, EPDM resilient seat, lead-free (NSF-372), with a 1379kPa (200 psi) single flange shut off rating (dead end service) and 121°C

(250°F) temperature rating.

2.2.4.2 Valves 65mm (2-½") dia. and up to 100mm (4") dia. shall have a 10-position lever. Valves 150mm (6") dia. and above shall have hand wheel gear activator.

Lug Style	- Kitz 6122EL/G - MAS D-Series LD4AELH/G - Center Line 200XXBG064052/5 - Apollo LD141-XX-SE1-X
Grooved ends	- Victaulic Series 608N (for copper piping) - Victaulic Series 861 Vic-300 (for SS piping)

2.2.5 Check Valves

2.2.5.1 50mm (2") dia. or less - shall be Class 125, brass or copper alloy body, brass disc, PTFE gasket, lead-free (NSF-61), Y pattern swing check.

Threaded ends	- Kitz 822 - Toyo 236A-LF - Apollo 163TLF
Soldered ends	- Kitz 823 - Toyo 237A-LF - Apollo 163SLF

2.2.5.2 65mm (2-½") dia. and over - shall be Class 150, stainless steel body and trim, PTFE or fluoroelastomer gaskets.

Flanged ends	- Kitz 150UOAM
Groved ends	- Victaulic Series 816

2.2.5.3 Wafer Check Valves – stainless steel body, shaft, disc and spring.

Single Flap	- Moygro W15A-666
Double Door	- Mueller 72-HHH-H-H - Powell 3070YMO

2.2.5.4 Silent Check Valves – carbon steel or stainless steel body, stainless steel trim, spring loaded center guided disc, stainless steel spring and shaft.

Flanged ends
- Mueller 101MHT (wafer)
- Mueller 105MHT (globe style)

2.2.6 Ball Valves

2.2.6.1 100mm (4") dia. or less - shall be rated for 1034kPa (150 psi) steam, 4137kPa (600 psi) non-shock cold water or oil, with full or standard port brass or bronze body, lead-free (NSF-61) brass or stainless steel ball, PTFE seats and packing.

Threaded ends
- Kitz 858
- Toyo 5044A-LF
- Apollo 70LF-100 series
- MAS B-3LF

Soldered ends
- Kitz 859
- Toyo 5049A-LF
- Apollo 70LF-200 series
- MAS B-4LF

Note: Ball valves may be used in lieu of gate or globe valves for pipe sizes of 100mm (4") dia. or less.

2.2.6.2 Gas ball valves:

2.2.6.2.1 50mm (2") dia. or less - shall be rated for 1034kPa (150 psi) steam, 4137kPa (600 psi) non-shock cold water or oil, with full or standard port brass or bronze body, brass chrome plated ball, Teflon seats and packing, lever handle, CSA approved (CGA 3.16).

Threaded
- Toyo 5044A
- Kitz 58
- MAS B3

2.2.6.2.2 65mm (2-½") dia. and over - shall be Class 150, carbon steel body, stainless steel ball and stem, Teflon packing and gaskets, locking lever and/or gear.

Flanged
- Kitz 150 SCTAM (1 piece)
- Kitz 150 SCTBZM (2 piece, full port)

2.2.7 Plug Valves

2.2.7.1 DN80 (3") dia. or less - shall be bronze eccentric plug valve, 1,379kPa (200 psi) non-shock cold water or oil, with memory stop and drip cap, grooved, flanged or screwed ends, as appropriate for

piping system.

- DeZurik PEC Series

2.2.7.2 DN100 (4") dia. up to DN300 (12") dia. - shall be bronze eccentric plug valve, 1,379kPa (200 psi) non-shock cold water or oil, with handwheel gear, and grooved, flanged or screwed ends, as appropriate for piping system.

- DeZurik PEC Series

2.3 VALVES FOR MEDIUM TO HIGH PRESSURE SERVICE

2.3.1 This section applies to valves used in domestic cold water and domestic hot water systems up to 3,440 kPa (500 psi) system operating pressure.

2.3.2 Gate Valves

2.3.2.1 50mm (2") dia. or less - shall be Class 300, stainless steel body and trim, OS&Y, PTFE packing and gasket.

Threaded ends - Kitz AK300UMM

2.3.2.2 65mm (2-½") dia. and over - shall be Class 300, stainless steel body and trim, OS&Y, PTFE packing and gasket.

Flanged ends - Kitz 300UMHAM

2.3.3 Globe Valves

2.3.3.1 50mm (2") dia. or less - shall be Class 300, stainless steel body and trim, OS&Y, PTFE packing and gasket.

Threaded ends - Kitz AK300UPM

2.3.3.2 65mm (2-½") dia. and over - shall be Class 300, stainless steel body and trim, OS&Y, PTFE packing and gasket.

Flanged ends - Kitz 300UPAM

2.3.4 Butterfly Valves (up to 1,724 kPa / 250 psi operating pressure)

2.3.4.1 65mm (2-½") dia. and over - shall be Class 150, cast brass or stainless steel body with aluminum bronze or stainless steel disk, stainless steel stems, Teflon seat, lead-free (NSF-372), with a 2,068 kPa (300 psi) single flange shut off rating (dead end service) and 121°C (250°F) temperature rating.

2.3.4.2 Valves 65mm (2-½") dia. and up to 100mm (4") dia. shall have a 10-position lever. Valves 150mm (6") dia. and above shall have hand wheel gear activator.

Grooved ends - Victaulic Series 608N (for copper piping)
- Victaulic Series 861 Vic-300 (for SS piping)

2.3.5 Check Valves

2.3.5.1 50mm (2") dia. or less - shall be Class 300, stainless steel body, PTFE or fluoroelastomer gasket, swing type check.

Threaded ends - Kitz AK300UOM

Grooved ends - Victaulic Series 816

2.3.5.2 65mm (2-½") dia. and over - shall be Class 300, stainless steel body and bolted cover, PTFE gasket, swing type check.

Flanged ends - Kitz 300UOAM

2.3.5.3 Wafer Check Valves – stainless steel body, shaft, disc and spring.

Single Flap - Moygro W30A-666

Double Door - Mueller 74-HHH-H-H
- Powell 3070YMO

2.3.5.4 Silent Check Valves – carbon steel or stainless steel body, stainless steel trim, spring loaded center guided disc, stainless steel spring and shaft.

Flanged ends - Mueller 103MHT (wafer)
- Mueller 109MHT (globe style)

2.3.6 Ball Valves

2.3.6.1 100mm (4") dia. or less - shall be rated for 1034kPa (150 psi) steam, 4137kPa (600 psi) non-shock cold water or oil, with full or standard port brass or bronze body, lead-free (NSF-61) brass or stainless steel ball, PTFE seats and packing.

Threaded ends - Kitz 858
- Toyo 5044A-LF
- Apollo 70LF-100 series
- MAS B-3LF

Soldered ends
- Kitz 859
- Toyo 5049A-LF
- Apollo 70LF-200 series
- MAS B-4LF

Note: Ball valves may be used in lieu of gate or globe valves for pipe sizes of 100mm (4") dia. or less.

3 EXECUTION

3.1 GENERAL

3.1.1 Valves shall be the same size as the line in which installed.

3.1.2 Valves shall be located in such a manner that the top works, operators, and bonnets may be easily removed.

3.1.3 Seats and seals used in potable water systems shall be ANSI classified in accordance with NSF-61.

3.1.4 Stems of valves shall be positioned for maximum ease in use, but in no event in a manner causing a hazard, nor with stem down unless specifically shown as such.

3.1.5 Provide valves where shown on the Drawings, or on schematic diagrams, or in details, or as specified in the Contract Documents.

3.1.6 Provide drain valves at all low points. Drain valves shall be ball or gate valves, complete with cap and chain.

3.2 GATE VALVES

3.2.1 Provide gate valves:

3.2.1.1 Where indicated on the Drawings and in the Specification.

3.2.1.2 On all branch lines.

3.2.1.3 As isolation of each floor for all services.

3.2.1.4 At the base of all risers.

3.3 GLOBE OR ECCENTRIC PLUG VALVES

3.3.1 Provide globe and/or eccentric plug valves:

3.3.1.1 Where indicated on the Drawings and in the Specification.

3.3.1.2 On all bypass systems.

3.3.1.3 Where required for throttling control.

3.3.2 For balancing of domestic hot water recirculation system, provide thermostatic flow regulators in lieu of throttling valves. Refer to Section 22 11 19 – Domestic Water Piping Specialties.

3.4 BUTTERFLY VALVES

3.4.1 Provide butterfly valves:

3.4.1.1 Where indicated on Drawings and in the Specification.

3.4.2 For pipe sizes DN65 (2-½") and larger, butterfly valves may be used in lieu of gate valves.

3.5 CHECK VALVES

3.5.1 Provide check valves:

3.5.1.1 Where indicated on the Drawings and in the Specification.

3.5.1.2 On the discharge of all pumps.

3.5.1.3 On the discharge of multiple equipment.

3.6 BALL VALVES

3.6.1 Install ball valves in the following locations:

3.6.1.1 Where indicated on the Drawings and in the Specification.

3.6.1.2 At each single plumbing fixture.

3.6.1.3 At each single item of equipment.

3.6.2 For pipe sizes DN100 (4") and smaller, ball valves may be used in lieu of gate and globe valves.

END OF SECTION

Project Name: *UNIVERSITY OF TORONTO MISSISSAUGA*
Project No.: *2023-0059*
Section Name: ***Electric Pipe Tracing***
Section No.: ***22 05 33***
Date: *November 15, 2024*

INDEX

1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 – General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide an electrical pipe tracing system as indicated on the Drawings and specified in this Section.

1.2.2 Connect heat trace power supply from disconnect switches provided by Division 26 - Electrical. Refer to Division 26 – Electrical drawings for exact locations. Co-ordinate power requirements with Division 26 – Electrical. Refer to Section 20 05 14 – Electrical Wiring for wiring requirements.

1.2.3 Provide electric tracing for the following services:

1.2.3.1 All domestic water piping (cold, hot, hot recirculation), including humidification make-up, cooling tower make-up, and irrigation supply in unheated areas or outside the building.

1.2.3.2 All sanitary and storm drain lines in unheated areas except parking drain sanitary system.

1.2.3.3 Humidifier drain lines, exposed on roof.

1.2.3.4 Trench drains exposed to freezing.

1.2.3.5 Roof gutters.

1.3 SHOP DRAWINGS

1.3.1 Provide shop drawings for:

- heat trace cables
- power connection, splice and tee kits
- temperature sensors, moisture sensors, control panel, and contactor modules
- accessories including tape, straps, banding, labels

1.4 ELECTRICAL EQUIPMENT AND WORK

1.4.1 Read together with Division 26 – Electrical and adhere to its requirements. Supply and install all electrical apparatus, which is required and is not covered by Division 26 – Electrical.

1.4.2 The entire design and installation shall comply with the Ontario Electrical Safety Code and all applicable regulations. Heating cable circuits shall be protected by a ground-fault device for equipment protection. This requirement is in accordance with section 427-22 of the NEC-1996. Ground-fault protection is included with the control system specified for all applications.

2 PRODUCTS

2.1 GENERAL

2.1.1 Furnish and install a complete cUL Listed, CSA Certified, or FM approved system of heating cables, components, and controls to provide freeze protection of piping as indicated in the Contract Documents.

2.2 PIPE FREEZE PROTECTION CABLES

2.2.1 The self-regulating heating cable shall consist of two (2) 16 AWG nickel-copper bus wires embedded in parallel in a self-regulating polymer core that varies its power output to respond to temperature all along its length, allowing the heating cable to be cut to length in the field. The heating cable shall be covered by a radiation-crosslinked, modified polyolefin dielectric jacket. To provide a ground path and to enhance the heating cable's ruggedness, the heating cable shall have a braid of tinned copper and an outer jacket of modified polyolefin (-CR), as required per section 427-23 of the NEC-1996. For installation on plastic piping, the heating cable shall be applied using aluminum tape (AT-180). The heating cable shall be Tyco Thermal Controls, XL-Trace series, or approved equivalent.

2.2.2 In order to conserve energy and to prevent overheating, the heating cable shall have a self-regulating factor of at least 90 %. The self-regulation factor is defined as the percentage reduction, without thermostatic control, of the heating cable output going from 4.4°C (40°F) pipe temperature operation to 65.6°C (150°F) pipe temperature operation.

2.2.3 The heating cable shall operate on line voltage of 120 / 208 Volts without the use of transformers.

2.2.4 The heating cable for metal-pipe freeze protection shall be sized according to the table below. The required heating cable output rating is in Watts per meter (foot) at 10°C (50°F). (Heating cable selection is based on 51mm (2 inch) fiberglass insulation on metal piping.)

	Minimum Ambient Temperature	
Pipe size mm (inches)	**-17.8°C (0°F)**	**-28.9°C (-20°F)**
100 (4") or less	16.4 (5) Watts	16.4 (5) Watts
150 (6")	16.4 (5) Watts	26.2 (8) Watts
200 (8")	16.4 (5) Watts	26.2 (8) Watts
250 (10") or more	16.4 (5) Watts	2 strips of 16.4 (5) Watts

2.2.5 Power connection, end seal, splice, and tee kit components shall be cUL Listed, CSA Certified, or FM Approved for use as part of the system to provide pipe freeze protection. Component enclosures shall be rated NEMA 4X to prevent water ingress and corrosion. Installation shall not require the installing Subcontractor to cut into the heating-cable core to expose the bus wires. All components that make an electrical connection shall be re-enterable for servicing. Installation of power-connection kits shall be under Division 22 - Plumbing.

2.2.6 No component shall use silicone to seal the electrical connections. An exception will be made in areas where a conduit transition is required.

2.3 TRENCH DRAIN DE-ICING CABLES

2.3.1 Heating cables for trench drain de-icing shall be approved as snow-melting and de-icing equipment to applicable Canadian standards.

2.3.2 The heating cable shall be Pyrotenax brand, type MI series heating cable manufactured by Tyco Thermal Controls, or approved equivalent. The heating element shall be magnesium-oxide insulated, with a resistance-alloy conductor and seamless Alloy 825-sheath. No combustible materials shall be allowed between

the heating element and sheath. All heating cable materials shall be inorganic to resist corrosion. Cables shall be designed for heat output not exceeding 16.4 W/m (5 W/ft).

2.3.3 This Subcontractor is responsible for field-measurement of trench drain segment lengths to confirm tender design suitability.

2.4 GUTTER DE-ICING CABLES

2.4.1 Heating cables for canopy gutters shall be approved and listed as snow-melting and de-icing equipment to applicable Canadian standards.

2.4.2 Gutter de-icing cables shall be Raychem IceStop self-regulating heating cable manufactured by Tyco Thermal Controls, model GM-2XT or approved equivalent. It shall consist of a continuous conductive-polymer core, radiation-crosslinked, between two 16AWG nickel-plated copper bus wires.

2.4.3 Gutter de-icing cables shall vary their heat output according to temperature, such that heat output in ice or snow at 32°F (0°C) is no less than 12 W/ft when operating at 208V.

2.4.4 Gutter de-icing cables shall have a Fluoropolymer jacket for improved resistance to UV, organic chemical exposure, and abrasion.

2.4.5 Power connection, end seal, splice, and tee kit components shall be cUL Listed, CSA Certified, or FM Approved for use as part of the de-icing system. Component enclosures shall be rated NEMA 4X to prevent water ingress and corrosion. Installation shall not require the Installing Contractor to cut into the heating-cable core to expose the bus wires. All components that make an electrical connection shall be re-enterable for servicing. Tyco Thermal Controls RayClic series or approved equivalent. Installation of power-connection kits shall be under Division 22 - Plumbing. All fasteners shall be provided by the heating cable manufacturer.

2.5 TEMPERATURE AND MOISTURE SENSORS

2.5.1 Drainage piping shall have one sensor per “zone”, mounted to the ceiling in unheated space and shall operate on Proportional Ambient Sensing Control. Trench Drain and Canopy Gutter De-Icing cables shall be energized upon the detection of precipitation at low temperatures, and remain energized until runoff is clear.

2.5.2 Temperature sensors shall be 100-ohm platinum RTD (Resistance Temperature Devices), with 3m tails mechanically protected by a corrugated steel sheath and ½" gland fitting for connection to the junction box. Digit race RTD10CS or approved equivalent. Temperature sensors shall be connected to the control system terminals as indicated on heat-tracing schedules. Coordinate conduit and low-voltage signal wiring with Division 26 - Electrical. RTD wiring shall be shielded 3-conductor, 22AWG + drain, Belden type 8771 or approved equivalent.

2.5.3 Aerial Snow-Sensors shall detect precipitation occurring below 38°F (4°C) and close an internal contact to send a demand signal to the control system. Snow Sensors shall operate at 120V. Digit race LCD-7A or approved equivalent.

2.5.4 Gutter Moisture Sensors shall be mounted horizontally in the gutter as indicated on construction drawings, and shall detect the presence of moisture (i.e. runoff water) below 38°F (4°C) to send a demand signal to the control system. The intent of this device is to hold associated circuits on until all melt water is clear of the drainage system. Digit race type GIT-3A or approved equivalent. This Subcontractor is responsible for providing auxiliary relays to prevent line voltage reaching low-voltage control terminals.

2.6 CONTROL SYSTEM

2.6.1 DDC Control System

2.6.1.1 All sensors shall communicate with a DDC system, Digit race ACCS-30 or approved equivalent. This approach serves to minimize the number of sensing devices required for efficient system operation and also to eliminate field-location of control devices and thus reduce the risk of tampering.

2.6.1.2 The Heating Cable manufacturer shall provide a DDC system with pre-programmed parameters to concurrently control and monitor heating cable circuits fire-protection pipe freeze protection. All system programming shall be through a CSA-listed central User Interface Terminal, Tyco Thermal Controls type ACCS-UIT2 or approved equivalent.

2.6.1.3 Heating Cable circuits and sensor signals (refer to Subsection 2.5 above) shall be connected to cUL-listed remote Power Control Modules, Tyco Thermal Controls type ACCS-PCM2-5 or approved equivalent. The Power Control Modules shall each house five two-pole contactors rated to 30A/277V, and five sensor inputs. Power

Control Modules shall also include ground-fault sensing devices for each heating cable circuit, the status of which shall be monitored by the control system.

2.6.1.4 Power Control Modules and User Interface Terminal shall be inter-connected using RS-485 communication series. Coordinate communication conduit requirements with Division 26 - Electrical.

2.6.1.5 The Control System shall be capable of communicating ground fault, temperature alarms, and status alarms through programmable alarm contacts. Coordinate with Division 26 - Electrical.

2.6.1.6 The Control System shall be capable of communicating operating status, power consumption, and alarms to the Building Automation System in BACnet protocol.

2.6.2 No heat tracing circuit shall extend more than 600mm (24") beyond a point where such junctions permit optional flow paths. In such cases, separately controlled tracers shall be used.

2.6.3 Separately controlled heating circuits shall be provided on dead end legs and closed bypasses.

2.6.4 Where the rating of the thermostat would be exceeded, it shall be used in conjunction with a relay or contactor.

3 EXECUTION

3.1 PIPE FREEZE PROTECTION

3.1.1 Hydrostatically test all piping prior to installation of tracing cables.

3.1.2 Heating Cable Installation shall comply with manufacturer’s recommendations.

3.1.3 The cable shall be fastened to metallic piping at intervals no more than 300mm (12”) using heat-resistant fiberglass tape, type GT-66 or approved equivalent. Metallic tie-wraps shall not be acceptable as they may puncture the heating cable jacket. When installing on polymer-based piping, aluminum heat-transfer tape shall be installed along the entire length of heating cable to improve performance.

3.1.4 Extra cable shall be used at points such as valves and flanges to compensate for increased heat loss.

3.1.5 All terminations shall be protected from the weather and from physical damage.

3.1.6 Any field alternations or deviations shall proceed only after authority via signed change order has been issued by the Consultant. All changes shall be accurately recorded by the Contractor and shall be turned over to the Consultant upon completion of the work.

3.1.7 Junction boxes, thermostats, and the like shall not be attached to the insulation, but shall be mounted on brackets fabricated of galvanized angle, channel or other material of sufficient strength to support equipment mounted on them.

3.1.8 Apply “Electric Traced” labels to the outside of the thermal insulation, on alternating sides at 3m intervals.

3.2 TRENCH DRAIN DE-ICING

3.2.1 Trench Drain installation should be complete prior to heating cable installation so as to reduce the risk of damage.

3.2.2 Heating Cables shall be connected to power at ceiling-mounted junction boxes as indicated in the Contract Documents. Trench Drain cable cold-leads shall enter Trench drain piping through appropriate pipe fittings. No heating cable shall be located in the air. This Subcontractor is responsible for ensuring that cold leads are long enough to reach from drain pipe fittings to junction box.

3.2.3 Heating Cables shall be laid along the entirety of the base of the trench and fastened at no less than 5m intervals to clips (e.g. Tyco Thermal Controls type GMK-RC) adhered to the trench drain walls. No penetrations shall be made to the Trench itself. Adhesives shall be suitable for attaching metal clips to trench drain material; coordinate with Trench Drain supplier.

3.3 GUTTER DE-ICING

3.3.1 Canopy gutter construction shall be completed prior to installation of de-icing cables.

3.3.2 Comply with manufacturer’s installation recommendations.

3.3.3 Gutters wider than 150mm (6”) require two runs of heating cables. Heating cables shall be fastened using a pair of heating cable clips (eg type GMK-RC) every 3m (10ft).

3.3.4 Drains shall be traced to 1m (3ft) inside heated space using a loop of heating cable to maintain a continuous circuit. Protect the cable from rough edges at drain entry using a hanger bracket (eg type GM-RAKE).

3.3.5 Power Connection, splice and tee kits shall be mounted outside of the gutter itself. Wall- or pipe-mount brackets may be provided with power connections.

3.4 SENSORS

3.4.1 Install all sensing devices in accordance with manufacturer's recommendations. Refer to notes in Subsection 2.5 above.

3.4.2 Temperature sensors installed on piping (for Line-Sensing) shall be located opposite the heating cable so as to sense the coldest temperature on the segment of pipe.

3.4.3 Temperature sensors installed in air (for Ambient-Sensing) shall be strapped to the ceiling in a location such that the temperature is representative of the exposure temperature of any associated heat-tracing. Ambient temperature sensors shall not be installed adjacent to exhaust vents.

3.4.4 Aerial Snow-Sensors shall be installed in a location such that they are exposed to precipitation from all directions and not subject to heating or exhaust vents. They shall be wired such that line voltage is not introduced to the signal run.

3.4.5 Gutter Snow-Sensors shall be installed between runs of heating cable with sensor grid pointed "upstream", i.e. toward the flow of melt-water. They shall be wired such that line voltage is not introduced to the signal run.

3.5 CONTROL SYSTEM

3.5.1 Install all control components in accordance with manufacturer's recommendations.

3.5.2 Sensor signal wiring shall be connected to the appropriate terminal within the appropriate power control module.

3.5.3 Control system components shall all be connected in series, using RS-485 twisted pair communication wiring. Coordinate necessary communication conduit runs with Division 26 – Electrical Subcontractor.

3.6 TESTING, COMMISSIONING AND REPORTING

3.6.1 All Self-Regulating Cables (for pipe tracing and gutter tracing) shall be tested for insulation resistance using a megohmmeter at 500, 1000, and 2500VDC and results shall exceed 1000MΩ to be acceptable. Self-Regulating cables shall also be tested for capacitance to verify continuous circuit lengths, with results recorded in nF and in approximate corresponding length. Refer to manufacturer's installation guides for nF/ft conversion rates for each type of cable.

3.6.2 All Mineral-Insulated Cables (for trench drain de-icing) shall be tested for insulation resistance using a megohmmeter at 500VDC and results shall consistently exceed 100 MΩ to be acceptable. Cables shall also be tested for continuity, with results recorded in resistance (Ω) and approximate corresponding length.

3.6.3 Sensors and Control System shall be concurrently tested and commissioned with the assistance of the manufacturer. Temperature sensors may be tested by observing readings and comparing with actual temperature. Moisture sensors shall be tested by simulating activation criteria (low temperature and moisture) and observing contact engagement.

3.6.4 The Division 22 - Plumbing Subcontractor is responsible for carrying testing, programming and commissioning costs as part of this Contract.

END OF SECTION

Project Name: *UNIVERSITY OF TORONTO MISSISSAUGA*
Project No.: *2023-0059*
Section Name: ***Motor Starters and MCCs***
Section No.: ***22 05 36***
Date: *November 15, 2024*

INDEX

1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools equipment, training commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 All motor starters for mechanical equipment.

1.2.1.2 All motor control centres for mechanical equipment.

1.3 SUBMITTALS

1.3.1 Provide shop drawings for:

1.3.1.1 All motor starters.

1.3.1.2 All motor control centres.

1.4 ELECTRICAL EQUIPMENT AND WORK

1.4.1 Read together with Division 26 – Electrical and adhere to its requirements. Supply and install all electrical apparatus, which is required and is not covered by Division 26 – Electrical.

2 **PRODUCTS**

2.1 MOTOR CONTROL CENTRES

2.1.1 Provide motor control centres where indicated, specified and shown on schedules containing motor starters, control, interlocks and pilot lights.

2.1.2 Control centres shall consist of standard vertical section of 2,286mm (90") and width and depth as required to house the equipment contained, all joined together to form a rigid free standing, completely dead front EEMAC 2 drip tight enclosed assembly. Arrange all units for front access only.

2.1.3 Wire all control units for EEMAC Class II, Type “B” construction with all interwiring between starters and assemblies, terminal

boards for each starter and all control wiring and load power connections to terminal boards.

2.1.4 All horizontal and vertical bus shall be tin-plated copper. Vertical bus rating not less than 300 amperes or larger where required to accommodate the loads served plus 25% spare capacity. Horizontal bus rating as indicated but in no case less than the ampacity of the feeder to the motor control centre. Provide a horizontal tin-plated copper ground 6mm x 32mm ($^1/_4$" x 1-$^1/_4$") for the full length of the motor control centre. Provide 3 phase, 3-wire, or 3 phase, 4-wire mains with main circuit breaker as shown on the Drawings. Coordinate feeder supply with Division 16 – Electrical and provide all cable lugs and/or bus duct terminations.

2.1.5 Unless otherwise indicated in the Contract Documents motor starters shall:

2.1.5.1 Be of the combination type containing motor starter and fusible disconnect switch. All components and wiring shall be readily accessible and shall be connected to the vertical bus with self-aligning plug-on connectors having free-floating spring action. A minimum of one padlock hasp per starter shall be provided on the panel fastener to allow padlocking in either connect or disconnect position.

2.1.5.2 Contain fuse clips for Class J, Form I, High Rupturing Capacity (HRC) fuses.

2.1.5.3 Be provided with an operating handle interlocked with door so that the handle must be in the “OFF” position before the door can be opened. A semi-secret release shall be provided allowing bypassing of the interlock.

2.1.5.4 Be provided with dual horsepower rated disconnect switches, quick-make, quick-break type.

2.1.5.5 Be full voltage magnetic type complete with three external manual reset thermal overload relays and low voltage protection. Identify each unit with an engraved lamacoid (white core) nameplate. Adhere to Section 15075 – Mechanical Identification colour scheme for tags. Provide a Siemens 3UN8 or 3UN6 trip unit or Klockner-Moeller equivalents in motor starters for all motors provided with thermistor type protection embedded in the stator windings. Provide 3UN8 units for 3-wire momentary contact control circuits and 3UN6 units for 2-wire maintained contact control circuits.

2.1.5.6 Have an integral control transformer complete with fusible protection for operation of all line voltage controls.

2.1.5.7 Have all covers equipped with start/stop pushbuttons and/or selector switches and push to test pilot lights as indicated on the wiring diagrams.

2.1.5.8 Have manual reset thermal overload relays in each of the three phases to suit the service factor and acceleration time of the motor served.

2.1.6 Provide a “Failsafe Industries” catalogue #M-600 or approved equal insulation resistance monitor in motor starters for fire pumps and fan motors used solely for smoke control. Provide a long life lamp in the starter cover to flash under alarm condition. Identify lamp with a lamacoid plate reading “LOW INSULATION RESISTANCE”. Provide dry contacts for remote annunciation at the Building Automation Control System.

2.1.7 Unless otherwise shown on the Motor Control Centre and Starter Schedules, each motor control centre shall have not less than the following spaces:

2.1.7.1	One section	one size 1.
2.1.7.2	Two sections	two size 1.
2.1.7.3	Three sections	two size 1 one size 2
2.1.7.4	Four sections	two size 1 two size 2.

2.1.8 Short circuit interrupting capacity for all starters shall be minimum of _____ kA for all MCC's, or higher to meet co-ordination study. Support all bus work to suit rating.

2.2 <u>MOTOR STARTERS</u>

2.2.1 Provide where indicated, shown the Motor Starter Schedules and as specified in this Section separate motor starters not forming part of a motor control centre for all mechanical equipment (except those equipped with packaged starters).

2.2.2 Motor starters shall be supplied by the manufacturer of the motor control centres specified, and shall meet the requirements therein complete with disconnect switch, fuses, control transformer, and all

auxiliary devices.

2.2.3 Provide combination type with non-fused disconnect switch for individual motor starters equal to CGE CR 208, where overcurrent protection has been provided at motor control centre or distribution source.

2.2.4 Provide combination type with fusible disconnect switches equal to CGE CR 208 for grouped motor starters supplied from a common feeder or splitter. Include all interconnection power wiring.

2.2.5 Manual starters for single phase fractional horsepower motors unless otherwise indicated shall be equal to CGE CR 1061 with pilot light in cover. In finished areas, provide flush mounted units with stainless steel covers and pilot lights.

2.2.6 Where starters are grouped, provide a common backboard, interlocking and control wiring indicated on the Motor Control Schedules and engraved nameplates indicating source of control supply if separate from the starter.

2.2.7 Short circuit interrupting capacity for all starters shall be minimum of _____ kA for all starters, or higher to meet co-ordination study. Support all bus work to suit rating.

3 EXECUTION

3.1 MOTOR CONTROL CENTRES

3.1.1 Mount motor control centres on 100mm (4") high concrete bases.

3.1.2 Provide watertight connections for all services entering the top of the motor control centres.

3.1.3 Check all overload relays or heaters to ensure they are in accordance with the recommendations of the starter manufacturer by size and motor run-up time.

3.1.4 After installation, verify sequence of all control devices.

3.1.5 Provide lamacoid plastic plates identifying motor control centres. Adhere to Section 20 05 53 – Identification colour scheme for tags. Provide phase identification. Provide warning label for motors under remote control.

3.2 MOTOR STARTERS

3.2.1 Provide lamacoid plastic plates identifying all starters. Provide warning label for motors under remote control. Adhere to Section 20 05 53 – Identification colour scheme for tags.

END OF SECTION

Project Name: *UNIVERSITY OF TORONTO MISSISSAUGA*
Project No.: *2023-0059*
Section Name: ***Cleanouts***
Section No.: ***22 05 76***
Date: *November 15, 2024*

INDEX

1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SHOP DRAWINGS

1.2.1 Submit shop drawings for the following equipment:

1.2.1.1 Cleanouts

2 **PRODUCTS**

2.1 CLEANOUTS AND CLEANOUT ACCESS COVERS

2.1.1 Provide cleanouts where shown on Contract Drawings on all drainage and waste systems, and as required by the Local Plumbing Code, including the following:

2.1.1.1 Where there is a change of direction of 45 degrees or more.

2.1.1.2 Not more than 15m (50’-0”) apart on straight runs for DN100 (4") and less; 30m (100'-0") for DN150 (6") and greater.

2.1.1.3 On sanitary drain stacks serving kitchen sinks, at every second floor.

2.1.1.4 At the base of every stack and rainwater leader.

2.1.1.5 Where drains leave the building.

2.1.1.6 On footing drains where shown on the Drawings.

2.1.2 Bring cleanouts below floor up to finished floor with a ‘Y’ and 1/8th bend. Locate all cleanouts for easy access and in areas of least traffic, as directed by Consultant.

2.1.3 Make cleanouts full size of drain up to and including 100mm (4”) drains. For drains larger than 100mm (4”), use 100mm (4”) cleanouts.

2.1.4 Cleanouts in floor – cast iron body, removable positive gasket seal closure, 150mm (6”) adjustable round cover. J.R.Smith Series 4000; Zurn ZN1400 Series; Mifab C1100-R Series, Watts CO-200 Series.

2.1.4.1 Finished areas with nickel bronze top. J.R.Smith 4020; Zurn ZN1400-NH; Mifab C1100-R-1, Watts CO-200-R-1.

2.1.4.2 Tiled areas with nickel bronze top. J.R.Smith 4140; Zurn ZN1400-NH-X; Mifab C1100-T-1, Watts CO-200-T-1.

2.1.4.3 Terrazzo areas with nickel bronze top. J.R.Smith 4180; Zurn ZN1400-NH-Z; Mifab C1100-UR-1, Watts CO-200-U-1.

2.1.4.4 Concrete areas with extra heavy cast iron top. J.R.Smith 4220; Zurn Z1400-NH; Mifab C1100-XR-4, Watts CO-200-RX-4.

2.1.5 Cleanouts in walls.

2.1.5.1 Face-of-wall access cover for openings in tile, masonry and plaster walls with round C.P. bronze frame and secured cover. J.R.Smith 4720, Watts CO-300 Series.

2.1.5.2 Flush-with-wall access cover for plaster and wet wall constructions with round C.P. bronze frame and secured cover. J.R.Smith 4725; Zurn Z1463; Mifab C1440-R6, Watts CO-300 Series.

2.1.5.3 Access doors in tile, masonry and plaster walls, and in acoustic tile: refer to Section 15050 – Basic Materials and Methods.

2.1.5.4 Urinal cleanout – wall access cleanout with bronze plug, S.S. bolt and wingnut, and 100mm (4") polished S.S. secured cover. J.R.Smith SQ4-1819; Zurn Z1666-1; Mifab C1440-RD-3, Watts WUCO.

2.1.6 Cleanouts at the base of each stack and rainwater leader – cast iron cleanout tee and countersunk iron plug with gasket seal, less cover. J.R.Smith 4510; Zurn Z1445-HBXSP; Mifab C1460, Watts CO-460.

2.1.7 Cleanouts for concealed cast iron stacks – cast iron cleanout tee and countersunk iron plug with gasket seal, S.S. round cover and screw. J.R.Smith 4530; Zurn Z1446-HBXSP; Mifab C1460-RD-3, Watts CO-460-RD.

2.1.8 Cleanouts for exposed and concealed copper stacks to be by pipe manufacturer.

3 EXECUTION

3.1 CLEANOUTS AND CLEANOUT ACCESS COVERS

3.1.1 Cleanouts on drains outside building shall be brought up to grade with a DN100 (4") 'Y' and 1/8th bend in medium weight soil pipe with solid brass recess plug-in top. Provide necessary support for soil pipe and set cleanout flush with grade in a 300mm by 300mm by 150mm (12" x 12" x 6") concrete pad.

3.1.2 In all areas with seamless flooring and plastic terrazzo finishes provide special flanges. These flanges shall be 100mm (4") larger in diameter than the drain of cleanout top of sleeve diameter, and located approximately 5mm ($^{3}/_{16}$") below the top flanges to be of the same material as the drain or cleanout finish.

3.1.3 Provide special flanges for cleanouts as described above.

END OF SECTION

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SPEC NOTE:			
Specification Created by Balazs Farkas – July 3, 2006			
Revision Number	Revision Date	Revision By	Summary of Revision
2	May 19, 2023	Mohit Kumar	Revised to indicate PEX piping to be used for in-suite piping only.

1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools, equipment, training, commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 Domestic cold water piping, including connections to all fixtures and equipment, capped connections, and connections to municipal water supply.

1.2.1.2 Domestic hot water piping, including connections to all fixtures and equipment and capped connections.

1.2.1.3 PEX tubing for potable water distribution system.

1.3 REGULATORY REQUIREMENTS

1.3.1 Standards listed by reference, including revisions by issuing authority, form part of this Specification Section to extent indicated. Standards listed are identified by issuing authority, authority abbreviation, designation number, title, or other designation established by issuing authority. Standards subsequently referenced in this Section are referred to by issuing authority abbreviation and standard designation.

1.3.2 In addition to specific requirements for pipe fittings as further specified in this document and where applicable, the equipment

shall comply with the Boiler and Pressure Vessels Act (the “Act”) and CSA Standard B51.

1.3.3 In compliance with the Act and relevant Codes, all fittings shall be registered by the manufacturer, and shall be identified by the appropriate Canadian registration number.

1.3.4 Where fittings are provided without the appropriate Canadian registration number, the Contractor shall obtain a copy of the manufacturer's Statutory Declaration as provided to the authorities having jurisdiction.

1.3.5 All welding and fabrication shall be to the requirements of the ANSI/ASME B31.9 code for pressure piping and CSA standard B51 code for the Construction and Inspection of Boilers and Pressure Vessels.

1.3.6 All copper piping shall be certified to ASTM Standard B42 for Seamless Copper Pipe or ASTM Standard B88 for Seamless Copper Water Tube.

1.3.7 All stainless steel piping shall be certified to ASNI/AWWA C220-98, ASME B16.9 for fittings and ASTM A269 for tubing.

1.3.7.1 ASTM F876 Standard Specification for Cross-Linked Polyethylene (PEX) Tubing.

1.3.7.2 ASTM F877 Standard Specification for Cross-Linked Polyethylene (PEX) Plastic Hot and Cold Water Distribution Systems.

1.3.7.3 ASTM F1960 Standard Specification for Cold Expansion Fittings with PEX Reinforcing Rings for use with Cross-Linked Polyethylene (PEX) Tubing.

1.3.7.4 CAN/CSA B137.5 Cross-Linked Polyethylene (PEX) Tubing Systems for Pressure Applications.

1.3.7.5 CAN/ULC-S101-M89 Standard Methods of Fire Endurance Tests of Building Construction and Materials.

1.3.7.6 CAN/ULC-S115-M95 Standard Method of Fire Tests of Firestop Systems.

1.3.7.7 CAN/ULC-S102.2-M88 Standard for Surface Burning Characteristics of Flooring, Floor Covering and Miscellaneous Materials and Assemblies.

1.3.8 Plastic Pipes Institute (PPI):

1.3.8.1 PPI Technical Report TR-4/00.

1.3.9 Wirsbo, AQUAPEX *Installation Handbook*, current edition.

1.4 SUBMITTALS

1.4.1 Provide shop drawings for all specified Products, including:

1.4.1.1 Piping material and fittings.

1.4.1.2 Joining material (flux, solder, filler metal, coupling)

1.4.1.3 Submit verification of Standard Grade hydrostatic pressure ratings from Plastic Pipe Institute in accordance with TR-4/00. The following three (3) standard grade ratings are required: 93°C (200°F) at 551 kPa (80 psi); 82°C (180°F) at 689 kPa (100 psi) and 23°C (73.4°F) at 1,102 kPa (160 psi).

1.4.1.4 Submit Product Submittal sheets for tubing, manifolds, stand-up brackets, connection system, and fittings.

1.4.2 Submit appropriate ULC or Warnock Hersey and CSA listings as proof of compliance with provincial building and plumbing codes.

1.4.2.1 Submit listings that indicate that the PEX tubing system has been listed to CAN/ULC-S101 when the PEX tubing is incorporated in and traverses a CAN/ULC-S101 floor/ceiling assembly. The listing must be appropriate to assemblies on site.

1.4.2.2 Submit listings that indicate that the PEX tubing firestop system has been listed to CAN/ULC-S115 when the PEX tubing penetrates a fire separation. The listing must be appropriate to assemblies on site.

1.4.2.3 Submit listings that indicate that the PEX tubing system has been listed to CAN/ULC-S102.2 for maximum 25 flame spread and maximum 50 smoke developed.

1.4.2.4 Submit listings that indicate that the PEX tubing system has been listed to CAN/CSA-B137.5.

1.4.3 Submit the following:

1.4.3.1 Copy of manufacturer's letter indicating that the installer has been recognized by the manufacturer as a "Trained Installer" trained in

the use of its PEX tubing potable water distribution system.

1.4.3.2 Manufacturer's installation instructions.

1.4.3.3 Installer shall provide in writing to the Owner that the PEX tubing and components furnished under this specification conforms to the material and mechanical requirements specified herein.

1.4.4 Include the following in the closeout documentation:

1.4.4.1 Warranty documents specified in the Contract Documents.

1.4.4.2 Manufacturer's field reports specified in this Section.

1.4.4.3 Project record documents for installed materials in accordance with Section 20 00 00 - General Requirements.

1.4.5 Division 22 - Plumbing Subcontractor to prepare and submit an alternative compliance application under the OBC if stainless steel piping is used for domestic water service.

1.5 QUALITY ASSURANCE

1.5.1 Qualifications:

1.5.1.1 Installer experienced in performing work of this Section who has specialized in installation of work similar to that required for this project.

1.5.1.2 Installation must be by skilled tradesmen holding a trade qualification license or apprentices under the supervision of a licensed tradesperson.

1.5.2 Pre-installation Meetings:

1.5.2.1 Conduct pre-installation meeting to verify project requirements, manufacturer's installation instructions and manufacturer's warranty requirements.

1.6 DELIVERY, STORAGE AND HANDLING

1.6.1 Comply with manufacturer's ordering instructions and lead-time requirements to avoid construction delays.

1.6.2 Deliver materials to job site in manufacturer's original, unopened, undamaged containers with identification labels intact.

1.6.3 Store materials protected from exposure to harmful weather and job site conditions.

1.6.4 Store PEX tubing in cartons or under cover to avoid dirt or foreign material from being introduced into the tubing.

1.6.5 Do not expose PEX tubing to direct sunlight for more than 30 days. If construction delays are encountered, installer is responsible for providing cover to portions of tubing exposed to direct sunlight.

1.7 WARRANTY

1.7.1 Refer to the Articles of Agreement, General Conditions and Section 20 00 00 - General Requirements for project warranty provisions.

1.7.2 PEX manufacturer's warranty shall conform to the following:

1.7.2.1 PEX tubing and fittings shall carry a twenty-five (25) year non-prorated warranty against failure due to defect in material or workmanship.

1.7.2.2 All tubing manufacturer's valves and stops shall carry a one (1) year non-prorated warranty against failure due to defect in material or workmanship.

1.7.2.3 The assembly of manufacturer's tubing and fittings shall carry a twenty-five (25) year non-prorated warranty on maintaining a leak-proof seal.

1.7.2.4 Warranty shall provide for repair or replacement of any tube, fittings, or connection, which are proven to be defective and pay for consequential damages.

1.7.2.5 Warranty shall be transferable to subsequent owners.

1.7.2.6 Effective Warranty: Current manufacturer's warranty at time of installation.

1.7.2.7 Warranty shall commence on Date of Substantial Completion.

2 PRODUCTS

2.1 PIPES AND FITTINGS

2.1.1 For 860 kPa (125 psi) or less operating pressure use 860 kPa (125 psi) rated fittings. For 860 kPa to 1,730 kPa (125 psi to 250 psi) operating pressure use 1,730 kPa (250 psi) rated fittings.

2.1.2 Buried water lines:

2.1.2.1 Piping shall be IPEX “Blue Brute” PVC, 100mm – 300mm (4” – 12”), to Standards AWWA C900, CAN/CSA B137.3, ULC Cex448, UNI-B-3-80.

2.1.2.2 Fittings for 100, 150 and 200mm (4”, 6” & 8”) PVC pipe shall be injection moulded, colour coded blue with push-on gasketed joints conforming to AWWA C907 (latest revision), be ULC listed, FM approved and be certified by the Canadian Standards Association to CAN/CSA B 137.2. Injection moulded fittings shall be produced from 4000 psi HDB compound.

2.1.2.3 Gaskets shall be made of SBR. Gaskets must be removable from the pipe gasket race, in order to aid cleaning the bell and spigot should it be necessary prior to assembly.

2.1.2.4 Service connections to PVC mains shall be effected by using PVC moulded tapped couplings 100mm, 150mm & 200mm (4”, 6” & 8”) conform to AWWA C907 and be certified by the Canadian Standards Association to CAN/CSA B137.2.

2.1.2.5 Service saddles shall be stainless steel 304 and be a minimum 18-gauge (1.3mm) construction and shall have AWWA taper (CC) outlet thread. Service saddles shall be used for taps on pipe sizes larger than 200mm (8”), where tapped couplings cannot be used.

2.1.2.6 Mechanical joint restraints shall conform to ASTM F1674 and manufacturer’s specifications. Restraining collars shall be attached to the fitting bell behind the gasket face. Tie-rods shall run from the collar behind the bell to a suitable collar on the connecting pipe. Tie-rods to be Denso wrapped.

2.1.2.7 Concrete thrust blocks shall conform to Ontario Provincial Standards Specification (OPSS) 1350 with nominal minimum 28-day compression strength of 20 MPa (2,900 psi). Thrust blocks as per UNI-B-3-92 and shall be constructed as per Ontario Provincial Standards Drawing (OPSD) 1103.01 and OPSD 1103.02.

2.1.2.8 Tracer wire shall be 12-gauge Thermoplastic Water Resistant insulated wire, Nylon jacketed (TWN) multi-strand copper and shall be installed along all PVC watermains at the 12 o’clock position and as close to the pipe as possible. The tracer wire shall be brought to the surface at all fire hydrants, looped twice around the hydrant barrel 100mm (4”) below finished grade and fastened by means of a washer to a breakaway flange bolt.

2.1.3 Domestic cold water, hot water, and hot water recirculation piping shall be type 'L' hard copper with wrought copper or cast brass fittings and 95/5 solder joints or brazed joints using phosphorus based filler metal, up to 1,380 kPa (200 psi) operating pressure.

2.1.3.1 Alternatively, for domestic cold water and hot water piping, 100mm (4") dia. and larger, stainless steel piping, Schedule 10 (up to 250 psi) / Schedule 40 (for operating pressure above 250 psi), conforming to AWWA Standard C220 with roll-grooved joints can be used.

2.1.3.2 Domestic cold water and hot water stainless steel piping shall conform to ASME B16.9 and ASTM A269 and only grade 304/304L and 316/316L shall be used.

2.2 <u>PEX POTABLE WATER DISTRIBUTION SYSTEM</u>

2.2.1 Plumbing tubing system to be Wirsbo AQUAPEX Professional Plumbing System as manufactured by Uponor Canada Inc.

2.2.2 Tube shall be cross-linked polyethylene (PEX) manufactured by PEX-A or peroxide method.

2.2.2.1 PEX tubing shall be manufactured in accordance with ASTM F876, ASTM F877 and CAN/CSA-B137.5. The tube shall be listed to ASTM by an independent third party agency.

2.2.2.2 PEX tubing shall have Standard Grade hydrostatic design and pressure ratings of 93°C (200°F) at 551 kPa (80 psi); 82°C (180°F) at 689 kPa (100 psi) and 23°C (73.4°F) at 1,102 kPa (160 psi). Temperature and pressure ratings shall be issued by the Plastic Pipe Institute (PPI), a division of the Society of the Plastic Industry (SPI).

2.2.2.3 Minimum bend radius for cold bending of the PEX tubing shall not be less than six (6) times the outside diameter. Bends with a radius less than stated shall require the use of a bend support as supplied by tube manufacturer.

2.2.2.4 PEX tube dimension shall be 12mm (½") up to and including 40mm (1-½") nominal inside diameter in accordance with ASTM F876 and ASTM F877 and as indicated on the Contract Drawings.

2.2.3 Manifolds to be either:

2.2.3.1 Wirsbo Quick & Easy AQUACENTER

2.2.3.2 Wirsbo Quick & Easy PLS Manifold

2.2.3.3 Wirsbo Quick & Easy Type “L” Copper Manifold

2.2.4 Fittings shall be Wirsbo Quick & Easy, manufactured of polysulfone or brass. Fittings shall be PEX-A cold expansion type fitting.

2.2.4.1 Fittings shall be supplied by the PEX tubing manufacturer.

2.2.4.2 PEX-A cold expansion type fitting shall be an assembly consisting of insert and PEX-A cold expansion ring.

2.2.5 Ice maker and washing machine outlet boxes shall be supplied by the PEX tubing manufacturer.

2.2.6 Fixture shut-offs shall be supplied by the PEX tubing manufacturer.

2.2.7 Wall penetration brackets, drop ear bend support type, designed for wall membrane penetrations shall be supplied by PEX tubing manufacturer.

2.2.8 Concrete tube support brackets “Stand-Up” to hold PEX tubing in place in structural concrete slabs shall be of rigid PVC construction and be designed for that purpose.

3 EXECUTION

3.1 GENERAL

3.1.1 Comply with manufacturer’s product data, including Product technical bulletins, installation instructions, and Product carton instructions for installation.

3.1.2 Ream all piping and keep plugged to prevent entry of dirt. Use pipes, which conform to CSA and ASTM standards.

3.1.3 Install piping in a professional manner and in accordance with the practices of the trade.

3.1.4 Consider the piping shown on the Drawings as diagrammatic, for clearness in indicating the general runs and connections and that the piping may, or may not, in all parts be shown in the true position. This does not relieve the responsibility for the proper erection of the systems of piping in every respect suitable for the work intended.

3.1.5 Ensure that fabrication, welded or otherwise, meets the

requirements of the ASA B31.9 Code for Pressure Piping, the CSA B51 Code for Boiler, Pressure Vessel, and Pressure Piping, and all requirements of the Boilers and Pressure Vessels Act of the Province of Ontario.

3.1.6 Use only fittings, or other materials to be incorporated in the work, which are approved by TSSA's Boiler and Pressure Vessels Safety Program, for the class of work for which they are used.

3.1.7 Thoroughly clean the inside of fittings and outside of pipe with steel wool and coat with flux, before soldering or brazing any copper pipe work joint. Remove the working parts of valves before soldering or brazing commences, and replace after soldering or brazing is complete.

3.1.8 Provide swing joints in runouts to units, off horizontal mains.

3.1.9 In Victaulic grooved piping systems, install swing joints consisting of flexible couplings, pipe nipples and elbows that provide simultaneous movement in all directions. Refer to Victaulic design submittal #26.12.

3.1.10 Use di-electric connections for cathodic protection wherever pipes of dissimilar material are connected together. When connecting grooved end steel to copper piping, use Victaulic dielectric waterway, Style 647-GG.

3.1.11 All traps and fittings shall be of same material or equal in quality and thickness to the pipe to which they are connected.

3.1.12 Provide unions or flanges at all connections to equipment or fixtures requiring servicing or replacement.

3.1.12.1 Unions or flanges for servicing are not required in installations using Victaulic couplings. (The couplings shall serve as disconnect points.)

3.1.13 In copper pipes, provide wrought copper unions with soldered joints for pipe up to and including 50mm (2"), and 1,035 kPa (150 psi) cast brass flanges for pipes 65mm (2-$^1/_2$") or larger.

3.1.14 Install all grooved end components as per manufacturers latest recommendation. All grooved products shall be of one manufacturer. The grooved coupling manufacturer's factory trained representative shall provide on-site training for contractor's field personnel in the use of grooving tools and installation of

grooved joint products.

3.1.15 Provide thrust restraints on mechanical pipe joints where required to accommodate axial thrust. Scope of bracing shall include but not be limited to all joints at the base of all vertical storm drains, including cleanouts, and all joints in horizontal piping at the lowest level which drains by gravity to the street services.

3.1.16 PEX piping systems are only acceptable for use in potable water distribution within residential occupancy suites.

3.2 EXAMINATION

3.2.1 Verify conditions, which have been previously installed under other sections, are acceptable for PEX tubing system installation in accordance with manufacturer's instructions.

3.3 EQUIPMENT CONNECTIONS

3.3.1 Install piping connection to equipment, to prevent any strain on pipe and equipment and to facilitate removal equipment without disconnecting more than the minimum of pipework or shutting down any other piece of equipment.

3.3.2 Install equipment and apparatus requiring servicing and/or replacing with unions or flanges.

3.3.3 Install valves, and automatic valve assemblies prefabricated and in uniform arrangement.

3.3.4 Install piping, automatic control valves, thermostat wells, orifice plates, etc., and any other appurtenances, supplied under the work of other Specification Sections or by the Owner for insertion in piping and equipment.

3.3.5 Provide di-electric fittings between dissimilar metals where corrosion may occur.

3.4 CONNECTIONS FOR OTHER TRADES

3.4.1 Provide valved hot and/or cold water to all equipment supplied by others, requiring same and connect.

3.4.2 Provide quick fill valved connections for chilled water, hot water, and condenser water systems.

3.4.3 Provide valve bypass arrangement for water differential pressure

transmitters. Coordinate exact quantity and location with the Division 25 - Integrated Automation Subcontractor.

3.5 PEX INSTALLATION

3.5.1 Install PEX tubing for potable water distribution system within residential occupancy suites only.

3.5.2 Install PEX tubing in accordance with tubing manufacturer's recommendations and as indicated on Contract Drawings.

3.5.3 Manifolds shall be isolated with potable water ball valves.

3.5.4 PEX tubing shall not be exposed to direct sunlight for more than 30 days.

3.5.5 Insulation must cover the PEX tubing when exposed to a direct UV light source such as fluorescent light bulbs.

3.5.6 Ensure that no glues, solvents, sealants, or chemicals come in contact with the tubing without prior permission from the tube manufacturer.

3.5.7 PEX tubing passing through structural concrete slabs shall be sleeved with utility grade polyethylene tubing one (1) pipe diameter larger than the PEX tubing.

3.5.8 PEX tubing passing through metal studs shall be use grommets or sleeves at the penetration.

3.5.9 Protect PEX tubing with sleeves where abrasion may occur.

3.5.10 Use strike protectors where PEX tubing has the potential for being struck with a screw or nail.

3.5.11 Manufacturer's bend supports shall be used where bends are less than six (6) times outside pipe diameter.

3.5.12 Manufacturer's concrete tube support bracket shall be used in structural concrete applications at all fixture and manifold locations.

3.5.13 Manufacturer's wall penetration brackets shall be used at all wall membrane penetrations.

3.5.14 Pressure test PEX potable water distribution system with air or potable water in accordance with applicable codes or, in the absence of applicable codes, to a pressure of 173 kPa (25 psi)

above normal working pressure of the system. The pressure test shall last a minimum of 30 minutes. As the piping expands, restore pressure first at 10 minutes into the test, and again at 20 minutes. The test pressure must not fall more than 34kPa (5 psi) after 30 minutes. No leakage should be detected.

3.5.15 Comply with safety precautions when pressure testing, including use of compressed air, where applicable. Water shall not be used to pressurize the system if ambient air temperature has the possibility of dropping below 0°C (32°F).

3.6 TESTING

3.6.1 After all pipes have been placed in position and all branches installed, but before fixtures have been set or connected, test the tightness of all joints and the soundness of all pipes.

3.6.2 Make all tests before piping is furred in.

3.6.3 Notify the Consultant at least 48 hours before commencing with test, and give the Consultant a written certificate confirming these tests.

3.6.4 Test all water lines hydrostatically at 1-1/2 times the working pressure but at not less than 1,380 kPa (200 psi), for a period of not less than four (4) hours without any drop in pressure. Do testing before piping is buried or furred in and before pressure sensitive devices are installed in the pipework. Correct all defects disclosed by tests. Retest until all results are acceptable.

3.6.5 If any leaks are discovered by the above tests, remove and replace the faulty portions of the systems and repeat the test. Repeat this procedure until the system is accepted by the Consultant's representative on the Site. Do not caulk threaded joints.

3.6.6 Check horizontal pipe with an accurate level for any alterations in pitch. Inspect laterals, cross arms, and eliminate pockets. Correct any cases of water hammer.

3.7 FIELD QUALITY CONTROL

3.7.1 Provide PEX manufacturer's field service consisting of produce use recommendations and periodic site visit for inspection of product installation in accordance with manufacturer's instructions.

3.7.2 Manufacturer shall visit the site on a monthly basis during the

installation of the PEX piping system. Each visit shall be documented with a report issued to the Consultant.

3.8 FLUSHING AND CLEANING

3.8.1 Inspect the systems, and remove any heavy debris and excessive oil and dirt.

3.8.2 Flush all completed systems with clear water at the highest obtainable pressure and velocity.

3.8.3 During flushing and cleaning, maintain all isolating and control valves in the open position.

3.8.4 Sterilize domestic hot and cold water piping. Provide chemical and bacteriological test data to prove that sterilization has been carried out.

3.8.5 Flush, chlorinate and reflush all outside water mains in accordance with AWWA C651-05 Specifications.

3.9 STREET SERVICES

3.9.1 Connect building cold water services, fire water, main storm and sanitary sewers to street mains where shown, and make all necessary arrangements with authorities and utilities involved. Pay for all permits and inspections and for all work to be done by the local authorities and utility companies.

3.9.2 Check and verify all invert elevations before proceeding with any of the work of this Section.

3.10 COMPLETION

3.10.1 Provide a declaration, signed by a responsible officer of the Division 22 – Plumbing Subcontractor indicating that the following procedures and tests have been performed in accordance with the Drawings and Specifications. Provide two (2) copies of the signed declaration to the Consultant.

3.10.1.1 Water pressure test performed and leak free.

3.10.1.2 Plumbing inspections made and issue necessary certificates.

END OF SECTION

INDEX

1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SHOP DRAWINGS

1.2.1 Submit shop drawings for the following equipment:

1.2.1.1 Hose bibs

1.2.1.2 Water meter

1.2.1.3 Thermostatic mixing valves

1.2.1.4 Backflow preventers

1.2.1.5 Pressure reducing valves

1.2.1.6 Shock absorbers

1.2.1.7 Domestic hot water storage tanks

2 **PRODUCTS**

2.1 SHOCK ABSORBERS

2.1.1 Shock absorbers shall be P.P.P. Inc 'SS' Series.

2.2 HOSE BIBS

2.2.1 Outside wall hydrants ('N.F.W.H.') shall be non-freeze flush type with stainless steel box, polished nickel bronze hinged locking cover and key and integral vacuum breaker. J.R.Smith 5509-QTNB; Zurn Z-1300-SS; Mifab MHY-20-3; Watts HY-725-SS.

2.2.2 Non-freeze wall hydrants ('N.F.W.H.') shall be ¼ turn non-drip, ceramic cartridge, 19mm (¾") non-freeze wall type with bronze face, adjustable wall-flange operating key, and self-draining integral vacuum breaker. Length to suit wall thickness. J.R.Smith 5609-QT; Zurn Z-1310; Mifab MHY-16; Watts HY-420.

2.2.3 Inside hose bibs (H.B.) shall be with rough chrome plated, heavy duty, angled body, 12mm (1/2") with 19mm (3/4") hose end vacuum breaker. Acorn 'Neptune' 8121CR.

2.2.4 Inside combination cold and hot water hose bibs 'HB-2' in mechanical rooms and garbage rooms shall be DN15 (1/2") with DN20 (3/4") hose end vacuum breaker.

2.3 MAIN INCOMING WATER METER

2.3.1 Water meter for 2" and larger shall be 'Neptune Technology' TRU/FLO Compound Meter or equal, with digital pulse output.

2.3.2 Provide 3-valve by-pass around meter and drain valve.

2.3.3 Provide remote reading totalizer complete with wiring and plastic conduit.

2.3.4 Provide cold water meter couplers, tails and spacer tubes.

2.4 WATER SUB-METER

2.4.1 Water meter 2" and smaller shall be 'Neptune Technology' T-10 Meter, with digital pulse output.

2.4.2 Provide 3-valve by-pass around meter and drain valve.

2.4.3 Provide remote reading totalizer complete with wiring and plastic conduit.

2.4.4 Provide hot and cold water meter couplers, tails and spacer tubes.

2.5 BACKFLOW PREVENTERS

2.5.1 Provide backflow preventers in accordance with CAN/CSA-B64.10-11.

2.5.2 Acceptable Products for non-potable applications are as follows:

2.5.2.1 B64.4 Reduced Pressure Principle Type (RP) – Conbraco Series 40-200, Watts 009/909, Wilkins 975XL/975, Febco 825YA/YD, Hersey Grinnell FRP-2, Ames 4000.

2.5.2.2 B64.5 Double Check Valve Type (DCVA) – Conbraco Series 40-100, Watts 007/757, Wilkins 950XL/950, Febco 805/850, Hersey Grinnell FDC/HDC, Ames 2000/3000.

2.5.3 Acceptable Products for potable applications are as follows:

2.5.3.1 B64.4 Reduced Pressure Principle Type (RP) – Apollo Valves Series 40-200, Watts 009/909, Wilkins 375XL, Febco 825YA/YD,

Ames 4000B (or 4000SS).

2.5.3.2 B64.5 Double Check Valve Type (DCVA) – Conbraco Series 40-100, Watts 007/757, Wilkins 950XL/950, Febco 805/850, Ames 2000/3000.

2.5.4 Use screwed connections to DN50 (2") size, flanged connections for larger sized valves, bronze or cast iron body, bronze trim, and stainless steel pilot trim.

2.5.5 Backflow preventers shall have a minimum working pressure of 1,724 kPa (250 psi).

2.6 PRESSURE REDUCING VALVES

2.6.1 Water Service – up to 1,035 kPa (150 psi)

2.6.1.1 DN15 to DN65 (½" to 2-½") – Watts Regulator Series #223 or Acceptable Alternative Manufacturers Pressure Reducing Valve, size as shown on the Drawings, bronze body, direct operated, single renewable seated stainless steel trim, diaphragm actuated.

2.6.1.2 DN80 to DN150 (3” to 6”) - Watts Regulator Series #2300 or Acceptable Alternative Manufacturers Pressure Reducing Valve, size as shown on the Drawings, cast iron body, direct operated, single renewable seated stainless steel trim, diaphragm actuated.

2.6.2 Water Service – up to 2,070 kPa (300 psi)

2.6.2.1 DN15 to DN65 (½" to 2-½") – Watts Regulator Series #223 or Acceptable Alternative Manufacturers Pressure Reducing Valve, size as shown on the Drawings, bronze body, direct operated, single renewable seated stainless steel trim, diaphragm actuated.

2.6.2.2 DN80 to DN200 (3” to 8”) - Watts Regulator Series #F115 or Acceptable Alternative Manufacturers Pressure Reducing Valve, size as shown on the Drawings, ductile iron body, pilot operated, stainless steel trim, diaphragm actuated, flanged suitable for 400 psi inlet pressure, with adjustable opening speed.

2.6.3 Valve shall regulate accurately throughout the range of pressures and flow conditions scheduled, function quietly, and shut tight on a dead end shut-off. Flanged or grooved ends, disc and diaphragms of hycar material. No springs shall be in the path of the water and no stuffing of boxes. All parts must be easily accessible without removal of the valve from the line. Provide Type ‘Y’ Strainer (Suffix

'S') in front of PRV. Tested and certified to ASSE Std. 1003.

2.7 BACKWASH FILTERS

2.7.1 Provide automatic operation protective backwash filters similar to Judo-Profi JPF+AT\P-_ ___mm (_"). Filter shall be capable of handling up to __ L/s (___ USgpm) water flow at maximum pressure drop of ___ kPa (_ psi).

2.7.2 Filter upper housing shall be made of high-grade polymer based materials, bottom housing made of high-grade cast iron coated with rilsan. Filter shall be equipped with a clear sight-glass, which allows viewing the filtration, soiling and backwash functions. Filter shall have stainless steel screen with 0.1mm (0.004 inches) sieve size, silver plated for germ prophylaxis.

2.7.3 Automatic backwash shall be generated by a time actuated relay, with the following adjustable range from 1 to 2,000 hours and a differential pressure control setting adjustable from 6.9-248 kPa (1-36 psi) differential.

2.7.4 Back-washing shall utilize point rotation system without any interruption of the water supply. Simultaneous cleaning of the sight-glass during the backwash process.

2.7.5 Electronic control system shall include LED indicators for operation mode, alarm buzzer and manual override button for back-wash start-up. Filter shall be complete with 120/24 VAC plug-in transformer
(21 VA).

2.8 HOT WATER MIXING VALVES

2.8.1 Provide master thermostatic valves conforming to requirements of CSA B.125 to control valve discharge water temperature to 49°C (120°F). Select valves to provide the required maximum flow rate at a maximum pressure drop of 69 kPa (10 psi).

2.8.2 Thermostatic Valves shall be listed to ASSE 1017 – Temperature Actuated Mixing Valves For Hot Water Distribution Systems. Valves should also have Uniform Plumbing Code Canadian (cUPC) listing.

2.8.3 Valve body to cast bronze to ASTM B 584. Bronze internal components to ASTM B 139.

2.8.4 Valve shall have Manufacturer's name, as well as ASSE 1017 and cUPC logos, clearly displayed for conformance to standard.

2.8.5 Provide factory assembled and tested large TYPE TM thermostatic water mixing valve, small TYPE TM valve, DURA-trol® solid bi-metal thermostat (directly linked to valve porting to control the intake of hot and cold water and compensate for supply temperature or pressure fluctuations) with Seven Year Limited Warranty, color coded dials (HOT-COLD with directional indicators), locking temperature regulator handles, adjustable limit stops set for 49°C (120°F), integral hot and cold supply check stops.

2.8.6 Provide outlet ball valve shutoffs, color-coded dial thermometer, and inlet piping manifold.

2.8.7 Factory preassembled and hydrostatically tested to ASSE 1017 requirements, rough bronze finished system shall provide full time standby service should one mixing valve require maintenance.

2.8.8 Valves shall be piped strictly in accordance to Manufacturer's required piping method and be factory assembled and shipped to site for installation.

2.9 THERMOSTATIC FLOW REGULATOR

2.9.1 Flow regulator shall be Circuit Solver as manufactured by Therm-Omega-Tech, Inc., or equivalent, NSF-61 certified for use in all domestic water systems.

2.9.2 Circuit Solver shall regulate the flow of recirculated domestic hot water based on water temperature entering the regulator regardless of system operating pressure.

2.9.3 Even when fully closed the Circuit Solver shall bypass a small amount hot water to maintain dynamic control of the recirculating loop.

2.9.4 Circuit Solver shall be factory adjustable as required by project conditions.

2.9.5 Circuit Solver shall be available in sizes ranging from DN15 (½ inch) NPT to DN50 (2") NPT, with standard tapered female pipe thread connection, rated to 1,378 kPa (200 psi) maximum operating pressure and to 148.9°C (300°F) maximum working temperature.

2.9.6 Body and all internal components shall be constructed of stainless steel with major components constructed of type 303 stainless steel.

2.9.7 Thermal actuator shall be spring loaded and self cleaning, delivering closing thrust sufficient to keep orifice opening free of scale deposits.

2.10 AUTOMATIC WATER BALANCING VALVES

2.10.1 Potable Water Automatic Balancing Valves 15mm (½") – 20mm (¾"):

2.10.1.1 Designed specifically for use in drinking water applications. NSF Certified in accordance with ANSI/ NSF 61 for commercial cold and hot water service, rated to 83degC (180degF) and ANSI/NSF 372. Lead-free construction; Series 300 stainless steel body, nickel plated brass union nut and tamper-resistant flow cartridge in 300 series stainless steel. Valve shall be suitable for a flow range of 0.33 GPM/1.50 LPM to 12 GPM/45.4 LPM and flow rate pre-set accuracy variation of +/-5% over 95% of the control range. Valves shall be offered with two pressure differential control ranges of 2-3 psi/ 13-220 kPa or 5-60 psi/ 35-414 kPa differential.

2.10.2 Standard of Acceptance: Victaulic/ IMI TA Series 76X, RWV 9519-AB/9517-AB

3 **EXECUTION**

3.1 UNIONS, FLANGES, DI-ELECTRIC COUPLINGS

3.1.1 Provide unions or flanges at all connections to equipment of fixtures requiring servicing or replacing.

3.1.2 In copper pipes, provide wrought copper unions with soldered joints for pipes up to and including DN50 (2") sizes and 1,034 kPa (150 psi) cast brass flanges for pipes DN100 (4") or larger.

3.1.3 Install approved dielectric isolation in following specified systems:

3.1.3.1 Domestic cold water systems

3.1.3.2 Make-up water systems

3.1.3.3 Expansion pipes where make-up is connecting to the expansion tank

3.1.3.4 In all other locations where specifically noted or shown on the Drawings

3.1.4 Install approved dielectric isolation at the transition between noble materials such as copper, brass bronze, high alloy castings, or stainless steel and low alloy ferrous materials such as black iron, galvanized iron, or cast iron. These dielectric isolators must be installed in such a way that they are not shorted out by accidental contacts to process equipment, building steel, instrumentation tubing, or electrical neutrals. Ensure that dielectric unions are constructed of materials that are compatible galvanically with the systems to which they are connected, e.g. a dielectric union for installation between copper and iron must be constructed with a body of iron and a tailpiece of copper or brass.

3.2 SHOCK ABSORBERS

3.2.1 Provide shock absorbers on both hot and cold water systems. Install in an upright position at all quick closing valves, solenoids, groups of plumbing fixtures and isolated fixtures. Locate and size as required and in accordance with the Plumbing and Drainage Institute Standard No. WH201 P.D.I. and as per manufacturer's instruction.

3.3 BACKFLOW PREVENTERS

3.3.1 Provide backflow preventers for all potential cross connections, including domestic water connections to all heating, cooling and refrigeration equipment, to irrigation system, where shown on drawings, and as required by the Ontario Plumbing Code and local authority having jurisdiction. As a minimum standard, installation shall be in conformance with CAN/CSA-B64.10-11.

3.3.2 Provide bronze body, spring loaded, soft seated, silent check valve upstream of backflow preventers. Up to and including DN50 (2"): Watts Series 600, Conbraco 61-500, Wilkins Model 40. DN65 (2-½") and above: Apco Series 300, Mueller.

3.3.3 Installation of silent check valve upstream of double check valves servicing main domestic water line is not required.

3.4 KITCHEN, AND OTHER OWNER'S EQUIPMENT

3.4.1 Provide complete roughing-in and final connections for kitchen, laboratory, and other Owner's equipment as shown on the drawings and as further delineated by the kitchen, laboratory, and

other Owner's equipment drawings provided by the Owner and/or by other Specialist Consultants. This Subcontractor shall prepare complete 1:50 scale drawing with all services shown as required for approval by the Consultant.

3.4.2 No roughing-in shall be started and no final connections made to equipment until complete roughing-in and connection drawings have been provided by the Owner.

3.4.3 Provide valved and capped connections to equipment supplied by others.

3.4.4 When the equipment has been installed, do all final connections to equipment.

3.4.5 Provide vacuum breaker on each domestic water connection serving each laboratory fixture. Conbraco Series 38-502, Watts 9D/N-LF9, Wilkins 750A/760, Febco 815, Hersey Grinnell BCP.

3.5 DOMESTIC HOT WATER STORAGE TANKS

3.5.1 Install tanks on 100mm (4”) high concrete housekeeping pad.

3.5.2 Provide a temperature and pressure relief valve for each tank. Pipe to nearest drain.

3.6 BACKWASH FILTER

3.6.1 Run DN20 (3/4") backwash flushing drain, two (2) connections for 100mm (4”), three (3) connections for 125mm (5”) filter, to nearest large capacity funnel floor drain using an indirect connection.

3.7 THERMOSTATIC FLOW REGULATOR

3.7.1 Install thermostatic flow regulator in each domestic hot water recirculation riser/branch beyond the last hot water device in that branch. Provide suitable line size isolation valves and access panel as required in non-accessible ceilings and walls.

END OF SECTION

Project Name: *UNIVERSITY OF TORONTO MISSISSAUGA*
Project No.: *2023-0059*
Section Name: ***Domestic Water Pumps***
Section No.: ***22 11 23***
Date: *November 15, 2024*

INDEX

1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools equipment, training commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 Domestic hot water recirculation pumps.

1.3 SUBMITTALS

1.3.1 Provide shop drawings for:

1.3.1.1 Circulators

1.3.1.2 Recirculation pumps

1.3.1.3 Domestic water pressure booster system

1.3.2 Submit letter from manufacturer certifying domestic water booster pump system has been installed in accordance with its recommendations.

1.3.3 The submittal data for the pumping system shall include, but not be limited to: pump curves, individual computer data sheets, system drawings, and complete description of control panel, with wiring diagram, sequencing data, instrumentation and alarms.

2 **PRODUCTS**

2.1 DOMESTIC HOT WATER RECIRCULATING PUMP

2.1.1 Provide domestic hot water recirculating system consisting of pump and ancillaries.

2.1.2 Pump shall be bronze fitted.

2.1.3 Install line size butterfly, ball, or gate valves and strainer on pump suction. Install line size swing check valves and butterfly, ball, or gate valve on pump discharge.

3 EXECUTION

3.1 GENERAL REQUIREMENTS

3.1.1 Provide pump and install it in accordance with the requirements of the respective manufacturer.

3.1.2 Ensure that the piping does not stress the pump casing because of misalignment.

3.1.3 After connections have been made, fill system before starting pump. Do not run dry under any circumstances.

3.1.4 Support piping from building structure to prevent any strain on pump casing. Make final check for alignment of piping connections before pump connections are tightened.

3.2 RECIRCULATING PUMPS AND CIRCULATORS

3.2.1 Install line size butterfly, ball, or gate valve and strainer on pump suction. Install line size swing check valve and butterfly, ball, or gate valve on discharge.

END OF SECTION

Project Name: *UNIVERSITY OF TORONTO MISSISSAUGA*
Project No.: *2023-0059*
Section Name: ***Sanitary Waste and Vent Piping***
Section No.: ***22 13 16***
Date: *November 15, 2024*

INDEX

1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools, equipment, training, commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 Sanitary system, including drains, and vents.

1.2.1.2 Floor drains and fittings.

1.3 REGULATORY REQUIREMENTS

1.3.1 In addition to specific requirements for pipe fittings as further specified in this document and where applicable, the equipment shall comply with the Boiler and Pressure Vessels Act (the “Act”) and CSA Standard B51.

1.3.2 In compliance with the Act and relevant Codes, all fittings shall be registered by the manufacturer, and shall be identified by the appropriate Canadian registration number.

1.3.3 Where fittings are provided without the appropriate Canadian registration number, the Contractor shall obtain a copy of the manufacturer's Statutory Declaration as provided to the authorities having jurisdiction.

1.3.4 All welding and fabrication shall be to the requirements of the ANSI/ASME B31.9 code for pressure piping and CSA standard B51 code for the Construction and Inspection of Boilers and Pressure Vessels.

1.3.5 All copper piping shall be certified to ASTM Standard B88 for Seamless Copper Water Tube.

1.4 REFERENCES

1.4.1 ASTM D1784 – Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.

1.4.2 CAN/CSA B181.2 – PVC Drain, Waste and Vent Pipe and Pipe Fittings.

1.4.3 CAN/CSA B182.1 – Plastic Drain and Sewer Pipe and Pipe Fittings.

1.4.4 CAN/CSA B602 – Mechanical Couplings for Drain, Waste, and Vent Pipe and Sewer Pipe.

1.4.5 CAN/ULC-S102.2 Method of Test for Surface Burning Characteristics of Flooring, Floor Coverings, and Miscellaneous Materials and Assemblies.

1.4.6 CAN/ULC-S115 – Standard Method of Fire Tests of Firestop Systems

1.4.7 National Plumbing Code of Canada (NPC)

1.4.8 Ontario Building Code (OBC)

1.5 QUALITY ASSURANCE

1.5.1 Source Limitations: Obtain plastic piping and fittings from a single manufacturer.

2 **PRODUCTS**

2.1 PIPES AND FITTINGS

2.1.1 Buried sanitary drains:

2.1.1.1 Piping shall be IPEX “PVC BDS Solvent Weld” DR-35 100mm - 150mm (4” - 6”) CAN/CSA B182.1, or IPEX “Ring-Tite” PVC DR-35 100mm - 375mm (4” – 15”) CAN/CSA B182.2, to ASTM Standard D3034.

2.1.1.2 Fittings for 100, 125, 150, 200, 300, and 375-mm (4”, 5”, 6”, 8”, 10”, 12”, & 15”) PVC DR 35 pipe shall be injection-moulded or fabricated fittings, certified by the Canadian Standards Association to CAN/CSA B182.1 and B182.2. Pipe and fittings to be constructed by the same manufacturer to ensure compatibility.

2.1.1.3 Gaskets shall be factory installed and made of elastomer, EPDM. Nitrile gaskets shall be used, as determined by the Consultant, where contaminated soils or special chemical or temperature resistance is encountered or required.

2.1.1.4 PVC injection-moulded or fabricated tees shall be used for all service connections on new sewer main construction, including sewer mains for new subdivisions prior to assumption.

2.1.1.5 The pipe shall be jointed in accordance with the manufacturer's specifications.

2.1.1.6 Tracer wire shall be installed with all PVC pipe.

2.1.2 Sanitary piping cast into raft footings shall be ABS DWV.

2.1.3 Unburied sanitary drains, 75mm (3") dia. and under shall be copper drainage tube (DWV), cast brass fittings and 50/50 solder joints. Drains 100mm (4") dia. and over shall be standard weight cast iron pipe and fittings with mechanical joints.

2.1.3.1 Alternatively, PVC-DWV pipe and fittings may be used in accordance with the following:

2.1.3.1.1 For above-ground DWV applications, IPEX System 15 DWV certified to CAN/CSA B181.2 and having a Flame Spread Rating not more than 25.

2.1.3.1.2 For above-ground DWV applications within air plenums (including entry and exit from plenum), and in High Buildings, IPEX System XFR DWV certified to CAN/CSA B181.2 and having a Flame Spread Rating not more than 25 and Smoke Developed Classification not more than 50.

2.1.3.2 PVC pipe joints shall be solvent weld as follows:

2.1.3.2.1 IPEX System 15/System XFR One-Step PVC Cement certified to CSA B181.2.

2.1.3.2.2 IPEX System 15/System XFR Two-Step PVC Cement certified to CSA B181.2.

2.1.3.2.3 IPEX System 15/System XFR PVC Primer certified to CSA B181.2.

2.1.3.2.4 Sizes 1-1/2 inch to 6 inch: One-Step PVC Cement.

2.1.3.2.5 Sizes 8 inch and above: Two-Step PVC Cement with PVC Primer.

2.1.3.3 Sanitary drain lines serving waterless urinals and pool main drains up to 150mm (6") diameter shall be IPEX System 15 DWV certified to CAN/CSA B181.2 and having a Flame Spread Rating not more than 25. If drain lines are located within air plenums (including

entry and exit from plenum), or in High Buildings, piping shall be IPEX System XFR DWV certified to CAN/CSA B181.2 and having a Flame Spread Rating not more than 25 and Smoke Developed Classification not more than 50. Run PVC piping in full length up to the connection to buried service unless otherwise indicated on plans.

2.1.4 Pumped sanitary drains shall be Schedule 40 galvanized steel pipe; stretch reduced continuous weld, ASTM A53, with screwed fittings.

2.1.4.1 In lieu of the above specified piping, DWV piping with cast brass fittings and 50/50 solder joints may be used.

2.1.4.2 In lieu of the above specified piping, IPEX “Xirtec CPVC” S40 for use in an air plenum or High Building, or IPEX “Xirtec PVC” S40 otherwise, may be used.

2.1.4.3 Mechanical couplings (e.g. Victaulic) shall be permitted for pumped sanitary drain system, provided:

2.1.4.3.1 The couplings are located in accessible locations.

2.1.4.3.2 All couplings are by one manufacturer, suitable for pressure and temperature of respective system.

2.1.4.3.3 Rigid (zero-flex or equivalent) couplings with angle bolt pads are used in mechanical rooms.

2.1.4.3.4 Couplings for Schedule 40 piping to be manufactured from ductile iron conforming to ASTM-A536 and be complete with a Grade ‘E’ EPDM gasket, suitable for water service to 110°C (230°F).

2.1.4.3.5 Couplings for copper grooved piping in size 50mm (2") and above to be designed with angle bolt pads to provide a rigid joint, complete with EPDM flush-seal gasket suitable for temperatures from –34° (-30°F) to 110°C (230°F).

2.1.4.3.6 Fittings for Schedule 40 piping shall be manufactured from ductile iron conforming to ASTM-A536 or segmentally welded steel, with grooves designed to accept grooved end couplings.

2.1.5 Vents 50mm (2") dia. and less shall be type DWV copper, 65mm (2-$^1/_2$") and over galvanized.

2.1.5.1 In lieu of the above specified piping, IPEX System XFR for use in in air plenums and High Buildings, and IPEX System 15 otherwise,

may be used.

2.1.6 Fitting restraints for cast iron piping shall be HoldRite #117 series or approved equal. Field-devised methods and materials shall not be used to accomplish this application solution.

3 EXECUTION

3.1 GENERAL

3.1.1 Install in accordance with requirements of the Ontario Building Code or the local plumbing Authority Having Jurisdiction.

3.1.2 Ream all piping and keep plugged to prevent entry of dirt. Use pipes, which conform to CSA and ASTM standards.

3.1.3 Connect vent lines into the soil stack above highest fixture or extend separately through roof to a height of 600mm (24") above roofline and 3.6m (12 ft) away from any opening into building and flash properly.

3.1.4 Do not use double hubs, straight crosses, double T's or double TY's on any soil or waste pipe.

3.1.5 Install piping in a workmanlike manner and in accordance with current plumbing industry practices.

3.1.6 Consider the piping shown on the Drawings as diagrammatic, for clearness in indicating the general runs and connections and that the piping may, or may not, in all parts be shown in the true position. This does not relieve the responsibility for the proper erection of the systems of piping in every respect suitable for the work intended.

3.1.7 Cleanouts and other service items must be accessible.

3.1.8 Penetrations through structure shall be such that structural loads are not transferred to pipes.

3.1.9 On screwed piping, make up joints, metal to metal with red or white lead and oil applied to the thread. No hemp wick or packing will be permitted in making up screwed joints.

3.1.10 Thoroughly clean the inside of fittings and outside of pipe with steel wool and coat with flux, before soldering any copper pipe work joint. Remove the working parts of valves before soldering commences, and replace after soldering is complete.

3.1.11 Use di-electric connections for cathodic protection wherever pipes of dissimilar material are connected together. When connecting grooved end steel to copper piping, use Victaulic dielectric waterway, Style 647-GG.

3.1.12 All traps and fittings shall be of same material or equal in quality and thickness to the pipe to which they are connected.

3.1.13 Provide unions or flanges at all connections to equipment or fixtures requiring servicing or replacement.

3.1.14 In copper pipes, provide wrought copper unions with soldered joints for pipe up to and including 50mm (2"), and 1,035 kPa (150 psi) cast brass flanges for pipes 65mm (2-$^1/_2$") or larger.

3.1.15 Install all grooved end components as per manufacturers latest recommendation. All grooved products shall be of one manufacturer.

3.1.16 Provide fitting restraints on mechanical pipe joints where required to accommodate axial thrust. Fitting restraints shall include but not be limited to all fittings over 75mm (3”) in size, at the base of all vertical sanitary drains serving more than 10 storeys, including cleanouts, and all joints in horizontal piping at the lowest level which drains by gravity to the street services.

3.1.17 Provide fire-stop systems for all piping, at all penetrations through fire-rated separations tested and listed in accordance with CAN/ULC-S115.

3.2 <u>PVC PIPE DRAIN INSTALLATION</u>

3.2.1 In addition to the foregoing instructions (where applicable):

3.2.1.1 Plastic piping installed in a building classified as a “High Building” or installed within a ceiling space used as an air plenum shall have a Flame Spread Rating less not more than 25 and Smoke Developed Classification not more than 50.

3.2.1.2 Installation by a qualified installer.

3.2.1.3 This Subcontractor to meet with PVC pipe manufacturer prior to construction to review the procedures concerning all aspects of installation described herein (solvent welding, supports, expansion/contraction and testing). The Contractor shall provide the Engineer with a written record of the meeting.

3.2.1.4 Pipe must be cut squarely. Burrs and other loose materials shall be removed by chamfering of the pipe-end.. When required, PVC purple primer, Xirtec 07, shall first be generously applied to the pipe-end and inside the fitting hub. Next, CSA certified PVC solvent cement shall be applied to the pipe-end and inside the fitting hub while these areas are still moist. The pipe-end shall next be inserted to the full depth of the fitting hub and given a one-quarter turn. The pipe-end shall then be held in position until the solvent cement cures to the point of initial set. Pipe and fitting solvent weld joints shall be allowed to fully cure prior to pressure testing (follow the pipe manufacturers' recommended cure times).

3.2.1.5 For pumped discharge piping, ensure piping is braced to structure to avoid excessive movement.

3.2.1.6 This Subcontractor to accommodate all effects of thermal expansion and contraction movement by the use of line offsets or mechanical joint rubber couplings at sufficient intervals. As a general guideline, for piping installed in a controlled climate, straight pipe runs of less than 30m (100 ft) shall not require any expansion/contraction measures; for piping exposed to external weather elements, only runs of 15m (50 ft) or less shall not require expansion/contraction accommodation.

3.2.1.7 CSA certified mechanical joint couplings shall be installed at every second floor of the building. Rigidly support the stack pipe on alternating floors to minimize potential movement.

3.2.1.8 Provide fire-stop systems for all piping, at all penetrations through fire-rated separations tested and listed in accordance with CAN/ULC-S115.

3.3 <u>TESTING</u>

3.3.1 After all pipes have been placed in position and all branches installed, but before fixtures have been set or connected, test the tightness of all joints and the soundness of all pipes.

3.3.2 Make all tests before piping is furred in.

3.3.3 Notify the Consultant at least 48 hours before commencing with test, and give the Consultant a written certificate confirming these tests.

3.3.4 Sanitary, Waste, and Vent Piping: Securely close all openings in pipe ends throughout the work by means of approved plugs and fill

the entire piping system, including stacks, branches to fixtures and all horizontal runs with water, up to highest opening and let this water stand at this level for not less than two (2) hours. Perform another test after the fixtures are set, connected, and connections are made to all equipment. Test by running water into all pipes, fixtures, traps, and apparatus in order to detect any imperfect material or workmanship. Where it is impossible to test the whole system at one time, divide into parts. Perform a smoke or ball test or any other test required by authorities having jurisdiction.

3.3.5 Test all pumped drain lines hydrostatically at 1-1/2 times the working pressure but at not less than 1,380 kPa (200 psi), for a period of not less that four (4) hours without any drop in pressure. Do testing before piping is buried or furred in and before pressure sensitive devices are installed in the pipework. Correct all defects disclosed by tests. Retest until all results are acceptable.

3.3.6 If any leaks are discovered by the above tests, remove and replace the faulty portions of the systems and repeat the test. Repeat this procedure until the system is accepted by the Consultant's representative on the site. Do not caulk threaded joints.

3.3.7 Check horizontal pipe with an accurate level for any alterations in pitch. Inspect laterals, cross arms, and eliminate pockets.

3.3.8 For PVC piping:

3.3.8.1 Testing to be conducted after all solvent weld joints have cured.

3.3.8.2 Perform hydrostatic pressure test prior to the piping system being commissioned.

3.3.8.3 Pressure test underground piping systems before backfilling in accordance with requirements of the Ontario Building Code or the local plumbing Authority Having Jurisdiction.

3.3.8.4 Pressure test above-ground piping systems in accordance with requirements of the Ontario Building Code or the local plumbing Authority Having Jurisdiction.

3.3.8.5 As per manufacturer's instructions.

3.3.8.6 The system should be slowly filled with water and all air bled from the highest and farthest points in the installation.

3.3.8.7 Once the system has reached the desired test pressure, it should

remain at this pressure for one hour.

3.3.8.8 During this time, visually inspect all joints for leaks.

3.3.8.9 If any leaks are discovered, remove and replace the faulty portion(s) of the system and allow to cure fully before re-testing.

3.3.8.10 Follow proper safety precautions and use protective equipment during testing.

3.3.8.11 Prepare test and inspection reports.

3.4 DRAIN PIPES IN RAFT FOOTINGS

3.4.1 Firmly restrain piping by tying off to adjacent rebars for entire horizontal length.

3.4.2 After leak test, leave water in pipe during concrete pour.

3.4.3 Notify Consultant at least 48 hours before pour.

3.5 FLUSHING AND CLEANING

3.5.1 General

3.5.1.1 Inspect the systems, and remove any heavy debris and excessive oil and dirt.

3.5.1.2 Flush all completed systems with clear water at the highest obtainable pressure and velocity.

3.6 STREET SERVICES

3.6.1 Connect building main and sanitary sewer to street main where shown, and make all necessary arrangements with authorities and utilities involved. Pay for all permits and inspections and for all work to be done by the local authorities and utility companies.

3.6.2 Check and verify all invert elevations before proceeding with any of this Work.

3.7 COMPLETION

3.7.1 Provide a declaration, signed by a responsible officer of the Division 22 – Plumbing Subcontractor indicating that the following procedures and tests have been performed in accordance with the Drawings and Specifications. Provide two (2) copies of the signed

declaration to the Consultant.

3.7.1.1 Pressure test performed and leak free.

3.7.1.2 Plumbing inspections made and issue necessary certificates.

END OF SECTION

Project Name: *UNIVERSITY OF TORONTO MISSISSAUGA*
Project No.: *2023-0059*
Section Name: ***Sanitary Waste Piping Specialties***
Section No.: ***22 13 19***
Date: *November 15, 2024*

INDEX

1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SHOP DRAWINGS

1.2.1 Submit shop drawings for the following equipment:

1.2.1.1 Floor drains

1.2.1.2 Trap primers

1.2.1.3 Grease interceptors

1.2.1.4 Catch basins

2 **PRODUCTS**

2.1 FLOOR DRAINS

2.1.1 Finished Areas – 'FD-1'

2.1.1.1 Cast iron body floor drain, reversible flashing clamp with weep holes, adjustable top and 125mm (5") diameter, nickel bronze, 6mm (1/4") thick secured strainer, full 100mm (4") throat opening. J.R.Smith 2005A; Zurn ZN415-B; Mifab F1100C-1, Watts FD-100-C-A5-1. For quarry or mosaic tiled areas provide 125mm x 125mm (5" x 5") square nickel bronze strainer. J.R.Smith 2005B; Zurn ZN415-Y; Mifab F1100C-S, Watts FD-100-C-L5-1.

2.1.2 Mechanical Rooms, Plenums and Unfinished Areas – 'FD-2'

2.1.2.1 Cast iron body floor drain, flashing clamp with weep holes, adjustable top and 200mm (8") diameter, heavy duty, nickel bronze grate. J.R.Smith 2320NB; Zurn ZN556; Mifab F1320C-1, Watts FD-320-1.

2.1.3 Mechanical Rooms and Unfinished Areas – Floating Floor Drains – 'FD-2A'

2.1.3.1 Cast iron body floor drain, flashing clamp with weep holes, adjustable top and 216mm (8-1/2") diameter, heavy duty, cast iron grate with movement compensator and vibration isolator. J.R.Smith 9340-WSH; Zurn Z624-KC; Mifab F1620C-4, Watts FD-

620.

2.1.4 Electrical Rooms, Transformer Vault, Switchgear Room – 'FD-3'

2.1.4.1 Same as 'FD-1', but with backwater valve. J.R.Smith 2320NB-BV; Zurn ZN556-X; Mifab F1320C-1-8, Watts FD-320-1-8.

2.1.5 Garbage Room, Loading Area – 'FD-4'

2.1.5.1 Cast iron body drain, flashing clamp with weep holes, adjustable top, 280mm x 280mm (11" x 11") hinged, vandalproof, cast iron bar grate, and 100mm (4") deep, slotted sediment bucket. J.R.Smith 2360-HSU; Zurn Z-610-H-VP; Mifab F1340C-5-6-14-16, Watts FD-460-AF-5-6-9.

2.2 HUB DRAINS

2.2.1 Unfinished Areas – 'HD-1'

2.2.1.1 Cast iron body drain, reversible flashing clamp with weep holes and cast iron hub adaptor. J.R.Smith 2005-2645; Zurn Z415-1030; Mifab F1100C-DD-50, Watts FD-100-C-DD-50.

2.2.2 Finished Areas – 'HD-2'

2.2.2.1 Cast iron body drain, reversible flashing clamp with weep holes and nickel bronze hub adaptor. J.R.Smith 2005-2645NB; Zurn ZN415-1030; Mifab F1100C-DD-1, Watts FD-100-C-DD-1.

2.3 FUNNEL FLOOR DRAINS

2.3.1 Unfinished Areas – 'FFD-1'

2.3.1.1 Cast iron body combination funnel and floor drain, reversible flashing clamp with weep holes, adjustable top, 200mm (8") diameter, heavy duty, cast iron grate 13mm (1/2") thick strainer with 89mm x 229mm (3-1/2" x 9") cast iron funnel. J.R.Smith 2320-3591-CI; Zurn Z556 with Z414-1; Mifab F1320C-G-50, Watts FD-320-G-50.

2.4 BACKWATER VALVE

2.4.1 Backwater Valve in Branch Mains – 'BV'

2.4.1.1 Cast iron backwater valve, bolted access cover with gasket, bronze seat, automatic flapper type backwater valve, and stainless steel hardware. For extended floor access provide PVC extension and

cover. J.R.Smith 7012-MEXT (up to 8” (200mm)); Zurn Z1095-EXT (up to 10” (250mm)); Mifab BV1200-R-1 (up to 12” (300mm); Watts BV-200-EXT (up to 6” (150mm).

2.4.1.2 Provide access pit and cover for backwater valve if invert is greater than 457mm (18") from finished floor.

2.5 PLANTER DRAINS

2.5.1 Interior and Exterior Planters – ‘PD-4’

2.5.1.1 Cast iron body planting area drain with galvanized dome strainer covered with stainless steel mesh. J.R.Smith 2675-CID; Zurn Z110-ZCIC; Mifab F1820-13, Watts FD-860-PA.

2.6 INSPECTION PITS

2.6.1 Install checkered steel cover plate with access maintenance hole and anchor frame on inspection pits. Covers shall be sealed and gasketed.

2.7 TRAP PRIMERS

2.7.1 One to Four Drain

2.7.1.1 Provide P.P.P MP-500 complete with adjustable timer trap seal primer. Tap size to be 15mm (1/2”) with integral stainless steel screen. Electrical components shall include circuit breaker, test switch, timer solenoid valve (UL listed) and 120V/1Ph/60Hz connection.

2.7.2 More than Four Drain

2.7.2.1 Provide P.P.P. PT complete with adjustable timer trap seal primer. Primer shall be activated by a 20mm (3/4”) normally closed solenoid valve. Manifold shall be prefabricated type “L” copper tubing. Electrical components shall include circuit breaker, switch, timer, solenoid valve (UL Listed). Electronic assembly tested and certified to UL73. Electrical connection shall be 120V/1Ph/60Hz. Cabinet shall be 356mm x 406mm x 86mm made from 16 GA steel and galvanized. Access door shall be prime coated steel complete with screw driver latch.

3 **EXECUTION**

3.1 TRAPS

3.1.1 Provide every fixture and floor drain with traps in accordance with local regulations. Provide each trap with its own brass plug and ferrule cleanout.

3.1.2 For traps located in ceilings, provide access doors.

3.1.3 For drains in apparatus casings or air plenums, provide deep seal trap. For drains in outside air plenums, provide running trap located as far as possible from drains.

3.1.4 All traps for floor and hub drains shall be protected with trap primers. For electronic trap primers, run line voltage wiring to the nearest electrical panel with spare circuit.

3.1.5 Division 22 contractor must coordinate with electrical trade for circuit locations during scope drawing stage, otherwise Division 22 trade will be responsible for all costs associated with circuit wiring.

3.1.6 Trap seal primers must be installed above finished floor. Piping must have a minimum of 300mm (12”) from bottom of outlet before 90 degree elbow can be used. Furthest distance from primer to floor drain is 6m. Trap primer make up line must have a continuous slope to the floor drain.

3.1.7 If required by authorities having jurisdiction, provide building traps complete with cleanout and fresh air inlet with special grilles to meet the Consultant's approval.

3.2 DRAINS

3.2.1 In all areas with seamless flooring and plastic terrazzo finishes provide special flanges. These flanges shall be 100mm (4") larger in diameter than the drain top or sleeve diameter, and located approximately 5mm ($^{3}/_{16}$") below the top flanges to be of the same material as the drain finish.

3.2.2 Provide special flanges for the following items as described above:

3.2.2.1 Floor drains

3.2.2.2 Hub drains

3.2.2.3 Combination drains

3.2.2.4 Area drains

3.3 UNIONS, FLANGES, DI-ELECTRIC COUPLINGS

3.3.1 Provide unions or flanges at all connections to equipment of fixtures requiring servicing or replacing.

3.3.2 In copper pipes, provide wrought copper unions with soldered joints for pipes up to and including DN50 (2") sizes and 1,034 kPa (150 psi) cast brass flanges for pipes DN100 (4") or larger.

3.3.3 Install approved dielectric isolation in following specified systems:

3.3.3.1 In all locations where specifically noted or shown

3.3.4 Install approved dielectric isolation at the transition between noble materials such as copper, brass bronze, high alloy castings, or stainless steel and low alloy ferrous materials such as black iron, galvanized iron, or cast iron. These dielectric isolators must be installed in such a way that they are not shorted out by accidental contacts to process equipment, building steel, instrumentation tubing, or electrical neutrals. Ensure that dielectric unions are constructed of materials that are compatible galvanically with the systems to which they are connected, e.g. a dielectric union for installation between copper and iron must be constructed with a body of iron and a tailpiece of copper or brass.

3.4 KITCHEN AND OTHER OWNER'S EQUIPMENT

3.4.1 Provide complete roughing-in and final connections for laboratory, and other Owner's equipment as shown on the Drawings and as further delineated by the kitchen, laboratory, and other Owner's equipment drawings provided by the Owner. Contractor shall prepare complete 1:50 scale drawing with all services shown as required for approval by the Consultant.

3.4.2 No roughing-in shall be started and no final connections made to equipment until complete roughing-in and connection drawings have been provided by the Owner.

3.4.3 Provide a complete venting system as part of the roughing-in. Venting shall be acceptable to the local plumbing inspector.

3.4.4 Provide capped connections to equipment supplied by others.

3.4.5 When the equipment has been installed, do all final connections to equipment.

END OF SECTION

Project Name: *UNIVERSITY OF TORONTO MISSISSAUGA*
Project No.: *2023-0059*
Section Name: ***Storm Drain Piping***
Section No.: ***22 14 16***
Date: *November 15, 2024*

INDEX

1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools, equipment, training, commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 Storm drainage system.

1.3 REGULATORY REQUIREMENTS

1.3.1 In addition to specific requirements for pipe fittings as further specified in this document and where applicable, the equipment shall comply with the Boiler and Pressure Vessels Act (the “Act”) and CSA Standard B51.

1.3.2 In compliance with the Act and relevant Codes, all fittings shall be registered by the manufacturer, and shall be identified by the appropriate Canadian registration number.

1.3.3 Where fittings are provided without the appropriate Canadian registration number, the Contractor shall obtain a copy of the manufacturer's Statutory Declaration as provided to the authorities having jurisdiction.

1.3.4 All welding and fabrication shall be to the requirements of the ANSI/ASME B31.9 code for pressure piping and CSA standard B51 code for the Construction and Inspection of Boilers and Pressure Vessels.

1.3.5 All copper piping shall be certified to ASTM Standard B88 for Seamless Copper Water Tube.

2 **PRODUCTS**

2.1 PIPES AND FITTINGS

2.1.1 For 860 kPa (125 psi) or less operating pressure use 860 kPa (125 psi) rated fittings. For 860 kPa to 1,730 kPa (125 psi to 250 psi) operating pressure use 1,730 kPa (250 psi) rated fittings.

2.1.2 Buried storm drains:

2.1.2.1 Piping shall be IPEX “Ring-Tite” PVC DR-35 (345 kPa – 50 psi), 100mm - 150mm (4” - 6”) CAN/CSA B1800, 200mm - 375mm (8” – 15”) CAN/CSA B1800, to ASTM Standard D3034.

2.1.2.2 Fittings for 100, 125, 150, 200, 300, and 375-mm (4”, 5”, 6”, 8”, 10”, 12”, & 15”) PVC DR 35 pipe shall be injection-moulded fittings, certified by the Canadian Standards Association to CAN/CSA B182.1 and B182.2. Pipe and fittings to be constructed by the same manufacturer to ensure compatibility.

2.1.2.3 Gaskets shall be factory installed and made of elastomer, EPDM. Nitrile gaskets shall be used, as determined by the Consultant, where contaminated soils, special chemical, or temperature resistance is encountered or required.

2.1.2.4 PVC injection-moulded or fabricated tees shall be used for all service connections on new sewer main construction, including sewer mains for new subdivisions prior to assumption.

2.1.2.5 The pipe shall be jointed in accordance with the manufacturer’s specifications.

2.1.2.6 Tracer wire shall be installed with all PVC pipe.

2.1.3 Storm drain piping cast into raft footings shall be ABS DWV.

2.1.4 Unburied storm drains, 75mm (3") dia. and under shall be copper drainage tube (DWV), cast brass fittings and 50/50 solder joints. Drains 100mm (4") dia. and over shall be standard weight cast iron pipe and fittings with mechanical joints.

2.1.5 Fitting restraints for cast iron piping shall be HoldRite #117 series or approved equal. Field-devised methods and materials shall not be used to accomplish this application solution.

2.1.6 Pumped storm drains shall be Schedule 40 galvanized steel pipe; stretch reduced continuous weld, ASTM A53, with screwed fittings.

2.1.6.1 In lieu of the above specified piping, DWV piping with cast brass fittings and 50/50 solder joints may be used.

2.1.7 Mechanical couplings (e.g. Victaulic) shall be permitted for pumped storm drain system, provided:

2.1.7.1 The couplings are located in accessible locations.

2.1.7.2 All couplings are by one manufacturer, suitable for pressure and temperature of respective system.

2.1.7.3 Rigid (zero-flex or equivalent) couplings with angle bolt pads are used in mechanical rooms.

2.1.7.4 Couplings for Schedule 40 piping to be manufactured from ductile iron conforming to ASTM-A536 and be complete with a Grade 'E' EPDM gasket, suitable for water service to 110°C (230°F).

2.1.7.5 Couplings for copper grooved piping in size 50mm (2") and above to be designed with angle bolt pads to provide a rigid joint, complete with EPDM flush-seal gasket suitable for temperatures from –34° (-30°F) to 110°C (230°F).

2.1.7.6 Fittings for Schedule 40 piping shall be manufactured from ductile iron conforming to ASTM-A536 or segmentally welded steel, with grooves designed to accept grooved end couplings.

2.1.7.7 Fittings for copper piping shall be full flow copper fittings per ASTM B-75, or bronze sand casting per ASTM B-584.

3 EXECUTION

3.1 GENERAL

3.1.1 Ream all piping and keep plugged to prevent entry of dirt. Use pipes, which conform to CSA and ASTM standards.

3.1.2 Do not use double hubs, straight crosses, double T's or double TY's on any waste pipe.

3.1.3 Install piping in a professional manner and in accordance with current plumbing industry practices.

3.1.4 Consider the piping shown on the Drawings as diagrammatic, for clearness in indicating the general runs and connections and that the piping may, or may not, in all parts be shown in the true position. This does not relieve the responsibility for the proper erection of the systems of piping in every respect suitable for the work intended.

3.1.5 On screwed piping, make up joints, metal to metal with red or white lead and oil applied to the thread. No hemp wick or packing will be permitted in making up screwed joints.

3.1.6 Ensure that welding is performed, using either gas or electric

welding equipment. Thoroughly clean pipe surfaces and level the ends of each pipe and fitting before welding. Securely align and space piping so that the width of circumferential welds is two and one-half times the pipe wall thickness. Ensure that the deposited metal forms a gradual increase in thickness from the outside surface to the centre of the weld.

3.1.7 Ensure that the pipe welding is done by a welder holding a certificate from the Department of Labour for the class of piping to be welded.

3.1.8 When welding or cutting with a torch, take every precaution to prevent fire. Ensure that welding or torch cutting operators have a fully charged 4.5kg (10 lb.) carbon dioxide fire extinguisher with them, when welding or cutting in building, or tunnels. Protect wooden structures with asbestos blanket.

3.1.9 Ensure that fabrication, welded or otherwise, meets the requirements of the ASA B31.9 Code for Pressure Piping, the CSA B51 Code for Boiler, Pressure Vessel, and Pressure Piping, and all requirements of the Boilers and Pressure Vessels Act of the Province of Ontario.

3.1.10 Use only fittings, or other materials to be incorporated in the work, which are approved by TSSA's Boiler and Pressure Vessels Safety Program, for the class of work for which they are used.

3.1.11 Thoroughly clean the inside of fittings and outside of pipe with steel wool and coat with flux, before soldering any copper pipe work joint. Remove the working parts of valves before soldering commences, and replace after soldering is complete.

3.1.12 Use di-electric connections for cathodic protection wherever pipes of dissimilar material are connected together. When connecting grooved end steel to copper piping, use Victaulic dielectric waterway, Style 47-GG.

3.1.13 All fittings shall be of same material or equal in quality and thickness to the pipe to which they are connected.

3.1.14 Provide unions or flanges at all connections to equipment requiring servicing or replacement.

3.1.15 In copper pipes, provide wrought copper unions with soldered joints for pipe up to and including 50mm (2"), and 1,035 kPa (150 psi) cast brass flanges for pipes 65mm (2-$^1/_2$") or larger.

3.1.16 Install all grooved end components as per manufacturer's latest recommendation. All grooved Products shall be of one manufacturer.

3.1.17 Provide fitting restraints on mechanical pipe joints where required to accommodate axial thrust. Fitting restraints shall include but not be limited to all fittings over 75mm (3") in size, at the base of all vertical storm drains, including cleanouts, and all joints in horizontal piping at the lowest level, which drains, by gravity to the street services.

3.2 TESTING

3.2.1 After all pipes have been placed in position and all branches installed, test the tightness of all joints and the soundness of all pipes.

3.2.2 Make all tests before piping is furred in.

3.2.3 Notify the Consultant at least 48 hours before commencing with test, and give Consultant a written certificate confirming these tests.

3.2.4 Storm Drain Piping: Securely close all openings in pipe ends throughout the work by means of approved plugs and fill the entire piping system, including stacks, branches to drain and all horizontal runs with water, up to highest opening and let this water stand at this level for not less than two (2) hours. Perform another test after the fixtures are set, connected, and connections are made to all equipment. Test by running water into all pipes, drain, and apparatus in order to detect any imperfect material or workmanship. Where it is impossible to test the whole system at one time, divide into parts. Perform a smoke or ball test or any other test required by authorities having jurisdiction.

3.2.5 If any leaks are discovered by the above tests, remove and replace the faulty portions of the systems and repeat the test. Repeat this procedure until the system is accepted by the Consultant's representative on the Site. Do not caulk threaded joints.

3.2.6 Check horizontal pipe with an accurate level for any alterations in pitch. Inspect laterals, cross arms, and eliminate pockets. Correct any cases of water hammer.

3.3 DRAIN PIPES IN RAFT FOOTINGS

3.3.1 Firmly restrain piping by tying off to adjacent rebars for entire horizontal length.

3.3.2 After leak test, leave water in pipe during concrete pour.

3.3.3 Notify Consultant at least 48 hours before pour.

3.4 FLUSHING AND CLEANING

3.4.1 General

3.4.1.1 Inspect the systems, and remove any heavy debris and excessive oil and dirt.

3.4.1.2 Flush all completed systems with clear water at the highest obtainable pressure and velocity.

3.4.1.3 During flushing and cleaning, maintain all isolating and control valves in the open position.

3.5 STREET SERVICES

3.5.1 Connect building main storm sewer to street main where shown, and make all necessary arrangements with authorities and utilities involved. Pay for all permits and inspections and for all work to be done by the local authorities and utility companies.

3.5.2 Check and verify all invert elevations before proceeding with any work of this Section.

3.6 COMPLETION

3.6.1 Provide a declaration, signed by a responsible officer of the Division 22 – Plumbing Subcontractor indicating that the following procedures and tests have been performed in accordance with the Drawings and this Specifications. Provide two (2) copies of the signed declaration to the Consultant.

3.6.1.1 Water pressure test performed and leak free.

3.6.1.2 Plumbing inspections made and issue necessary certificates.

END OF SECTION

Project Name: *UNIVERSITY OF TORONTO MISSISSAUGA*
Project No.: *2023-0059*
Section Name: ***Sump Pumps***
Section No.: ***22 14 29***
Date: *November 15, 2024*

INDEX

1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools equipment, training commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 Sump pumps.

1.3 SUBMITTALS

1.3.1 Provide shop drawings for:

1.3.1.1 Sump pumps

1.3.2 The submittal data for the pumping system shall include, but not be limited to: pump curves, individual computer data sheets, system drawings, and complete description of control panel, with wiring diagram, sequencing data, instrumentation and alarms.

2 **PRODUCTS**

2.1 SUBMERSIBLE SUMP PUMPS

2.1.1 Sump pumps shall be type, and size as shown on the Drawings.

2.1.2 Pumps shall be cast iron with impellers to pass 38mm (1-$^{1}/_{2}$") dia. solids, sealed motor, integral leg supports, and oil resistant power cord.

2.1.3 Each unit shall be with the following accessories:

2.1.3.1 Frame and cover plate with access door and all necessary openings for floats and vent. Provide neoprene rubber grommets and seal for a gas tight installation of sewage pumps.

2.1.3.2 High water level switch with alarm buzzer and additional contact for remote signaling via the control system. Alarm shall be housed in a NEMA 1 enclosure and mounted on sump cover plate. Wiring by Division 22 - Plumbing.

2.1.3.3 Single-phase pump shall be with integral level control.

2.1.3.4 Three phase pumps shall be with external float controls.

2.1.3.5 MTM railing system with chain for pump removal.

2.1.4 Duplex units shall be complete with mechanical alternator and three (3) float switches set to operate both pumps on a high flow condition.

2.1.5 NEMA 1 control panel shall have the following standard features:

2.1.5.1 ULC 508 or CSA approved

2.1.5.2 Main Disconnect

2.1.5.3 Thermal & Short circuit protection using internal circuit breakers

2.1.5.4 Failure protection with automatic transfer to non operating pump (Duplex System Only)

2.1.5.5 Control Transformer with fused primary (UL508)

2.1.5.6 Power on and Pump Run indicating lights

2.1.5.7 HOA selector switch

2.1.6 Provide a non-slam check valve in each discharge pipe above the cover plate and pipe to gravity drain.

2.1.7 Concrete sump pits shall be provided by Division 03 - Concrete. This Section shall supply and set all sleeves and connections to sump.

2.2 <u>SUMP PUMPS</u>

2.2.1 Sump pumps shall be of type and size as shown on the Drawings.

2.2.2 Sump pumps shall have cast iron casing, inlet strainer, and centrifugal impeller.

2.2.3 Each pump shall be complete with stainless steel shaft Schedule 80 steel pipe pump leg and discharge pipe, heavy duty thrust bearing in cover plate and bronze guide bearings. Extend bearing lubrication tubing to grease nipples in cover plate. Shafts longer than 200mm (8 ft) or ¾-room height shall be split with intermediate bearings.

2.2.4 Motor shall be mounted on a cast iron support and shall be connected to the shaft with a Falk flexible coupling.

2.2.5 Provide a heavy-duty cover plate complete with frame, inspection access plate, and all necessary openings for floats and vent.

2.2.6 Provide operating float switches complete with all probes and floats. Duplex units shall be supplied with mechanical alternator and two (2) operating float switches, set to operate both pumps on a high level condition.

2.2.7 Controls shall include compression type high water alarm complete with alarm buzzer and additional contact for remote signaling via the BAS. Alarm shall be housed in a NEMA 1 enclosure and mounted on sump cover plate.

2.2.8 Control Panel

2.2.8.1 System shall include NEMA 1 control panel with the following standard features:

2.2.8.1.1 ULC 508 or CSA approved

2.2.8.1.2 Main Disconnect

2.2.8.1.3 Thermal & Short circuit protection using internal circuit breakers

2.2.8.1.4 Failure protection with automatic transfer to non operating pump (Duplex System Only)

2.2.8.1.5 Control Transformer with fused primary (UL508)

2.2.8.1.6 Power on and Pump Run indicating lights

2.2.8.1.7 Hand-Off-Auto (HOA) selector switch

2.2.9 Provide a non-slam check valve in each discharge pipe above the cover plate and pipe to gravity drain with galvanized pipe.

2.2.10 Concrete sump pits shall be provided under the work of Division 03 - Concrete. This Section shall supply and set all sleeves and connections to sump.

3 EXECUTION

3.1 GENERAL REQUIREMENTS

3.1.1 Provide pump and install it in accordance with the requirements of the respective manufacturer.

3.1.2 Ensure that the piping does not stress the pump casing because of misalignment.

3.1.3 After connections have been made, fill system before starting pump. Do not run dry under any circumstances.

3.1.4 Support piping from building structure to prevent any strain on pump casing. Make final check for alignment of piping connections before pump connections are tightened.

3.2 SUBMERSIBLE SUMP PUMPS

3.2.1 Line side power wiring shall be by Division 26 - Electrical.

3.2.2 Field control wiring shall be provided by this Section.

3.2.3 Provide certified shop drawings of the cover frame to the Division 03 – Concrete Subcontractor. Coordinate sump location with the Division 03 – Concrete Subcontractor.

END OF SECTION

Project Name: *UNIVERSITY OF TORONTO MISSISSAUGA*
Project No.: *2023-0059*
Section Name: ***Electric Domestic Water Heaters***
Section No.: ***22 33 00***
Date: *November 15, 2024*

INDEX

1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools equipment, training commissioning and certification required to complete the work as shown on the drawings and specified herein, including:

1.2.1.1 Electric domestic hot water heaters.

1.3 SUBMITTALS

1.3.1 Submit shop drawings for:

1.3.1.1 Electric domestic hot water heaters

1.3.2 As a minimum provide the following information:

1.3.2.1 Data sheets for heaters.

1.3.2.2 Power and control wiring diagrams.

1.3.2.3 Physical outline dimensions showing clearances, and connection entries.

1.3.2.4 Boiler control panel specification, sequence of operation.

1.3.3 Submit letter from boiler manufacturer certifying that boiler and all appurtenances have been installed in accordance with their recommendations.

2 **PRODUCTS**

2.1 ELECTRIC DOMESTIC HOT WATER HEATERS

2.1.1 Provide water heaters with capacity as shown on Drawings.

2.1.2 Water heaters shall have the ULC seal of certification and be factory equipped with an AGA/ASME rated temperature and pressure relief valve.

2.1.3 Water heaters shall meet or exceed the standby loss requirements

of ASHRAE Standard 90.1-2010.

2.1.4 Tanks shall have a working pressure of 1,035 kPa (150 psi), and shall be completely assembled.

2.1.5 Floor mount water heater tank shall have a double coating of high temperature porcelain enamel and furnished with magnesium anode rods rigidly supported. Heater shall be equipped with "screw-in" type elements featuring a stainless steel outer sheath of INCO-LOY 840 material. Tank shall be insulated with 75mm (3") of rigid polyurethane foam insulation. Heater shall be constructed with an element diagnostic panel utilizing light emitting diodes. Each LED will correspond to the number and location of the heating elements and monitor their on-off function. Water heater shall be provided with internal power circuit fusing, control circuit fusing, magnetic contactors, 120 Volt control circuit transformer and immersion thermostats with manual reset high limit control.

2.1.6 Ceiling mount water heater tank interior shall be coated with a high temperature porcelain enamel and furnished with an R-Tech resistored magnesium anode rod rigidly supported. Water heaters shall be equipped with a copper, resistored, "screw-in" type element. Tank shall be insulated with rigid polyurethane foam insulation. Water heaters shall be equipped with a surface mounted thermostat with an integral, manual reset, high limit control.

2.1.7 Water heaters shall be covered by a three-year limited warranty against tank leaks.

3 EXECUTION

3.1 GENERAL

3.1.1 Provide a temperature and pressure relief valve for each water heater. Pipe to nearest drain.

3.1.2 Line side power wiring shall be provided by Division 26 - Electrical. Provide certified wiring schematics to Division 26 - Electrical for associated equipment.

3.1.3 Field control wiring of local safeties and interlocks shall be provided by this Section.

3.1.4 Flush and clean boilers on completion of installation, according to manufacturer's written instructions.

3.1.5 After completing boiler installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes including chips, scratches, and abrasions with manufacturer's stainless steel polish.

3.1.6 Provide two (2) site visits during installation with written reports forwarded to the Consultant.

3.1.7 Provide complete start up service to set all controls. Include both initial start up as well as follow-up. Recalibrate all controls as required.

END OF SECTION

Project Name: *UNIVERSITY OF TORONTO MISSISSAUGA*
Project No.: *2023-0059*
Section Name: ***Plumbing Fixtures***
Section No.: ***22 40 00***
Date: *November 15, 2024*

INDEX

1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SHOP DRAWINGS

1.2.1 Submit shop drawings for the following equipment:

1.2.1.1 Plumbing fixtures and brass.

1.2.1.2 Fixture carriers and other appurtenances.

2 **PRODUCTS**

2.1 FIXTURES

2.1.1 WC-1 Toilet - Floor Mounted Flush Valve

2.1.1.1 American Standard 3341001.020 Toilet - HURON, Toilet, Floor mounted with rear outlet, Toilet operates in the range of 4.8 to 6.0 LPF (1.28 - 1.6 GPF), White finish Vitreous china, EverClean® antimicrobial surface, Elongated bowl.

Centoco 500STSCCFE-001 Seat - FAST-N-LOCK, For elongated bowl, Open front, Polypropylene, Toilet seat, Less seat cover, and Plastic commercial check hinges, White finish, FAST-N-LOCK mounting system takes the guess work out when tightening the hardware. The specially designed fasteners in click" when the appropriate torque is reached. The bolt and nut material shall be stainless steel

Sloan SL-ROYAL 152-1.28-ESS-TMO-SWB Flush Valve - ROYAL® Automatic no-touch Concealed Water closet flushometer, Hardwired, constructed from Semi-red brass, Rough brass finish, High Efficiency 4.8 LPF (1.28 GPF).

Sloan SL-EL-154 Faucet and Flush Valve Power Kit - For flush valve

Franke Commercial CM-16104 Backrest - wall mounting, back rest, solid core plastic laminate panel back, Antique whiteWC-2 Toilet – Floor Mounted Finish Valve (Barrier Free Design)

2.1.2 WC-2 Toilet - Floor Mounted Flush Valve

2.1.2.1 American Standard 3341001.020 Toilet - HURON, Toilet, Floor mounted with rear outlet, Toilet operates in the range of 4.8 to 6.0 LPF (1.28 - 1.6 GPF), White finish Vitreous china, EverClean® antimicrobial surface, Elongated bowl.

Centoco 500STSCCFE-001 Seat - FAST-N-LOCK, For elongated bowl, Open front, Polypropylene, Toilet seat, Less seat cover, and Plastic commercial check hinges, White finish, FAST-N-LOCK mounting system takes the guess work out when tightening the hardware. The specially designed fasteners in click" when the appropriate torque is reached. The bolt and nut material shall be stainless steel

Sloan SL-ROYAL 152-1.28-ESS-TMO-SWB Flush Valve - ROYAL® Automatic no-touch Concealed Water closet flushometer, Hardwired, constructed from Semi-red brass, Rough brass finish, High Efficiency 4.8 LPF (1.28 GPF).

Sloan SL-EL-154 Faucet and Flush Valve Power Kit - For flush valve

Franke Commercial CM-16104 Backrest - wall mounting, back rest, solid core plastic laminate panel back, Antique whiteWC-2 Toilet – Floor Mounted Finish Valve (Barrier Free Design)

2.1.3 U-1 Urinal - Wall Hung Flush Valve

2.1.3.1 TOTO High-Efficiency 1/8 GPF Washout Urinal #UT105U(V)(G). The wall-mounted ADA compliant, high-efficiency washout urinal shall be 0.125GPF/0.47LPF when paired with a flushometer valve. Urinal shall have optional SanaGloss ceramic glaze.

2.1.3.2 Flush valve shall be Delta Model 81T231BTA-MMO batter flush valve, polished chrome plated vandal resistant metal cover with top mounted sensor operated H2Optics electronics

2.1.4 L-1 Double Basin

2.1.4.1 Bradley Verge Lavatory System LVRD2. Evero Natural Quartz, a Bradley exclusive material that is specially formulated to allow for moldable and contoured shapes, is made from a bland of acrylic modified bio-based polyester resin, natural quartz, granite, and other exotic minerals.

2.1.4.2 Faucet shall be Delta DEMD series electronic solar lavatory faucet (Quantity: 2), battery powered, vandal resistant concealed aerator,

0.5 GPM (1.9 L/min) flow control spray aerator.

2.1.5 L-2 Single Basin (Barrier Free Design and General Use)

2.1.5.1 Bradley Verge LVQD1 washbar and basin system complete with mounting, access panel, drain assembly, polished chrome finish,

2.1.5.2 Faucet shall be Delta DEMD series electronic solar lavatory faucet (Quantity: 2), battery powered, vandal resistant concealed aerator, 0.5 GPM (1.9 L/min) flow control spray aerator.

2.1.6 KS-1

2.1.6.1 Franke Commercial UCS6105P-1 Sink - Single compartment sink, Kitchen sink, with overall dimension 578 mm (22-3/4") long, 451 mm (17-3/4") wide, 127 mm (5") high, constructed from 18 gauge Type 304 Stainless steel, Bowl dimensions are 533 mm (21") long, 406 mm (16") wide, 127 mm (5") deep, Polished to #4 satin finish, Center back waste location, 38 mm (1-1/2") (DN38) brass tailpiece, 89 mm (3-1/2") crumb cup strainer, waste fitting included, Undercoated to reduce condensation and resonance, Codes and Compliances: ANSI A117.1 compliant, ASME A112.19.3 compliant, CSA B45.4 compliant. Chicago Faucets 430-ABCP Faucet - Counter mounted, Manual, Single handle, Sink faucet, Polished chrome finish, Single hole centerset, Lead Free ANSI/NSF 61 compliant, ECAST® brass construction, Ceramic cartridge with volume control, 5.7 LPM (1.5 GPM) maximum flowrate, Pressure compensating Econo-Flo™ non-aerated laminar spray outlet, Tubular cast brass spout, 229 mm (9") spout reach, 146 mm (5-3/4") high, 108 mm (4-1/4") lever handle, 13 mm (1/2") NPSM supply inlet, Includes hot limit safety stop. Lawler TMM-1070-87500 Mixing Valve - The point of use mechanical mixing valve with thermostatic limit stop, MECHANICAL MIXING VALVE, Lead free brass body construction, the temperature adjusting dial is located on the cold inlet. Turning the dial clockwise will lower the outlet temperature, turning the dial counter-clockwise will raise it. The valve cannot be adjusted above its shut-off temperature of 120F, Compression Fitting, 84 mm (3-5/16") high, ASSE 1070 approved ASSE lead free Certified for ASSE 1070 applications, 3/8" MNPT (9.5 mm) inlet, 3/8" MNPT (9.5 mm) outlet, lintegral rubber duck-bill backflow checks, High temperature limit stop, Automatically shuts down flow of water when temperature reaches 120 °F, 5 PSI Minimum Operating pressure, 140 °F max, 118 °F ±3 °F, 125 PSI max supply pressure, 1.8 LPM (0.5 GPM) tempered flowrate @ 5 PSI pressure drop, Protects against scalding and chilling, 8 LPM (2.1 GPM) flowrate @ 45 PSI. McGuire LFBV170

Supply - CONVERTIBLE™ Commercial Faucet Lead Free Chrome-plated finish Brass body, 138 - 862 kPa (20 - 125 PSI) operating pressure, 4 to 60 °C (40 to 140 °F) operating temperature, Convertible loose key handle, Quarter turn ball valve, Angle stop, Deep bell flange, 305 mm (12") copper flexible risers, 13 mm (1/2") Sweat inlet x 10 mm (3/8") O.D., 82 °C (180 °F) maximum during high-temperature system flush, ASME A112.18.1 compliant, NSF/ANSI 372 compliant, NSF/ANSI 61 compliant. McGuire 8912CB P-Trap - Heavy cast brass, Adjustable P-Trap, 292 mm (11-1/2") length, With cleanout plug, Steel box flange, Neoprene gasket, Seamless tubular brass bend, Slipnuts

2.1.7 J-1 Janitor Mop Sink Floor Mounted

2.1.7.1 Stern Williams SBC-1725 Sink - Single compartment sink, Mop service sinks, with overall dimension 813 mm (32") long, 813 mm (32") wide, 305 mm (12") high, constructed from Precast terrazzo, Bowl dimensions are 749 mm (29-1/2") long, 749 mm (29-1/2") wide, 254 mm (10") deep, Pearl grey marble chips and white portland cement, Drop front featured, Cast integrally and provides for a caulked lead connection not less than 25 mm (1") deep to a 76 mm (3") pipe, Without tiling flange. Chicago Faucets 897-RCF Faucet - Wall-hung, Manual, Two handles, Mop sink faucet, Rough chrome plated finish, 194 - 213 mm (7-5/8" to 8-3/8") adjustable centerset, Round wall escutcheons, Brass construction, Adjustable supply arms, 1/4 turn ceramic cartridge, No flow restrictor, Threaded hose end, Spout with pail hook, 146 mm (5-3/4") spout reach, 273 mm (10-3/4") high, Top brace, 60 mm (2-3/8") lever handle with indexed buttons, Atmospheric vacuum breaker is not intended for continuous pressure applications. Lawler 570-86820 Mixing Valve - Point of Use and Master controlled fixtures, Thermostatic master water mixing control valve, Nickel plated finish, Lead free brass body construction, To adjust the mixed outlet temperature of the valve, remove the cap to gain access to the adjusting spindle. The spindle should be rotated-clockwise to reduce the temperature, counter-clockwise to increase the temperature until the desired set point is reached, The temperature is adjusted with the help of Spindle, 4-7/8" (124 mm) Height, ASSE 1070 approved Certified to CSA B125.3 for ASSE 1070 applications, 3/8" MNPT (9.5 mm) inlet, 3/8" MNPT (9.5 mm) outlet, internal checks, 95-115 °F outlet water temperature range, Offers choice of temperature settings from 95° through 115 °F., 125 PSI max hydrostatic pressure, 40-80 °F, 10 °F, 180 °F max, ±20% pressure variation, ±5 °F, 11 LPM (3 GPM) tempered flowrate @ 5 PSI pressure drop, Protects against scalding and chilling, 7 GPM

flowrate @ 45 PSI, 1.9 - 30 LPM (0.5 - 8 GPM) range for flowrate

2.1.8 S-1 Counter Mounted Sink

2.1.8.1 Franke Commercial LBS6808P-1-1 Sink - Single compartment sink, Single hole centerset, Commercial sinks, with overall dimension 508 mm (20") long, 521 mm (20-1/2") wide, 203 mm (8") high, constructed from 18 gauge Type 304 Stainless steel, Bowl dimensions are Left bowl is 457mm (18") long and right bowl is 305mm (12") long, 406 mm (16") wide, 203 mm (8") deep, Polished to #4 satin finish, Factory installed EZ TORQUE™ fasteners, Factory applied rim seal, Center back waste location, 38 mm (1-1/2") (DN38) brass tailpiece, 89 mm (3-1/2") crumb cup strainer, Undercoated to reduce condensation and resonance, Codes and Compliances: ASME A112.19.3 compliant, CSA B45.4 compliant. Chicago Faucets 434-ABCP Faucet - Counter mounted, Manual, Single handle, Sink faucet, Polished chrome finish, Single hole centerset, Lead Free ANSI/NSF 61 compliant, ECAST® brass construction, With supply, Ceramic cartridge with volume control, 5.7 LPM (1.5 GPM) maximum flowrate, Spray outlet, Gooseneck spout, Pull down, 210 mm (8-1/4") spout reach, 432 mm (17") high, Lever handle, 13 mm (1/2") NPSM supply inlet for 10 mm (3/8") or 13 mm (1/2") flexible riser, Includes hot limit safety stop. Lawler TMM-1070-87500 Mixing Valve - The point of use mechanical mixing valve with thermostatic limit stop, MECHANICAL MIXING VALVE, Lead free brass body construction, the temperature adjusting dial is located on the cold inlet. Turning the dial clockwise will lower the outlet temperature, turning the dial counter-clockwise will raise it. The valve cannot be adjusted above its shut-off temperature of 120F, Compression Fitting, 84 mm (3-5/16") high, ASSE 1070 approved ASSE lead free Certified for ASSE 1070 applications, 3/8" MNPT (9.5 mm) inlet, 3/8" MNPT (9.5 mm) outlet, Iintegral rubber duck-bill backflow checks, High temperature limit stop, Automatically shuts down flow of water when temperature reaches 120 °F, 5 PSI Minimum Operating pressure, 140 °F max, 118 °F ±3 °F, 125 PSI max supply pressure, 1.8 LPM (0.5 GPM) tempered flowrate @ 5 PSI pressure drop, Protects against scalding and chilling, 8 LPM (2.1 GPM) flowrate @ 45 PSI. McGuire LFBV170 Supply - CONVERTIBLE™ Commercial Faucet Lead Free Chrome-plated finish Brass body, 138 - 862 kPa (20 - 125 PSI) operating pressure, 4 to 60 °C (40 to 140 °F) operating temperature, Convertible loose key handle, Quarter turn ball valve, Angle stop, Deep bell flange, 305 mm (12") copper flexible risers, 13 mm (1/2") Sweat inlet x 10 mm (3/8") O.D., 82 °C (180 °F) maximum during high-temperature system flush, ASME A112.18.1

compliant, NSF/ANSI 372 compliant, NSF/ANSI 61 compliant. McGuire 8912CB P-Trap - Heavy cast brass, Adjustable P-Trap, 292 mm (11-1/2") length, With cleanout plug, Steel box flange, Neoprene gasket, Seamless tubular brass bend, Slipnuts. Acorn 1950LC-1-9-H1-CSS Basin - Off-floor, wall outlet Security lavatory, Type 304 16 gauge Stainless steel, Satin finish, Single hole centerset, Less overflow, Self-draining soap dish, 76 mm (3") high backsplash, Rectangular bowl, 38 mm (1-1/2") standard elbow waste outlet plain end, Installed on a finished wall from the front side utilizing a concealed arm carrier (by others), 1.9 LPM (0.5 GPM) maximum flowrate, Without valves (must specify deck punching), Centerset with spout, Concrete, block or steel wall (specify thickness), Overall Dimensions: 508 mm (20") long, 381 mm (15") wide, 178 mm (7") high, Bowl Dimensions: 368 mm (14-1/2") long, 241 mm (9-1/2") wide, 152 mm (6") deep.

2.1.9 S-2 Wall Hung Sink

2.1.9.1 Acorn 1950LC-1-9-H1-CSS Basin - Off-floor, wall outlet Security lavatory, Type 304 16 gauge Stainless steel, Satin finish, Single hole centerset, Less overflow, Self-draining soap dish, 76 mm (3") high backsplash, Rectangular bowl, 38 mm (1-1/2") standard elbow waste outlet plain end, Installed on a finished wall from the front side utilizing a concealed arm carrier (by others), 1.9 LPM (0.5 GPM) maximum flowrate, Without valves (must specify deck punching), Centerset with spout, Concrete, block or steel wall (specify thickness), Overall Dimensions: 508 mm (20") long, 381 mm (15") wide, 178 mm (7") high, Bowl Dimensions: 368 mm (14-1/2") long, 241 mm (9-1/2") wide, 152 mm (6") deep. Chicago Faucets 434-ABCP Faucet - Counter mounted, Manual, Single handle, Sink faucet, Polished chrome finish, Single hole centerset, Lead Free ANSI/NSF 61 compliant, ECAST® brass construction, With supply, Ceramic cartridge with volume control, 5.7 LPM (1.5 GPM) maximum flowrate, Spray outlet, Gooseneck spout, Pull down, 210 mm (8-1/4") spout reach, 432 mm (17") high, Lever handle, 13 mm (1/2") NPSM supply inlet for 10 mm (3/8") or 13 mm (1/2") flexible riser, Includes hot limit safety stop. Lawler TMM-1070-87500 Mixing Valve - The point of use mechanical mixing valve with thermostatic limit stop, MECHANICAL MIXING VALVE, Lead free brass body construction, the temperature adjusting dial is located on the cold inlet. Turning the dial clockwise will lower the outlet temperature, turning the dial counter-clockwise will raise it. The valve cannot be adjusted above its shut-off temperature of 120F, Compression Fitting, 84 mm (3-5/16") high, ASSE 1070 approved ASSE lead free Certified for ASSE 1070 applications,

3/8" MNPT (9.5 mm) inlet, 3/8" MNPT (9.5 mm) outlet, Iintegral rubber duck-bill backflow checks, High temperature limit stop, Automatically shuts down flow of water when temperature reaches 120 °F, 5 PSI Minimum Operating pressure, 140 °F max, 118 °F ±3 °F, 125 PSI max supply pressure, 1.8 LPM (0.5 GPM) tempered flowrate @ 5 PSI pressure drop, Protects against scalding and chilling, 8 LPM (2.1 GPM) flowrate @ 45 PSI. McGuire LFBV170 Supply - CONVERTIBLE™ Commercial Faucet Lead Free Chrome-plated finish Brass body, 138 - 862 kPa (20 - 125 PSI) operating pressure, 4 to 60 °C (40 to 140 °F) operating temperature, Convertible loose key handle, Quarter turn ball valve, Angle stop, Deep bell flange, 305 mm (12") copper flexible risers, 13 mm (1/2") Sweat inlet x 10 mm (3/8") O.D., 82 °C (180 °F) maximum during high-temperature system flush, ASME A112.18.1 compliant, NSF/ANSI 372 compliant, NSF/ANSI 61 compliant.

2.1.10 EW-1 Wall Mounted Eyewash

2.1.10.1 Uline Model H-9460 Eyewash Drench Hose-Wall Mount

2.1.10.1.1 Lawler TMM-1070-87500 Mixing Valve - The point of use mechanical mixing valve with thermostatic limit stop, MECHANICAL MIXING VALVE, Lead free brass body construction, the temperature adjusting dial is located on the cold inlet. Turning the dial clockwise will lower the outlet temperature, turning the dial counter-clockwise will raise it. The valve cannot be adjusted above its shut-off temperature of 120F, Compression Fitting, 84 mm (3-5/16") high, ASSE 1070 approved ASSE lead free Certified for ASSE 1070 applications, 3/8" MNPT (9.5 mm) inlet, 3/8" MNPT (9.5 mm) outlet, Iintegral rubber duck-bill backflow checks, High temperature limit stop, Automatically shuts down flow of water when temperature reaches 120 °F, 5 PSI Minimum Operating pressure, 140 °F max, 118 °F ±3 °F, 125 PSI max supply pressure, 1.8 LPM (0.5 GPM) tempered flowrate @ 5 PSI pressure drop, Protects against scalding and chilling, 8 LPM (2.1 GPM) flowrate @ 45 PSI.

2.1.11 ESH-1 Emergency Shower

2.1.11.1 Guardian GBF1672 Emergency Equipment - Wall Mounted, constructed from Stainless steel, 20 GPM, 915 mm (36") projection, 1" I.P.S. brass stay-open ball valve with stainless steel in panic bar". Furnished with stainless steel access panel and 1" I.P.S. unions for valve, Ø254 mm (10") x 5 5/8 (143 mm), 1" NPT female inlet supply, Codes and Compliances:, ADA Compliance, ANSI-compliant, Notes:, 16 gauge stainless steel cabinet with

flange featuring 3/8" return for recessed mounting in wall. Unit can be installed in either a corridor or a lab room, close to where accidents might occur. Lawler 911E/F-Unit 84908 Mixing Valve - Emergency mixing valve, Thermostatic High-low master water mixing valve, Chrome plate finish, Temperature adjustment shall be vandal-resistant, 229 x 205 x 127 mm (9" x 8" x 5") , In the event that the liquid motor fails, the control mechanism closes off the hot water port with the reverse seat and fully opens the internal variable bypass to allow cold water flow, The control mechanism shall employ a liquid-filled thermostatic motor to drive the valve without additional power requirements. The control mechanism shall employ a stainless steel sliding piston control device with reverse seat closure and both fixed and variable cold water bypass, Listed to ASSE 1071, 32 mm (1-1/4") NPT inlet, 32 mm (1-1/4") NPT outlet, In the event of interruption of the hot water supply, the control mechanism shall allow cold flow through both the fixed and variable bypass., In the event of interruption of the cold water supply, the control mechanism closes off the hot water port, stopping all flow. Positive hot water shut-off, Outlet Thermometer, 85 F, 70-90 F, 120 F Recommended inlet temperature, 125 PSI max inlet pressure, 65 PSI recommended operating pressure, 7.5 LPM (2 GPM) tempered flowrate @ 5 PSI pressure drop, 11 LPM (3 GPM) tempered flowrate @10 PSI pressure drop, 18 LPM (5 GPM) tempered flowrate @ 20 PSI pressure drop, 26 LPM (7 GPM) tempered flowrate @ 20 PSI pressure drop, 38 LPM (10 GPM) tempered flowrate @ 40 PSI pressure drop. Watts FD-323NH Floor Drain - Epoxy coated cast iron, Floor drain,Adjustable Round 203 mm (8") diameter top, 76 mm (3") pipe size, No-hub outlet, Heel proof ductile iron grate, Anchor flange, Body collar with weepholes, 116 cm² (18 sq. in.) free area, Certification and Compliances include: ASME A112.21.1M compliant.

2.1.12 DF-1 Wall Mounted, Surface Mounted, Drinking Fountain with Bottle Filler

2.1.12.1 Murdock Mfg A171108S-UG Drinking Fountain - shall be Wall mounted (On wall), Surface mounted, Drinking fountain with Bottle filler, Hands-free sensor operation or pushbutton operated activation, Requires less than 5 pounds of force to activate (push button), 1 serving station, Indoor application, Lead free stainless steel bubbler, Gray finish cooler with satin finish bottle filler, Laminar flow provides clean fill with minimal splash, 12 m³/h (52.8 GPM), Bottle Filler included, 3.79 LPM (1 GPM) fill rate, Refrigerant R-134a is controlled by accurately calibrated capillary

tube., 100 mesh inlet strainer, 335 watts, 4.4 Amps, 120 VAC/9.0VDC Plug-in Transformer, with -BF12 Only, 20-105 psig bubbler water-pressure range, Adjustable thermostat control, Codes and compliances:, ADA compliant when installed without shroud option, Buy American Act, ADA & ICC A117.1, NSF/ANSI 61 & 372 (lead free), UL 399, GreenSpec, CAN/CSA C22.2 No.120, ASME A112.19.3/CSA B45.4. McGuire LFHST01 Stop Valves - Lead Free, Chrome-plated finish, 3/8" I.P.S x 3/8" O.D. McGuire 8872C P-Trap - Heavy cast brass, Adjustable P-Trap, 292 mm (11-1/2") distance, With cleanout plug, Steel shallow flange, Neoprene gasket, Slipnuts, 17 gauge seamless tubular wall bend, ASME A112.18.2 CSA B125.2, CSA compliant. Watts CA-321 Carrier - epoxy coated, Urinal Carrier, Floor Mounted Urinal Carrier with Bearing Plate, Wall Plate, welded feet, Universal steel hangar support plate, bottom bearing plate, Heavy gauge steel offset uprights, integral mounting brackets, Plated hardware.

3 EXECUTION

3.1 TRAPS

3.1.1 Provide every fixture with traps in accordance with local regulations. Provide each trap with its own brass plug and ferrule cleanout.

3.1.2 For traps located in ceilings, provide access doors.

3.2 UNIONS, FLANGES

3.2.1 Provide unions or flanges at all connections to fixtures requiring servicing or replacing.

3.2.2 In copper pipes, provide wrought copper unions with soldered joints for pipes up to and including DN50 (2") sizes and 1,034 kPa (150 psi) cast brass flanges for pipes DN100 (4") or larger.

3.3 FIXTURES

3.3.1 Supply and install all hangers, supports, brackets, reinforcement, steel back-up plates, etc. for the proper installation of fixtures and supply fittings.

3.3.2 Install all components in strict accordance with manufacturer's recommendations.

3.3.3 Where plumbing fixtures contact wall, and/or floors, seal joints with

Dow Corning #781, building sealant, make watertight and bead smooth in a neat professional manner.

3.3.4 Exposed trim, supplies, traps, fittings, etc. shall be brass, heavily chrome plated unless noted otherwise.

3.3.5 Provide a trap for each fixture.

3.3.6 Vent fixtures in accordance with Section 22 13 16 – Sanitary Waste and Vent Piping.

3.3.7 Install chrome plated angle on straightaway type screwdriver compression stops, as required, on all hot and cold water service connections to all fixtures.

3.3.8 Install escutcheon plates where all service connections to fixtures pass through walls or floors. Plates shall be cast brass, heavy chrome plated. Same internal diameter as external diameter of pipe.

END OF SECTION

HIDI

DIVISION 23 – HVAC

SPECIFICATIONS

FOR THE

UNIVERSITY OF TORONTO MISSISSAUGA

PRE-ENGINEERED BUILDING

Prepared by:

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DISCIPLINES
MECHANICAL
ELECTRICAL
FIRE PROTECTION
LIGHTING DESIGN
COMMUNICATIONS & AV
SECURITY & RISK
COMMISSIONING
ENERGY SERVICES

Our Project No. 2023-0059

SEAL:

November 15, 2024

Project Name: *UNIVERSITY OF TORONTO MISSISSAUGA*
Project No.: *2023-0059*
Section Name: ***Table of Contents***
Section No.: ***Division 23 - HVAC***
Date: *November 15, 2024*

Project Name: *UNIVERSITY OF TORONTO MISSISSAUGA*
Project No.: *2023-0059*
Section Name: ***Electric Pipe Tracing***
Section No.: ***23 05 33***
Date: *November 15, 2024*

INDEX

1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 – General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide an electrical pipe tracing system as indicated on the Drawings and specified in this Section.

1.2.2 Connect heat trace power supply from disconnect switches provided under Division 26 - Electrical. Refer to Division 26 – Electrical Drawings for exact locations. Co-ordinate power requirements with Division 26 – Electrical. Refer to Section 20 05 14 – Electrical Wiring for wiring requirements.

1.2.3 Provide electric tracing for the following services:

1.2.3.1 All water lines in unheated areas, except glycol heating system.

1.3 SHOP DRAWINGS

1.3.1 Provide shop drawings for:

- heat trace cables
- temperature controls and ancillaries
- accessories including banding.

1.4 ELECTRICAL EQUIPMENT AND WORKS

1.4.1 Read together with Division 26 – Electrical and adhere to its requirements. Supply and install all electrical apparatus, which is required and is not covered by Division 26 – Electrical.

1.4.2 The entire design and installation shall comply with the Ontario Electrical Safety Code and all applicable regulations. Heating cable circuits shall be protected by a ground-fault device for equipment protection. This requirement is in accordance with section 427-22 of the NEC-1996. Ground-fault protection is included with the control system specified for all applications.

2 **PRODUCTS**

2.1 GENERAL

2.1.1 Furnish and install a complete cUL Listed, CSA Certified, or FM approved system of heating cables, components, and controls to provide freeze protection of piping as indicated in the Contract Documents.

2.2 PIPE FREEZE PROTECTION CABLES

2.2.1 The self-regulating heating cable shall consist of two (2) 16 AWG nickel-copper bus wires embedded in parallel in a self-regulating polymer core that varies its power output to respond to temperature all along its length, allowing the heating cable to be cut to length in the field. The heating cable shall be covered by a radiation-crosslinked, modified polyolefin dielectric jacket. To provide a ground path and to enhance the heating cable's ruggedness, the heating cable shall have a braid of tinned copper and an outer jacket of modified polyolefin (-CR), as required per section 427-23 of the NEC-1996. For installation on plastic piping, the heating cable shall be applied using aluminum tape (AT-180). The heating cable shall be Tyco Thermal Controls, XL-Trace series, or approved equivalent.

2.2.2 In order to conserve energy and to prevent overheating, the heating cable shall have a self-regulating factor of at least 90 %. The self-regulation factor is defined as the percentage reduction, without thermostatic control, of the heating cable output going from 4.4°C (40°F) pipe temperature operation to 65.6°C (150°F) pipe temperature operation.

2.2.3 The heating cable shall operate on line voltage of 120 / 208 Volts without the use of transformers.

2.2.4 The heating cable for metal-pipe freeze protection shall be sized according to the table below. The required heating cable output rating is in Watts per meter (foot) at 10°C (50°F). (Heating cable selection is based on 50mm (2 inch) fiberglass insulation on metal piping.)

	Minimum Ambient Temperature	
Pipe size mm (inches)	**-17.8°C (0°F)**	**-28.9°C (-20°F)**
100 (4") or less	16.4 (5) Watts	16.4 (5) Watts

Pipe size mm (inches)	Minimum Ambient Temperature -17.8°C (0°F)	-28.9°C (-20°F)
150 (6")	16.4 (5) Watts	26.2 (8) Watts
200 (8")	16.4 (5) Watts	26.2 (8) Watts
250 (10") or more	16.4 (5) Watts	2 strips of 16.4 (5) Watts

2.2.5 Power connection, end seal, splice, and tee kit components shall be cUL Listed, CSA Certified, or FM Approved for use as part of the system to provide pipe freeze protection. Component enclosures shall be rated NEMA 4X to prevent water ingress and corrosion. Installation shall not require the installing Subcontractor to cut into the heating-cable core to expose the bus wires. All components that make an electrical connection shall be re-enterable for servicing. Installation of power-connection kits shall be part of the work of Division 23 - HVAC.

2.2.6 No component shall use silicone to seal the electrical connections. An exception will be made in areas where a conduit transition is required.

2.3 TEMPERATURE AND MOISTURE SENSORS

2.3.1 Hydronic chilled and condensate water piping shall have one sensor per circuit pipe-mounted and shall also reference local ambient-temperature sensors for Proportional Ambient Sensing Control.

2.3.2 Temperature sensors shall be 100-ohm platinum RTD (Resistance Temperature Devices), with 3m tails mechanically protected by a corrugated steel sheath and ½" gland fitting for connection to the junction box. Digit race RTD10CS or approved equivalent. Temperature sensors shall be connected to the control system terminals as indicated on heat-tracing schedules. Coordinate conduit and low-voltage signal wiring with Division 16 – Electrical Subcontractor. RTD wiring shall be shielded 3-conductor, 22AWG + drain, Belden type 8771 or approved equivalent.

2.4 CONTROL SYSTEM

2.4.1 DDC Control System

2.4.1.1 All sensors shall communicate with a DDC system, Digit race ACCS-30 or approved equivalent. This approach serves to minimize the number of sensing devices required for efficient system operation and also to eliminate field-location of control devices and thus reduce the risk of tampering.

2.4.1.2 The Heating Cable manufacturer shall provide a DDC system with pre-programmed parameters to concurrently control and monitor heating cable circuits fire-protection pipe freeze protection. All system programming shall be through a CSA-listed central User Interface Terminal, Tyco Thermal Controls type ACCS-UIT2 or approved equivalent.

2.4.1.3 Heating Cable circuits and sensor signals (refer to Subsection 2.5 above) shall be connected to cUL-listed remote Power Control Modules, Tyco Thermal Controls type ACCS-PCM2-5 or approved equivalent. The Power Control Modules shall each house five two-pole contactors rated to 30A/277V, and five sensor inputs. Power Control Modules shall also include ground-fault sensing devices for each heating cable circuit, the status of which shall be monitored by the control system.

2.4.1.4 Power Control Modules and User Interface Terminal shall be inter-connected using RS-485 communication series. Coordinate communication conduit requirements with Division 26 - Electrical.

2.4.1.5 The Control System shall be capable of communicating ground fault, temperature alarms, and status alarms through programmable alarm contacts. In accordance with NFPA13, all Wet Sprinkler heat tracing circuit alarms shall be programmed to a specific terminal for remote notification at the fire alarm panel. Coordinate with Division 26 - Electrical.

2.4.1.6 The Control System shall be capable of communicating operating status, power consumption, and alarms to the Building Automation System in BACnet protocol.

2.4.2 No heat tracing circuit shall extend more than 600mm (24") beyond a point where such junctions permit optional flow paths. In such cases, separately controlled tracers shall be used.

2.4.3 Separately controlled heating circuits shall be provided on dead end legs and closed bypasses.

2.4.4 Where the rating of the thermostat would be exceeded, it shall be used in conjunction with a relay or contactor.

3 EXECUTION

3.1 PIPE FREEZE PROTECTION

3.1.1 Hydrostatically test all piping prior to installation of tracing cables.

3.1.2 Heating Cable Installation shall comply with manufacturer's recommendations.

3.1.3 The cable shall be fastened to metallic piping at intervals no more than 300mm (12") using heat-resistant fiberglass tape, type GT-66 or approved equivalent. Metallic tie-wraps shall not be acceptable as they may puncture the heating cable jacket. When installing on polymer-based piping, aluminum heat-transfer tape shall be installed along the entire length of heating cable to improve performance.

3.1.4 Extra cable shall be used at points such as valves and flanges to compensate for increased heat loss.

3.1.5 All terminations shall be protected from the weather and from physical damage.

3.1.6 Any field alternations or deviations shall proceed only after authority via signed change order has been issued by the Consultant. All changes shall be accurately recorded by the Contractor and shall be turned over to the Consultant upon completion of the work.

3.1.7 Junction boxes, thermostats, and the like shall not be attached to the insulation, but shall be mounted on brackets fabricated of galvanized angle, channel or other material of sufficient strength to support equipment mounted on them.

3.1.8 Apply "Electric Traced" labels to the outside of the thermal insulation, on alternating sides at 3m intervals.

3.2 SENSORS

3.2.1 Install all sensing devices in accordance with manufacturer's recommendations. Refer to notes in Subsection 2.3 above.

3.2.2 Temperature sensors installed on piping (for Line-Sensing) shall be located opposite the heating cable so as to sense the coldest

temperature on the segment of pipe.

3.2.3 Temperature sensors installed in air (for Ambient-Sensing) shall be strapped to the ceiling in a location such that the temperature is representative of the exposure temperature of any associated heat-tracing. Ambient temperature sensors shall not be installed adjacent to exhaust vents.

3.3 CONTROL SYSTEM

3.3.1 Install all control components in accordance with manufacturer's recommendations.

3.3.2 Sensor signal wiring shall be connected to the appropriate terminal within the appropriate power control module.

3.3.3 Control system components shall all be connected in series, using RS-485 twisted pair communication wiring. Coordinate necessary communication conduit runs with Division 26 - Electrical.

3.4 TESTING, COMMISSIONING AND REPORTING

3.4.1 All Self-Regulating Cables (for pipe tracing) shall be tested for insulation resistance using a megohmmeter at 500, 1000, and 2500VDC and results shall exceed 1000MΩ to be acceptable. Self-Regulating cables shall also be tested for capacitance to verify continuous circuit lengths, with results recorded in nF and in approximate corresponding length. Refer to manufacturer's installation guides for nF/ft conversion rates for each type of cable.

3.4.2 Sensors and Control System shall be concurrently tested and commissioned with the assistance of the manufacturer. Temperature sensors may be tested by observing readings and comparing with actual temperature. Moisture sensors shall be tested by simulating activation criteria (low temperature and moisture) and observing contact engagement.

3.4.3 The Division 23 – HVAC Subcontractor is responsible for carrying testing, programming and commissioning costs as part of this Contract.

END OF SECTION

Project Name: *UNIVERSITY OF TORONTO MISSISSAUGA*
Project No.: *2023-0059*
Section Name: ***Motor Starters and MCCs***
Section No.: ***23 05 36***
Date: *November 15, 2024*

INDEX

1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools equipment, training commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 All motor starters for mechanical equipment.

1.2.1.2 All motor control centres for mechanical equipment.

1.3 SUBMITTALS

1.3.1 Provide shop drawings for:

1.3.1.1 All motor starters.

1.3.1.2 All motor control centres.

1.4 ELECTRICAL EQUIPMENT AND WORK

1.4.1 Read together with Division 26 – Electrical and adhere to its requirements. Supply and install all electrical apparatus, which is required and is not covered by Division 26 – Electrical.

2 **PRODUCTS**

2.1 MOTOR CONTROL CENTRES

2.1.1 Provide motor control centres where indicated, specified and shown on schedules containing motor starters, control, interlocks and pilot lights.

2.1.2 Control centres shall consist of standard vertical section of 2,286mm (90") and width and depth as required to house the equipment contained, all joined together to form a rigid free standing, completely dead front Electrical Equipment Manufacturers Association of Canada (EEMAC) 2 drip tight enclosed assembly. Arrange all units for front access only.

2.1.3 Wire all control units for EEMAC Class II, Type “B” construction

with all interwiring between starters and assemblies, terminal boards for each starter and all control wiring and load power connections to terminal boards.

2.1.4 All horizontal and vertical bus shall be tin-plated copper. Vertical bus rating not less than 300 amperes or larger where required to accommodate the loads served plus 25% spare capacity. Horizontal bus rating as indicated but in no case less than the ampacity of the feeder to the motor control centre. Provide a horizontal tin-plated copper ground 6mm x 32mm ($^1/_4$" x 1-$^1/_4$") for the full length of the motor control centre. Provide 3 phase, 3-wire, or 3 phase, 4-wire mains with main circuit breaker as shown on the Drawings. Coordinate feeder supply with Division 26 – Electrical and provide all cable lugs and/or bus duct terminations.

2.1.5 Unless otherwise indicated in the Contract Documents, motor starters shall:

2.1.5.1 Be of the combination type containing motor starter and fusible disconnect switch. All components and wiring shall be readily accessible and shall be connected to the vertical bus with self-aligning plug-on connectors having free-floating spring action. A minimum of one padlock hasp per starter shall be provided on the panel fastener to allow padlocking in either connect or disconnect position.

2.1.5.2 Contain fuse clips for Class J, Form I, High Rupturing Capacity (HRC) fuses.

2.1.5.3 Have an operating handle interlocked with door so that the handle must be in the “OFF” position before the door can be opened. A semi-secret release shall be provided allowing bypassing of the interlock.

2.1.5.4 Have dual horsepower rated disconnect switches, quick-make, quick-break type.

2.1.5.5 Be full voltage magnetic type complete with three external manual reset thermal overload relays and low voltage protection. Identify each unit with an engraved lamacoid (white core) nameplate. Adhere to Section 20 05 53 – Identification colour scheme for tags. Provide a Siemens 3UN8 or 3UN6 trip unit or Klockner-Moeller equivalents in motor starters for all motors provided with thermistor type protection embedded in the stator windings. Provide 3UN8 units for 3-wire momentary contact control circuits and 3UN6 units for 2-wire maintained contact control circuits.

2.1.5.6 Have an integral control transformer complete with fusible protection for operation of all line voltage controls.

2.1.5.7 Have all covers equipped with start/stop pushbuttons and/or selector switches and push to test pilot lights as indicated on the wiring diagrams.

2.1.5.8 Have manual reset thermal overload relays in each of the three phases to suit the service factor and acceleration time of the motor served.

2.1.6 Provide a “Failsafe Industries” catalogue #M-600 or approved equal insulation resistance monitor in motor starters for fire pumps and fan motors used solely for smoke control. Provide a long life lamp in the starter cover to flash under alarm condition. Identify lamp with a lamacoid plate reading “LOW INSULATION RESISTANCE”. Provide dry contacts for remote annunciation at the Building Automation Control System.

2.1.7 Unless otherwise shown on the Motor Control Centre and Starter Schedules, each motor control centre shall have not less than the following spaces:

2.1.7.1	One section	one size 1.
2.1.7.2	Two sections	two size 1.
2.1.7.3	Three sections	two size 1 one size 2
2.1.7.4	Four sections	two size 1 two size 2.

2.1.8 Short circuit interrupting capacity for all starters shall be minimum of _____ kA for all MCC's, or higher to meet co-ordination study. Support all bus work to suit rating.

2.2 <u>MOTOR STARTERS</u>

2.2.1 Provide where indicated, shown on the Motor Starter Schedules and as specified in this Section separate motor starters not forming part of a motor control centre for all mechanical equipment (except those equipped with packaged starters).

2.2.2 Motor starters shall be supplied by the manufacturer of the motor control centres specified, and shall meet the requirements therein complete with disconnect switch, fuses, control transformer, and all

auxiliary devices.

2.2.3 Provide combination type with non-fused disconnect switch for individual motor starters equal to CGE CR 208, where overcurrent protection has been provided at motor control centre or distribution source.

2.2.4 Provide combination type with fusible disconnect switches equal to CGE CR 208 for grouped motor starters supplied from a common feeder or splitter. Include all interconnection power wiring.

2.2.5 Manual starters for single phase fractional horsepower motors unless otherwise indicated shall be equal to CGE CR 1061 with pilot light in cover. In finished areas, provide flush mounted units with stainless steel covers and pilot lights.

2.2.6 Where starters are grouped, provide a common backboard, interlocking and control wiring indicated on the Motor Starter Schedules and engraved nameplates indicating source of control supply if separate from the starter.

2.2.7 Short circuit interrupting capacity for all starters shall be minimum of _____ kA for all starters, or higher to meet co-ordination study. Support all bus work to suit rating.

3 EXECUTION

3.1 MOTOR CONTROL CENTRES

3.1.1 Mount motor control centres on 100mm (4") high concrete bases.

3.1.2 Provide watertight connections for all services entering the top of the motor control centres.

3.1.3 Check all overload relays or heaters to ensure they are in accordance with the recommendations of the starter manufacturer by size and motor run-up time.

3.1.4 After installation, verify sequence of all control devices.

3.1.5 Provide lamacoid plastic plates identifying motor control centres. Adhere to Section 20 05 53 – Identification colour scheme for tags. Provide phase identification. Provide warning label for motors under remote control.

3.2 MOTOR STARTERS

3.2.1 Provide lamacoid plastic plates identifying all starters. Provide warning label for motors under remote control. Adhere to Section 20 05 53 – Identification colour scheme for tags.

END OF SECTION

Project Name: *UNIVERSITY OF TORONTO MISSISSAUGA*
Project No.: *2023-0059*
Section Name: ***Parking Ventilation Control System***
Section No.: ***23 09 26***
Date: *November 15, 2024*

INDEX

1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools equipment, training commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 Garage ventilation control system.

1.2.2 Provide all communication units, a communication interface to digital system controllers, field sensors, and controls as required to meet the specified performance.

1.2.3 Provide all labour, including calibration, commissioning, and additional work necessary to provide a complete and fully operating system.

1.2.4 The system shall include the following features:

1.2.4.1 Display of toxic gas concentration

1.2.4.2 Ability to modify alarm set points

1.2.4.3 Automatic and manual fan start/stop

1.2.4.4 Display of alarm status

1.2.5 All communication wiring interconnecting the control panels and power wiring to field panels and other devices requiring a main supply to be provided under this Section.

1.3 SUBMITTALS

1.3.1 Submit Shop Drawings for the following:

1.3.1.1 All control components.

1.3.1.2 Identified schematic control diagrams for all systems, each diagram indicating control components, component catalogue numbers, operation sequence, and interlocking.

1.3.1.3 List of connected data points, including controllers to which they are connected and input/output devices (sensors, transducers, etc.), show panel spare capacity.

1.3.1.4 Technical specification data sheets of each system component.

2 PRODUCTS

2.1 GENERAL

2.1.1 Honeywell Analytics/Vulcain parking ventilation system shall be suitable for small to large applications where the ventilation system will be hooked up directly to the addressable controller (stand-alone system complete with controller). System shall be or able to handle one (1) to 96 CO/NO2 sensors/transmitters.

2.2 DETECTORS

2.2.1 Detectors to be Model E^{3}Point for Carbon Monoxide or Nitrogen Dioxide, surface mount.

2.2.2 The transmitter will be powered by the control panel power supply rated at 24 V AC. Fully addressable gas transmitter must be capable of communicating digitally with controller through an RS-485 communication port. Gas transmitters must be installed in a true daisy chain with an end of the line resistor on the last transmitter. The gas transmitter will incorporate an electrochemical cell for toxic gas monitoring and catalytic bead sensor for combustible gases. Unit sensing cell must compensate for variations in relative humidity and temperature to maintain high levels of accuracy.

2.2.3 When placed in a network configuration the transmitter will be capable of transmitting gas concentrations through the controller. For local activation of fans or louvers (or other equipment) an on-board DPDT relay 5 A, 30 V DC or 250 V AC (resistive load) will be activated at programmable set points (and programmable time delays) through the control panel. An LCD display will provide gas concentration readings.

2.2.4 Transmitter will be capable of operating within relative humidity ranges of 5-95% and temperature ranges of -20°C to 40°C (-4°F to 104°F).

2.2.5 Unit to be certified to ANSI/UL 61010-1 label and CAN/CSA-C22.2 No. 61010-1. Transmitter must be manufactured in an ISO 9001-

2000 production environment.

2.2.6 The transmitter shall have a plug-in capability for a field replaceable gas cartridge with a smart sensor capable of self-testing. The replaceable gas cartridge shall be factory calibrated and certified to the target gas ready for operation without the requirement for site calibration.

2.2.7 For local activation of audible alarms, the transmitter shall have an on-board device able to generate an audible output of 85 dB @ 3 m (10 ft).

2.2.8 Detector alarm levels are to be activated and the unit is to be installed in accordance with the following parameters:

Toxic Gases	First Alarm Setpoint (TLV-TWA)	Second Alarm Setpoint (TLV-STEL)	Sensor Location	Radius of Coverage
Carbon Monoxide (CO)	25 PPM	100 PPM	900-1200mm (3-4 ft) above the floor	15m (50 feet)
Nitrogen Dioxide (NO_2)	0.72 PPM	2.0 PPM	300 mm (1 ft) below ceiling	15 m (50 ft)

2.2.9 Local Building Codes recommendations take precedence over these parameters. Coverage can differ depending on application

2.3 CONTROLLER VA301C

2.3.1 The control panel must be capable of communicating digitally with the networked transmitters and relay modules through three RS-485 Modbus communication buses. Each communication bus must be capable of accepting a combination of up to 32 addressable transmitters, relay modules, or annunciator panels at a maximum distance of 2,000 feet. The power supply shall be of either 24 V AC or 24 V DC

2.3.2 The controller will manage four internal DPDT relays at fully programmable alarm levels (and within programmable time delays) and be capable of activating multiple relay modules of eight relays each. The relay rating will be no lower than 5 A, 30 V DC or 250 V AC (resistive load).

2.3.3 The controller must include a self-test function that allows for the activation/deactivation of all the programmed outputs by simulating a continuous 5% increase/decrease value until the maximum/minimum value is reached.

2.3.4 The controller must include a real-time clock that enables operation of the outputs for a specific timeframe.

2.3.5 The controller must also include an energy saving feature that allows for output operation on alarms set at the max, min or average value of a specific group of transmitters. This feature must also allow for the activation of outputs upon a certain number of a specific group (¾, ½, 1/3 and ¼) of transmitters reaching their alarm levels. A total of 128 groups can be assigned.

2.3.6 The controller will be capable of communicating with an annunciator panel that can serve as a remote display panel in a secondary control room.

2.3.7 The controller will indicate the exact concentration of gas, the gas detected, and the location of the sensor by sweeping through the network and displaying the detected levels at each point on a graphic LCD display.

2.3.8 BACnet option (if required)

2.3.8.1 The controller must enable BACnet™ communication through its optional BACnet output using BACnet/IP protocol over twisted-pair Ethernet (10BaseT) wires.

2.3.9 Data logging option (if required – BACnet option includes data logging)

2.3.10 An optional data logging capability must provide long-term data logging to determine trends. The controller must collect data automatically and must store it on a digital Flash media card.

2.4 <u>OPTIONAL SYSTEM ACCESSORIES</u>

2.4.1 VA 301 AP Annunciator Panel

2.4.1.1 Provide as indicated model VA 301 AP remote annunciator panel for remote gas detection system status indication.

2.4.1.2 The Honeywell Analytics/Vulcain 301AP remote annunciator panel must be capable of communicating digitally with the networked Controller and transmitters through the RS-485 Modbus

communication bus network.

2.4.1.3 Power requirement shall be either 17-27 V AC or 24-38 V DC, 200 mA as provided by the VA 301C central controller (or optionally from a 120/24V step down transformer).

2.4.1.4 The VA 301 AP annunciator shall have 3 DPDT relays programmable and addressable via the VA 301C central controller. Relay output rating: 5 A, 30 V DC or 250 V AC (resistive load).

2.4.1.5 The VA 301 C AP annunciator shall incorporate audible and visual status indicators and will indicate the exact concentration of gas, the gas detected, and the location of the sensor on the network and display the detected levels at each point on a graphic LCD display.

2.4.1.6 Visual indicators:

2.4.1.6.1 Alarm A: red LED

2.4.1.6.2 Alarm B: red LED

2.4.1.6.3 Alarm C: red LED

2.4.1.6.4 Power: green LED

2.4.1.6.5 Fault: yellow LED

2.4.1.6.6 Tx (Transmitter Status): yellow LED

2.4.1.6.7 Display: Alphanumeric backlight liquid crystal display (LCD)

2.4.2 Audible alarm for local warning shall be a 65 dB at 1 m (3 feet) horn/buzzer.

2.4.2.1 The unit shall be fabricated of ABS polycarbonate and have an enclosure rating: NEMA 4X, indoor.

2.4.2.2 The unit shall have operating humidity range of 0-95% RH, non-condensing and an operating temperature range of 0 to 40°C (32 to 104°F)

2.4.2.3 The unit shall be certified to: CSA C22.2 no. 205-M1983 UL 1244

2.4.3 Strobe and Horn type STAS or STACKSTAS for 24 V AC or 120 V AC

2.4.3.1 Strobe & Horn combo unit will be capable of operating within relative humidity ranges of 0-100% and temperature ranges of -35°C to 66°C
(-30°F to 150°F) suitable for indoor or outdoor operation. Rating of horn will be no less than 85dB at 3m (10 feet). Intensity of light will be no less than 40W (120V) and will flash at a frequency of 1 per second. Honeywell Analytics Model STAS. Unit will be certified by CSA.

2.4.4 Power Transformer type T100VA, T200VA, T300VA or Class 2 devices type T100VAC2,T200VAC2 or T300VAC2

2.4.4.1 Transformer shall have an input voltage of 120 V AC and an output voltage of 24 V AC with a VA range of 50-300. Operating frequency shall be 60 Hz. Unit will provide insulation systems up to 130°C (266°F) (50-1300 VA). Unit will operate at sound levels of less than 40 dB. Transformers shall be of fused type.

2.4.5 Relay Modules VA301R8

2.4.5.1 Relay module will be powered by the control panel's power output or by power transformer rated at 24 Volts AC or DC (always respect minimum voltage requirements at device). Module must be capable of communicating digitally with the Vulcain controller through an RS-485/MODBUS communication port. Relay module will have eight relays rated at no lower than 5A, 30 V DC or 250 V AC (resistive load). Honeywell Analytics model VA301R8

2.4.6 Detector Guards E3PT- GUARD

2.4.6.1 Provide protective guard for detectors as indicated. The grid is made of a 9-gauge steel wire. The guard must be designed to allow calibration without removing the guards.

2.4.7 Splash Guard NEMA 4X Enclosure (As Required)

2.4.7.1 Provide Model "ECLAB" NEMA 4X rated splash guard for gas sensors in all areas subject to exposure to water spray.

3 EXECUTION

3.1 PREPARATION

3.1.1 Examine areas and conditions under which the control system is to be installed.

3.2 GENERAL

3.2.1 Install hazardous gas monitoring equipment including sensors, audible alarms, control panels as shown on the Contract Drawings, and as recommended by manufacturer of equipment, and as required by authorities having jurisdiction.

3.2.2 Install conduit and wiring from sensors to control panel and to the fan starters/ HVAC control panel as recommended by manufacturer of equipment.

3.2.3 Install all equipment, accessories, conduits, and interconnecting wiring in a neat manner by skilled and qualified workpersons using the latest standard practices of the industry.

3.2.4 Unless otherwise specified in the Contract Documents, meet manufacturer's latest printed instructions for materials, planned maintenance and installation methods.

3.2.5 All equipment installed shall be mechanically stable and, as necessary, fixed to wall or floor. Anti-vibration mounts to be provided, if required, for the proper isolation of equipment.

3.2.6 Install equipment to allow for easy maintenance access. Ensure equipment does not interfere in any way with access to adjacent equipment and personal traffic in the surrounding space.

3.2.7 Coordinate final location of all sensors with the Consultant's field representative prior to installation.

3.2.8 Field power wiring shall be provided under Division 26 - Electrical. Provide certified wiring schematics to Division 26 - Electrical for associated equipment.

3.2.9 Field control wiring shall be provided under this Section.

3.3 SEQUENCE OF OPERATION

3.3.1 Diesel engine emissions (Nitrogen Dioxide)

3.3.1.1 Low Level Alarm

3.3.1.1.1 If any NO_2 sensor (or group of sensors as programmed) detect 0.72 PPM Nitrogen Dioxide gas, Low Alarm relay is activated by the main gas detection control panel, ventilation fans operate and dampers operate in zones a in zones as indicated. Low Alarm indicator lights on the main Gas detection control panel LED lights for point in alarm.

3.3.1.2 High Level Alarm

3.3.1.2.1 If hazardous NO_2 gas concentrations are not cleared after 30 minutes or if NO2 gas concentration continues to rise and any sensor detects a Nitrogen Dioxide concentration of 2.0 PPM gas, High Alarm relay is activated, High Alarm indicator lights on the main Gas detection control panel and panel audible alarm is activated, Audible Alarm to sound and contacts continue to operate the ventilation exhaust fans.

3.3.2 Gasoline engine emissions (Carbon Monoxide)

3.3.2.1 Low Level Alarm

3.3.2.1.1 If any CO sensor (or group of sensors as programmed) detect 25 PPM Carbon Monoxide gas, Low Alarm relay is activated by the main gas detection control panel, ventilation fans operate and dampers operate in zones as indicated. Low Alarm indicator lights on the main Gas detection control panel LED lights for point in alarm.

3.3.2.2 High Level Alarm

3.3.2.2.1 If hazardous CO gas concentrations are not cleared after 30 minutes or if CO gas concentration continues to rise and any sensor detects a Carbon Monoxide concentration of 100 PPM gas, High Alarm relay is activated, High Alarm indicator lights on the main Gas detection control panel and panel audible alarm is activated, Audible Alarm to sound and contacts continue to operate the ventilation exhaust fans.

3.4 START-UP

3.4.1 After installation, test and calibrate equipment to demonstrate operation of functions described above under sequence of operation by manufacturers certified service technician. Issue certificate of operational and installation compliance to facility operators.

END OF SECTION

Project Name: *UNIVERSITY OF TORONTO MISSISSAUGA*
Project No.: *2023-0059*
Section Name: ***Refrigerant Piping***
Section No.: ***23 23 00***
Date: *November 15, 2024*

INDEX

1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools equipment, training commissioning and certification required to complete the work as shown on the drawings and specified herein, including:

1.2.1.1 Refrigerant system, including piping, valves, fittings and accessories.

1.3 REGULATORY REQUIREMENTS

1.3.1 All welding and fabrication shall be to the requirements of the ANSI/ASME B31.1 code for pressure piping and CSA standard B51 code for the Construction and Inspection of Boilers and Pressure Vessels.

1.3.2 All copper piping shall be certified to ASTM Standard B88 for Seamless Copper Water Tube.

2 **PRODUCTS**

2.1 GENERAL

2.1.1 Refrigerant piping, valves, fittings, and accessories shall be in accordance with ASHRAE 15 and ASME B31.5, except as specified herein. Refrigerant piping, valves, fittings, and accessories shall be compatible with the fluids used and capable of withstanding the pressures and temperatures of the service. Refrigerant piping, valves, and accessories used for refrigerant service shall be cleaned, dehydrated, and sealed (capped or plugged) prior to shipment from the manufacturer's plant.

2.2 PIPE, FITTINGS AND END CONNECTIONS (JOINTS)

2.2.1 Steel Pipe

2.2.2 Steel pipe for refrigerant service shall be ASTM A 53/A 53M, Schedule 40, with butt- or socket-welded fittings, threaded fittings or flanged fittings and connections.

2.2.2.1 Flanges shall be Class 150. Gaskets shall be nonasbestos compressed material 1.59 mm (1/16 inch) thickness, full face or self-centering flat ring type. Gaskets shall contain aramid fibers bonded with styrene butadeine rubber (SBR) or nitrile butadeine rubber (NBR). Bolts shall be high or intermediate strength material.

2.2.3 Steel Tubing

2.2.3.1 Tubing shall be cold-rolled, electric-forged, welded-steel in accordance with ASTM A 334/A 334M, Grade 1. Joints and fittings shall be socket type provided by the steel tubing manufacturer.

2.2.4 Copper Tubing

2.2.4.1 Copper tubing shall be annealed or hard drawn as required. Copper tubing shall be soft annealed where bending is required and hard drawn where no bending is required. Soft annealed copper tubing shall not be used in sizes larger than 35 mm (1-3/8 inches). Joints shall be brazed except that joints on lines 22 mm (7/8 inch) and smaller may be flared. Fittings shall be cast copper alloy for flared copper tube, or wrought copper and bronze solder-joint pressure fittings. Joints and fittings for brazed joint shall be wrought-copper or forged-brass sweat fittings. Cast sweat-type joints and fittings shall not be allowed for brazed joints. Brass or bronze adapters for brazed tubing may be used for connecting tubing to flanges and to threaded ends of valves and equipment.

2.2.5 Solder

2.2.5.1 Solder shall be grade Sb5, tin-antimony alloy for service pressures up to 1,034 kPa (150 psig). Solder flux shall be liquid or paste form, non-corrosive.

2.2.6 Brazing Filler Metal

2.2.6.1 Filler metal shall be type BAg-5 with AWS Type 3 flux, except Type BCuP-5 or BCuP-6 may be used for brazing copper-to-copper joints.

2.3 <u>VALVES</u>

2.3.1 Valves shall be designed, manufactured, and tested specifically for refrigerant service. Valve bodies shall be of brass, bronze, steel, or ductile iron construction. Valves 25 mm (1 inch) and smaller shall have brazed or socket welded connections. Valves larger

than 25 mm (1 inch) shall have butt welded end connections. Threaded end connections shall not be used, except in pilot pressure or gauge lines where maintenance disassembly is required and welded flanges cannot be used. Internal parts shall be removable for inspection or replacement without applying heat or breaking pipe connections. Valve stems exposed to the atmosphere shall be stainless steel or corrosion resistant metal plated carbon steel. Direction of flow shall be legibly and permanently indicated on the valve body. Control valve inlets shall be fitted with integral or adapted strainer or filter where recommended or required by the manufacturer. Purge, charge and receiver valves shall be of manufacturer's standard configuration.

2.3.2 Refrigerant Stop Valves

2.3.2.1 Valve shall be the globe or full-port ball type with a back-seating stem especially packed for refrigerant service. Valve packing shall be replaceable under line pressure. Valve shall be provided with a handwheel operator and a seal cap. Valve shall be the straight or angle pattern design as indicated.

2.3.3 Check Valves

2.3.3.1 Valve shall be the swing or lift type as required to provide positive shutoff at the differential pressure indicated. Valve shall be provided with resilient seat.

2.3.4 Liquid Solenoid Valves

2.3.4.1 Valves shall comply with ARI 760 and be suitable for continuous duty with applied voltages 15 percent under and 5 percent over nominal rated voltage at maximum and minimum encountered pressure and temperature service conditions. Valves shall be direct-acting or pilot-operating type, packless, except that packed stem, seal capped, manual lifting provisions shall be furnished. Solenoid coils shall be moisture-proof, UL approved, totally encapsulated or encapsulated and metal jacketed as required. Valves shall have safe working pressure of 2,760 kPa (400 psi) and a maximum operating pressure differential of at least 1,375 kPa (200 psi) at 85 percent rated voltage. Valves shall have an operating pressure differential suitable for the refrigerant used.

2.3.5 Expansion Valves

2.3.5.1 Valve shall conform to ARI 750 and ASHRAE 17. Valve shall be the diaphragm and spring-loaded type with internal or external

equalizers, and bulb and capillary tubing. Valve shall be provided with an external superheat adjustment along with a seal cap. Internal equalizers may be utilized where flowing refrigerant pressure drop between outlet of the valve and inlet to the evaporator coil is negligible and pressure drop across the evaporator is less than the pressure difference corresponding to 1°C (2°F) of saturated suction temperature at evaporator conditions. Bulb charge shall be determined by the manufacturer for the application and such that liquid will remain in the bulb at all operating conditions. Gas limited liquid charged valves and other valve devices for limiting evaporator pressure shall not be used without a distributor or discharge tube or effective means to prevent loss of control when bulb becomes warmer than valve body. Pilot-operated valves shall have a characterized plug to provide required modulating control. A de-energized solenoid valve may be used in the pilot line to close the main valve in lieu of a solenoid valve in the main liquid line. An isolatable pressure gauge shall be provided in the pilot line, at the main valve. Automatic pressure reducing or constant pressure regulating expansion valves may be used only where indicted or for constant evaporator loads.

2.3.6 Safety Relief Valves

2.3.6.1 Valve shall be the two-way type, unless indicated otherwise. Valve shall bear the ASME code symbol. Valve capacity shall be certified by the National Board of Boiler and Pressure Vessel Inspectors. Valve shall be of an automatically reseating design after activation.

2.3.7 Evaporator Pressure Regulators, Direct-Acting

2.3.7.1 Valve shall include a diaphragm/spring assembly, external pressure adjustment with seal cap, and pressure gauge port. Valve shall maintain a constant inlet pressure by balancing inlet pressure on diaphragm against an adjustable spring load. Pressure drop at system design load shall not exceed the pressure difference corresponding to a 1°C (2°F) change in saturated refrigerant temperature at evaporator operating suction temperature. Spring shall be selected for indicated maximum allowable suction pressure range.

2.3.8 Refrigerant Access Valves

2.3.8.1 Refrigerant access valves and hose connections shall be in accordance with ARI 720.

2.4 PIPING ACCESSORIES

2.4.1 Filter Driers

2.4.1.1 Driers shall conform to ARI 710. Sizes 15 mm (5/8 inch) and larger shall be the full flow, replaceable core type. Sizes 15 mm (1/2 inch) and smaller shall be the sealed type. Cores shall be of suitable desiccant that will not plug, cake, dust, channel, or break down, and shall remove water, acid, and foreign material from the refrigerant. Filter driers shall be constructed so that none of the desiccant will pass into the refrigerant lines. Minimum bursting pressure shall be 10.3 MPa (1,500 psi).

2.4.2 Sight Glass and Liquid Level Indicator

2.4.2.1 Assembly and Components

2.4.2.1.1 Assembly shall be pressure- and temperature-rated and constructed of materials suitable for the service. Glass shall be borosilicate type. Ferrous components subject to condensation shall be electro-galvanized.

2.4.2.2 Gauge Glass

2.4.2.2.1 Gauge glass shall include top and bottom isolation valves fitted with automatic checks, and packing followers; red-line or green-line gauge glass; elastomer or polymer packing to suit the service; and gauge glass guard.

2.4.2.3 Bull's-Eye and Inline Sight Glass Reflex Lens

2.4.2.3.1 Bull's-eye and inline sight glass reflex lens shall be provided for dead-end liquid service. For pipe line mounting, two plain lenses in one body suitable for backlighted viewing shall be provided.

2.4.2.4 Moisture Indicator

2.4.2.4.1 Indicator shall be a self-reversible action, moisture reactive, color changing media. Indicator shall be furnished with full-color-printing tag containing color, moisture and temperature criteria. Unless otherwise indicated, the moisture indicator shall be an integral part of each corresponding sight glass.

2.4.3 Vibration Dampeners

2.4.3.1 Dampeners shall be of the all-metallic bellows and woven-wire type.

2.4.4 Flexible Pipe Connectors

2.4.4.1 Connector shall be a composite of interior corrugated phosphor bronze or Type 300 Series stainless steel, as required for fluid service, with exterior reinforcement of bronze, stainless steel or monel wire braid. Assembly shall be constructed with a safety factor of not less than 4 at 150°C (300°F). Unless otherwise indicated, the length of a flexible connector shall be as recommended by the manufacturer for the service intended.

2.4.5 Strainers

2.4.5.1 Strainers used in refrigerant service shall have brass or cast iron body, Y-or angle-pattern, cleanable, not less than 60-mesh noncorroding screen of an area to provide net free area not less than ten times the pipe diameter with pressure rating compatible with the refrigerant service. Screens shall be stainless steel or monel and reinforced spring-loaded where necessary for bypass-proof construction.

2.4.6 Pressure and Vacuum Gauges

2.4.6.1 Gauges shall conform to ASME B40.100 and shall be provided with throttling type needle valve or a pulsation dampener and shut-off valve. Gauge shall be a minimum of 85 mm (3-1/2 inches) in diameter with a range from 0 kPa (0 psig) to approximately 1.5 times the maximum system working pressure. Each gauge range shall be selected so that at normal operating pressure, the needle is within the middle-third of the range.

2.4.7 Temperature Gauges

2.4.7.1 Temperature gauges shall be the industrial duty type and be provided for the required temperature range. Gauges shall have Celsius scale in 1 degree / Fahrenheit scale in 2 degree graduations scale (black numbers) on a white face. The pointer shall be adjustable. Rigid stem type temperature gauges shall be provided in thermal wells located within 1.5 m (5 feet) of the finished floor. Universal adjustable angle type or remote element type temperature gauges shall be provided in thermal wells located 1.5 to 2.1 m (5 to 7 feet) above the finished floor. Remote element type temperature gauges shall be provided in thermal wells located 2.1 m (7 feet) above the finished floor.

2.4.7.2 Stem Cased-Glass

2.4.7.2.1 Stem cased-glass case shall be polished stainless steel or cast aluminum, 229 mm (9 inches) long, with clear acrylic lens, and non-mercury filled glass tube with indicating-fluid column.

2.4.7.3 Bimetallic Dial

2.4.7.3.1 Bimetallic dial type case shall be not less than 89 mm (3-1/2 inches), stainless steel, and shall be hermetically sealed with clear acrylic lens. Bimetallic element shall be silicone dampened and unit fitted with external calibrator adjustment. Accuracy shall be one percent of dial range.

2.4.7.4 Liquid-, Solid-, and Vapor-Filled Dial

2.4.7.4.1 Liquid-, solid-, and vapor-filled dial type cases shall be not less than 89 mm (3-1/2 inches), stainless steel or cast aluminum with clear acrylic lens. Fill shall be nonmercury, suitable for encountered cross-ambients, and connecting capillary tubing shall be double-braided bronze.

2.4.7.5 Thermal Well

2.4.7.5.1 Thermal well shall be identical size, 15 or 20 mm (1/2 or 3/4 inch) NPT connection, brass or stainless steel. Where test wells are indicated, provide captive plug-fitted type 15 mm (1/2 inch) NPT connection suitable for use with either engraved stem or standard separable socket thermometer or thermostat. Mercury shall not be used in thermometers. Extended neck thermal wells shall be of sufficient length to clear insulation thickness by 25 mm (1 inch).

2.4.8 Escutcheons

2.4.8.1 Escutcheons shall be chromium-plated iron or chromium-plated brass, either one piece or split pattern, held in place by internal spring tension or set screws.

2.5 FIELD APPLIED INSULATION

2.5.1 Field applied insulation shall be provided and installed in accordance with Section 20 07 00 – Mechanical Insulation.

3 EXECUTION

3.1 GENERAL

3.1.1 Pipe shall be cut accurately to measurements established at the jobsite, and worked into place without springing or forcing,

completely clearing all windows, doors, and other openings. Cutting or other weakening of the building structure to facilitate piping installation will not be permitted without written approval. Pipe or tubing shall be cut square, shall have burrs removed by reaming, and shall permit free expansion and contraction without causing damage to the building structure, pipe, joints, or hangers.

3.1.2 Install all piping in the best professional manner and in accordance with the best practices of the trade.

3.1.3 Install piping so that there is no interference with the installation of equipment, other piping, systems, ducts or the work of other Trades.

3.1.4 Consider the piping shown on the Drawings as diagrammatic, for clearness in indicating the general runs and connections and that the piping may, or may not, in all parts be shown in the true position. This does not relieve the responsibility for the proper erection of the systems of piping in every respect suitable for the work intended.

3.1.5 Install piping in designated spaces, shafts, and chases. Space and arrange piping to best utilize available space. Arrange grouped valves in equally spaced steps or in straight rows.

3.1.6 Layout and install piping, valves, fittings and cleanouts to facilitate easy maintenance. Install valves and control devices in locations where they can be reached from the floor, platform, or an 2.4m (8 ft) high stepladder. The maximum reach allowed to operate and to service any device shall be 600mm (24"). Do not locate any valves, couplings, or flanged/union connections directly above electrical panels, motor starters or MCC's.

3.1.7 Ensure that welding is performed, using either gas or electric welding equipment. Thoroughly clean pipe surfaces and level the ends of each pipe and fitting before welding. Securely align and space piping so that the width of circumferential welds is two and one-half times the pipe wall thickness. Ensure that the deposited metal forms a gradual increase in thickness from the outside surface to the centre of the weld.

3.1.8 Ensure that the pipe welding is done by a welder holding a certificate from the Department of Labour for the class of piping to be welded.

3.1.9 When welding or cutting with a torch, take every precaution to

prevent fire. Ensure that welding or torch cutting operators have a fully charged 4.5kg (10 lb.) carbon dioxide fire extinguisher with them, when welding or cutting in building, or tunnels. Protect wooden structures with asbestos blanket.

3.1.10 Ensure that fabrication, welded or otherwise, meets the requirements of the ASA B31.1 Code for Pressure Piping, the CSA B51 Code for Boiler, Pressure Vessel, and Pressure Piping, and all requirements of the Boilers and Pressure Vessels Act of the Province of Ontario.

3.1.11 Directional Changes

3.1.11.1 Changes in direction shall be made with fittings, except that bending of pipe 100 mm (4 inches and smaller will be permitted, provided a pipe bender is used and wide weep bends are formed. Mitering or notching pipe or other similar construction to form elbows or tees will not be permitted. The centerline radius of bends shall not be less than 6 diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be accepted.

3.1.12 Functional Requirements

3.1.12.1 Piping shall be installed 4 mm per m (1/2 inch per 10 feet) of pipe in the direction of flow to ensure adequate oil drainage. Open ends of refrigerant lines or equipment shall be properly capped or plugged during installation to keep moisture, dirt, or other foreign material out of the system. Piping shall remain capped until installation. Equipment piping shall be in accordance with the equipment manufacturer's recommendations and the contract drawings. Equipment and piping arrangements shall fit into space allotted and allow adequate acceptable clearances for installation, replacement, entry, servicing, and maintenance.

3.1.13 Fittings and End Connections

3.1.13.1 Threaded Connections

3.1.13.1.1 Threaded connections shall be made with tapered threads and made tight with PTFE tape or equivalent thread-joint compound applied to the male threads only. Not more than three threads shall show after the joint is made.

3.1.13.2 Brazed Connections

3.1.13.2.1 During brazing, the pipe and fittings shall be filled with a pressure regulated inert gas, such as nitrogen, to prevent the formation of scale. Before brazing copper joints, both the outside of the tube and the inside of the fitting shall be cleaned with a wire fitting brush until the entire joint surface is bright and clean. Brazing flux shall not be used. Surplus brazing material shall be removed at all joints. Steel tubing joints shall be made in accordance with the manufacturer's recommendations. Joints in steel tubing shall be painted with the same material as the baked-on coating within 8 hours after joints are made. Tubing shall be protected against oxidation during brazing by continuous purging of the inside of the piping using nitrogen. Piping shall be supported prior to brazing and not be sprung or forced.

3.1.13.3 Welded Connections

3.1.13.3.1 Welded joints in steel refrigerant piping shall be fusion-welded. Branch connections shall be made with welding tees or forged welding branch outlets. Pipe shall be thoroughly cleaned of all scale and foreign matter before the piping is assembled. During welding the pipe and fittings shall be filled with an inert gas, such as nitrogen, to prevent the formation of scale. Beveling, alignment, heat treatment, and inspection of weld shall conform to ASME B31.1. Weld defects shall be removed and rewelded at no additional cost. Electrodes shall be stored and dried as recommended by the manufacturer. Electrodes that have been wetted or that have lost any of their coating shall not be used.

3.1.13.4 Flared Connections

3.1.13.4.1 When flared connections are used, a suitable lubricant shall be used between the back of the flare and the nut in order to avoid tearing the flare while tightening the nut.

3.1.13.5 Flanged Connections

3.1.13.5.1 When steel refrigerant piping is used, union or flange joints shall be provided in each line immediately preceding the connection to each piece of equipment requiring maintenance, such as compressors, coils, chillers, control valves, and other similar items. Flanged joints shall be assembled square end tight with matched flanges, gaskets, and bolts. Gaskets shall be suitable for use with the refrigerants to be handled.

3.1.14 Valves

3.1.14.1 General

3.1.14.2 Refrigerant stop valves shall be installed on each side of each piece of equipment such as compressors condensers, evaporators, receivers, and other similar items in multiple-unit installation, to provide partial system isolation as required for maintenance or repair. Stop valves shall be installed with stems horizontal unless otherwise indicated. Ball valves shall be installed with stems positioned to facilitate operation and maintenance. Isolating valves for pressure gauges and switches shall be external to thermal insulation. Safety switches shall not be fitted with isolation valves. Filter dryers having access ports may be considered a point of isolation. Purge valves shall be provided at all points of systems where accumulated noncondensible gases would prevent proper system operation. Valves shall be furnished to match line size, unless otherwise indicated or approved.

3.1.14.3 Expansion Valves

3.1.14.3.1 Expansion valves shall be installed with the thermostatic expansion valve bulb located on top of the suction line when the suction line is less than 54 mm (2-1/8 inches) in diameter and at the 4 o'clock or 8 o'clock position on lines larger than 54 mm (2-1/8 inches). The bulb shall be securely fastened with two clamps. The bulb shall be insulated. The bulb shall be installed in a horizontal portion of the suction line, if possible, with the pigtail on the bottom. If the bulb must be installed in a vertical line, the bulb tubing shall be facing up.

3.1.15 Vibration Dampers

3.1.15.1 Vibration damper shall be provided in the suction and discharge lines on spring mounted compressors. Vibration dampers shall be installed parallel with the shaft of the compressor and shall be anchored firmly at the upstream end on the suction line and the downstream end in the discharge line.

3.1.16 Strainers

3.1.16.1 Strainers shall be provided immediately ahead of solenoid valves and expansion devices. Strainers may be an integral part of an expansion valve.

3.1.17 Filter Dryer

3.1.17.1 A liquid line filter dryer shall be provided on each refrigerant circuit

located such that all liquid refrigerant passes through a filter dryer. Dryers shall be sized in accordance with the manufacturer's recommendations for the system in which it is installed. Dryers shall be installed such that it can be isolated from the system, the isolated portion of the system evacuated, and the filter dryer replaced. Dryers shall be installed in the horizontal position except replaceable core filter dryers may be installed in the vertical position with the access flange on the bottom.

3.1.18 Sight Glass

3.1.18.1 A moisture indicating sight glass shall be installed in all refrigerant circuits down stream of all filter dryers and where indicated. Site glasses shall be full line size.

3.1.19 Discharge Line Oil Separator

3.1.19.1 Discharge line oil separator shall be provided in the discharge line from each compressor. Oil return line shall be connected to the compressor as recommended by the compressor manufacturer.

3.1.20 Accumulator

3.1.20.1 Accumulators shall be provided in the suction line to each compressor.

3.1.21 Flexible Pipe Connectors

3.1.21.1 Connectors shall be installed perpendicular to line of motion being isolated. Piping for equipment with bidirectional motion shall be fitted with two flexible connectors, in perpendicular planes. Reinforced elastomer flexible connectors shall be installed in accordance with manufacturer's instructions. Piping guides and restraints related to flexible connectors shall be provided as required.

3.1.22 Temperature Gauges

3.1.22.1 Temperature gauges shall be located on the sensing element of each automatic temperature control device where a thermometer is not an integral part thereof, on the liquid line leaving a receiver and on the suction line at each evaporator or liquid cooler. Thermal wells for insertion thermometers and thermostats shall extend beyond thermal insulation surface not less than 25 mm (1 inch).

3.1.23 Pipe Hangers, Inserts, and Supports

3.1.23.1 Hangers used to support piping 50 mm (2 inches) and larger shall be fabricated to permit adequate adjustment after erection while still supporting the load. Piping subjected to vertical movement, when operating temperatures exceed ambient temperatures, shall be supported by variable spring hangers and supports or by constant support hangers.

3.1.23.2 C-Clamps

3.1.23.2.1 Field-fabricated C-clamp bodies or retaining devices are not acceptable.

3.1.23.3 Horizontal Pipe Supports

3.1.23.3.1 Horizontal pipe supports shall be installed not more than 300 mm (1 foot) from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 1.5 m (5 feet) apart at valves. Pipe hanger loads suspended from steel joist with hanger loads between panel points in excess of 23 kg (50 pounds) shall have the excess hanger loads suspended from panel points.

3.1.23.4 Vertical Pipe Supports

3.1.23.4.1 Vertical pipe shall be supported at each floor, except at slab-on-grade, and at intervals of not more than 4.5 m (15 feet), not more than 2.4 m (8 feet) from end of risers, and at vent terminations.

3.1.24 Pipe Guides

3.1.24.1 Guides using, steel, reinforced polytetrafluoroethylene (PTFE) or graphite slides shall be provided where required to allow longitudinal pipe movement. Lateral restraints shall be provided as required. Slide materials shall be suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered.

3.1.24.2 Steel Slides

3.1.24.2.1 Where steel slides do not require provisions for restraint of lateral movement, an alternate guide method may be used. On piping 100 mm (4 inches) and larger, a saddle shall be used. On piping under 100 mm (4 inches), a protection shield may be attached to the pipe or insulation and freely rest on a steel slide plate.

3.1.24.3 High Temperature Guides with Cradles

3.1.24.3.1 Where there are high system temperatures and welding to piping is

not desirable, then the guide shall include a pipe cradle, welded to the guide structure and strapped securely to the pipe. The pipe shall be separated from the slide material by at least 100 mm (4 inches), or by an amount adequate for the insulation, whichever is greater.

3.1.24.4 Multiple Pipe Runs

3.1.24.4.1 In the support of multiple pipe runs on a common base member, a clip or clamp shall be used where each pipe crosses the base support member. Spacing of the base support members shall not exceed the hanger and support spacing required for an individual pipe in the multiple pipe run.

3.1.24.5 Structural Attachments

3.1.24.5.1 Attachment to building structure concrete and masonry shall be by cast-in concrete inserts, built-in anchors, or masonry anchor devices. Inserts and anchors shall be applied with a safety factor not less than 5. Supports shall not be attached to metal decking. Masonry anchors for overhead applications shall be constructed of ferrous materials only. Structural steel brackets required to support piping, headers, and equipment, but not shown, shall be provided under this section.

3.1.25 Pipe Alignment Guides

3.1.25.1 Pipe alignment guides shall be provided where indicated for expansion loops, offsets, and bends and as recommended by the manufacturer for expansion joints, not to exceed 1.5 m (5 feet) on each side of each expansion joint, and in lines 100 mm (4 inches or smaller not more than 600 mm (2 feet) on each side of the joint.

3.1.26 Pipe Anchors

3.1.26.1 Anchors shall be provided wherever necessary or indicated to localize expansion or to prevent undue strain on piping. Anchors shall consist of heavy steel collars with lugs and bolts for clamping and attaching anchor braces, unless otherwise indicated. Anchor braces shall be installed in the most effective manner to secure the desired results using turnbuckles where required. Supports, anchors, or stays shall not be attached where they will injure the structure or adjacent construction during installation or by the weight of expansion of the pipeline. Where pipe and conduit penetrations of vapor barrier sealed surfaces occur, these items shall be anchored immediately adjacent to each penetrated

surface, to provide essentially zero movement within penetration seal. Detailed drawings of pipe anchors shall be submitted for approval before installation.

3.2 CLEANING AND ADJUSTING

3.2.1 Clean uncontaminated systems by evacuation and purging procedures currently recommended by refrigerant and refrigerant equipment manufacturers, and as specified herein, to remove small amounts of air and moisture. Systems containing moderate amounts of air, moisture, contaminated refrigerant, or any foreign matter shall be considered contaminated systems. Restoring contaminated systems to clean condition including disassembly, component replacement, evacuation, flushing, purging, and re-charging, shall be performed using currently approved refrigerant and refrigeration manufacturer's procedures. Restoring contaminated systems shall be at no additional cost. Water shall not be used in any procedure or test.

3.3 REFRIGERANT PIPING TESTS

3.3.1 After all components of the refrigerant system have been installed and connected, the entire refrigeration system shall be subjected to pneumatic, evacuation, and startup tests as described herein. Any material, equipment, instruments, and personnel required for the test shall be provided by the Contractor. The services of a qualified technician shall be provided as required to perform all tests and procedures indicated herein.

3.3.2 Preliminary Procedures

3.3.2.1 Prior to pneumatic testing, equipment which has been factory tested and refrigerant charged as well as equipment which could be damaged or cause personnel injury by imposed test pressure, positive or negative, shall be isolated from the test pressure or removed from the system. Safety relief valves and rupture discs, where not part of factory sealed systems, shall be removed and openings capped or plugged.

3.3.3 Pneumatic Test

3.3.3.1 Pressure control and excess pressure protection shall be provided at the source of test pressure. Valves shall be wide open, except those leading to the atmosphere. Test gas shall be dry nitrogen, with minus 55°C (minus 70°F) dewpoint and less than 5 ppm oil. Test pressure shall be applied in two stages before any refrigerant

pipe is insulated or covered. First stage test shall be at 69 kPa (10 psi) with every joint being tested with a thick soap or color indicating solution. Second stage tests shall raise the system to the minimum refrigerant leakage test pressure specified in ASHRAE 15 with a maximum test pressure 25 percent greater. Pressure above 690 KPa (100 psig) shall be raised in 10 percent increments with a pressure acclimatizing period between increments. The initial test pressure shall be recorded along with the ambient temperature to which the system is exposed. Final test pressures of the second stage shall be maintained on the system for a minimum of 24 hours. At the end of the 24 hour period, the system pressure will be recorded along with the ambient temperature to which the system is exposed. A correction factor of 2 kPa (0.3 psi) will be allowed for each degree C (F) change between test space initial and final ambient temperature, plus for increase and minus for a decrease. If the corrected system pressure is not exactly equal to the initial system test pressure, then the system shall be investigated for leaking joints. To repair leaks, the joint shall be taken apart, thoroughly cleaned, and reconstructed as a new joint. Joints repaired by caulking, remelting, or back-welding/brazing shall not be acceptable. Following repair, the entire system shall be retested using the pneumatic tests described above. The entire system shall be reassembled once the pneumatic tests are satisfactorily completed.

3.3.4 Evacuation Test

3.3.4.1 Following satisfactory completion of the pneumatic tests, the pressure shall be relieved and the entire system shall be evacuated to an absolute pressure of 300 micrometers. During evacuation of the system, the ambient temperature shall be higher than 2°C (35°F). No more than one system shall be evacuated at one time by one vacuum pump. Once the desired vacuum has been reached, the vacuum line shall be closed and the system shall stand for 1 hour. If the pressure rises over 500 micrometers after the 1 hour period, then the system shall be evacuated again down to 300 micrometers and let set for another 1 hour period. The system shall not be charged until a vacuum of at least 500 micrometers is maintained for a period of 1 hour without the assistance of a vacuum line. If during the testing the pressure continues to rise, check the system for leaks, repair as required, and repeat the evacuation procedure. During evacuation, pressures shall be recorded by a thermocouple-type, electronic-type, or a calibrated-micrometer type gauge.

3.3.5 System Charging and Startup Test

3.3.5.1 Following satisfactory completion of the evacuation tests, the system shall be charged with the required amount of refrigerant by raising pressure to normal operating pressure and in accordance with manufacturer's procedures. Following charging, the system shall operate with high-side and low-side pressures and corresponding refrigerant temperatures, at design or improved values. The entire system shall be tested for leaks. Fluorocarbon systems shall be tested with halide torch or electronic leak detectors.

3.3.6 Refrigerant Leakage

3.3.6.1 If a refrigerant leak is discovered after the system has been charged, the leaking portion of the system shall immediately be isolated from the remainder of the system and the refrigerant pumped into the system receiver or other suitable container. Under no circumstances shall the refrigerant be discharged into the atmosphere.

3.3.7 Contractor's Responsibility

3.3.7.1 The Contractor shall, at all times during the installation and testing of the refrigeration system, take steps to prevent the release of refrigerants into the atmosphere. The steps shall include, but not be limited to procedures which will minimize the release of refrigerants to the atmosphere and the use of refrigerant recovery devices to remove refrigerant from the system and store the refrigerant for reuse or reclaim. At no time shall more than 85 g (3 ounces) of refrigerant be released to the atmosphere in any one occurrence. Any system leaks within the first year shall be repaired in accordance with the requirements herein including material, labor, and refrigerant if the leak is the result of defective equipment, material, or installation.

END OF SECTION

Project Name: *UNIVERSITY OF TORONTO MISSISSAUGA*
Project No.: *2023-0059*
Section Name: ***Ductwork and Accessories***
Section No.: ***23 30 13***
Date: *November 15, 2024*

INDEX

1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools equipment, training commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 All rigid supply, return and exhaust air ductwork and plenums.

1.2.1.2 All flexible ductwork.

1.2.1.3 Emergency generator ventilation system.

1.2.1.4 Balancing dampers.

1.2.1.5 Fire dampers.

1.2.1.6 Smoke dampers.

1.2.1.7 Flexible connections.

1.2.1.8 Acoustic lining.

1.2.1.9 Combination fire/smoke dampers.

1.2.1.10 Backdraft dampers.

1.2.1.11 Wall boxes.

1.2.2 Control and smoke dampers, airflow measuring stations shall be supplied under the work of Division 25 – Integrated Automation and installed as per of the work of this Section.

1.3 SUBMITTALS

1.3.1 Submit shop drawings for all products supplied in this Section.

1.4 DEFINITIONS

1.4.1 References to SMACNA shall mean “HVAC Duct Construction Standards, Metal and Flexible”, current edition.

2 **PRODUCTS**

2.1 DUCTWORK

2.1.1 Fabricate the following ductwork from galvanized steel, in accordance with requirements of SMACNA 1000 Pa (4" w.g.) pressure class:

2.1.1.1 All supply air ductwork from air handling units to air terminal control units.

2.1.1.2 All ventilation air supply ductwork.

2.1.1.3 All ductwork used for smoke exhaust, including relief air ductwork.

2.1.2 Fabricate the following ductwork from aluminum in accordance with requirements of SMACNA 500 Pa (2" w.g.) pressure class:

2.1.2.1 Dishwasher exhaust ductwork.

2.1.2.2 Shower exhaust.

2.1.3 Fabricate the following ductwork from galvanized steel, in accordance with requirements of SMACNA 500 Pa (2" w.g.) pressure class:

2.1.3.1 All remaining rigid rectangular ductwork and plenums.

2.1.4 Galvanized steel shall be Class G90 have a coating thickness of 275 g/m^2 (0.9 oz./sq.ft) total both sides galvanizing coat to ASTM A653 standards.

2.1.5 Aluminum shall be utility grade with not more than 0.40% copper minimum tensile strength of 110.3 MPa (16,000 psi) and suitable for Pittsburg lock seam construction. Refer to SMACNA manual for conversion of galvanized duct thickness to acceptable aluminum duct thickness.

2.1.6 Construct round ductwork to meet the requirements of SMACNA 1500 Pa (6" w.g.) pressure class and as follows:

2.1.6.1 Provide welded slip joint construction round duct fittings. Wipe pipe and fittings with Durodyne S-2 duct sealer before assembly. Secure joints with self-tapping screws, and then brush again with thick coat of duct sealer.

2.1.6.2 Provide die-formed round elbows through to 200mm (8") diameter

constructed by 1.0mm (20-gauge) galvanized steel. Provide five-section construction for larger elbows.

2.1.6.3 Provide conical round tees.

2.1.7 Construct flat oval ductwork using galvanized steel construction as follows:

2.1.7.1 Factory fabricated by United Sheet Metal, spiral uniseal through 500mm (20") minor axis, 0.7mm (24-gauge) for up to 600mm (24") major axis.

2.1.7.2 Fittings shall be continuous weld, 1.0mm (20-gauge) up to 900mm (36") major axis.

2.1.7.3 Elbows shall be easy bend.

2.1.7.4 Transitions shall have OTR-10 reinforcement.

2.2 BALANCING DAMPERS

2.2.1 Construct all dampers of the same type of material used for the ductwork.

2.2.2 For dampers in rectangular ductwork:

2.2.2.1 Construct volume dampers not greater than 225mm (9") in height of minimum 1.6mm (16-gauge) steel, centrally hinged. Use a Durodyne type KS-385 linkage.

2.2.2.2 Construct volume dampers with a height greater than 225mm (9") of not less than 1.6mm (16-gauge) steel with reinforced leaves, centrally hinged, bronze or nylon bushings, mounted on a 13mm (½") square rod in 2.7mm (12-gauge), 38mm (1-½") channel frame, securely held by a Durodyne KP-22 locking quadrant with indicating device. The dampers shall be of multi-blade, opposed type construction with a maximum blade length not exceeding 1.2m (4 ft) and a maximum blade height of 150mm (6").

2.2.2.3 Allowable leakage when closed against 1kPa (4" w.g.) at 7.62 m/s (1,500 fpm) face velocity 10%. Provide threaded rod and nut (metric thread) lever adjustment with washer and locknut.

2.2.2.4 Place quadrants on insulated cuts on a bracket so that the quadrant lock is outside the insulation at all times. Place quadrants such that the limiting two (2) positions of the damper correspond to the limiting positions of the quadrant.

2.2.3 For dampers in round ductwork, use double thickness, aero-dynamically shaped, butterfly dampers with rounded edges, tack welded to steel shafts set in nylon bushings complete with glands and asbestos rope packing. Use quadrants as described for low-pressure ductwork louver dampers. Use dampers constructed to function at the indicated pressures, smoothly without undue noise or vibration. Allowable leakage 5% against 1.5kPa (6" w.g.) and at 10.2 m/s (2,000 fpm) face velocity.

2.2.4 Splitter dampers to be constructed of galvanized sheet metal, two (2) gauges heavier than the duct, maximum 1.3mm (18-gauge). Splitter dampers up to 600mm (24") will be securely attached to a single steel pivot rod, which will be set in metal sockets attached to duct. End of the splitter to be turned over to form a teardrop and on this end the rod will be connected. On splitter dampers 625mm (25") and larger, provide two (2) rods. These rods will be provided with setscrew locking devices to hold position. Splitter dampers to be made rigid by reinforcing them Duct panels surrounding splitter damper will not be cross-broken, but will be reinforced to prevent sagging or drumming. Length of splitter shall be at least 300mm (12") long or 1-1/2 times the width of the smaller branch whichever is longer.

2.2.5 Quadrants on insulated ducts to be placed on a bracket so that quadrant lock is on surface of insulation. Quadrants will be placed so that the limiting two (2) positions of the damper correspond to the limiting positions of the quadrant.

2.3 <u>FIRE DAMPERS</u>

2.3.1 Provide, where shown and required by ordinance or codes, fire dampers made to NFPA Standard 90A and ULC listed and to the approval of all authorities having jurisdiction. Fire damper shall be complete with steel frame, fusible link, steel blades, stainless steel closure springs and blade lock for horizontal curtain type dampers.

2.3.2 Dampers shall be Type ‘B’ (with pocket) unless space limitations do not permit.

2.3.3 Provide horizontal or vertical fire dampers to suit each application.

2.3.4 Provide dynamic fire dampers for air systems which fan blowers do not shut down during a fire alarm. Provide static fire dampers for air systems which fan blowers shut down during a fire alarm.

2.4 <u>SMOKE DAMPERS</u>

2.4.1 Smoke dampers to be Ruskin SD35 Class III (or equal), dampers to maintain smoke-rating integrity of membrane being pierced.

2.4.2 Assembly to have the following construction:

2.4.2.1 Frame: 127 x minimum 1.6 mm (5 inches x minimum 16 gage) roll formed, galvanized steel hat-shaped channel, reinforced at corners. Structurally equivalent to 2.3 mm (13 gage) U-channel type frame.

2.4.2.2 Blades: Opposed, single skin with 3 longitudinal grooves, minimum 1.6 mm (16 gage) galvanized steel, width maximum 152 mm (6 inches). Flat blades are not acceptable.

2.4.2.3 Bearings: Self-lubricating stainless steel sleeve type, turning in extruded hole in frame.

2.4.2.4 Jamb seal: Stainless steel, flexible metal compression type. Glue-on seals are not acceptable.

2.4.2.5 Linkage: Concealed in frame.

2.4.2.6 Axles: Minimum 13mm (½ inch) diameter plated steel, hex-shaped, mechanically attached to blade.

2.4.2.7 Mounting: Vertical or Horizontal.

2.4.2.7.1 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.

2.4.2.7.2 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.

2.4.2.7.3 Controlled closing and locking of damper in 7 to 15 seconds to allow duct pressure to equalize. Instantaneous closure is not acceptable.

2.4.2.8 Actuator: Electric 120 V, 60 Hz, two-position, fail close, externally mounted.

2.4.2.9 Finish: Mill galvanized.

2.4.2.10 One piece mounting angle with pre-punched screw holes.

2.4.2.11 Factory sleeve: Minimum 1.0mm (20 gage) thickness, minimum

432mm (17 inches long. Silicone caulk factory applied to sleeve at damper frame to comply with leakage rating requirements.

2.4.2.12 Break-away connections

2.4.3 Optional accessories:

2.4.3.1 Two position indicator switches linked directly to damper blade to remotely indicate damper blade position.

2.4.3.2 Phototelectronic type/Ionization type duct smoke detector, factory mount.

2.4.4 Provide multiple dampers where sizes exceed code limitations.

2.4.5 Select dampers with airflow resistance not exceeding 13 Pa (0.05" w.g.) at design flow rates.

2.5 FLEXIBLE CONNECTIONS

2.5.1 Connect fan units to ductwork by means of 150mm (6") wide heavy 'Ventglas' fabric securely fastened to equipment and ductwork by a galvanized steel band, provided with tightening screws. Ensure that all connections are leakproof. Provide 1.3mm (18-gauge) protective collar over flexible connections.

2.6 FLEXIBLE DUCTWORK

2.6.1 Connections to diffusers will be by means of Flexmaster T/L triple-lock aluminum flexible ducting made of dead soft aluminum, and manufactured in a manner to produce a triple-lock mechanical seam forming a continuous and secure air tight joint.

2.7 ACOUSTIC DUCT LINING

2.7.1 Where indicated on drawings, line ductwork inside with fibreglass acoustic duct insulation. Insulation to comply with ULC S110-M.

2.7.2 Facing for low velocity duct liner (max. 12.2 m/s - 2,400 fpm) shall be a tightly bonded mat, stenciled as per NFPA 90.

2.7.3 Facing for circular ducts and medium/high velocity ductwork (over 12.2 m/s - 2,400 fpm), or where indicated on drawings shall be with perforated, minimum 28 percent open area, minimum 0.85mm (22-gauge) thick galvanized steel finish.

2.7.4 Provide lining with minimum thickness and density as follows:

2.7.4.1 In ductwork 25 mm (1") at 24 kg/m^3 (1-½ lb/ft^3), unless otherwise noted on drawings.

2.7.4.2 In plenums 50 mm (2") at 32 kg/m^3 (2 lb/ft^3).

2.7.4.3 In linear slot diffuser plenums 13 mm (½") at 24 kg/m^3 (1-½ lb/ft^3).

2.7.5 Lining media shall have a flamespread classification of not greater than 25, when tested in accordance with ASTM E84, NFPA Standard 255, CAN 4-S102, or UL No. 723. Furthermore, fuel contribution and smoke development rating shall not be greater than 50, when tested in accordance with ASTM E84, NFPA Standard 255, CAN 4-S102, or UL No. 723.

2.7.6 Lining shall be suitable for duct velocity of 30.5 m/s (6,000 fpm), without erosion damage.

2.7.7 Media shall have the following physical properties:

2.7.7.1 Maximum thermal conductivity of 1.42 W/m^2 °C (0.24 BTU/ft^2 hr °F), at 25mm (1") thickness and 24 kg/m^3 (1-½ lb/ft^3) density.

2.7.7.2 Sound absorption coefficient (NRC) of minimum 0.7, at 25mm (1") thickness and 24 kg/m^3 (1-½ lb/ft^3) density (ASTM C423).

2.8 BACKDRAFT DAMPERS

2.8.1 Backdraft dampers shall have galvanized steel channel frames, full blade-length shafts, brass, ball or nylon bearings, neoprene blade strips secured to pivot side of blades, counter balance weights and suitable for vertical or horizontal mounting.

2.8.2 Maximum blade length shall be 750mm (30”). Use multiple units for larger sizes.

2.8.3 Maximum resistance to air flow shall be 50 Pa (0.2” w.g.) at design airflow. Increase damper size to meet pressure drop requirement.

2.9 COMBINATION FIRE AND SMOKE DAMPERS

2.9.1 Combination fire/smoke dampers to be Ruskin FSD35 Class III dampers to maintain fire-rating integrity of membrane being pierced. Minimum fire rating shall be 1-½ hours in accordance with UL555.

2.9.2 Assembly to have the following construction:

2.9.2.1 Frame: 127 x minimum 1.6 mm (5 inches x minimum 16 gage) roll formed, galvanized steel hat-shaped channel, reinforced at corners. Structurally equivalent to 2.3 mm (13 gage) U-channel type frame.

2.9.2.2 Blades: Opposed, single skin with 3 longitudinal grooves, minimum 1.6 mm (16 gage) galvanized steel, width maximum 152 mm (6 inches). Flat blades are not acceptable.

2.9.2.3 Bearings: Self-lubricating stainless steel sleeve type, turning in extruded hole in frame.

2.9.2.4 Jamb seal: Stainless steel, flexible metal compression type. Glue-on seals are not acceptable.

2.9.2.5 Linkage: Concealed in frame.

2.9.2.6 Axles: Minimum 13mm (½ inch) diameter plated steel, hex-shaped, mechanically attached to blade.

2.9.2.7 Mounting: Vertical or Horizontal.

2.9.2.8 Temperature release device: Heat-Actuated, Quick Detect

2.9.2.8.1 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.

2.9.2.8.2 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.

2.9.2.8.3 Controlled closing and locking of damper in 7 to 15 seconds to allow duct pressure to equalize. Instantaneous closure is not acceptable.

2.9.2.9 Actuator: Electric 120 V, 60 Hz, two-position, fail close, externally mounted.

2.9.2.10 Finish: Mill galvanized.

2.9.2.11 One piece mounting angle with pre-punched screw holes.

2.9.2.12 Factory sleeve: Minimum 1.0mm (20 gage) thickness, minimum 432mm (17 inches long. Silicone caulk factory applied to sleeve at damper frame to comply with leakage rating requirements.

2.9.2.13 Break-away connections

2.9.3 Optional accessories:

2.9.3.1 UL classified dual temperature fire stat, allowing the damper to be reopened after initial closure on heat.

2.9.3.2 Two position indicator switches linked directly to damper blade to remotely indicate damper blade position.

2.9.3.3 Phototelectronic type/Ionization type duct smoke detector, factory mount.

2.9.4 Provide multiple dampers where sizes exceed code limitations.

2.9.5 Select dampers with airflow resistance not exceeding 13 Pa (0.05" w.g.) at design flow rates.

2.10 WALL INTAKE AND EXHAUST BOXES

2.10.1 Intake/Exhaust wall boxes shall be provided equal to Airvent Metal Products model Type A or Type R. Boxes to be constructed of galvanized (corrosion resistant) steel with flanged profile. Air flow pattern shall have a designed velocity differential ratio to prevent the bifurcated air streams from mixing in a high-rise application. The boxes shall be of modular design to allow for left or right duct connections. The boxes shall incorporate spring assisted damper system. The damper mechanisms shall be factory adjusted to suit the building height and barometric condition Damper blade shall be under constant tension to prevent damper chatter due to wind and stack effect. Both the hinge assembly and the damper tension device shall be completely out of the air stream. Provide tie-down straps for masonry and precast installation. Seams of boxes to be sealed internally using a selant for leak resistance, ASTM-331, UL listed, conforming to NFPA 90A and 90B with 0 flame spread and smoke development rating. Alternatively, boxes to be of welded construction.

3 **EXECUTION**

3.1 DUCTWORK

3.1.1 All ductwork construction and installation to be in accordance with recommendations of the current SMACNA standards unless otherwise noted in this Section.

3.1.2 Sheet metal, which is not to be insulated, will be cross-broken on

the four sides of each panel section. All vertical and horizontal sheet metal barriers, duct offsets; elbows, as well as the panels of straight sections of ducts will be cross-broken. Cross-breaking to be applied to the sheet metal between the standing seams or reinforcing angles. The centre of the cross-break will be of the required height to assure surfaces being rigid. Insulated sheet metal and ducts will not be cross-broken.

3.1.3 Where it is necessary that ducts be divided, due to pipes, hangers, or other obstructions, which must pass through the ducts, provide teardrop shaped deflectors around these obstructions so that they will not interfere with the movement of air. Ductwork around these deflectors to be increased in size to maintain equivalent free area around deflectors. Holes in ductwork to be caulked and cover-plated to close any space left between edge of hole and obstruction passing through ducts. The passing of pipes or other obstructions through ducts will only be done when authorized at the Site, by the Consultant.

3.1.4 In square elbows and in elbows where radius is less than 1-$^{1}/_{2}$ x width of duct, sheet metal deflector vanes will be installed the full height of duct, being securely riveted in place. All vanes to be double thickness vanes of same gauge as duct in which they are installed. Vanes to be tack welded. For vane lengths over 1.2m (4 ft) tack weld vanes to 9mm ($^{3}/_{8}$") tie-rod at mid-span.

3.1.5 All necessary allowances and provisions will be made in the installation of the ducts for structural framing of the building and when changes or offsets are necessary, the required areas shall be maintained. All of these changes however, must be approved, and installed as directed by the Consultant at that time.

3.1.6 During installation, the open ends of ducts must be protected with blank, flanged sheet metal baffles, securely attached to prevent debris and dirt from entering.

3.1.7 Where ducts are shown connecting to masonry openings and/or along the edges of all plenums at floors, walls, etc., provide a continuous 38mm x 38mm x 4.7mm (1-½" x 1-½" x $^{3}/_{16}$") galvanized angle steel, which will be bolted to the structure and made airtight to same by applying caulking compound on the angles before they are drawn down tight. The sheet metal at these locations will be bolted to the angle steel framing.

3.1.8 All air ducts, casings, plenums, etc., to be constructed of lock forming quality prime galvanized steel sheets, which are free from

blisters, slivers, imperfectly coated spots, etc., no second quality sheet metal allowed.

3.1.9 Ducts to be constructed using double or Pittsburgh lock corner seams. All seams to be hammered down and made airtight. For transverse joint refer to current ASHRAE Guide for low-pressure ductwork.

3.1.10 Gauges and reinforcing of sheet metal ductwork will be as indicated in the current SMACNA manual, except 0.55mm (26-gauge) ductwork will not be allowed.

3.1.11 All sheet metal connections for apparatus plenum chambers, etc., to be constructed on 1.3mm (18-gauge) metal reinforced with 38mm x 38mm x 4.7mm (1-½" x 1-½" x $^{3}/_{16}$") galvanized angles up to 2.4m (8 ft) in height. When height exceeds 2.4m (8 ft) angles shall not be less than 50mm x 50mm x 6mm (2" x 2" x ¼"). In all case provide connections structurally designed for maximum fan pressures.

3.1.12 Angles on all apparatus and plenum chambers to be installed on not more than 1.2m (4 ft) centres and at all vertical and longitudinal seams on the plenum construction.

3.1.13 Ensure that all openings required through floors, walls, partitions, etc., for the duct system are provided in the exact location.

3.1.14 The bottom joint and 150mm (6") of vertical joint on outside air intake ducts and mixing chamber ducts will be soldered and made watertight. Provide drain connection and run copper drainpipe to nearest floor drain.

3.1.15 Provide 50mm (2") insulated sheet metal blank off panels behind unused portions of exterior louvers.

3.1.16 Connect flexible ductwork using stainless steel worm drive clamps, adjustable clamps, or duct straps applied over two wraps of duct tape.

3.1.17 Maximum length of flexible ducts shall be 3.6m (12 ft). Utilize rigid ductwork as required to meet this requirement.

3.1.18 Install flexible ductwork clear of ceiling assemblies, light fixtures, etc. Support by 25mm (1"), 0.85mm (22-gauge) galvanized steel straps at 1.5m (5 ft) centres.

3.1.19 Frame and install motorized dampers. Attach each motorized damper module to channel framing.

3.1.20 Seal all ductwork in accordance with the appropriate SMACNA "Standard Duct Sealing Requirements". All sealants shall be ULC listed in accordance with standard S-102. Where insulation is applied internally to ductwork, metal duct shall act as vapour barrier and all joints to be completely sealed. Ductwork shall be leak tested at the rated pressure in accordance with SMACNA HVAC Duct Leakage Test Manual. A leak test report shall be provided to the Consultant. Duct sealing and leak testing shall be conducted before ductwork is insulated or concealed by drywall to allow for re-sealing or repairing duct sections.

3.1.21 Ductwork modification:

3.1.21.1 Make all necessary allowances and provisions for the structural framing of the building. Do not execute any such changes without permission of the Consultant.

3.1.21.2 Transform or divide low-pressure ducts (up to 500 Pa / 2" w.g. static pressure) as may be required. Maintain the indicated cross sectional areas. Do not exceed an aspect ratio of 4 to 1. Install air stream deflectors when pipes and other small obstructions must pass through ducts, but maintain the free passage area.

3.1.21.3 Transform rectangular ducts for pressures higher than 500 Pa (2" w.g.). Do not exceed the initial pressure drop. Do not exceed an aspect ratio of 4 to 1. Do not pass any obstructions through any of these ducts.

3.1.21.4 Round or oval ducts for pressures higher than 500 Pa (2" w.g.). Do not change dimensions without obtaining approval. Do not pass any obstructions through any of these ducts.

3.2 <u>BALANCING DAMPERS</u>

3.2.1 Provide balancing dampers in all locations necessary for balancing the air system including but not necessarily limited to the following locations:

3.2.1.1 Where ducts enter or leave duct shafts, (including ducts to last floor where shafts may not exist).

3.2.1.2 In all supply branches without reheat coil stations (e.g. corridors, electrical rooms, etc.).

3.2.1.3 In all other locations shown on the Drawings.

3.2.2 Note: For clarity of Drawings, balancing dampers mentioned under paragraphs 3.2.1.1. and 3.2.1.2. are not shown or indicated on the Drawings, but must be supplied and installed.

3.2.3 In each branch connection, install splitter dampers in supply ducts and louver dampers in return ducts.

3.2.4 Install duct mounted louver type dampers between angle steel duct framing, using neoprene gasket. In stainless steel ducts, cover the neoprene gaskets with Teflon tape.

3.2.5 Bolt all dampers in plenum wall to a counter frame using a neoprene gasket between damper and wall.

3.2.6 Install access doors and panels at all dampers, to provide access to the entire damper assembly.

3.3 FIRE DAMPERS, SMOKE DAMPERS, COMBINATION SMOKE/FIRE DAMPERS

3.3.1 Before proceeding with any work, submit erection drawings approved by all authorities having jurisdiction showing location and construction details of all fire dampers.

3.3.2 Install dampers at locations indicated on the drawings and in accordance with manufacturer's UL approved installation instructions.

3.3.3 Install dampers square and free from racking with blades running horizontally.

3.3.4 Provide steel retaining angle and steel wall sleeve/collar for proper installation of the damper.

3.3.5 Do not compress or stretch damper frame into duct or opening.

3.3.6 Handle damper using sleeve or frame. Do not lift damper using blades, actuator, or jackshaft.

3.3.7 Enlarge duct sections around fire dampers, to allow unrestricted duct area while damper is in open position. Provide approved type access doors with airtight gaskets, for inspection and servicing of fire dampers. Provide dampers in supply and return take-offs at each floor of the multiple louver type.

3.3.8 Install bracing for multiple section assemblies to support assembly weight and to hold against system pressure. Install bracing as needed.

3.3.9 Provide fire dampers in all ducts over 0.013m^2 (0.14 sq.ft) in area in the location shown on drawings, whether or not specifically requested by ordinances and codes.

3.3.10 For stainless steel exhaust ducts provide butterfly fire dampers constructed of stainless steel.

3.3.11 Line side power wiring and control wiring connections to fire alarm system for smoke dampers and combination fire/smoke dampers shall be provided by Division 26 - Electrical. Coordinate wiring requirements and exact location of dampers with Division 26 - Electrical Contractor.

3.4 CONTROL DAMPERS

3.4.1 Install automatic control dampers in all relief ducts to the outside, in all return ducts to the main air handling units from all main return-relief fans, and elsewhere where shown. Install all damper sections between angle steel frames attached to the ductwork.

3.5 WATERPROOF EXHAUST

3.5.1 Provide waterproof ductwork where aluminum ductwork is specified in the Contract Documents. All joints shall be made watertight using caulking. Slope ducts back to source to facilitate drainage. Where this is not feasible, provide intermediate drains piped to nearest floor drain. All joints shall be made watertight.

3.6 CLEANING OF AIR SYSTEMS

3.6.1 Wipe clean all ductwork internally before erection.

3.6.2 After completing the systems, vacuum clean all ductwork and all apparatus internally through cleanouts.

3.6.3 Run air systems for at least twelve (12) operational hours using throwaway filters in place of permanent filters. Include for additional throwaway filter as well as for filters for all air handling units provided under this Contract.

3.6.4 Have all ductwork inspected for internal cleanliness. Obtain the Consultant’s permission for the installation of all permanent filters in order to facilitate balancing.

3.7 DUCT ACCESS PANELS AND TEST HOLES

3.7.1 Access Panels:

3.7.1.1 Provide all access doors of the same material as used for the ducts in which they are to be installed. Ensure through gasketing and suitable fastening materials that the entire systems are completely free from corrosion, water leakage (washable ducts), and air leakage (all ducts).

3.7.1.2 Ensure that all duct access doors are easily accessible through the structure.

3.7.1.3 All access doors will be in accordance with NFPA Standard 90-A. Construct all duct or apparatus access panels from double thickness frame, 25mm (1") apart, with necessary reinforcing for rigidity. Provide access panels on insulated ducts apparatus with 25mm (1") space filled with fibreglass insulation. Make panels airtight with a continuous rubber gasket. Provide openings in ductwork or casings with continuous galvanized reinforcing bars, extended on insulated ductwork or casings, to the face of the insulation.

3.7.1.4 Provide 450mm x 450mm (18" x 18") and smaller panels with at least two (2) brass window sash fasteners, larger panels with at least two (2) brass pin hinges and two (2) fasteners. Make fasteners on wall-through panels operational from inside and outside. Provide all panels with brass drawer type handles (two (2) minimum, each).

3.7.1.5 Provide access panels where shown, and in the following locations whether shown or not:

3.7.1.5.1 In ductwork to facilitate full cleaning of all ducts.

3.7.1.5.2 Bottom of all duct risers.

3.7.1.5.3 Next to outside air intakes and outlets.

3.7.1.5.4 At fire dampers.

3.7.1.5.5 Into plenums and apparatus casings to facilitate maintenance and cleaning of all components.

3.7.1.5.6 Immediately upstream and downstream of each reheat coil.

3.7.1.6 In ducts vulnerable to settlement of liquids or solids, provide reach-

through type access doors size 250mm x 200mm (10" x 8") of rigid construction complete with frame and counter frame, bolted and gasketed. Provide insulated doors in ducts that are to be used for access.

3.7.1.7 In all other ducts provide access doors of adequate size to allow for inspection, cleaning and for general maintenance, of dampers, filters, louvers, birdscreens, coils, thermostats, thermometers, firestats, fire linkages and all other duct mounted appurtenances. Provide reach-through type access doors of rigid construction with frame and counter-frame, hinged and sash locked with gasket. Insulate doors for ducts that are to be insulated.

3.7.2 Test Holes:

3.7.2.1 At each main branch in ductwork and at each fan discharge and suction, provide sufficient number of Pitot tube test holes for balancing systems. Also, provide test holes for traverse at fan discharge.

3.7.2.2 Test holes to be located within easy reach of catwalks or ladders.

3.7.2.3 Each test hole will have 19mm (¾") clear opening, provided with a metal ring plate with a threaded hole, and a matching screwed head plug. Where these plugs are installed in insulated ductwork, provide and extension collar against which the insulation can be finished.

3.7.2.4 Reinforced holes to be provided where thermometers, manometers, thermostats, gauges, damper rods, etc., occur in ductwork. Extended collars will be provided for the reinforced holes where these occur on insulated ductwork.

3.7.2.5 Where copper tubing passes through ductwork, or casing, provide a rubber grommet to prevent damage to copper tubing.

3.8 <u>ACOUSTIC DUCT LINING</u>

3.8.1 Secure to ductwork with approved fire retardant adhesive suitable for fibreglass insulation using 100% coverage and 2.7mm (12-gauge) anchors, or minimum 1.9mm (14-gauge) weld pins on 400mm (16”) centres. Cut-off excess fastener length after mechanical fasteners (speed clips) have been applied. Transverse joints shall be firmly butted with no gaps and longitudinal corner joints shall be overlapped and compressed. Coat all joints, raw edges, rips, and protrusions with approved mastic. Provide

continuous sheet metal edge protectors at entering and leaving edges of lined duct sections, and all joints.

3.8.2 Duct dimensions shown are clear inside dimensions. Increase duct dimensions to suit thickness of duct lining.

3.8.3 Unless noted otherwise in the Contract Documents, acoustic insulation shall be installed in accordance with SMACNA Standard for Metal and Flexible Duct.

3.8.4 Extent of ductwork acoustic lining:

3.8.4.1 Downstream of air terminal control units (CAV, VAV and fan powered), except units supplied with integral attenuator, for min. 1,524mm (5 ft) length.

3.8.4.2 Downstream of heat pump units, for min. 2,438mm (8 ft) overall length, or min. 914mm (3 ft) length beyond the first 90 degree elbow.

3.8.4.3 All toilet exhaust branch ducts which serve different toilet rooms from same riser on the same level unless at least 5m (16 ft) of ductwork, including at least three (3) of 90 degree elbow separate grilles in separate rooms.

3.8.4.4 Air transfer ducts for full length.

3.8.4.5 Return air stub ducts at shaft intake openings for full length.

3.8.4.6 All ductwork serving spaces with noise criteria of NC-30 or lower.

3.8.4.7 Where indicated on the Drawings.

3.8.5 Where ductwork velocities exceed 12.2 m/s (2,000 fpm), use of internal lining shall be reviewed with the Consultant in fulfilling the above requirements. If internal lining is deemed unsatisfactory for the particular application, provide perforated metal facing over internal lining, or sound traps as directed.

3.9 INSULATED PLENUMS AND CASINGS

3.9.1 Provide insulated metal sandwich panels for all exterior intake and exhaust air plenums consisting of prefabricated 1.3mm (18-gauge) galvanized sheet metal panels and 50mm (2") rigid fibreglass insulation with interlocking joints securely fastened.

3.9.2 Provide steel supports, joiner sections, floor channels, opening

frames and sealing materials. Provide 1.3mm (18-gauge) minimum channel stiffeners at not greater than 800mm (32") centres.

3.9.3 Connect corners and butt joints with 1.6mm (16-gauge) galvanized sections. Seal all joints with rubber mastic. Use angle joints to attach panel edges to walls.

3.9.4 Construct entire plenum to resist deflection and seal sufficiently to avoid air leakage when subjected to a pressure differential between inside and outside of up to 2,490 Pa (10" w.g.)

3.9.5 Provide access doors suitable for personnel pass through.

3.9.6 Insulate plenum floors with 25mm (1") rigid fibreglass insulation and cover with 1.6mm (16-gauge) galvanized sheet metal panels.

3.9.7 Seal penetrations through plenum walls with gland seals.

3.9.8 Construct drain pans from 1.6mm (16-gauge) type 304 stainless steel. Weld all joints. Install DN32 (1-¼") DWV drain connection to nearest drain complete with deep seal trap (minimum 100mm / 4"). Install to completely drain the pan.

END OF SECTION

Project Name: *UNIVERSITY OF TORONTO MISSISSAUGA*
Project No.: *2023-0059*
Section Name: ***Duct Silencers***
Section No.: ***23 33 19***
Date: *November 15, 2024*

INDEX

1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 – General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools, equipment, training commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 Complete noise control system to prevent noise levels from exceeding the room criteria listed in Table 1, Chapter 48 of the ASHRAE 2011 HVAC Applications Handbook.

1.2.2 System shall include sound attenuating units (silencers), sound proofing construction, and external sound proofing, provided under this Section, and acoustic duct lining provided under Section 23 30 13 – Ductwork and Accessories.

1.2.3 In addition to the work covered under this Section, coordinate the equipment supplied under the work of other Sections of this Division and of other Divisions, to comply with the requirements contained in this Section.

1.3 SUBMITTALS

1.3.1 The Division 23 – HVAC Subcontractor shall supply to the noise control manufacturer approved drawings of all equipment to be acoustically attenuated, including sound power level data.

1.3.2 The noise control manufacturer shall supply shop drawings of all silencers to be used on the project. The data shall include dynamic insertion loss, generated noise and pressure drop. Data shall be certified by a qualified independent testing laboratory.

1.3.2.1 The insertion loss shall consist of sound pressure level in the diffuse sound field of a reverberant room where a silencer is substituted for the same length of empty duct and the rest of the system unchanged.

1.3.2.2 The test method used by the Independent Testing Laboratory certifying the silencer data shall be fully described.

1.3.2.3 The certification of the pressure drop, insertion loss, and generated

noise data shall be based upon tests of the same silencer for all measurements.

1.3.3 Submit letter from manufacturer certifying silencers have been installed in accordance with their recommendations and the contract documents.

1.4 QUALITY ASSURANCE

1.4.1 Noise levels due to equipment and ductwork shall permit attaining sound pressure levels in all eight (8) octave bands in occupied spaces conforming to room criteria listed in Table 1, Chapter 48 of the ASHRAE 2011 HVAC Applications Handbook.

1.4.2 Acoustical Performance within Equipment Spaces:

1.4.2.1 Equipment room noise levels and noise transmission to adjacent buildings shall comply with the local statutory requirements.

1.4.3 Motor Acoustical Performance:

1.4.3.1 All motor drives when installed per plans and specifications shall operate with noise levels not exceeding 80 dBA.

1.4.3.2 Noise levels shall be determined in accordance with IEEE Standard #85 Test "Procedure for Airborne Noise Measurements on Rotating Electric Equipment".

1.4.4 Transformer Acoustical Performance:

1.4.4.1 Maximum permissible sound pressure level when operated under installed conditions shall be 80 dBA when measured with an ANSI S1.4-1983 "Type 1" sound level meter at any point which is 1.0m (40") from the equipment housing.

1.4.5 Air Distribution System; Pressure Reducing Device Noise.

1.4.5.1 Maximum permissible sound power levels in octave bands of airborne transmission through the combination of grille, registers, diffusers, terminal units, related pressure reducing devices and fan coil units, when operated in installed condition per Plans and Specifications, shall be no greater than the maximum in the following table for diffuser heights of less than 4m (13 feet) above finished floor level:

Air Distribution System Equipment/Terminal Device Noise			
Maximum PWL (dB re: 10^{-12} Watt)			
Octave Band	NC-35	NC-40	NC-45
1	62	66	68
2	56	60	63
3	49	54	58
4	46	51	56
5	43	48	53
6	42	47	52
7	41	46	51
8	42	47	52

1.4.5.2 The contractor is hereby advised to exercise the following in order to assure satisfactory acoustical performance of the terminal devices:

1.4.5.2.1 Provide proper duct connections to the terminal inlets, with at least three (3) duct diameters of straight ductwork, either flexible or sheet metal, before the duct attachment to the terminal.

1.4.5.2.2 Ensure proper air balancing.

1.4.5.2.3 Avoid excessive dampering near the terminals.

1.4.6 Variable Volume (VAV) Box, Fan Powered VAV Box, Fan Coil and Heat Pump Unit Above Ceiling; Radiated Noise:

1.4.6.1 Maximum permissible radiated sound power levels in octave bands when operated over occupied spaces in an installed condition, above a ceiling, shall be as per the following table:

Maximum Radiated Sound Power (dB re: 10^{-12} Watt)			
Octave Band	NC-35	NC-40	NC-45

Maximum Radiated Sound Power (dB re: 10^{-12} Watt)			
Octave Band	NC-35	NC-40	NC-45
1	72	76	79
2	70	74	77
3	61	65	68
4	60	64	68
5	57	62	68
6	56	60	65
7	66	70	75
8	65	70	75

2 PRODUCTS

2.1 GENERAL

2.1.1 Silencers shall be of the size, configuration, capacity, and acoustic performance as specified in the Silencer Schedule in the Contract Documents. All silencers shall be factory fabricated and supplied by the same manufacturer.

2.1.2 Silencer performance including silencers with fibreglass cloth and Mylar encapsulated media must have been substantiated by laboratory testing according to ASTM E477 and so certified when submitted for approval.

2.1.3 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. A sheet metal elbow in combination with a rectangular silencer is not acceptable as an elbow silencer.

2.1.4 Completely prefabricate all silencers using incombustible materials. Silencers shall have rounded inlets and tapered diffuser outlets. Equip circular silencers with centre bodies with spun noses and tapered diffuser outlets.

2.1.5 Media shall be incombustible acoustic quality, shot free fibreglass

insulation with long, resilient fibres bonded with thermosetting resin. Density shall be required to insure conformance with laboratory test data. Fibreglass shall be packed with a minimum 10% compression during silencer assembly. Media shall be bacteria and fungus resistant, 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 fibreglass.

2.1.6 Media shall have a flamespread classification of not greater than 25, when tested in accordance with ASTM E84, NFPA Standard 255, or UL No. 723. Furthermore, fuel contribution and smoke development rating shall not be greater than 50, when tested in accordance with ASTM E84, NFPA Standard 255 or UL No. 723

2.1.7 Silencers shall have 50mm (2") slip connections unless specified otherwise in the Contract Documents. Silencers shall be constructed from galvanized sheet metal or steel sheet. If steel sheet is used, silencers shall be painted with anti-rust prime coat. Supply lifting lugs on units with cross sectional dimensions larger than 600mm (24"). Where silencer is mounted in stainless steel ductwork, the silencer shall be all stainless steel construction to match the ductwork gauges used.

2.1.8 Where indicated on the Silencer Schedule, media shall be encapsulated in fibreglass cloth or Mylar film to prevent erosion, shedding, and impregnation of the fibreglass media.

2.1.9 All perforated metal shall be adequately stiffened to insure flatness and form. All seams and joints should be mastic filled to insure airtight construction.

2.1.10 Silencers shall not fail structurally when subjected to a differential air pressure of 1,992 Pa (8" w.g.)

2.2 <u>RECTANGULAR/ELBOW SILENCERS</u>

2.2.1 Rectangular silencers shall be constructed according to one of the following classes. Silencers over 1200 mm (48") in any one cross sectional dimension shall be constructed in modules not exceeding 1200 mm (48").

2.2.2 Class I: Outer shell shall be minimum 0.85mm (22-gauge) and 0.55mm (26-gauge) inner perforated liner of galvanized steel with airtight mastic filled seams and 50 mm (2") slip connections at each end.

2.2.3 Class II: Outer shell shall be minimum 1.3mm (18-gauge) and 0.85mm (22-gauge) inner perforated liner of galvanized steel with spot-welded and caulked seams and steel angle flanges at each end.

2.2.4 Class III: The outer casing shall be a minimum of 1.6mm (16-gauge) hot rolled steel with all seams continuously welded, 0.85mm (22-gauge) inner perforated liner of galvanized steel and steel angle flanges at each end.

2.3 CIRCULAR SILENCERS

2.3.1 Circular silencers shall be welded construction with a minimum 1.6mm (16-gauge) sheet metal outer shell and 0.85mm (22-gauge) perforated sheet metal inner shell for diameters over 600mm (24"). For smaller sizes, 1.3mm (18-gauge) and 0.7mm (24-gauge) respectively shall be acceptable.

2.4 CROSSTALK SILENCERS

2.4.1 Crosstalk silencers shall be constructed of 0.85mm (22-gauge) galvanized outer shell and 0.55mm (26-gauge) galvanized perforated metal.

2.5 REACTIVE SILENCERS

2.5.1 No-media silencers shall contain no absorptive material. Attenuation shall be accomplished by virtue of controlled impedance membranes and broadly tuned resonators.

2.6 HTL CASINGS

2.6.1 Where indicated on the Silencer Schedule, silencers shall have breakout/in protection (HTL - Type I, II, III) 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 NC level. Standard acoustical panels will not be accepted as HTL Walls.

2.6.2 Such HTL walls will extend from within the mechanical equipment room to a point at which flanking through the silencer casing is not a problem.

2.6.3 Mechanical attachment of the HTL walls to the silencer casing is

only permitted at the mechanical room end of the silencer and the termination point of the HTL Wall treatment.

2.7 ACOUSTIC PERFORMANCE

2.7.1 Silencer dynamic insertion loss shall not be less than that listed in the Silencer Schedule. Select silencers to provide the performance stipulated by paragraph 1.2.1.1.

2.7.2 Silencer generated noise shall not be greater than that listed in the Silencer Schedule.

2.7.3 Acoustic performance shall include dynamic insertion loss and generated noise for forward flow (air and noise in same direction) or reverse flow (air and noise in opposite direction) in accordance with project's air distribution system requirements.

2.7.4 All silencer ratings shall be determined in a duct-to-reverberant room test facility, which provides for airflow in both directions through the test silencer in accordance with the ASTM E477-99 test standard. The test set-up, procedure, and facility shall eliminate all effects due to flanking, directivity, end reflection, standing waves, and reverberation room absorption.

2.8 AERODYNAMIC PERFORMANCE

2.8.1 Silencer pressure drops shall not exceed those listed in the Silencer Schedule. Silencer pressure drop measurements shall be made in accordance with the ASTM E477-99 test standard. Tests shall be conducted and reported on the identical units for which acoustical data is presented.

3 EXECUTION

3.1 GENERAL

3.1.1 Protect all acoustic media from dirt and moisture during construction.

3.1.2 Have the manufacturer inspect the complete installation after system start-up and submit a letter to the Consultant stating that the complete vibration isolation and noise control installation is installed in accordance with its Drawings and instructions and operates to its satisfaction.

3.1.3 After the system has been air balanced, the noise control manufacturer shall visit the job and check the sound levels in those

areas requested by the Consultant. Conduct sound tests as requested by the Consultant. Determine the necessary corrective measures if applicable, and submit a written report.

3.1.4 Sound measurements shall be in accordance with the “American Standard Method for the Physical Measurement of Sound S1.2”.

3.1.5 Sound measuring equipment shall be in accordance with ANSI Standards S1.4 or S1.11.

3.1.6 Maximum static pressure loss:

3.1.6.1 After installation measure total system pressure before and after attenuators.

3.1.6.2 If pressure loss exceeds maximum static pressure loss shown in Schedules, at no charge, replace attenuators and/or modify entrance and/or discharge aerodynamic flow to obtain specified performance.

3.2 SOUND PROOF CONSTRUCTION FOR DUCT PENETRATIONS

3.2.1 Required for openings between ductwork and following construction:

3.2.1.1 Equipment room walls.

3.2.1.2 Floors, except in shafts.

3.2.2 Sound proofing

3.2.2.1 Fill openings with fibrous glass blanket or board for full depth of penetration.

3.2.3 Caulk each side of opening with non-hardening, non-aging caulking compound similar to Johns Manville "Duxeal".

END OF SECTION

Project Name: *UNIVERSITY OF TORONTO MISSISSAUGA*
Project No.: *2023-0059*
Section Name: ***Fans***
Section No.: ***23 34 00***
Date: *November 15, 2024*

INDEX

1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools equipment, training commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 All fans, not part of equipment assemblies.

1.3 SUBMITTALS

1.3.1 Provide shop drawings for all fans. Shop drawings shall include sound power levels for inlet and outlet at rated capacity, and fan curves.

1.3.2 As a minimum, provide the following information:

1.3.2.1 Product data sheets indicating rated capacities, sound power levels for inlet and outlet at rated capacity, and fan curves for 75%, 100% and 125% of rated RPM.

1.3.2.2 Physical outline dimension drawing showing required clearances, weights, and location and size of connection entries.

1.3.3 Provide manufacturer's certification letter. Refer to Section 20 00 00 – General Requirements.

2 **PRODUCTS**

2.1 GENERAL

2.1.1 Provide all fans indicated on the Drawings.

2.1.2 Provide all fan ratings based upon tests performed in accordance with code adopted jointly by the ASHRAE and AMCA. Provide each fan with the AMCA seal. Provide fans with a high efficiency and a pressure characteristic that is constantly rising from free delivery to shut-off. Fans to have non-overloading horsepower characteristics.

2.1.3 The fan manufacturer shall provide certified performance curves of

capacity vs. static pressure; BHP vs. capacity and noise sound power; values at rated RPM and at 75% and 125% of rated RPM. When installed, the fan not performing to the curve will be tested by the fan manufacturer and be 'made good' at no cost to the Owner.

2.1.4 Provide all fan wheels statically and dynamically balanced in the manufacturer's plant in accordance with AMCA Standard 204, Balance Quality and Vibration Levels for Fans. Fans to operate quietly and without pulsations.

2.1.5 The fan manufacturer shall check that the motor horsepower specified in the Contract Documents is sufficient to accelerate the fan to operating speed without motor overload within normal time limits. If it is found insufficient, the Consultant shall be notified, prior to tendering, and a larger motor and starter will be provided to prevent overloading. If, when installed, motor overload and stopping occur due to fan inertia, the fan manufacturer shall pay all costs incurred for changing motors, starters, wiring, etc.

2.1.6 Fans used for smoke exhaust shall be suitable for continuous operation at 205°C (400°F).

2.1.7 Fan belts shall be oil and heat resistant, non-static type. Drives shall be precision-machined cast iron type, keyed and securely attached to the wheel and motor shafts. Drives shall be sized for 150% of the installed motor horsepower.

2.1.8 For belt driven fans with variable pitch motor drive, the drive must be factory set to the specified fan RPM.

2.1.9 For belt driven fans with fixed drives, allow for one (1) drive change for air balancing purposes (parts only, labour by the Subcontractor responsible for the Air Balancing work under Section 20 05 93).

2.2 <u>CENTRIFUGAL INLINE FANS</u>

2.2.1 Fan shall be duct mounted, belt driven centrifugal square inline (HP – high pressure).

2.2.2 The fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. Housing shall be minimum 1.3mm (18-gauge) steel with airflow straightening vanes and integral duct flanges. Adjustable motor plate shall utilize threaded studs for positive belt tensioning. Access door and mounting feet shall be located in the specified position.

2.2.3 Unit shall bear an engraved aluminum nameplate. Nameplate shall indicate design airflow, static pressure, and maximum fan RPM. Unit shall be shipped in ISTA certified transit tested packaging.

2.2.4 All steel fan components shall have an electrostatically applied, baked polyester powder coating. Each component shall be subject to a five stage environmentally friendly wash system, followed by a minimum 2-mil thick baked powder finish. Paint must exceed 1,000-hour salt spray under ASTM B117 test method.

2.2.5 Wheel shall be centrifugal backward inclined, constructed of 100% aluminum, including a precision-machined cast aluminum hub. Wheel inlet shall overlap an aerodynamic aluminum inlet cone to provide maximum performance and efficiency.

2.2.6 Motor shall be heavy-duty type with permanently lubricated sealed ball bearings and furnished at the specified voltage, phase, and enclosure.

2.2.7 Bearings shall be designed and individually tested specifically for use in air handling applications. Construction shall be heavy-duty regreasable ball type in a cast iron housing selected for a minimum L50 life in excess of 200,000 hours at maximum cataloged operating speed.

2.2.8 Supply the following accessories unless described otherwise in the plans and schedules:

2.2.8.1 UL safety disconnect switch

2.2.8.2 Wiring between motor and disconnect switch

2.2.8.3 Spring vibration isolator set

2.2.8.4 Flexible duct connectors (intake and discharge side)

2.3 <u>DUCT/CEILING INLINE FANS</u>

2.3.1 Fan shall be inline or ceiling mounted, direct driven, centrifugal exhaust fan.

2.3.2 The fan wheel housing and integral outlet duct shall be injection molded from a specially engineered resin exceeding UL requirements for smoke and heat generation. The outlet duct shall have provision for an aluminum backdraft damper with continuous aluminum hinge rod. The inlet box shall be minimum 0.85mm (22-

gauge) galvanized steel. Motor shall be isolation mounted to a one piece galvanized stamped steel integral motor mount/inlet. A field wiring compartment with disconnect receptacle shall be standard. Unit shall be shipped in ISTA Certified Transit Tested Packaging.

2.3.3 (GN) To accommodate different mounting positions, an adjustable prepunched mounting bracket shall be provided.

2.3.4 (GC) To accommodate different ceiling thickness, an adjustable prepunched mounting bracket shall be provided. A white, high impact styrene injection molded grill shall be provided as standard. Unit shall be designed with provision for field conversion from ceiling to in-line.

2.3.5 Wheel shall be centrifugal forward curved type, injection molded of polypropylene resin.

2.3.6 Motor shall be open drip proof type with permanently lubricated bearings and include impedance or thermal overload protection and disconnect plug. Motor shall be furnished at the specified voltage.

2.3.7 The following accessories shall be provided by the manufacturer:

2.3.7.1 Fan mount speed controller

2.3.7.2 Wiring between motor and speed controller.

2.3.7.3 Reinforced aluminum backdraft damper with continuous hinge rod.

2.4 <u>ROOFTOP EXHAUST FANS</u>

2.4.1 Fan shall be a spun aluminum, roof mounted, belt driven, upblast centrifugal exhaust ventilator.

2.4.2 The fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The spun aluminum structural components shall be constructed of minimum 1.3mm (16-gauge) marine alloy aluminum, bolted to a rigid aluminum support structure. The aluminum base shall have a one-piece inlet spinning and continuously welded curb cap corners for maximum leak protection. The windband shall have a rolled bead for added strength. A two-piece top cap shall have stainless steel quick release latches to provide access into the motor compartment without the use of tools. An integral conduit chase shall be provided into the motor compartment to facilitate wiring

connections. The motor, bearings and drives shall be mounted on a minimum 1.9mm (14-gauge) steel power assembly, isolated from the unit structure with rubber vibration isolators. These components shall be enclosed in a weather-tight compartment, separated from the exhaust airstream. Lifting lugs shall be provided to help prevent damage from improper lifting. Unit shall bear an engraved aluminum nameplate. Nameplate shall indicate design airflow, static pressure, and maximum fan RPM. Unit shall be shipped in ISTA certified transit-tested packaging.

2.4.3 Wheel shall be centrifugal backward inclined, constructed of 100 percent aluminum, including a precision-machined cast aluminum hub. Wheel inlet shall overlap an aerodynamic aluminum inlet cone to provide maximum performance and efficiency.

2.4.4 Motor shall be heavy-duty type with permanently lubricated sealed ball bearings and furnished at the specified voltage, phase, and enclosure.

2.4.5 Bearings shall be designed and individually tested specifically for use in air handling applications. Construction shall be heavy-duty regreasable ball type in a cast iron pillow block housing selected for a minimum L50 life in excess of 200,000 hours at maximum catalogued operating speed.

2.4.6 Fan curbs shall have a minimum of 2” (50mm) insulation and have a galvanized steel anchor flange extending min 230mm at perimeter, except at upslope side [supply air side in our installation] minimum 450mm flange

2.4.7 Supply the following accessories unless described otherwise in the plans and schedules:

2.4.7.1 UL safety disconnect switch

2.4.7.2 Wiring between motor and disconnect switch

2.4.7.3 Insulated prefabricated curb

2.4.7.4 Gravity backdraft damper unless fan is equipped with automatic damper

3 EXECUTION

3.1 <u>INSTALLATION</u>

3.1.1 Install fans as shown, with resilient mountings and fan restraining

snubbers as specified with vibration isolation and flexible electrical leads.

3.1.2 Install fans with flexible connections on inlet ductwork and on discharge ductwork in accordance with Section 23 30 13 – Ductwork and Accessories.

3.1.3 Provide and install guards on inlets and/or discharge for all fans which are not duct connected.

3.1.4 Align shafts, belt drive, and motor, adjust belt tension, and check motor rotation before start-up.

3.1.5 Protect motors and fans during construction and rotate fans, by hand, every month between delivery and acceptance of building.

3.1.6 Provide torque restrains consisting of spring hangers mounted at 45° angle, for axial fans with 3.73 kW (5 HP) or larger motor and/or 623 Pa (2.5") ESP, installed with flexible connectors.

3.1.7 Adjust variable pitch fan/motor sheaves during balancing to achieve specified air quantities.

3.1.8 Provide sheaves and belts for final air balance where specified in the Contract Documents.

END OF SECTION

Project Name: *UNIVERSITY OF TORONTO MISSISSAUGA*
Project No.: *2023-0059*
Section Name: ***Air Terminal Units***
Section No.: ***23 36 00***
Date: *November 15, 2024*

INDEX

1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools equipment, training commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 All VAV terminal units.

1.2.1.2 All fan powered VAV terminal units.

1.2.2 Power wiring shall be connected under the work of Division 26 - Electrical.

1.3 SUBMITTALS

1.3.1 Provide shop drawings for all terminal units.

1.3.2 In addition to general submittal requirements, shop drawings shall include sound power data in accordance with the following:

1.3.2.1 All sound power data shall be based on tests conducted in accordance with ANSI/AHRI Standard 880-2011 in an AHRI certified laboratory.

1.3.2.2 Sound data shall include both valve and fan simultaneous operation, and fan only operation (for fan powered boxes).

1.3.2.3 Sound power level in decibels (re. 10** - 12w) shall be submitted for octave bands 2 through 7 for both discharge and radiated sound power. The data shall be tabulated for design minimum inlet static pressure, and minimum inlet pressure plus 25mm w.g. (1" w.g.), with fan operating at an external static pressure of 13mm w.g. (½") (for fan powered terminal).

2 **PRODUCTS**

2.1 GENERAL

2.1.1 The Contract Documents are based on selected manufacturer as scheduled or shown in the tender form. If an alternate supplier

from the approved equals list is used, the noise and vibration levels of the alternate product shall be equal to or less than the specified products. Any additional noise attenuation features required to meet the noise and vibration performance of the specified boxes shall be provided by this Division at no additional cost to the Owner.

2.1.2 Terminal units shall be certified under the AHRI Standard 880 Certification Program and carry the AHRI Seal. Noncertified terminals may be submitted after testing at an independent testing laboratory under conditions selected by the engineering consultant in full compliance with AHRI Standard 880. These tests must be witnessed by the engineering consultant with all costs to be borne by the terminal manufacturer. Testing does not ensure acceptance.

2.1.3 All components shall be factory installed, wired, calibrated, and tested by the box manufacturer to ensure a fully functional unit.

2.1.4 Provide a single 120V (208V for fan powered terminals) power wire for connection to adjacent junction box.

2.2 VARIABLE VOLUME TERMINALS

2.2.1 Provide single duct, variable air volume terminals of the sizes and capacities shown in the drawings.

2.2.2 The terminal casing shall be minimum 0.76mm (22-gauge) galvanized steel, internally lined with 12mm (½ inch) dual density insulation which complies with requirements of UL 181 and NFPA 90A. All exposed insulation edges shall be coated with NFPA 90A approved sealant to prevent entrainment of fibers in the airstream. The discharge connection shall be slip and drive construction for attachment to metal ductwork. The casing shall be constructed to hold leakage to the maximum values shown in L/s (cfm) in the below table:

Inlet Size	**dPs, Pa (in wg)**			
	125 (0.5”)	**250 (1”)**	**500 (2”)**	**750 (3”)**
4, 5, 6	0.9 (2)	1.4 (3)	1.8 (4)	2.4 (5)
7, 8	1.8 (4)	2.4 (5)	3.3 (7)	4.2 (9)
9, 10	1.8 (4)	2.8 (6)	3.6 (8)	4.8 (10)

Inlet Size	dPs, Pa (in wg)			
	125 (0.5")	**250 (1")**	**500 (2")**	**750 (3")**
12	2.4 (5)	3.3 (7)	4.8 (10)	5.6 (12)
14	2.8 (6)	4.2 (9)	6.1 (13)	7.2 (16)
16	3.3 (7)	4.8 (10)	6.6 (14)	8.0 (17)

2.2.3 The damper shall be heavy gauge steel with shaft rotating in self-lubricating bearings. Nylon bearings are not acceptable. Shaft shall be clearly marked on the end to indicate damper position. Stickers or other removable markings are not acceptable. The damper shall incorporate a mechanical stop to prevent overstroking and a synthetic seal to limit close-off leakage to the maximum values shown in L/s (cfm) in the below table:

Inlet Size	dPs, Pa (in wg)			
	250 (1")	**500 (2")**	**1,000 (4")**	**1,500 (6")**
4, 5, 6	1.4 (3)	1.8 (4)	2.8 (6)	3.3 (7)
7, 8	1.4 (3)	1.8 (4)	2.8 (6)	3.3 (7)
9, 10	1.4 (3)	1.8 (4)	2.8 (6)	3.3 (7)
12	1.4 (3)	1.8 (4)	2.8 (6)	3.3 (7)
14	1.4 (3)	2.4 (5)	3.3 (7)	3.6 (8)
16	1.8 (4)	2.4 (5)	3.3 (7)	4.2 (9)

2.2.4 Actuators shall be capable of supplying at least 3.9 Nm (35-inch lbs) of torque to the damper shaft and shall be mounted externally for service access. Terminals with internal actuator mounting or linkage connection must include gasketed access panel, removable without disturbing ductwork. Casing with access panel shall be constructed to hold leakage to the maximum values shown in table contained in Subsection 2.2.2 above.

2.2.5 At an inlet velocity of 10.2 m/s (2,000 fpm), the minumum static pressure required to operate any terminal size shall not exceed 32

Pa (0.13 inch w.g.) for the basic terminal.

2.3 CONTROLS

2.3.1 The terminal unit supplier shall provide the airflow sensor, and control transformer.

2.3.2 Actuators, flow transducers, zone sensors, and controllers shall be supplied by the Subcontractor responsible for the controls work under Section 25 11 00 to the terminal unit manufacturer for installation, testing, and calibration by the terminal unit manufacturer at the expense of the terminal unit manufacturer. Refer to Division 25 – Integrated Automation.

2.3.3 Airflow sensor shall be designed to provide a differential pressure signal, which is amplified over the full capacity range of the terminal. Pressure measuring taps shall be provided external to the unit.

2.3.4 Provide all necessary internal control tubing, wiring, and mounting brackets for a complete operating unit.

2.3.5 All control components shall be mounted inside a protective metal shroud provided by the terminal unit manufacturer.

2.3.6 Primary air delivery shall be pressure independent. Room temperature control shall operate satisfactorily at primary supply duct static pressures ranging from 249 to 1245 Pa (1” to 5” w.g.) Maximum and minimum terminal unit volumes shall be factory set and calibrated. Settings shall be field adjustable.

3 **EXECUTION**

3.1 INSTALLATION

3.1.1 Install VAV and FPVAV terminal units in accordance with manufacturer’s recommendations.

3.1.2 Each terminal unit shall be clearly marked with an identification label listing the terminal’s tag number, and minimum and maximum air settings. Coordinate terminal tag number with the Subcontractor responsible for the work of Division 25 - Integrated Automation.

3.1.3 Suspend terminals from slab using threaded rod hangers and angle iron trapeze hangers. Refer to Section 20 05 48 - Vibration Isolation for isolator requirements.

3.1.4 Refer to Section 23 30 13 – Ductwork and Accessories for acoustic lining requirements of downstream ductwork.

END OF SECTION

Project Name: *UNIVERSITY OF TORONTO MISSISSAUGA*
Project No.: *2023-0059*
Section Name: ***Diffusers, Registers and Grilles***
Section No.: ***23 37 13***
Date: *November 15, 2024*

INDEX

1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools equipment, training commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 All supply, return, and exhaust air grilles and diffusers, including all specified ancillaries.

1.3 SUBMITTALS

1.3.1 Provide shop drawings for all registers, grilles, and diffusers.

1.3.2 Shop drawings to indicate dimensions, construction details, finishes and materials, accessories, performance data including throw, pressure drop and sound performance at the specified air flow rates.

1.3.3 Review requirements of outlets as to size, finish, and type of mounting with the Consultant prior to submitting shop drawings and schedules of outlets.

2 **PRODUCTS**

2.1 GENERAL

2.1.1 Air outlet application to be based on required maximum space noise levels. Refer to Section 23 33 19 – Duct Silencers.

2.1.2 Provide baffles to direct air away from walls, columns or other obstructions within the radius of diffuser operation.

2.1.3 Provide plaster frame for diffusers located in plaster and gypsum board surfaces.

2.1.4 Provide anti-smudge frames or plaques on diffusers located in rough textured surfaces such as acoustical plaster.

2.2 REGISTERS, GRILLES AND DIFFUSERS

2.2.1 Refer to the Diffuser and Grille Schedule on Drawings.

3 **EXECUTION**

3.1 AIR OUTLETS (DIFFUSERS, GRILLES AND REGISTERS)

3.1.1 Paint the inside of all duct openings with black flat paint before installing diffusers or registers to it.

3.1.2 Provide sponge rubber gasket around all register frames to ensure an airtight seal against finished wall or ceiling.

3.1.3 Registers and diffusers will be installed in such a manner as to facilitate repeated removals without damaging ceiling or wall construction and finish.

3.1.4 Positions indicated are approximate only. Check location of outlets with the Consultant and make necessary adjustments in position to conform to architectural features, sprinklers, symmetry and lighting arrangement.

3.1.5 Provide diffusers, grilles, and registers as shown on schedule.

3.1.6 On round duct work the angle of duct mounted grilles shall be confirmed with Engineer prior to the start of installation.

END OF SECTION

Project Name: *UNIVERSITY OF TORONTO MISSISSAUGA*
Project No.: *2023-0059*
Section Name: ***Louvers***
Section No.: ***23 37 19***
Date: *November 15, 2024*

INDEX

1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools equipment, training commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 Ductwork connection to louvers. (Louvers provided by others).

1.2.1.2 All prefinished exterior and interior fixed louvers, not provided by the Architectural Division. Exterior exhaust louvres at suites are supplied by window system's manufacturer.

1.2.1.3 Ductwork connection to louvres.

1.3 SUBMITTALS

1.3.1 Provide submittals specified and as required to assess conformance with the Contract Documents, in accordance with the General Conditions.

1.3.2 Shop Drawings:

1.3.2.1 Submit shop drawings for review by Consultant.

1.3.2.2 Show complete layout of all louvres, full details of construction including sill, jamb and head members, structural supports, type and thickness of materials, duct connections, blank-off areas, all dimensions and all other items and accessories for a complete installation.

1.3.3 Samples:

1.3.3.1 Submit duplicate samples of each finish and colour required for Consultant approval.

1.4 DESIGN

1.4.1 Design all members to withstand within acceptable deflection limitations their own weight, and the minimum 138 kPa (20 psi) design load due to the pressure and suction of wind as calculated

in accordance with the Building Code of Ontario, based on a 30-year probability.

1.4.2 Deflection limits for all members - a maximum of 1/175 of the span under design loading. Submit wind load calculations to the Consultant for approval before commencing fabrication.

1.4.3 Design louvres such that an area of 45% minimum of the face area allows free passage of air for standard louvres and 30.9% for acoustical louvres.

1.4.4 Fixed exterior louvres shall be storm-proof type. Fabricate exterior louvres without mullions or reinforcing visible on the outside. Finished appearance shall be that of continuous horizontal blades housed in a rectangular frame. Provide weep holes at 610 mm (24 inches) on centre for drainage to exterior.

1.5 DELIVERY AND STORAGE

1.5.1 Brace units to prevent distortion during shipment and protect finished surfaces by heavy wrappings.

1.5.2 Store in protective wrapping, until required for installation.

2 PRODUCTS

2.1 LOUVERS

2.1.1 Air louvers and birdscreen in outside wall for air intakes and outlets will be provided by Division 23.

2.2 MANUFACTURER AND TYPE

2.2.1 Louver specification is based on louvres as manufactured by Construction Specialties Ltd. Equivalent product manufactured by E.H. Price Limited and Empco are also acceptable provided they meet all design criteria and material standard.

2.2.2 Model numbers quoted are C/S.

2.2.2.1 Exterior Fixed Ventilation Louvres: C/S #4135

2.2.2.2 Interior Fixed Louvres: C/S GS #410

2.3 MATERIALS

2.3.1 Aluminum: Extrusions of aluminum alloy 6063-T5 temper.

2.3.2 Steel: CSA G40.15 galvanized finish.

2.3.3 Fastenings: type 304 stainless steel.

2.3.4 Aluminum Finish: Fluoropolymer Kynar 500 Resin. "Acroflur" by Valspar (2 coat system) or Acrynar by PPG. Colour to be selected by the Consultant.

2.3.5 Bird Screens: Intercrimp, 1.6 mm (1/16") ∅ aluminum wire, 12 mm (1/2") mesh in an extruded aluminum frame, for all exterior active louvres. Screening shall be replaceable within frames.

2.3.6 Insulation: Mineral wool Roxul RXL 40, 90 mm (3.5") thick.

2.3.7 Steel Sheet: 1.90mm (14-ga.) flat galv. steel to ASTM A-446 grade A, G90 coating hot-dip.

2.3.8 Steel Finish: Baked enamel, manufacturers standard. Colour from standard range.

2.4 FABRICATION

2.4.1 Fit and assemble in shop.

2.4.2 Provide for anticipated expansion and contraction of frames and supports at maximum 6.1 m (20 ft) on centre.

2.4.3 Accurately fit elements at intersections and joints, plumb and level.

2.4.4 Isolate dissimilar metals, metal and concrete and metal and masonry with heavy coat of bituminous paint.

2.4.5 Fabricate aluminum frame and sill from minimum 200mm (0.08") thick aluminum extrusions, blades to be 102 mm (4") wide x 3.18 mm (0.125") storm proof type, with reinforcing bosses. Galvanized steel louvres to be fabricated out of 1.32mm (18-ga.) galv. steel sheet, blades to be roll-formed and stepped for max. weather resistance.

2.4.6 Structural supports to be minimum 51 x 51 x 6 mm (2" x 2" x 1/6") galv. steel angles or extruded aluminum tees.

2.4.7 Provide all accessories and other items for a complete installation.

2.4.8 Provide necessary templates and instructions where fastenings or anchors have to be built in by others. Verify dimensions on the site before preparing drawings or proceeding with shop work.

2.4.9 Supply and build in 1.29mm (16-ga.) sheet aluminum flashing at head and sills to prevent entry of moisture into building.

3 **EXECUTION**

3.1 INSTALLATION

3.1.1 This Contractor shall provide insulated galvanized sheet metal blank-offs on all unused sections of the louvers. Blank-off sections shall be a sandwich panel made of 1.3mm (18-gauge) outer skin, 51mm (2") rigid fibreglass insulation, and 1.0mm (20-gauge) inner skin. Panels shall be securely fastened to louvre and caulked airtight.

3.2 EXAMINATION

3.2.1 Examine surfaces to which louvers are to be attached and do not commence installation unless such surfaces are satisfactory.

3.2.2 Commencement of installation will denote acceptance of surfaces.

3.3 INSTALLATION

3.3.1 Installation of louvers by the louver manufacturer's own erection crews.

3.3.2 Install louvers plumb, true and in line. Provide bird screens to active sections of fixed louvers and where free flow-through ventilation is required.

3.3.3 Installed units shall be free of rattle, vibration, and distortion.

3.3.4 Provide and install 51 mm (2”) thick insulated blank-off metal panel to inactive sections of louvers. Match colour of metal to colour of louvers. Panels shall be securely fastened to louvers and caulked airtight.

3.3.5 Install steel louvers to interior of air intake shafts in parking levels, where supply fans are installed. All exterior louvers to be aluminum.

END OF SECTION

Project Name: *UNIVERSITY OF TORONTO MISSISSAUGA*
Project No.: *2023-0059*
Section Name: ***Air Filters***
Section No.: ***23 41 00***
Date: *November 15, 2024*

INDEX

1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools equipment, training commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 Duct mount filters.

1.2.1.2 Bag and flat filters in air handling equipment.

1.3 SUBMITTALS

1.3.1 Provide shop drawings for:

1.3.1.1 All air filters.

1.3.2 As a minimum provide the following information:

1.3.2.1 Product data sheets indicating media type, average filter efficiency, pressure drop at clean and dirty condition.

1.3.2.2 Physical outline dimension drawing showing frame dimensions, required clearances, and weights.

1.4 REGULATIONS

1.4.1 Air filters shall conform to requirements of Class 1 filters in accordance with CAN4-S111.

2 **PRODUCTS**

2.1 AIR FILTERS

2.1.1 Provide filters shown on the Filter Schedule and on the Equipment Schedules on the Drawings. They shall be as manufactured by American Air Filter of Canada Ltd or approved equivalent.

2.1.2 Throw Away Filters shall be Renu-Kleen consisting of 1.3mm (18-gauge) galvanized steel wire grids with rear grid fixed and front grid hinged and equipped with latch mechanism. Filter pad shall

be fibreglass filter media with graduated density, held in place with a thermoplastic bond with each fibre coated with dust holding 'Visosin'.

2.1.3 Bag type Filters shall be high efficiency Dri-Pak. They shall consist of a permanent 1.6mm (16-gauge) galvanized steel holding frame with latches and replaceable cartridge.

2.1.4 Each cartridge shall contain not less than 2.2 sq.m (23.7 sq. ft) of medium area per 0.093 sq.m (1 sq. ft) of face area.

2.1.5 Frames shall permit servicing from clean air side, when no automatic roll pre-filter is provided, or from rear when preceded by automatic roll filter. When no automatic roll prefilter is provided, the holding frame shall be arranged to accommodate Throw Away Filters as specified above. Frames shall be pre-punched to permit ready assembly into filter banks.

2.1.6 Filter media shall be No. 90 having and efficiency of 80-85% based on NBS or AFI dust spot method using atmospheric dust. Initial pressure drop at 2.54 m/s (500 fpm) face velocity shall not exceed 92 Pa (0.37" w.g.) and final 'replace' resistance shall be set at 199 Pa (0.80" w.g.).

2.1.7 Each cell shall be 610mm x 915mm (24" x 36") or 305mm x 915mm (12" x 36") as required to meet the specified face area of each filter bank.

2.1.8 Supply and install across each filter or filter bank, one Airflow Model PL7 'B' pack manometer for wall mounting. Unit shall have steel casing and zero adjustment knob. Scale shall be 127mm (5") long, reading 0mm to 25mm w.g. (0.0 to 1.0" w.g.).

2.1.9 Provide scale markings to indicate pressure drop at which filters are to be replaced.

2.1.10 Provide, for all air handling systems, all necessary filters for start-up, early use, balancing, and commissioning, including temporary blanket filters. Provide separate price for one (1) complete set of new filters on turnover of the equipment to the Owner.

3 EXECUTION

Not used.

END OF SECTION

Project Name: *UNIVERSITY OF TORONTO MISSISSAUGA*
Project No.: *2023-0059*
Section Name: ***Energy Recovery Air Handling Unit***
Section No.: ***23 72 00***
Date: *November 15, 2024*

INDEX

1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 – General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools, equipment, training, commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 Energy recovery air handling units.

1.3 SUBMITTALS

1.3.1 Provide shop drawings for:

1.3.1.1 Energy recovery air handling units.

1.3.2 Shop drawings shall indicate unit dimensions, unit weight, required clearances, wall, door and base construction details, coil rack and drain pan details, isolation base detail, isolator selection, field connection details, damper details, lifting lug details, and trapping requirements for cooling coil condensate.

1.3.3 Product data shall indicate dimensions, weights, capacities, ratings, fan performance, motor electrical characteristics, metal gauges, and finishes of materials.

1.3.4 Provide fan curves with specified operating point clearly plotted.

1.3.5 Submit sound power levels for both fan inlet and outlet at rated capacity. Provide sound power levels at the inlet and outlet of the unit.

1.3.6 Submit product data of filter media, filter performance data, filter assembly, and filter frames.

1.3.7 Submit electrical requirements for power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.

1.3.8 Submit manufacturer's recommended installation instructions.

1.3.9 Provide manufacturer’s certification letter. Refer to Section 20 00

00 – General Requirements.

1.4 QUALITY ASSURANCE

1.4.1 The following shall be used as selection criteria and are to be as specified: Airflow rates, external static pressures, water flow rates. The following shall be equaled or bettered: Coil face velocities, filter face velocities, casing leakage rates. The following shall be met within 10% of specified values: Water pressure drops.

1.4.2 Provide unit produced by a recognized manufacturer who maintains a local service agency and parts stock. Shop manufacture and test all units.

1.4.3 Air handling units and major components shall be products of the manufacturer regularly engaged in production of such equipment.

1.4.4 Fans shall conform to AMCA bulletins regarding testing and construction. (Airfoil fans shall bear the AMCA certified rating seal for airflow and sound).

1.4.5 Coils shall be ARI certified.

1.4.6 Filter media shall be ULC listed.

1.4.7 Unit shall be factory CSA approved.

1.4.8 Fans shall conform to AMCA bulletins regarding testing and construction. Airfoil fans shall bear the AMCA certified rating seal for airflow and sound.

2 **PRODUCTS**

2.1 DESCRIPTION

2.1.1 Provide factory assembled air handling unit in configuration as indicated on the Drawings. Unit shall include all specified components installed at the factory. Field fabrication of units and their components will not be accepted.

2.1.2 The unit shall be designed to be supported by a concrete housekeeping pad.

2.1.3 Units too large to fit on a standard tractor trailer may be shipped to the Site in sections. Otherwise, units shall be shipped in one piece.

2.1.4 Units shall be factory built-up from a continuous structural steel base. Formed metal bases will not be accepted.

2.2 CASING

2.2.1 Walls and roofs shall be constructed of 1.6mm (16-gauge) galvanized steel 50mm (2") thick acoustic thermal panels. The inner liner shall be 0.8mm (22-gauge) perforated galvanized steel. Insulation shall be 50mm (2") thick 72 kg/m^3 (4.5 lb/ft^3) density fibreglass. Provide neoprene liner to seal insulation. All permanently joined flanged panel surfaces shall be sealed with an individual strip of 3mm x 9mm ($^1/_8$" x $^3/_8$") tape sealer. Wall and roof seams shall be turned inward to provide a clean flush exterior finish. All panel seams shall be sealed during assembly to produce an airtight unit.

2.3 INSULATION

2.3.1 All insulation used in air handling unit walls, roof and base shall have a Flame spread rating of 25 and a Smoke Developed rating of 50 per ASTM E84 and UL 723 and Can/ULC S102-M88.

2.3.2 Insulation shall meet NFPA 90A and 90B.

2.4 STRUCTURAL BASE CONSTRUCTION

2.4.1 Units shall be constructed from a minimum C6 x 40 kg/sq.m (8.2 lb/sq.ft) channel structural steel perimeter base, with 50mm x 50mm x 6mm (2" x 2" x ¼") intermediate structural steel channel and angle iron supports. Perimeter structural steel base shall be designed to directly support the weight of the walls. Intermediate structural steel and angle iron shall support the weight of all internal components (i.e. fans, coils, enthalpy wheels, etc.). Maximum base deflection shall be 6mm (¼") on unsupported spans of 4m (13 ft). Structural steel base shall be designed so that it can be point loaded or set on an uneven surface and shimmed by the contractor within 4m (13 ft) spans without deflecting more than 6mm (¼"). The structural steel base shall be either I-beam construction or C-channel (not box channel) so that the base will shed all water. Base shall be provided with lifting lugs, minimum four (4) per shipping split. Formed metal bases formed from sheet metal will not be acceptable. Base shall prevent wall panel joints from separating during lifting, transportation, and rigging.

2.4.2 A 2.7mm (12-gauge) checker plate floor shall be installed on the base. Floor seams shall be continuously welded providing a

completely flat unit floor. Checker plate floor shall be coated with grey epoxy paint. A 38mm (1-½“) perimeter collar shall be provided to ensure the unit is internally watertight. The collar shall be alternately screwed down and tack welded to the unit base on 0.3 m (1 ft) centres. Caulk joint to be watertight. The base shall be insulated with 50mm (2”) thick, 24 kg/m^3 (1.5 lb/ft^3) density fibreglass insulation and sheeted with a 0.8mm (22-gauge) galvanized steel liner. The base liner shall be broken, tack welded and sealed for rigidity and vapour barrier integrity.

2.5 ROOF CURB

2.5.1 A prefabricated heavy gauge galvanized steel, mounting curb shall be provided for field assembly on the roof decking prior to unit shipment. The roof curb shall be a full perimeter type with complete perimeter support of the air handling section and condensing section. The curb shall be a minimum of 24" high and include a nominal 2"×4" wood nailing strip. Gasket shall be provided for field mounting between the unit base and roof curb. The roof curb shall be approved by the National Roofing Contractors Association.

2.5.2 Minimum of 2” (50mm) insulation

2.5.3 Galvanized steel anchor flange extending min 230mm at perimeter, except at upslope side [supply air side in our installation] minimum 450mm flange

2.6 ACCESS DOORS

2.6.1 Access doors shall be 1.6mm (16-gauge) galvanized steel double wall with 0.8mm (22-gauge) perforated galvanized steel liner on the inside. Corners shall be welded for rigidity. 72 kg/m^3 (4.5 lb/ft^3) density insulation shall be sandwiched between the outer and inner skins. A 250mm (10”) round, double pane tempered glass window shall be provided in each door.

2.6.2 Provide two vent lock door latches installed on both sides of door. Provide a continuous stainless steel piano hinge welded to door and casing. Door opening shall be fully gasketed with continuous 12mm (½“) closed cell hollow round black gasket with a metal encapsulated reinforced backing that mechanically fastens to the door opening perimeter. Door frames shall be framed from 1.6mm (16-gauge) galvanized steel with the outside of the door flush to the unit. Minimum door width shall be 610 mm (24“). Door height shall be the maximum permitted by the height of the unit up to 1,830mm (72”).

2.6.3 Doors shall open against positive pressure.

2.7 FANS

2.7.1 Provide fan wheel diameter and class construction as scheduled. Fans must carry the AMCA seal for airflow and sound.

2.7.2 Provide airfoil blades on all fans wheels. Provide forward curved blades where scheduled. Provide solid shafts keyed to the fan wheel. Coat fan shaft with rust inhibitor. Hollow shafts will not be acceptable.

2.7.3 Fan bearings shall be self-aligning pillow block, grease lubricated, extra heavy-duty anti-friction ball or spherical roller type, selected for an L10 life of 80,000 hours at design operating conditions. Bearings are to be mounted on the integral fan scroll bracing.

2.7.4 Fan and motor shall be mounted on an all welded, structural steel, prime coated and internal isolation base with springs. The outlet of the fan shall be separated from the unit casing by means of a factory installed flexible connection. The internally mounted motor shall be provided on a slide rail base to allow proper adjustment of belt tension.

2.7.5 Provide open expanded metal belt guard having sides of galvanized steel and expanded metal face with opening for fan tachometer readings.

2.7.6 Provide fixed pitch sheaves rated at 150% of motor nameplate power. Allow for one (1) drive change for air balancing purposes (parts only, labour by air balancer).

2.7.7 On air handling units with variable speed drives, ensure all casing penetrations for wiring to external VFD are sealed airtight.

2.7.8 Provide plenum fan inlets on the fan wall and air outlets from the casing with a smooth 50mm (2”) radius bell-mouth fitting, free of protruding structural members and flanges.

2.7.9 Provide plenum fans with fully guarded fan wheel.

2.7.10 Inverter duty rated motors shall be supplied with a factory installed shaft grounding kit. The kit shall consist of brushes or conductive rings with micro fibers which divert unwanted shaft currents away from the bearings to the ground.

2.8 VIBRATION ISOLATION

2.8.1 An integral all weld steel vibration isolation base shall be provided for the fan and motor.

2.8.2 Provide open spring mounts with ISO stiff springs, sound deadening pads, and levelling bolts.

2.8.3 Horizontal stiffness shall be equal to vertical stiffness.

2.8.4 Spring deflection shall be 50mm (2).

2.8.5 Isolators shall have earthquake restraints. Upon request, the unit manufacturer shall submit a restraint detail certified by a professional engineer.

2.9 COILS

2.9.1 Coils shall be fully enclosed within casing and mounted on angle frames manufactured to allow coils to be individually removed. Cooling coil frames shall be 2.8mm (12-gauge) 304 stainless steel. Heating coil frames shall be 1.6mm (16-gauge) satin coat steel painted with red oxide primer.

2.9.2 Removable coil access panels shall be provided to remove coils through casing wall. Coil covers shall be double wall construction with all exposed edges of insulation covered with sheet metal including holes through the cover for coil header stub outs. Coils shall be individually removable towards the access side.

2.9.3 All drain pans shall be double wall continuously welded 304 stainless steel. Intermediate drain pans shall be interconnected with stainless steel 25mm (1") down pipes. Condensate drain shall be a minimum DN30 (1-1/4") diameter stainless steel tube extending 25mm (1") out from unit for solder connection to trap. Drain pans shall be sloped within unit and fully drainable.

2.9.4 Coils shall be certified in accordance with ARI Standard 410.

2.9.5 Construction:

2.9.5.1	Tubes	- Horizontal, copper.
2.9.5.2	Fins	- Aluminum mechanically bonded to tubes.
2.9.5.3	Headers connections.	- Seamless copper with vent and drain
2.9.5.4	Casing	- 1.6mm (16-gauge), galvanized steel channels

with 1.6mm (16-gauge) center and end supports.

2.9.5.5 Connections - Same end, counterflow, with vent, drain, supply and return stubs extended to outside of unit casing with grommets for airtight casing.

2.10 PREFILTERS

2.10.1 Prefilters shall be 50mm (2") AM-AIR 300, medium efficiency MERV 6, pleated, disposable type. The filter shall be listed by Underwriters Laboratories as Class 2.

2.10.2 Prefilters shall be installed in a prefabricated channel rack.

2.10.3 Prefilters shall be lift out from upstream access section.

2.11 FINAL FILTERS

2.11.1 Final filters shall be high performance, AAF deep pleated 559mm (22") long bag disposable type. Each filter shall consist of glass fibre media, media support grid, contour stabilizer and enclosing frame.

2.11.2 Final filter media shall be of high-density microfine glass fibres laminated to a non-woven synthetic backing to form a lofted filter blanket. The filter media shall have an average efficiency of MERV 14. The filter shall be listed by Underwriters Laboratories as Class 2.

2.11.3 Holding frames shall be factory fabricated of 1.6mm (16-gauge) galvanized steel and shall be equipped with gaskets and two (2) heavy duty positive sealing fasteners. Each fastener shall be capable of withstanding 100 kgf/sq.m (25 lbf/sq.ft) pressure without deflection. They will be capable of being attached or removed without the use of tools.

2.11.4 Final filters shall be lift out from upstream access section.

2.12 DRAINS

2.12.1 Provide DN30 (1-¼") capped floor drain connections on the side of the unit for complete drainability of the base pan for the following sections:

2.12.1.1 Fresh Air Plenums

2.12.1.2 Humidifier Sections

2.12.1.3 Fan Sections

2.12.1.4 Sections upstream and downstream of coils

2.13 FINISH

2.13.1 Unit shall be finish painted with two component etch bond primer and finish painted with alkyd enamel. All uncoated steel shall be painted with red oxide primer. All metal surfaces shall be prepainted with vinyl wash primer to ensure paint bond to metal.

2.14 LIGHTS

2.14.1 Marine lights with protective cast metal cage and glass globes complete with duplex receptacles shall be installed on the wall across from the access doors. One (1) switch with an indicator light shall be installed on the exterior of the unit. Factory wire from switch to all lights in EMT conduit with liquid tight connections. Electrical power shall be 120V/1/60 by Division 16 - Electrical.

2.15 FILTER GAUGES

2.15.1 Magnehelic gauges shall be accurate to +/- 2% of full range.

2.15.2 Provide sensing probes and shut off valves for each gauge.

2.15.3 Provide one gauge flush mounted into the casing for each filter bank.

2.16 AIRFLOW MEASURING PROBES

2.16.1 Provide on indicated fans, airflow measuring probes capable of continuously monitoring the air volume of the respective scrolled and/or plenum fan.

2.16.2 Each airflow probe shall contain multiple, averaged velocity pressure taps located symmetrically around the throat of the fan inlet and a single static pressure tap located on the fan housing. The entire airflow monitoring probe must be located outside the inlet throat as to not obstruct airflow.

2.16.3 The probes shall be capable of producing steady, non-pulsating signal of the velocity pressure, independent of the upstream static pressure without adversely affecting the performance of the fan. The sensing probes shall be accurate 3% of actual fan airflow.

The fan inlet sensing rings shall be FreeFlo Sensing Ring as manufactured by Haakon Industries Ltd or Air Monitor Voluprobe.

2.17 AIRFLOW DISPLAY

2.17.1 Provide on indicated fans a method of displaying digitally, in real time, the fans current airflow.

2.17.2 The display shall be capable of showing the airflow of two (2) independent fans simultaneously.

2.17.3 For interaction with a controller, the display shall output one (1) 0-10VDC signal for each fan being monitored.

2.17.4 The display shall require no maintenance throughout its life.

2.17.5 The output signal shall be accurate to 8.5% of Natural Span, including non-linearity, hysteresis and non-repeatability.

2.18 ALUMINUM AIRFOIL DAMPERS

2.18.1 Aluminum airfoil frames and blades shall be a minimum of 2.1mm (12-gauge) extruded aluminum. Blades to be 152mm (6") wide single air foil design.

2.18.2 Frames shall be extruded aluminum channel with grooved inserts for vinyl seals. Standard frames 51mm x 102mm x 16mm (2" x 4" x 5/8") on linkage side, 25mm x 102mm x 25mm (1" x 4" x 1") on the other sides.

2.18.3 Pivot rods shall be 11mm (7/16") hexagon extruded aluminum interlocking into blade section. Bearings to be double sealed type with a Celcon inner bearing on a rod within a Polycarbonate outer bearing inserted into frame so that the outer bearing cannot rotate.

2.18.4 Bearing shall be designed so that there are no metal-to-metal or metal-to-bearing riding surfaces. Interconnecting linkage shall have a separate Celcon bearing to eliminate friction in linkage.

2.18.5 Blade linkage hardware is to be installed in frame out of airstream. All hardware to be on non-corrosive reinforced material or cadmium plated steel.

2.18.6 Damper seals shall be designed for minimum air leakage by means of overlapping seals.

2.18.7 Damper blades shall be maximum 1,016mm (40") long per section.

2.18.8 Dampers greater than two (2) sections wide shall be provided with a jackshaft.

2.18.9 Acceptable dampers are: T.A. Morrison "TAMCO series 1000" and "RUSKIN CD-50".

2.19 TEST PORTS

2.19.1 Provide Duro Dyne IP-4 test ports for unit air stream testing in each plenum section between each component within the AHU.

2.20 AIR LEAKAGE TESTING

2.20.1 Unit manufacturer shall factory pressure test each air handling unit to ensure the leakage rate of the casing does not exceed 1.0% of the unit air flow at 1.5 times the rated static pressure.

2.20.2 Test shall be conducted in accordance with SMACNA duct construction manual. A calibrated orifice shall be used to measure leakage airflow.

2.20.3 An officer of the air handling unit manufacturer shall certify test results. Forward copies of certified test results to the consultant.

2.20.4 "Double duct" or "side by side" units shall have each duct or side tested independently.

2.21 FLOOD TESTING

2.21.1 All unit bases shall be flooded to a level of 32mm (1-¼“) after manufacturing to assure no leakage through the floor and the perimeter water barrier. The results of the flood test shall be certified by the manufacturer.

2.22 HEAT WHEEL

2.22.1 Provide rotor media coated to prohibit corrosion: Provide all surfaces coated with a nonmigrating adsorbent specifically developed for the selective transfer of water vapor. Dry particles up to 800 microns shall pass freely through the media. Sensible and latent recovery efficiencies must be clearly documented through a certification program conducted in accordance with ASHRAE 84-78P and ARI 1060 standards. The media shall be cleanable with low temperature steam, hot water, or light detergent without degrading the latent recovery.

2.22.2 Provide the unit with a factory set, field adjustable purge section

designed to limit cross contamination to less than .04 percent of that of the exhaust air stream concentration.

2.22.3 The rotor shall be supplied with labyrinth face seals, which at no time are required to make contact with any rotating surface of the exchanger rotor. These multipass seals shall utilize four labyrinth stages for optimum performance.

2.22.4 Provide the rotor media in a segmented fashion to allow for field erection or replacement of one section at a time without requiring side access. The media shall be rigidly held by a structural spoke system made of extruded aluminum.

2.22.5 The rotor housing shall be a structural framework, which limits the deflection of the rotor due to air pressure loss to less than 0.8mm ($^{1}/_{32}$"). The housing sheet metal shall be made of galvanized steel to prevent corrosion. The housing structural framework shall be of tubular construction painted with epoxy paint.

2.22.6 The rotor shall be supported by two pillow block bearings, which can be maintained or replaced without the removal of the rotor from its casing or the media from its spoke system.

2.22.7 The rotor shall be driven by a self-adjusting belt system. Provide an A/C motor with internal overload protection for variable speed applications.

2.22.8 Variable speed control shall be accomplished by the use of an A/C inverter. Provide a speed adjustment pot mounted on the front of the enclosure. The Motor and drive system must allow for a turndown ratio of 80:1 (20 rpm to 1/4 rpm; 60 Hz to 1 Hz).

2.22.9 The BAS shall interface to the variable frequency drive to control rotational speed of the wheel via a 4-20 mA signal. All temperature sensors shall be provided as part of the work of Division 25 – Integrated Automation. Wheel manufacturer shall provide a control sequence to the Subcontractor responsible for the work of Division 25 for normal supply air control and for frost prevention control.

2.23 <u>ELECTRICAL</u>

2.23.1 Factory wire and test all air handling units. Have units approved by CSA or ETLc.

2.23.2 All line voltage wiring contained within the fan chamber or in any area requiring maintenance work shall be contained in liquid tight

flex complete with connectors.

2.23.3 Supply one (1), 575 V/60 Hz/3 Ph junction box for each motor complete with wiring from the junction box to the motor. Wire from the motors to the junction box in accordance with the local electrical code and contained by EMT conduit with liquid tight connections. Seal the casing penetrations in a manner that eliminates air leaks.

3 EXECUTION

3.1 INSTALLATION

3.1.1 Install units on a flat surface level on 100mm (4") housekeeping pad within 6mm (¼") and of sufficient strength to support the units.

3.1.2 Provide components furnished as per manufacturer's literature.

3.1.3 Provide piping connections to coils such that individual coils can be isolated, drained, and removed. Provide valved pressure gauge connections and thermometer wells on the entering and leaving piping.

3.1.4 Provide valves in water piping upstream and downstream of each coil for isolating the coils for maintenance, and to balance and trim the system.

3.1.5 Provide drain valves with hose end connection, cap, chain, and vent cocks to each coil.

3.1.6 Provide strainers ahead of all pumps and automatic modulating valves.

3.1.7 Field power wiring shall be provided under Division 26 - Electrical. Provide certified wiring schematics to Division 26 – Electrical for associated equipment.

3.1.8 Field control wiring shall be provided as part of the work of Division 25 – Integrated Automation. Provide certified control wiring schematics to the Subcontractor responsible for the work of Division 25.

3.1.9 Provide condensate traps in accordance with manufacturers recommendations. Pipe all drain pan connections the nearest floor drain with appropriately sized trap.

3.1.10 Before starting up any fans inspect and clean the inside of all air

handling systems including fans, ducts, coils, and terminal units to ensure that they are completely free from dust and debris.

END OF SECTION

INDEX

1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements shall apply to and govern this section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools equipment, training commissioning and certification required to complete the work as shown on the drawings and specified herein, including:

1.2.1.1 Split type A/C units.

1.2.1.2 Variable refrigerant volume A/C system.

1.3 SUBMITTALS

1.3.1 Provide shop drawings for split-system air conditioning systems.

1.3.2 As a minimum provide the following information:

1.3.2.1 Complete specifications.

1.3.2.2 Product data sheets indicating rated capacities, weight, and sound power levels.

1.3.2.3 Refrigerant piping diagram showing all required components (filter-drier, sightglass, traps, etc.) for split system.

1.3.2.4 Power and control wiring diagrams.

1.3.2.5 Physical outline dimension drawing showing required clearances, weights, and location and size of connection entries.

1.3.3 Provide manufacturer's certification letter. Refer to Section 20 00 00 – General Requirements.

2 **PRODUCTS**

2.1 SPLIT TYPE A/C UNITS

2.1.1 General

2.1.1.1 The split air conditioning system shall consist of a wall mounted packaged evaporator section and matching outdoor unit.

2.1.1.2 The units shall be made within North America. The units shall be listed by Intertek Testing Service (ITS) and bear the ETL label. All wiring shall be in accordance with the National Electrical Code (N.E.C.). The units shall be rated in accordance with ARI Standard 210/240 and bear the ARI label. The units shall be manufactured in a facility certified to ISO 9001.

2.1.1.3 The condensing unit shall contain an R-410 refrigerant charge for the evaporator section and condenser section. System SEER shall meet or exceed requirements of the ASHRAE 90.1 latest edition.

2.1.2 Warranty

2.1.2.1 The units shall have a manufacturer's warranty for a period of one (1) year from date of installation. The compressor shall have a warranty of five (5) years from date of installation. If, during this period, any part should fail to function properly due to defects in workmanship or material, it shall be replaced or repaired at the discretion of the manufacturer.

2.1.2.2 This warranty does not include labor.

2.1.3 Indoor Unit

2.1.3.1 The indoor unit shall be factory assembled and wired. The cabinet shall be fabricated of galvannealed steel, finished in "offwhite" with corrosion inhibiting polyester powder-coated paint.

2.1.3.2 The evaporator fans shall be a forward curve centrifugal type, dynamically balanced and directly mounted to the motor shafts. The motors shall be PSC type with internal thermal overload protection. The supply louvers shall be dual adjustable for airflow direction. Return air shall be filtered by means of an easily removable electrostatic washable filter. The indoor unit shall have fresh air capability thru the top and back of the unit.

2.1.3.3 The evaporator coil shall be on nonferrous construction with louvered fins bonded to rifled copper tubing. The tubing shall have inner grooves for high efficiency heat exchange. All tube joints shall be brazed with phoscopper or silver alloy. The coil shall be pressure tested at the factory. A condensate pan and drain shall be provided under the coil.

2.1.3.4 System refrigerant flow shall be controlled by means of an orifice piston in the indoor unit.

2.1.3.5 The unit electrical power shall be 208/230 volts, 1 phase, 60 hertz. The system shall be capable of satisfactory operation within voltage limits of 208/230 +/- 10% volts.

2.1.4 Control System

2.1.4.1 The control system shall consist of 24V wall thermostat control with anti-short cycle compressor protection; fan purge. Fan shall remain on for 60 seconds after heat/cool call is dropped for improved efficiency. An integral heating relay ensures that the fan operates whenever electric heat is energized.

2.1.4.2 Wiring shall run from indoor unit to the 24V wall thermostat and to outdoor unit. When running low voltage wiring a double insulated wire should be used. The control voltage between the indoor unit and the outdoor unit shall be 24 Volts A.C. The 24 Volts shall be generated from the outdoor unit 24-Volt 40VA transformer.

2.1.5 Outdoor Unit

2.1.5.1 The outdoor unit shall be completely factory assembled, piped, wired and contain a low voltage transformer. The cabinet shall be fabricated of G60 galvannealed steel, finished in “off-white” with corrosion inhibiting polyester powder-coated paint.

2.1.5.2 The unit shall be furnished with one (1) direct drive, propeller type fan arranged for horizontal discharge. The motor shall have inherent protection, be of the permanently lubricated type, and resiliently mounted for quiet operation. The fan shall be provided with a guard to prevent contact with moving parts. The compressor shall be of the high-performance reciprocating type with a thermal overload. The compressor shall be mounted so as to avoid the transmission of vibration.

2.1.5.3 The refrigeration system shall be equipped with a high pressure switch and have the capability to operate with a maximum height difference of 10.7m (35 feet) and overall refrigerant tubing length of 30.5m (100 feet) between indoor and outdoor sections without the need for line size changes or additional oil. The condenser coil shall be of nonferrous construction with louvered fins bonded to rifled copper tubing.

2.1.5.4 The unit shall be controlled by an electronic circuit board located in the indoor matching unit. The unit electrical power shall be 208/230 Volts, 1 phase, 60 hertz. The system shall be capable of satisfactory operation within voltage limits of 208/230 volts +/- 10%.

2.1.6 Startup Service

2.1.6.1 Furnish the services of factory-trained representatives to supervise the installation, starting and testing in accordance with the manufacturer's instructions. Upon completion of the installation, the manufacturer shall provide, to the owner, a written report on the start-up of these units.

2.2 VARIABLE REFRIGERANT VOLUME A/C SYSTEM

2.2.1 General

2.2.1.1 The units shall be listed by Electrical Laboratories (ETL) and bear the cETL label.

2.2.1.2 All wiring shall be in accordance with the National Electric Code (NEC).

2.2.1.3 The system will be produced in an ISO 9001 and ISO 14001 facility, which are standards set by the International Standard Organization (ISO). The system shall be factory tested for safety and function.

2.2.2 System Description

2.2.2.1 The variable capacity air conditioning system shall be a Daikin Variable Refrigerant Volume Series (heat / cool) split system as specified. The system shall consist of multiple evaporators, REFNET™ joints and headers, branch selector boxes (for heat recovery systems), a two or three pipe refrigeration distribution system using PID control, and Daikin VRV® condensing unit. The condensing unit is a direct expansion (DX), air cooled heat recovery, multi-zone air-conditioning system with variable speed inverter driven compressors using R-410A refrigerant. Outdoor air cooled condensing units may have a total connected indoor evaporator capacity of up to 130% of the rated outdoor condensing unit capacity with VRV-S systems and 200% with VRV-III systems.

2.2.2.2 Condensing unit shall be interconnected to indoor unit models that range in capacity from 7,500 Btu/h to 96,000 Btu/h. Each indoor unit or group of indoor units shall be independently controlled.

2.2.2.3 Operation of the system shall permit either individual cooling or heating of each indoor unit simultaneously, or all of the indoor units associated with one branch cool/heat selector box (with heat recovery systems). Each indoor unit or group of indoor units shall

be able to satisfy their set temperature independently via a local remote controller, or a centralized controller.

2.2.3 Refrigerant Piping

2.2.3.1 Y style piping joints and headers provided by the manufacturer shall be used to ensure proper refrigerant balance and flow for optimum system capacity and performance. T style joints and/or joints provided by the installing contractor shall not be acceptable.

2.2.4 Fan Coils

2.2.4.1 Daikin units shall be designed for R-410A refrigerant, and be equipped with an electronic expansion valve.

2.2.4.2 Computerized PID control shall be used to control superheat to deliver a comfortable room temperature condition. The unit shall be equipped with a programmed drying mechanism that dehumidifies while inhibiting changes in room temperature when used with Daikin remote control BRC1E71 and BRC2A71.

2.2.4.3 Indoor units shall be completely factory assembled and tested. Internal unit components shall be factory wired and piped, and complete with electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, condensate drain pan, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch.

2.2.4.4 All refrigerant pipes shall be charged with dehydrated air prior to shipment from the factory.

2.2.4.5 Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.

2.2.5 FXFQ / FXZQ – 4 WAY CEILING CASSETTE UNIT shall be designed for installation into the ceiling cavity and shall be equipped with an ivory white panel.

2.2.5.1 Unit shall provide up to four-way air distribution via motorized louvers which can be horizontally and vertically adjusted from 0° to 90°.

2.2.5.2 Cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation. Units sound pressure shall range from 28 dB(A) to 33 dB(A) at low speed measured at 5 feet below the unit.

2.2.5.3 Return air shall be through the concentric panel, which shall include a washable, resin net mold resistant filter. Return air thermistor shall be mounted inside concentric opening.

2.2.5.4 Units shall be provided with condensate drain pumps suitable for 21 inches of lift. Pump shall be located below the coil in the condensate pan with a built in safety alarm.

2.2.5.5 Units shall be supplied with an optional fresh air intake opening.

2.2.5.6 Units shall be provided with a remote “in-room” sensor kit for field installation. Sensor shall detect the room temperature at a remote location away from the indoor unit.

2.2.6 FX-DQ/MQ – CONCEALED CEILING DUCTED UNIT shall be designed for ceiling concealed installation and shall be supplied with a horizontal discharge air connection. A return air thermistor shall be mounted inside the return air opening.

2.2.6.1 FXDQ units shall have a maximum height of 7-7/8" and be designed to fit in tight ceiling plenums.

2.2.6.2 Standard filter shall be mold resistant, washable for FXDQ models. Filters for FXMQ fan coils are to be field supplied and installed in the ductwork by others.

2.2.6.3 Units shall be provided with a drain pump kit suitable for 18 to 23 inches of lift. Pump shall be located below the coil in the condensate pan with a built in safety alarm.

2.2.6.4 Cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation. Medium static units shall have a sound pressure range of 41 dB(A) to 45 dB(A). FXDQ units sound pressure level shall range from 29 dB(A) to 32 dB(A) at low speed and 33 dB(A) to 36 dB(A) at high speed 5 feet below the suction grille.

2.2.6.5 The fan shall be a direct-drive Sirocco type fan, with a statically and dynamically balanced impeller, with high and low fan speeds settings.

2.2.6.6 Units shall be provided with a remote “in-room” sensor kit for field installation. Sensor shall detect the room temperature at a remote location away from the indoor unit.

2.2.7 Condensing Unit

2.2.7.1 The unit shall be constructed from rust-proofed mild steel panels coated with a baked enamel finish. The unit shall be modular in design and shall allow for side-by-side installation with minimum spacing requirements.

2.2.7.2 Units shall be factory assembled and pre-wired with all necessary electronic and refrigerant controls. The refrigeration circuit of the condensing unit shall consist of Daikin scroll compressors, motors and fans (with air cooled units), condenser, electronic expansion valves, solenoid valves, 4-way valve, distribution headers, capillaries, filters, shut off valves, oil separators, service ports and refrigerant regulator.

2.2.7.3 The system shall automatically restart operation after a power failure and will not cause any settings to be lost, thus eliminating the need for reprogramming.

2.2.7.4 The unit shall incorporate an auto-charging feature and a refrigerant charge check function.

2.2.7.5 To ensure the liquid refrigerant does not flash when supplying to the various fan coil units, the circuit shall be provided with a sub-cooling feature.

2.2.7.6 The Daikin inverter scroll compressors (semi-hermetic) shall be variable speed (PAM inverter) controlled which are capable of changing speed to follow the variations in total cooling and heating load as determined by the suction gas pressure as measured in the condensing unit. In addition, samplings of evaporator and condenser temperatures shall be made so that the high/low pressures detected are read every 20 seconds and calculated. With each reading, the compressor capacity shall be controlled to eliminate deviation from target value.

2.2.7.7 Neodymium magnets shall be adopted in the rotor construction to yield a higher torque and efficiency in the compressor instead of the normal ferrite magnet type. At complete stop of the compressor, the neodymium magnets will position the rotor into the optimum position for a low torque start.

2.2.7.8 The following safety devices shall be included in the condensing unit; high pressure switch, control circuit fuses, crankcase heaters, fusible plug, high pressure switch, overload relay, inverter overload protector, thermal protectors for compressors and motors, over current protection for the inverter and anti-recycling timers.

2.2.7.9 Oil separators shall be standard with the equipment together with an intelligent oil management system. Oil recovery cycle shall be automatic occurring 2 hours after start of operation and then every 8 hours of operation.

2.2.7.10 In the case of multiple condenser modules, conjoined operation hours of the compressors shall be balanced by means of the Duty Cycling Function, ensuring sequential starting of each module at each start/stop cycle, completion of oil return, completion of defrost or every 8 hours.

2.2.7.11 The outdoor unit shall be capable of heating operation at -4°F dry bulb ambient temperature without additional low ambient controls. The system shall continue to provide heat to the indoor units in heating operation while in the defrost mode.

2.2.7.12 The fan motor shall have inherent protection and permanently lubricated bearings. The motor shall be provided with a fan guard to prevent contact with moving parts. The condensing unit shall consist of one or more propeller type, direct-drive 350 and 750 W fan motors that have multiple speed operation via a DC (digitally commutating) inverter. Motors shall be capable of delivering design air at high external static pressures up to 0.32 in WG (factory set as standard at 0.12 in. WG) to accommodate field applied duct for indoor mounting of condensing units.

2.2.7.13 Night setback control of the fan motor for low noise operation by way of automatically limiting the maximum speed shall be a standard feature.

2.2.7.14 Units sized 8-12 ton shall contain a minimum of 2 compressors, 14-20 ton units shall contain a minimum of 4 compressors. In the event of compressor failure the remaining compressors shall continue to operate and provide heating or cooling as required at a proportionally reduced capacity. The microprocessor and associated controls shall be designed to specifically address this condition.

2.2.7.15 The heat exchanger on the condensing units shall be manufactured from Hi-X seamless copper tube with N-shape internal grooves mechanically bonded on to aluminum fins to an e-Pass Design. The fins are to be covered with an anti- corrosion acrylic resin and hydrophilic film type E1.

2.2.8 Branch Selector Box (For Heat Recovery System)

2.2.8.1 Branch selector boxes shall be located as shown on the drawing. Selector box cabinets shall have a galvanized steel plate casing and shall house multiple refrigeration control valves, a liquid gas separator and a tube in tube heat exchanger. The unit shall contain sound absorption thermal insulating material made of flame and heat resistant foamed polyethylene.

2.2.8.2 The branch selector box shall also contain the required electronics to facilitate communications between the main processor and between the indoor units. The use of EEV's will ensure continuous heating during defrost (with air cooled systems), and have no heating impact during changeover modes. Use of multi-port branch selector boxes shall not be acceptable.

2.2.9 Controls

2.2.9.1 Fan coil units shall be supplied with Individual Zone Controllers, similar to Daikin model BRC1E71

2.2.9.2 Remote controllers shall be hard wired by installing contractor.

2.2.9.3 Controllers shall be able to function as follows:

2.2.9.3.1 The controller shall have a maximum wiring length of 1,640 feet.

2.2.9.3.2 The controller shall have a self diagnosis function that constantly monitors the system for malfunctions (total of 80 components).

2.2.9.3.3 The controller shall be able to immediately display fault location and condition.

2.2.9.3.4 An LCD digital display will allow the temperature to be set in 1°F units.

2.2.9.3.5 The controller shall be equipped with a thermostat sensor in the remote controller making possible more comfortable room temperature control.

2.2.9.3.6 The controller shall monitor room temperature and preset temperature by microcomputer and can select cool/heat operation mode automatically (REYQ heat recovery outdoor unit only).

2.2.9.3.7 The controller shall have a 48 hour clock / calendar backup.

2.2.9.3.8 Controller shall have built-in schedule timer

2.2.9.3.9 Select fan coils shall be provided with a field installed auxiliary heat

zone control adapter. Adapter shall have contacts for field connection of a remote 24V AC control relay. Wire the relay to a remote hot water radiator control valve for second stage heating. Relay, hot water control valve and wiring is to be provided under this Section, by the installing contractor.

2.2.10 Electrical

2.2.10.1 The power supply to the condensing unit shall be as scheduled.

2.2.10.2 Electrical power for branch selector boxes (where specified) shall be 208/230 volts, 1 phase, 60 hertz. The unit shall be capable of operation within the limits of 187 volts to 253 volts. The minimum circuit amps (MCA) shall be 0.1 and the maximum fuse amps (MFA) shall be 15.

2.2.10.3 The control voltage between the indoor and outdoor unit shall be 16VDC non-shielded 2 conductor cable.

2.2.10.4 The control wiring shall be a two-wire multiplex transmission system, making it possible to connect multiple indoor units to one outdoor unit with one 2-cable wire, thus simplifying the wiring operation.

3 EXECUTION

3.1 GENERAL

3.1.1 Install all units neat and level following manufacturer's instructions.

3.1.2 Install evaporator and condenser units using hanger kit and rubber isolators provided by unit supplier.

3.1.3 Install refrigerant piping between evaporator and condenser sections. Size piping as directed by unit's design manual. Refer to Sections 23 23 00 – Refrigerant Piping and 20 07 00 – Mechanical Insulation.

3.1.4 Provide all piping so unit and circuits are serviceable, without having to dismantle excessive lengths of pipe.

3.1.5 Field power wiring shall be provided by Division 26 - Electrical. Provide certified wiring schematics to Division 26 - Electrical for associated equipment.

3.1.6 Field control wiring shall be provided under Division 25 – Integrated Automation. Provide certified control wiring schematics

to Division 25 – Integrated Automation.

3.2 VARIABLE REFRIGERANT VOLUME A/C SYSTEM

3.2.1.1 The system must be installed by a factory trained contractor/dealer. Install all equipment as per manufacturer's recommendation.

3.2.2 For ceiling hung installations, provide a reinforced steel framework to adequately support all unit sections.

3.2.3 High/low pressure gas line, liquid and suction lines must be individually insulated between the outdoor and indoor units.

3.2.3.1 Control wiring shall be installed in a daisy chain configuration from indoor unit to indoor unit then to the branch selector box and outdoor unit. Control wiring shall run from the indoor unit terminal block to the specific controller for that unit.

END OF SECTION

Project Name: *UNIVERSITY OF TORONTO MISSISSAUGA*
Project No.: *2023-0059*
Section Name: ***Electric Heaters***
Section No.: ***23 83 33***
Date: *November 15, 2024*

INDEX

1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 – General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide electric heaters as indicated on the drawings and specified herein.

1.3 ELECTRICAL EQUIPMENT AND WORK

1.3.1 Read together with Division 26 – Electrical and adhere to its requirements. Supply and install all electrical apparatus, which is required and is not covered by Division 26 – Electrical.

1.4 SHOP DRAWINGS

1.4.1 Submit shop drawings for the following product:

1.4.1.1 Electric Heating Coils.

1.4.1.2 Electric Cabinet Heaters.

1.4.1.3 Electric Unit Heaters.

1.4.1.4 Electric Baseboard Heaters.

2 **PRODUCTS**

2.1 ELECTRIC HEATING COILS (DUCT HEATERS)

2.1.1 Coils shall be prewired, CSA approved, finned tubular type, heavy duty flanged construction and be complete with terminal box, and inlet and discharge screens.

2.1.2 Coils shall be complete with pressure differential switch, disconnect switch, control transformer, automatic reset thermal cutouts, fused control circuit, contactors if required, and SCR controller.

2.1.3 Provide and wire low voltage interlocking wiring to air supply fan, to ensure coils cannot be energized until supply fan is running. Coil to be controlled duct mount thermostat.

2.1.4 See equipment schedules for capacities and power characteristics.

2.2 ELECTRIC CABINET HEATERS

2.2.1 CSA approved heavy gauge, galvanized, baked enamel steel enclosure, resilient mounted fans and motor, open coil heating elements with protecting screen both faces, replaceable filters.

2.2.2 Integral grilles on surfaces and recessed units. Built-in thermostat.

2.2.3 Duct collars on inlet and outlet of ceiling mounted units. Remote thermostat. Mounting brackets.

2.2.4 Contactors, high limit switches, step-down transformers and isolating disconnect switches.

2.2.5 Three speed fan selector switch built in to unit.

2.2.6 Thermal protected motor, manual reset, with pre-lubricated sealed bearings.

2.3 ELECTRIC UNIT HEATERS

2.3.1 CSA approved heavy gauge galvanized, baked enamel steel enclosure, resilient mounted motor and propeller fan, and finned heating elements.

2.3.2 Directional louvers and fan guard.

2.3.3 Contactors high limit switches. Control transformers, disconnect switches, line voltage thermostat.

2.3.4 Thermally protected, manual reset motor with pre-lubricated sealed bearings.

2.3.5 Wall or ceiling mounted brackets as required.

2.4 ELECTRIC BASEBOARD HEATERS

2.4.1 Standard enclosure, remote low voltage thermostat, and high limit cutout.

3 **EXECUTION**

3.1 GENERAL

3.1.1 Install heaters in accordance with manufacturer's

recommendations.

END OF SECTION

DIVISION 25 – INTEGRATED AUTOMATION

SPECIFICATIONS

FOR THE

UNIVERSITY OF TORONTO MISSISSAUGA

PRE-ENGINEERED BUILDING

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DISCIPLINES
MECHANICAL
ELECTRICAL
FIRE PROTECTION
LIGHTING DESIGN
COMMUNICATIONS & AV
SECURITY & RISK
COMMISSIONING
ENERGY SERVICES

Our Project No. 2023-0059

SEAL:

November 15, 2024

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1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 – General Requirements shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide a Building Automation System (BAS) utilizing Distributed Digital Control (DDC) to serve new mechanical and associated systems as described on the drawings and in this specification.

1.2.2 Provide all labour, materials, Products, equipment, and services to supply, install, and commission the electronic control and monitoring system with electronic actuation as specified in Specification Division 25 – Integrated Automation.

1.2.3 Provide all computer hardware and software, operator input/output communication devices, communication units, a communication interface to digital system controllers, field sensors, and controls as required to meet the specified performance.

1.2.4 Provide all labour, including calibration, commissioning, software programming and data base generation, generation of colour graphics and additional work necessary to provide a complete and fully operating system.

1.2.5 Provide all necessary wiring for fully complete and functional control system as specified in the Contract Documents.

1.3 GENERAL SYSTEM REQUIREMENTS

1.3.1 Provide a single architecture common data base microprocessor based electronic control and monitoring BAS system for air handling equipment, heating and cooling and other specified systems employing distributed processing and direct digital control (DDC) with electronic sensing and electronic actuation to conform with the specification requirements. The BAS shall consist of the following:

1.3.1.1 Stand-Alone DDC Controllers

1.3.1.2 Application Specific Controllers

1.3.1.3 Personal computer operator workstation. All workstations shall be capable of connecting to the UTM network.

1.3.1.4 The system shall comply with the UTM BAS Requirements indicated in Appendix A

1.3.2 The system shall be modular in nature and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, DDC Controllers, Application Specific Controllers, and operator devices.

1.3.3 The BAS shall be designed and implemented entirely for use and operation on the Internet and the Owner's Intranet. This functionality for operational access shall extend down to the field panel and field point level.

1.3.4 The primary Controls Application Nodes (AN) shall be fully IT compatible nodes operating over the industry standard IT infrastructure provided for the Project. The Subcontractor responsible for the work of Division 25 (BAS Contractor) shall coordinate with the IT infrastructure support staff or Subcontractors to ensure compatibility and performance of the operation of the BAS over the LAN/WAN made available for its shared use. If the Owner's LAN/WAN is not made available at time of commissioning, this Division shall supply an independent network cabling system for this Division's communication.

1.3.5 The Controls Systems Tier 1 network shall be configured on IT industry standard off-the-shelf technologies compatible with other building systems and Project network arrangements.

1.3.6 All aspects of the Controls Systems Operator Interface shall be provided to operate through an IT industry standard Web Browsers such as Internet Explorer, Firefox, Chrome or Opera.

1.3.7 The Web Browser based Operator Interface provided shall incorporate complete tool sets, operational information displays, multi-Window displays and other interactive aids to assist interpretation and ease of use. Simple HTML based web page displays are not acceptable.

1.3.8 The Web Browser based Operator Interface provided shall not require the procurement or licensing of any special or proprietary software from the BAS Contractor or its suppliers for the Controls Systems OWS.

1.3.9 As required for the functional operation of the Controls Systems, the BAS Contractor shall provide all necessary digital processor programmable Server(s). These Server(s) shall be utilized for

Controls Systems Application configuration, for archiving, reporting and trending of data, for Operator transaction archiving and reporting, for network information management, for alarm annunciation, for Operator Interface tasks, for Controls Application management and the like. These Server(s) shall utilize IT industry standard data base platforms such as Microsoft SQL Server and Microsoft Data Engine (MSDE) or approved equal.

1.3.10 Provide a fully distributed processing, on-line, real-time, direct digital control Controls Systems Application in compliance with all applicable codes and as approved by the Authorities Having Jurisdiction (AHJ) at the Site. All communication between Controls Application Nodes shall be digital only.

1.3.11 All Controls Systems Application facilities and features shall be accessible via Enterprise Intranet and Internet Browser with user ID or Password access control for user access.

1.3.12 The Controls Systems Application shall support auto-dial/auto-answer communications to allow Controls Systems Nodes to communicate with other remote Controls Systems Nodes via standard telephone lines. The lines shall be provided by the Owner at the Owner's cost.

1.3.13 The Controls Systems Application network shall utilize an open architecture capable of each and all of the following:

1.3.13.1 Utilizing standard Ethernet communications and operate at a minimum speed of 100 Mb/sec.

1.3.13.2 Connecting via BACnet at the Tier 1 level in accordance with ANSI/ASHRAE Standard 135-2001.

1.3.13.3 Connecting via LonMark as per ANSI/EIA 709 (LonWorks) to LonMark FTT-10 transceivers at the Tier 2 level.

1.3.13.4 Connecting via manufacturer specific Protocol at the Tier 2 level. (i.e. Johnson Controls N2).

1.3.14 Downloading and Uploading

1.3.14.1 Provide the capability to generate and modify the Controls Systems Application software-based sequences, database elements, associated operational definition information, and user-required revisions to same at any designated Workstation together with the means to download same to the associated Controls

Systems Application Node.

1.3.14.2 The Controls Systems Application software tool provided for the generation of custom and database definitions shall be resident in both the Controls Systems Application Node and Controls Systems Application Server(s).

1.3.14.3 Provide the capability to upload Controls Systems Application operating software information, database items, sequences, and alarms to designated Server(s).

1.3.14.4 The functions of this Part shall be governed by the codes, approvals, and regulations applying to this Controls Systems Application as provided.

1.3.15 System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. Each DDC Controller shall operate independently by performing its own specified control, alarm management, operator I/O and data collection. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.

1.3.16 DDC Controllers shall be able to access any data from, or send control commands and alarm reports directly to, any other DDC Controller or combination of controllers on the network without dependence upon a central processing device. DDC Controllers shall also be able to send alarm reports to multiple operator workstations without dependence upon a central processing device.

1.3.17 Provide English language operator interface using readily understood English language abbreviations and mnemonics.

1.3.18 Future buildings must have the ability to communicate to this building using the BACNet Protocol. The successful Controls Contractor shall provide a PICS (Protocol Implementation Conformance Statement) for the BACNet Gateway. (Minimum conformance of Class 4). The intent is to ensure that existing and future buildings using alternate manufacturers will be able to integrate to this building.

1.4 SYSTEM PERFORMANCE

1.4.1 The system shall conform to the following:

1.4.1.1 Graphic Display. The system shall be dashboard based, and also capable of displaying a graphic with 20 dynamic points/objects with all current data within 10 seconds.

1.4.1.2 Graphic Refresh. The system shall update a graphic with 20 dynamic points/objects with all current data within 8 seconds.

1.4.1.3 Object Command. The maximum time between the command of a binary object by the operator and the reaction by the device shall be less than 2 seconds. Analog objects should start to adjust within 2 seconds.

1.4.1.4 Object Scan. All changes of state and change of analog values will be transmitted over the high-speed Ethernet network such that any data used or displayed at a controller or workstation will have been current within the previous 2 seconds.

1.4.1.5 Alarm Response Time. The maximum time from when an object goes into alarm to when it is annunciated at the workstation shall not exceed 45 seconds.

1.4.1.6 Program Execution Frequency. Custom and standard applications shall be capable of running as often as once every 1 second. The Contractor shall be responsible for selecting execution times consistent with the mechanical process under control.

1.4.1.7 Performance. Programmable controllers shall be able to execute DDC PID control loops at a frequency of at least once per second. The controller shall scan and update the process value and output generated by this calculation at this same frequency.

1.4.1.8 Multiple Alarm Annunciation. All workstations on the network must receive alarms within 5 seconds of each other.

1.4.1.9 Reporting Accuracy. The system shall report all values with an end-to-end accuracy as listed or better than those listed in the below table.

Measured Variable	**Reported Accuracy**
Space Temperature	±0.5ºC [±1ºF]
Ducted Air	±0.5ºC [±1ºF
Outside Air	±1.0ºC [±2ºF]
Dewpoint	±1.5ºC [±3ºF]
Water Temperature	±0.5ºC [±1ºF]
Delta-T	±0.15ºC[±0.25ºF]

Measured Variable	**Reported Accuracy**
Relative Humidity	±5% RH
Water Flow	±5% of full scale
Airflow (terminal)	±10% of full scale *(see Note*
Airflow (measuring stations)	±5% of full scale
Air Pressure (ducts)	±25 Pa [±0.1 "W.G.]
Air Pressure (space)	±3 Pa [±0.01 "W.G.]
Water Pressure	±2% of full scale *(see Note*
Electrical (A, V, W, Power factor)	5% of reading *(see Note 3)*
Carbon Monoxide (CO)	±5% of reading
Carbon Dioxide (CO_2)	±50 ppm
Note 1: 10%-100% of scale	
Note 2: For both absolute and differential	
Note 3: Not including utility-supplied meters	

1.4.1.10 Energy Reporting. The operating software shall have as standard, dashboard widgets which can be selected by the operator to create individual interface points as well as multi-trend graphics as standard.

1.4.1.11 Stability of Control. Control loops shall maintain measured variable at setpoint within the tolerances listed in the below table.

Controlled Variable	**Control Accuracy**	**Range of Medium**
Air Pressure	±50 Pa [±0.2" w.g.] ±3 Pa [±0.01" w.g.]	0-1.5 kPa [0-6" w.g.] -25 to 25 Pa [-0.1 to 0.1" w.g.]
Airflow	±10% of full scale	
Temperature	±0.5ºC [±1.0ºF]	
Humidity	±5% RH	
Fluid Pressure	±10 kPa [±1.5 psi]	0-1 kPa [1-150 psi]
Pressure Differential	±250 Pa [±1.0" w.g.]	0-12.5 kPa [0-50"w.g.]

1.5 COMMUNICATION

1.5.1 All control products provided for this project shall comprise a BACnet internetwork. Communication involving control components (i.e., all types of controllers and Operator Workstations) shall conform to ANSI/ASHRAE Standard 135-2004, BACnet.

1.5.2 Each BACnet device shall operate on the BACnet Data Link/Physical layer protocol specified for that device as defined in this Section.

1.5.3 The Contractor shall provide all communication media, connectors, repeaters, bridges, hubs, switches, and routers necessary for the internetwork.

1.5.4 All controllers shall have a communication port for connections with the Operator Workstations using the BACnet Data Link/ Physical layer protocol.

1.5.5 Communication services over the internetwork shall result in operator interface and value passing that is transparent to the internetwork architecture as follows:

1.5.6 Connection of an Operator Workstation device to any one controller on the internetwork will allow the operator to interface with all other controllers as if that interface were directly connected to the other controllers. Data, status information, reports, system software, custom programs, etc., for all controllers shall be available for viewing and editing from any one controller on the internetwork.

1.5.7 All database values (e.g., objects, software variables, custom program variables) of any one controller shall be readable by any other controller on the internetwork. This value passing shall be automatically performed by a controller when a reference to an object name not located in that controller is entered into the controller's database. An operator/installer shall not be required to set up any communication services to perform internetwork value passing.

1.5.8 The time clocks in all applicable controllers shall be automatically synchronized daily. An operator change to the time clock in any controller shall be automatically broadcast to all controllers on the network.

1.5.9 The network shall have the following minimum capacity for future expansion:

1.5.9.1 Each Building Controller shall have routing capacity for 99 controllers.

1.5.9.2 The Building Controller network shall have capacity for 1000 Building Controllers.

1.5.9.3 The system shall have an overall capacity for 12,500 Building Controller, Advanced Application Controller, and Application Specific Controller input/output objects.

1.6 QUALITY ASSURANCE

1.6.1 All labour, material, equipment and software not specifically referred to herein or on the plans, but are required to meet the functional intent, shall be provided without additional cost to the Owner.

1.6.2 Materials and equipment shall be the catalogue products of a single manufacturer regularly engaged in production and installation of automatic temperature control systems and shall be manufacturer's latest standard design that complies with the specification requirements. Products referenced under this Section establish the minimum acceptable standards of the Product features, quality, and performance.

1.6.3 The BAS Contractors shall be manufacturers or licensed factory representatives and installers of the manufacturers, specified for the local area in which the Site is located.

1.6.4 The installing Subcontractor shall have an established working relationship with the Control System Manufacturer.

1.6.5 The installing Subcontractor shall have successfully completed Control System Manufacturer's classes on the control system. The installing Subcontractor shall present for review the certification of completed training, including the hours of instruction and course outlines upon request.

1.6.6 All products used in this installation shall be new, currently under manufacture, and shall be applied in standard off the shelf products. This installation shall not be used as a test site for any new products unless explicitly approved by the Owner or Consultant in writing. Spare parts shall be available for at least 5 years after completion of this Contract.

1.6.7 The BAS Contractor shall have single source responsibility for the

complete installation and proper operation of the DDC control system and BAS, including debugging and proper calibration of each component in the entire system.

1.6.8 During the initial design the Owner will supply the BAS Contractor a range of BACnet addresses the BAS will run on. The BAS network will run either BACnet over IP or BACnet over MSTP. All BAS points will be network visible so that other BACnet systems can auto discover them. The Contractor shall consult with the Owner during the development of addresses.

1.6.9 The BAS shall be compatible with future control Products for 10 years or more.

1.6.10 Include all software, associated licensing, upgrades, and labour/materials for two (2) years from the date of the Total Performance of the Work.

1.7 REFERENCE STANDARDS

1.7.1 All work, materials, and equipment shall comply with the rules and regulations of all codes and ordinances of the local, provincial, and federal authorities. Such codes, when more restrictive, shall take precedence over these plans and Specifications.

1.7.2 Provide electrical and electronic equipment which is CSA approved where such approval is required by the regulatory authorities.

1.7.3 Provide ASCII American Standard for Communication and Information Interchange code input/output devices with standard EIA Electronic Industry Association interface.

1.8 SUBMITTALS

1.8.1 The Contractor shall provide shop drawings or other submittals on all hardware, software, and installation to be provided. No work may begin on any segment of this project until submittals have been reviewed and approved for conformity with the design intent. All drawings shall be done in DXF or pdf format and provided on magnetic/optical disk and as full-size drawings. When manufacturer's cut sheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Each submitted piece of literature and drawings shall clearly reference the specification and/or drawing that the submittal is to cover. General catalogs shall not be accepted as cut sheets to fulfill submittal

requirements. Submittals shall include:

1.8.1.1 A complete bill of materials of equipment to be used shall be listed indicating quantity, manufacturer, model number, and other relevant technical data.

1.8.1.2 Manufacturer's description and technical data, such as performance curves, product specification sheets, and installation/maintenance instructions for each system component.

1.8.1.3 Wiring diagrams and layouts for each control panel. Show all termination numbers.

1.8.1.4 A schematic diagram for all control wiring, communication wiring and power wiring shall be provided. Provide a schematic drawing of the central system installation. Label all cables and ports with computer manufacturers' model numbers, function and data link protocol(s). Show all interface wiring to the control system.

1.8.1.5 Schematic diagrams for all field sensors and controllers. Provide floor plans of all sensor locations and control hardware on the BAS graphics as it relates to the equipment being controlled.

1.8.1.6 Provide detailed riser diagrams of wiring between central control unit, operator workstation(s), routers, gateways and all control panels.

1.8.1.7 Examples of the color graphic dashboard screens shall be provided. Provide 3 screen shots from 5 existing projects representing various systems. For each screen, provide a conceptual layout of pictures and data, and show or explain which other screens can be directly accessed.

1.8.1.8 A schematic diagram of each controlled system. The schematics shall have all control points/objects labeled and with point/object names shown or listed. The schematics shall graphically show the location of all control elements in the system.

1.8.1.9 A complete control points list.

1.8.1.10 An instrumentation list for each controlled system. Each element of the controlled system shall be listed in table format. The table shall show element name, type of device, manufacturer, model number, and product data sheet number.

1.8.1.11 A complete description of the operation of the control system,

including sequences of operation. The description shall include and reference a schematic diagram of the controlled system.

1.8.1.12 A point/object list for each system controller including inputs and outputs (I/O), point/object number, the controlled device associated with the I/O point/object, and the location of the I/O device. Software flag points/objects, alarm points/objects, etc.

1.8.1.13 A BACnet Protocol Implementation Conformance Statement (PICS) for each type of controller and Operator Workstation included in the submittal. PICS shall include for each Product, as a minimum, a list of BACnet functional groups supported, BACnet services supported, BACnet data link options available and BACnet objects provided.

1.8.1.14 Point-to-point verification check sheets once completed.

1.8.2 Upon completion of the Work, provide a complete set of 'as-built' drawings, application software and layout colour graphics on compact disc. Drawings shall be provided as AutoCAD™ compatible files. Two complete sets of hard copies are also to be provided to the Owner.

1.9 OWNERSHIP OF PROPRIETARY MATERIAL

1.9.1 All project-developed software and documentation shall become the property of the Owner. These include, but are not limited to:

1.9.1.1 Project graphic images

1.9.1.2 Record drawings

1.9.1.3 Project database

1.9.1.4 Project-specific application programming code

1.9.1.5 All documentation

2 **PRODUCTS**

Not used.

3 **EXECUTION**

3.1 BAS DEMONSTRATION

3.1.1 All BAS Demonstration shall take place on the main Control

Systems Server and WAN. Schedule to add system to main Control Systems Server and WAN with Owner at least two (2) weeks in advance to the demonstration. At the time of request, provide all documentation that the following criterions are met:

3.1.1.1 Updated BAS submittals in electronic and hard copy to the Owner including the updated riser diagram for the system.

3.1.1.2 Reports on verification of Network Layout Verification including but not limited to Building Controller locations, cable routes with length of cable between controllers and any trunk extenders or trunk isolators.

3.1.1.3 Reports on verification of electrical characteristics of BAS network, communications and electrical integrity of Building Controllers.

3.1.1.4 Reports on verification of traffic on BAS Network including but not limited to COVs between Building Controllers, point commands by the operator, point commands by program across the network, alarm reporting on the network, any unresolved points in the system, integrity of the ports on any Building Controller isolator/extender and results of Building Controller tests running at selected baud rate.

3.1.1.5 Demonstrate to the Owner the updates of databases without errors or faults between the temporary Control Systems Server and Building Controllers. If there is no temporary server, demonstrate to Owner after system is added to main Control Systems Server.

3.1.1.6 Reports on verification of system log files, interruption of log files of system traffic and overall acceptable operation of the system where a temporary Control Systems Server is utilized.

3.1.2 Demonstrate the operation of the BAS hardware, software, and all related components and systems to the satisfaction of the Owner. Schedule the demonstration with the Owner seven (7) calendar days in advance. Demonstration shall not be scheduled until all hardware and software submittals, and the Start-Up Test Report are approved. If the Work fails to conform to the Contract Documents, and additional Site visits by the Owner are to be scheduled for re-demonstration, the Contractor shall reimburse the Owner for costs of subsequent Site visits.

3.1.3 The Contractor shall supply all personnel and equipment for the demonstration, including, but not limited to instruments, ladders, etc. The Contractor-supplied personnel must be competent with

and knowledgeable of all project-specific hardware, software, and the HVAC systems. All training documentation and submittals shall be at the Site.

3.1.4 Demonstration shall typically involve small representative samples of systems/equipment randomly selected by the Owner.

3.1.5 The system shall be demonstrated following the same procedures used in the Start-Up Test by using the approved checklists. Demonstration shall include, but not necessarily be limited to, the following:

3.1.5.1 Demonstrate that required software is installed on BAS workstations. Demonstrate that graphic screens, alarms, trends, and reports are installed as submitted and approved.

3.1.5.2 Demonstrate that points specified and shown can be interrogated and/or commanded (as applicable) from all workstations, as specified in the Contract Documents.

3.1.5.3 Demonstrate that remote dial-up communication abilities are in accordance with these Specifications.

3.1.5.4 Demonstrate correct calibration of input/output devices using the same methods specified for the Start-Up Tests. A maximum of 10 percent of I/O points shall be selected at random by the Owner for demonstration. Upon failure of any device to meet the specified end-to-end accuracy, an additional 10 percent of I/O points shall be selected at random by the Owner for demonstration. This process shall be repeated until 100 percent of randomly selected I/O points have been demonstrated to meet specified end-to-end accuracy.

3.1.5.5 Demonstrate that all DDC and other software programs exist at respective field panels. The Direct Digital Control (DDC) programming and point database shall be as submitted and approved.

3.1.5.6 Demonstrate that all DDC programs accomplish the specified sequence of operation.

3.1.5.7 Demonstrate that the panels and DDC network of panels automatically recover from power failures within five (5) minutes after power is restored.

3.1.5.8 Demonstrate that the stand-alone operation of panels meets the requirements of these Specifications. Demonstrate that the panels'

response to LAN communication failures meets the requirements of these Specifications.

3.1.5.9 Identify access to equipment selected by the Owner. Demonstrate that access is sufficient to perform required maintenance.

3.1.5.10 Demonstrate that required trend graphs and trend logs are set up per the requirements. Provide a sample of the data archive. Indicate the file names and locations.

3.1.6 BAS Demonstration shall be completed and approved prior to the Substantial Performance of the Work.

3.1.7 Any tests successfully completed during the demonstration will be recorded as passed for the functional performance testing and will not have to be retested.

3.2 <u>BAS ACCEPTANCE PERIOD</u>

3.2.1 After approval of the BAS Demonstration and prior to Total Performance of the Work, Acceptance Period shall commence. Acceptance Period shall not be scheduled until all HVAC systems are in operation and have been accepted, all required cleaning and lubrication has been completed (i.e., filters changed, piping flushed, strainers cleaned, and the like), and TAB report has been submitted and approved. Acceptance Period and its approval will be performed on a system-by-system basis if mutually agreed upon by the Contractor and the Owner.

3.2.2 Operational Test: At the beginning of the Acceptance Period, the system shall operate properly for set period as agreed with the Owner without malfunction, without alarm caused by control action or device failure, and with smooth and stable control of systems and equipment in conformance with these Specifications. At the end of this period, the Contractor shall forward the trend logs to the Owner for review. The Owner shall determine if the system is ready for functional performance testing and document any problems requiring the Contractor’s attention.

3.2.2.1 If the systems are not ready for functional performance testing, the Contractor shall correct problems and provide notification to the Owner that all problems have been corrected. The Acceptance Period shall be restarted at a mutually scheduled time for an additional period.

3.2.2.2 This process shall be repeated until Owner issues notice that the

BAS is ready for functional performance testing.

3.2.3 During the Acceptance Period, the Contractor shall maintain a hard copy log of all alarms generated by the BAS. For each alarm received, the Contractor shall diagnose the cause of the alarm, and shall list on the log for each alarm, the diagnosed cause of the alarm, and the corrective action taken. If in the Contractor's opinion, the cause of the alarm is not the responsibility of the Contractor, the Contractor shall immediately notify the Owner.

3.2.4 Once 5 consecutive days of alarm-free operation are complete and documented, operator training may begin.

3.3 TRAINING

3.3.1 Upon completion of the work and prior to the Substantial Performance of the Work, the Owner's operating and maintenance personnel shall be given complete instructions on the operation and maintenance of the complete system. Include a description of the information flow from field sensors, contacts and devices to the ASCs. Give an overview of the system's communication network to provide a better understanding to the operator of the interplay between initiating devices, field hardware panels, system communications, and their importance within the operating BAS.

3.3.2 An Owner's manual prepared for this project by BAS Contractor shall be used in conjunction with the training. Two copies of the Owner's manual shall be provided.

3.3.3 During system commissioning and at such time as acceptable performance of the BAS hardware and software has been established, the BAS Contractor shall provide on-site operator instruction to the owner's operating personnel. Operator instruction shall take place during normal working hours and shall be performed by a competent representative of the BAS Contractor, familiar with the BAS software, hardware, and accessories.

3.3.4 The Subcontractor responsible for the work of Division 25 shall give instruction to the Owner's designated personnel on the operation of all equipment within the central equipment center and describe its intended use with respect to the programmed functions specified. Operator orientation of the BAS shall include, but not be limited to, the overall operational program, equipment functions (both individually and as part of the total integrated system), commands, system generation, advisories, and appropriate operator intervention required in responding to the system's

operation.

3.4 WARRANTY

3.4.1 Labor and materials for the control system specified shall be warranted free from defects for a period of 12 months after final completion and acceptance. Control system failures during the warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to the Owner. The Contractor shall respond to the Owner's request for warranty service within 24 hours during normal business hours.

3.4.2 All work shall have a single warranty date, even when the Owner has received beneficial use due to an early system start-up. If the work specified is split into multiple contracts or a multi-phase contract, then each contract or phase shall have a separate warranty start date and period.

3.4.3 At the end of the final start-up, testing, and commissioning phase, if equipment and systems are operating satisfactorily to the Owner, the Owner will sign certificates certifying that the control system's operation has been tested and accepted in accordance with the terms of this specification. The date of acceptance shall be the start of warranty.

3.4.4 Operator workstation software, project-specific software, graphic software, database software, and firmware updates which resolve known software deficiencies as identified by the Contractor shall be provided at no charge during the warranty period. Any upgrades or functional enhancements associated with the above mentioned items also can be provided during the warranty period for an additional charge to the Owner by purchasing an in-warranty technical support agreement from the Contractor. Written authorization by the Owner must, however, be granted prior to the installation of any of the above-mentioned items.

3.4.5 The control contractor shall have in place the capability to monitor the operation of the system on a 24-hour basis.

3.4.6 Parts, which have a wear-out characteristic, such as printer ink cartridges, etc., shall not be counted as failures within the terms of this warranty, if they fail or become worn out beyond their stated life expectancy.

3.5 WARRANTY PHASE BAS OPPOSITE SEASON TRENDING AND TESTING

3.5.1 Throughout the warranty phase, trend logs shall be maintained. The Contractor shall forward archive trend logs to the Owner for review upon the Owner's request. The Owner will review these and notify the Contractor of any warranty work required.

3.5.2 Within twelve (12) months of the Substantial Performance of the Work, the Contractor shall schedule and conduct with the Owner an opposite season functional performance testing. The BAS Contractor shall participate in this testing and remedy any deficiencies identified.

3.6 BAS COMMISSIONING

3.6.1 Refer to Section 20 08 00 - Commissioning.

3.7 CONTROL STRATEGIES

3.7.1 Refer to Section 25 90 00 – Sequences of Operation for control sequences and to the associated control schematics on the Drawings for the required number of control loops. Provide all hardware and software necessary to achieve specified control. The sequence of events required for each control loop is described for each system in the control sequence.

END OF SECTION

INDEX

1 **GENERAL**

1.1 GENERAL

1.1.1 Sections 20 00 00 and 25 00 00 – General Requirements shall apply to and govern this Section.

1.1.2 Conform to the requirements of Section 26 00 00 - General Electrical Requirements.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools, equipment, training, commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 Pneumatic Tubing.

1.2.1.2 Wiring.

1.2.1.3 Control Valves and Actuators.

1.2.1.4 Control Dampers and Actuators.

1.2.1.5 Control Panels.

1.2.1.6 Sensors.

1.2.1.7 Pneumatic Control Components (Gauges, Switches, Relays, etc.).

1.2.1.8 Electric Control Components (Switches, EP Valves, Thermostats, Relays, etc.).

1.2.1.9 Transducers.

1.2.1.10 Current Switches.

1.2.1.11 Nameplates.

1.2.1.12 Testing Equipment.

1.2.2 Provide the following electrical work as part of the work of this Section, complying with requirements of Division 26 – Electrical and the requirements of this Section.

1.2.2.1 Control wiring between field-installed controls, indicating devices, and unit control panels in this Section, and as specified in other

Sections of this Division and under Divisions 20, 21, 22 and 23.

1.2.2.2 Interlock wiring between electrically interlocked devices, sensors, and between a hand or auto position of motor starters as indicated for all mechanical and controls.

1.2.2.3 Wiring associated with annunciator and alarm panels (remote alarm panels) and connections to their associated field devices.

1.2.2.4 Power wiring to field panels and other devices requiring a main supply from circuit breakers provided by Division 26 – Electrical in local emergency power and emergency lighting panels.

1.2.2.5 All other necessary wiring for fully complete and functional control system as specified in the Contract Documents.

1.3 ELECTRICAL WIRING

1.3.1 All wiring shall be in accordance with the latest edition of the Ontario Electrical Safety Code and Division 26 - Electrical. This includes wiring between control components and wiring from such components to electrical circuits of fans, pumps, and any other equipment.

1.3.2 Electrical interlock wiring of field devices (i.e., flow switches, thermostats) associated with equipment specified under other Sections of Division 25 and under Divisions 21, 22 and 23 is the responsibility of this Section, unless indicated otherwise in the Contract Documents.

1.4 CO-ORDINATION OF WORKS

1.4.1 The BAS Contractor shall design, provide, install, test, commission, and guarantee the system.

1.4.2 Provide all control devices, instrumentation, relays, auxiliary contacts, and transformers as specified in the Contract Documents and as required to meet the control and monitoring points and sequence of operation.

1.4.3 Extend control wiring requiring interfacing to systems by Division 26 – Electrical (i.e. fire alarm system, diesel generator control panel, etc.) to respective panel for termination by Division 26 - Electrical.

1.4.4 Dampers

1.4.4.1 Manual balancing dampers, fire dampers, combination fire/smoke dampers and back draft dampers are provided as part of the work of their respective Divisions.

1.4.5 Smoke dampers shall be supplied as part of the work of this Division and installed under Division 23 - HVAC. The BAS Contractor shall provide and connect all associated damper actuators and damper position sensor devices.

1.4.5.1 The BAS Contractor shall supply all remaining automatic control dampers not integral part of equipment specified elsewhere in Division 23. These dampers are to be installed as part of the work of Division 23 – HVAC under the direction of the BAS Contractor who will be fully responsible for the proper operation of the dampers. The BAS Contractor shall provide and connect all associated damper actuators.

1.4.5.2 The BAS Contractor shall provide and connect all damper actuators for dampers specified as an integral part of equipment specified elsewhere in the Contract Documents.

1.4.6 Automatic Control Valves

1.4.6.1 The BAS Contractor shall supply all automatic control valves required by the sequences of operation and not integral part of equipment specified elsewhere in Divisions 22 and 23. These valves are to be installed as part of the work of Division 22 – Plumbing and Division 23 – HVAC, under the direction of the BAS Contractor who will be fully responsible for the proper operation of the valves. The BAS Contractor shall provide and connect all associated valve actuators.

1.4.7 VAV and CAV Controls

1.4.7.1 Supply all actuators, flow transducers, and controllers to VAV/CAV terminal unit manufacturer for installation by the terminal unit manufacturer at the expense of the terminal unit manufacturer. Refer to Section 23 36 00 - Air Terminal Units.

1.4.8 Work by other sections

1.4.8.1 The following equipment is supplied by the BAS Contractor, installed under Division 22 and 23, and connected by the BAS Contractor.

1.4.8.1.1 Air flow measuring stations

1.4.8.1.2 Water pressure sensors

1.4.8.1.3 Water pressure taps, thermal wells, flow switches, flow meters, etc. that will have wet surfaces, shall be installed under the applicable piping Section under the direction of the BAS Contractor who will be fully responsible for the proper installation and application.

1.4.8.2 Division 26 - Electrical shall provide:

1.4.8.2.1 120-volt AC 15 amp dedicated emergency power circuits for power to the Building Automation System, including all mechanical rooms and control panels.

1.4.8.2.2 Termination at fire alarm system, diesel generator control panel, etc.

1.4.8.3 All other installation work required for the complete installation of the Building Automation System shall be provided by the BAS Contractor.

1.4.8.4 The BAS Contractor shall co-ordinate the control work involving Divisions 20, 21, 22, 23 and 26 - Electrical.

1.5 SUBMITTALS

1.5.1 Provide shop drawings for:

1.5.1.1 Control Valves and Actuators.

1.5.1.2 Control Dampers and Actuators.

1.5.1.3 Control Panels.

1.5.1.4 Sensors.

1.5.1.5 Pneumatic Control Components (Gauges, Switches, Relays, etc.).

1.5.1.6 Electric Control Components (Switches, EP Valves, Thermostats, Relays, etc.).

1.5.1.7 Transducers.

1.5.1.8 Current Switches.

1.5.1.9 Testing Equipment.

2 **PRODUCTS**

2.1 GENERAL

2.1.1 All materials shall meet or exceed all applicable referenced standards, and conform to codes and ordinances of authorities having jurisdiction.

2.1.2 Provide electronic, pneumatic, and electric control products in sizes and capacities indicated, consisting of valves, dampers, controllers, sensors, and other components as required for complete installation. Except as otherwise indicated in the Contract Documents, provide manufacturer's standard materials and components as published in their product information; designed and constructed as recommended by manufacturer, and as required for application indicated.

2.2 INSTRUMENT PIPE AND TUBE

2.2.1 Hydronic and instruments:

2.2.1.1 Connection to main piping: Provide 15mm (½ inch) minimum size threadolet, 15mm x 50mm (½ inch x 2 inch) brass nipple, and 15mm (½ inch) ball valve for connection to welded steel piping. Provide tee fitting for other types of piping.

2.2.1.2 Remote instruments: Adapt from ball valve to specified tubing and extend to remote instruments. Provide a union or otherwise removable fitting at ball valve so that connection to main can be cleaned with straight rod. Where manifolds with test ports are not provided for instrument, provide tees with 6mm (¼ inch) FPT branch with plug for use as test port. Adapt from tubing size to instrument connection.

2.2.1.3 Line mounted instruments: Extend rigid piping from ball valve to instrument. Do not use close or running thread nipples. Adapt from ball valve outlet to instrument connection size. Provide a plugged tee if pipe makes 90 degree bend at outlet of valve to allow cleaning of connection to main with straight rod without removing instrument.

2.2.1.4 Instrument tubing: Seamless copper tubing, Type K or L, ASTM B 88; with cast-bronze solder joint fittings, ANSI B1.18; or wrought-copper solder-joint fittings, ANSI B16.22; or brass compression-type fittings. Solder shall be 95/5 tin antimony, or other suitable lead free composition solder. Tubing outside diameter size shall be not less than the larger of 6mm (¼ inch) or the instrument connection size.

2.2.1.5 Rigid piping for line mounted instruments: Schedule 40 threaded brass, with threaded brass fittings.

2.2.2 Low pressure air instrument sensing lines:

2.2.2.1 Connections: Use suitable bulkhead type fitting and static sensing tip for static pressure connections. Adapt tubing to instrument connection.

2.2.2.2 Tubing: Virgin polyethylene non-metallic tubing type FR, ASTM D 2737, with flame-retardant harness for multiple tubing. Use compression or push-on brass fittings.

2.3 WIRING

2.3.1 Communication Wiring:

2.3.1.1 Communication wiring shall be provided in a customized color jacketing material. Material color shall be as submitted and approved by the Owner. In addition, all wiring jackets shall be labeled “BAS” in three (3) foot or fewer intervals along the length of the jacket material. An example is provided below:

Purpose	Function	Color	Label
Building Level	Communication	Orange	BAS Building Level Communication
Floor level	Communication	Blue	BAS Floor Level Communication
Inputs/Outputs	Panel to device	White	BAS Input Output Device Cable
24VAC	Control power	White/Black tracer	BAS 24 VAC Control Power

2.3.1.2 The BAS Contractor shall supply all communication wiring between Building Controllers, Routers, Gateways, AAC’s, ASC’s and local and remote peripherals (e.g., operator workstations, printers, and modems).

2.3.1.3 Local Supervisory LAN: For any portions of this network required under this Section of the Specification, the BAS Contractor shall use multimode fiber (62.5 micron) or Category 5E cable per

TIA/EIA 68 (10BaseT). Network shall be run with no splices and separate from any wiring over 30V.

2.3.1.4 Primary and Secondary Controller LANs: Communication wiring shall be individually 100% shielded pairs per manufacturer's recommendations for distances installed, with overall PVC cover, Class 2, plenum-rated run with no splices and separate from any wiring over 30V. Shield shall be terminated and wiring shall be grounded as recommended by building controller manufacturer.

2.3.2 Signal Wiring:

2.3.2.1 Signal wiring to all field devices, including, but not limited to, all sensors, transducers, transmitters, switches, etc. shall be twisted, 100% shielded pair, minimum 18-gage wire, with PVC cover. Signal wiring shall be run with no splices and separate from any wiring above 30V.

2.3.2.2 Signal wiring shield shall be grounded at controller end only unless otherwise recommended by the controller manufacturer.

2.3.3 Low Voltage Analog Output Wiring:

2.3.3.1 Low voltage control wiring shall be minimum 18-gage, twisted pair, 100% shielded, with PVC cover, Class 2 plenum-rated. Low voltage control wiring shall be run with no splices separate from any wiring above 30V.

2.3.4 Control Panels:

2.3.4.1 Provide control panels with suitable brackets for wall mounting, unless noted otherwise, for each control system. Locate panel adjacent to systems served. Mount center of control panels 1,524mm (60 inches) above finished floor or roof.

2.3.4.2 Interior mount: Fabricate panels of 0.0625mm (16-gauge) furniture-grade steel, totally enclosed on four sides, with removable perforated backplane, hinged door and keyed lock, with manufacturer's standard shop-painted finish and color.

2.3.4.3 Exterior mount: 0.0625mm (16-gauge) 304 or 316 stainless steel NEMA 4X enclosure. Panel shall have hinged door, keyed lock, and integral, thermostatically controlled heater. Provide hinged deadfront inside panel when flush-mounted control and/or indicating devices are included in panel. Fiberglass or aluminum, as applicable, to be used when gases that are being used in the

panel area are corrosive to stainless steel.

2.3.4.4 Provide UL-listed cabinets for use with line voltage devices.

2.3.4.5 Control panel shall be completely factory wired and piped, and all electrical connections made to a terminal strip.

2.3.4.6 All gauges and control components shall be identified by means of nameplates.

2.3.4.7 All control tubing and wiring shall be run neatly and orderly in open slot wiring duct with cover.

2.3.4.8 Provide a 150mm x 150mm (6” x 6”) minimum wireway (metal wiring/tubing) trough across the entire width of the panel mounted to the top of the panel with close nipples of sufficient size for additional 50% wiring and tubing capacity. Wireways shall not be less than 610mm (24”) in length. Control panel wiring shall be installed and distributed in the wireway to minimize routing of wiring and tubing within the control panel. Wireway construction to be the same as the associated control panel.

2.3.4.9 Complete wiring and tubing termination drawings shall be mounted in, and a second set mounted adjacent to, each panel in a frame with Lexan cover of sufficient size to be easily readable.

2.4 AUTOMATIC CONTROL DAMPERS

2.4.1 Provide factory fabricated automatic control dampers of sizes, velocity and pressure classes as required for smooth, stable, and controllable airflow. For dampers located near fan outlets, provide dampers rated for fan outlet velocity and close-off pressure, and recommended by damper manufacturer for fan discharge damper service. Control dampers used for smoke dampers shall comply with UL 555S. Control dampers used for fire dampers shall comply with UL 555.

2.4.2 Supply control dampers with a leakage rate of less than 15 L/s / m^2 (3 cfm/sq. ft.) at 249 Pa (1" w.g.) static pressure difference.

2.4.3 Use opposed blade type dampers for modulating service. Dampers for two position service, face and bypass and mixing may be parallel blade type.

2.4.4 Construct aluminum airfoil blades of minimum 2.0mm (12-gauge) extruded aluminum. Blades to be 150mm (6") wide single air foil

design.

2.4.5 Construct damper frames of extruded aluminum channel with grooved inserts for vinyl seals. Standard frames are 50mm x 100mm x 15mm (2" x 4" x 5/8") on linkage side, and 25mm x 100mm x 25mm (1" x 4" x 1") on the other sides.

2.4.6 Provide 22mm (7/8") hexagon extruded aluminum pivot rods that interlock into the blade section. Bearings to be double sealed type with a Celcon inner bearing on a rod within a Polycarbonate outer bearing inserted into frame so that the outer bearing cannot rotate.

2.4.7 Design the bearing to prevent metal-to-metal or metal-to-bearing riding surfaces. Interconnecting linkage shall have a separate Celcon bearing to eliminate friction in linkage.

2.4.8 Blade linkage hardware is to be installed in a frame out of the air stream. All hardware to be made of non-corrosive reinforced material or cadmium plated steel.

2.4.9 Supply overlapping damper seals that minimize air leakage.

2.4.10 Insulate all dampers in direct contact with outside air with 22mm (7/8") thick polyurethane foam. Blade construction must provide a 100% thermal break. Insulate frame with polystyrene.

2.4.11 Maximum allowable damper blade length is 1016mm (40") per section.

2.4.12 Provide dampers greater than two sections wide with a jackshaft.

2.4.13 Acceptable dampers are: T. A. MORRISON (TAMCO) 1000 / 9000 and RUSKIN CD-50 / CD-2000.

2.5 STANDARD SERVICE CONTROL VALVES

2.5.1 Control valve sizing and selection is the responsibility of the BAS Contractor. Provide a valve schedule that lists the requirements of the valves for Cv, close off, temperature, etc. This should be a result of analyzing the valves performance across the range of control.

2.5.2 Valves to be factory fabricated of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated in the Contract Documents.

2.5.3 Control valves shall be equipped with heavy-duty actuators, selected to proper close-off rating for each individual application.

2.5.4 Minimum close-off rating shall be considered at dead head rating of the pump.

2.5.5 The control valve assembly shall be provided and delivered from a single manufacturer as a complete assembly.

2.5.6 Characterized Control Valves

2.5.6.1 50mm (2”) and smaller: nickel-plated forged brass body rated at 2,758 kPa (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. 20mm (¾”) and smaller for terminal units: nickel plated forged brass body rated at 4,137 kPa (600 psi), chrome plated brass 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.

2.5.6.2 65mm (2-1/2”) through 80mm (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 package design, PTFE seats, and a stainless steel flow characterizing disc.

2.5.7 Plug-Type Globe Pattern for Water Service:

2.5.7.1 Where not specifically indicated in the Contract Documents, modulating valves shall be sized for maximum full flow pressure drop between 50% and 100% of the branch circuit it is controlling unless scheduled otherwise. Two-position valves shall be same size as connecting piping or size using a pressure differential of 6.9 kPa (1 psi).

2.5.7.2 Single Seated (Two-way) Valves: Valves shall have equal-percentage characteristic for typical heat exchanger service and linear characteristic for building loop connections unless otherwise scheduled on the drawings. Valves shall have cage-type trim, providing seating and guiding surfaces for plug on ‘top-and-bottom’ guided plugs.

2.5.7.3 Double Seated (Three-way) Valves: Valves shall have linear characteristic. Valves shall be balanced-plug type, with cage-type trim providing seating and guiding surfaces on ‘top-and-bottom’

guided plugs.

2.5.7.4 Two- and Three-Way Modulating: twice the load pressure drop, but not more than 34.5 kPa (5 psig).

2.5.7.5 50mm (2”) and smaller: ANSI Class 250 bronze body, stainless steel stem, brass plug, bronze seat, and a TFE packing.

2.5.7.6 65mm (2-1/2”) and larger: ANSI Class 125 or 250 as applicable, cast iron body, stainless steel stem, bronze plug, bronze seat, and a TFE V-ring packing.

2.5.7.7 Two- and three-way globe valves shall be used only if characterized control valves do not fit the sizing criteria or application.

2.5.8 Plug-Type Globe Pattern for Steam Service:

2.5.8.1 Two-Position: line size or sized using 10% of inlet gauge pressure.

2.5.8.2 Modulating: 103 kPa (15 psig) or less: inlet steam pressure, the pressure drop shall be 80% of inlet gauge pressure. Higher than 103 kPa (15 psig) inlet steam pressure: the pressure drop shall be 42% of the inlet absolute pressure.

2.5.8.3 Characteristics: Modified equal-percentage characteristics. Cage-type trim, providing seating and guiding surfaces for plug on "top and bottom" guided plugs.

2.5.8.4 50mm (2”) and smaller: ANSI Class 250 bronze body; stainless steel seat, stem and plug; and a TFE packing.

2.5.8.5 65mm (2-1/2”) and larger: ANSI Class 125 or 250 as applicable, cast iron body, stainless steel seat, stem and plug, and a TFE V-ring packing.

2.5.9 Ball Type:

2.5.9.1 Brass or bronze body; one-, two-, or three-piece design; threaded ends; reinforced Teflon seat; stainless steel ball; standard or ‘V’ style port; stainless steel stem, blow-out proof design, extended to match thickness of insulation.

2.5.9.2 Rating: Cold service pressure 4,138 kPa (600 psi) WOG; Steam working pressure 1,034 kPa (150 psi).

2.5.10 Segmented or Characterized Ball Type:

2.5.10.1 Carbon steel (ASTM 216) body, one-piece design with wafer style ends; reinforced teflon (PTFE) seat; stainless steel ASTM A351 ball; segmented design port with equal-percentage characteristic; stainless steel stem.

2.5.10.2 Rating: Cold service pressure 1,380 kPa (200 psi) WOG

2.5.11 Pressure Independent Control Valves

2.5.11.1 50mm (2") dia and smaller: forged brass body rated at no less than 2,758 kPa (400 psi), chrome plated brass ball and stem, female NPT union ends, dual EPDM lubricated O-rings and a brass or TEFZEL characterizing disc.

2.5.11.2 65mm (2-1/2") through 150mm (6') dia: 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.

2.5.11.3 Accuracy: The control valves shall accurately control the flow from 0 to 100% full rated flow with an operating pressure differential range of 34.5 kPa (5 psi) to 345 kPa (50 psi) differential across the valve with a valve body accuracy of +/- 5% variance due to differential pressure fluctuation or +/- 10% total assembly error incorporating differential pressure fluctuation, manufacturing tolerances and valve hysteresis.

2.5.11.4 Flow Characteristics: Equal percentage characteristics.

2.5.11.5 All actuators shall be capable of being electronically programmed in the field by use of external computer software or a dedicated handheld tool for the adjustment of flow. Programming using actuator mounted switches or multi-turn actuators are not acceptable. Actuators for 3-wire floating (tri-state) and for two-position 15mm (½") to 25mm (1") pressure independent control valves shall fail in place and have a mechanical device inserted between the valve and the actuator for the adjustment of flow.

2.5.11.6 Coil optimization 65mm (2-1/2") through 150mm (6") shall be accomplished by utilizing a pressure independent control valve assembly; two temperature sensors providing feedback of coil inlet water temperature and coil outlet water temperature; and a flow meter to provide analog flow feedback. Software shall control the valve to avoid the coil differential temperature from falling below a programmed setpoint. Independent trend logs data shall be

available by means of BACnet MS/TP trending data to include, but not be limited, to inlet and outlet coil water temperatures, valve position, absolute flow, absolute valve position, absolute power and heating/cooling energy in BTU/hr.

2.5.11.7 The BAS Contractor shall ensure that the manufacturer provides a published commissioning procedure following the guidelines of the National Environmental Balancing Bureau (NEBB) and the Testing Adjusting Balancing Bureau (TABB).

2.5.11.8 The control valve shall require no maintenance and shall not include replaceable cartridges.

2.5.12 Butterfly valves may be provided for two-position service. Where indicated on the Drawings, supply motorized butterfly valves complete with pipe tee of same rating as piping specification. Supply tight shut-off valves equipped with a limit switch for position indication.

2.5.12.1 50mm (2”) to 300mm (12”): valve body shall be full lugged cast iron 1,379 kPa (200 psig) body with a 304 stainless steel disc, EPDM seat, extended neck and shall meet ANSI Class 125/150 flange standards. Disc-to-stem connection shall utilize an internal spline. The shaft shall be supported at four locations by RPTFE bushings.

2.5.12.2 350mm (14”) and larger: valve body shall be full lugged cast iron 1,034 kPa (150 psig) body with a 304 stainless steel disc, EPDM seat, extended neck and shall meet ANSI Class 125/150 flange standards. Disc-to-stem connection shall utilize a dual-pin method to prevent the disc from settling onto the liner. The shaft shall be supported at four locations by RPTFE bushings.

2.5.12.3 Butterfly valves for medium pressure service: valve body shall be full lugged carbon steel ANSI Class 300 body with a 316 stainless steel disc without a nylon coating, RTFE seat, and be ANSI Class 300 flange standards. Blowout-proof shaft shall be 17-4ph stainless steel and shall be supported at four locations by glass-backed TFE bushings. Valve packing shall be Chevron TFE and shall include fully adjustable packing flange and separable packing gland. Valve body shall have long stem design to allow for 50mm (2”) insulation (minimum). Valve face-to-face dimensions shall comply with API 609 and MSS-SP-68. Valve assembly shall be completely assembled and tested, ready for installation.

2.5.13 The BAS Contractor shall ensure that the manufacturer warrants all components for a period of 5 years from the date of production,

with the first two years unconditional.

2.5.14 Cavitation Trim:

2.5.14.1 Provide cavitation trim where indicated and/or required, designed to eliminate cavitation and noise while maintaining an equal percentage characteristic. Trim shall be a series of plates with orifices to break the pressure drop into multi-stages.

2.6 CRITICAL SERVICE CONTROL VALVES

2.6.1 Control valve sizing and selection is the responsibility of the BAS Contractor. Provide a valve schedule that lists the requirements of the valves for Cv, close off, temperature, etc. This should be a result of analyzing the valves performance across the range of control.

2.6.2 General:

2.6.2.1 Provide selection of valve type or body material as determined by installation requirements and pressure class, based on maximum pressure and temperature in piping system.

2.6.2.2 Provide valve size in accordance with scheduled or specified maximum pressure drop across control valve.

2.6.2.3 Control valves shall be equipped with heavy-duty actuators and pilot positioners with proper close-off rating and capability for each individual application.

2.6.2.4 Minimum close-off rating shall be as scheduled and adequate for each application, and shall generally be considered at dead head rating of the pump.

2.7 ENERGY VALVES

2.7.1 Pressure Independent Control Valves with flow and temperature measurements. Based on Belimo.

2.7.1.1 50mm (2”) dia and smaller: forged brass body rated at no less than 2,758 kPa (400 psi), chrome plated brass ball and stem, female NPT union ends, dual EPDM lubricated O-rings and a brass or TEFZEL characterizing disc.

2.7.1.2 65mm (2-1/2”) through 150mm (6’) dia: 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.

2.7.1.3 Accuracy: The control valves shall accurately control the flow from 0 to 100% full rated flow with an operating pressure differential range of 34.5 kPa (5 psi) to 345 kPa (50 psi) differential across the valve with a valve body accuracy of +/- 5% variance due to differential pressure fluctuation or +/- 10% total assembly error incorporating differential pressure fluctuation, manufacturing tolerances and valve hysteresis.

2.7.1.4 Flow Characteristics: Equal percentage characteristics.

2.7.1.5 All actuators shall be capable of being electronically programmed in the field by use of external computer software or a dedicated handheld tool for the adjustment of flow. Programming using actuator mounted switches or multi-turn actuators are not acceptable. Actuators for 3-wire floating (tri-state) and for two-position 15mm (½") to 150mm (6") pressure independent control valves shall fail in place and have a mechanical device inserted between the valve and the actuator for the adjustment of flow.

2.7.1.6 Coil optimization 15mm (1/2") through 150mm (6") shall be accomplished by utilizing a pressure independent control valve assembly; two temperature sensors providing feedback of coil inlet water temperature and coil outlet water temperature; and a flow meter to provide analog flow feedback.

2.7.1.7 Software shall control the valve to avoid the coil differential temperature from falling below a programmed setpoint. Independent trend logs data shall be available by means of BACnet MS/TP trending data to include, but not be limited, to inlet and outlet coil water temperatures, valve position, absolute flow, absolute valve position, absolute power and heating/cooling energy in BTU/hr.

2.7.1.8 The BAS Contractor shall ensure that the manufacturer provides a published commissioning procedure following the guidelines of the National Environmental Balancing Bureau (NEBB) and the Testing Adjusting Balancing Bureau (TABB).

2.7.2 The control valve shall require no maintenance and shall not include replaceable cartridges.

2.8 VALVE AND DAMPER ACTUATORS

2.8.1 Size actuators and linkages to operate their appropriate dampers or valves with sufficient reserve torque or force to provide smooth modulating action or 2-position action as specified. Select spring-return actuators with manual override to provide positive shut-off of devices as they are applied.

2.8.2 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.

2.8.3 Electric damper actuators shall be spring return on outdoor air service.

2.8.4 Valves installed for outdoor service applications must be provided with actuators that operate satisfactorily at -30°C (-22°F) through 50°C (122°F).

2.8.5 Coupling shall be V-bolt dual nut clamp with a V-shaped, toothed cradle.

2.8.6 Mounting: actuators shall be capable of being mechanically and electrically paralleled to increase torque if required.

2.8.7 Fail-Safe Operation: mechanical, spring-return mechanism

2.8.8 Actuators to be overload protected electronically throughout rotation and come with electronic fail safe actuator for pressure independent valves 50mm (2-1/2”) through 150mm (6”).

2.8.9 Proportional actuators shall be fully programmable through an EEPROM without the use of actuator mounted switches.

2.8.10 Housing: minimum requirement NEMA type 2 / IP54 mounted in any orientation.

2.9 <u>POSITIONERS</u>

2.9.1 Positive positioning relays shall be provided on damper motors and valves when required to provide sufficient power, sequencing, repeatability, or speed of response. Positioner shall allow field adjustment of both starting pressure and operating span. Positioner shall provide an antilock feature and shall provide accurate positioning without excessive air bleed.

2.10 <u>SMOKE DAMPERS</u>

2.10.1 Provide Ruskin SD-35, Class I smoke dampers where indicated on the Drawings.

2.10.2 Provide parallel blade type dampers, suitable for horizontal or vertical mounting. Provide multiple dampers where sizes exceed code limitations.

2.10.3 Select dampers with airflow resistance not exceeding 13 Pa (0.05" w.g.) at design flow rates.

2.11 SMOKE DAMPER MOTORS

2.11.1 Size for torque required for damper seal at load conditions with one actuator per damper section. Mechanically paralleled or 'piggybacked' actuators are not permitted.

2.11.2 Coupling shall be V-bolt dual nut clamp with a V-shaped toothed cradle. Aluminum clamps or set screws are not acceptable.

2.11.3 Overload protection: microprocessor or an electronic based motor controller providing burnout protection if stalled before full rotation is reached. The actuator shall be electronically cut off at full open to eliminate noise generation with the holding noise level to be inaudible.

2.11.4 Actuator timing shall be per OBC and NFPA requirements.

2.11.5 Temperature rating: actuator shall have a UL555S listing by the damper manufacturer for 177°C (350°F).

2.11.6 Proportional smoke and fire damper actuators shall meet all requirements specified above and shall modulate 0-100% open in response to a 2-10vdc or 4-20mA control signal. A 2-10vdc feedback output shall provide a 2-10vdc signal for position indication.

2.11.7 Balancing smoke and fire damper actuators shall meet all requirements specified above and shall include an integral adjustable maximum opening potentiometer for airflow adjustment.

2.11.8 A manual override winder and locking mechanism shall be provided for override operation of the actuator on a loss of power to the actuator.

2.11.9 Actuator to include auxiliary switches for signaling, fan control, or position indication.

2.11.10 Housing for combination fire/smoke damper actuator to be steel, aluminum is not acceptable.

2.12 GENERAL FIELD DEVICES

2.12.1 Provide field devices for input and output of digital (binary) and analog signals into controllers (BCs, AACs, ASCs). Provide signal conditioning for all field devices as recommended by field device manufacturers and as required for proper operation in the system.

2.12.2 BAS Contractor shall assure that all field devices are compatible with controller hardware and software.

2.12.3 Field devices specified herein are generally 'two-wire' type transmitters, with power for the device to be supplied from the respective controller. If the controller provided is not equipped to provide this power, is not designed to work with 'two-wire' type transmitters, if field device is to serve as input to more than one controller, or where the length of wire to the controller will unacceptably affect the accuracy, the BAS Contractor shall provide 'four-wire' type equal transmitter and necessary regulated DC power supply or 120 VAC power supply, as required.

2.12.4 For field devices specified hereinafter that require signal conditioners, signal boosters, signal repeaters, or other devices for proper interface to controllers, the BAS Contractor shall provide proper devices, including 120V power as required. Such devices shall have accuracy and repeatability equal to, or better than, the accuracy and repeatability listed for respective field devices.

2.12.5 Accuracy: As stated in this Section, accuracy shall include combined effects of nonlinearity, non-repeatability and hysteresis.

2.13 ELECTRONIC TEMPERATURE SENSORS

2.13.1 Supply factory calibrated temperature sensors that utilize 1000-Ohm nickel wire or platinum (RTDs).

2.13.2 Temperature sensors utilized for measuring duct temperatures shall incorporate an averaging style temperature element (RTD) of sufficient length to ensure a proper average of the variation across the full cross section of the duct.

2.13.3 Temperature sensors utilized for measurement of fluid temperatures shall incorporate a separate well of a material suitable for the service.

2.13.3.1 Water service – brass

2.13.3.2 Steam service - 304 SS

2.13.3.3 Ethylene/propylene glycol service - 304 SS

2.13.4 Temperature sensors utilized for wall mounting in occupied spaces and connected to ASCs used for terminal unit control must be complete with a momentary contact switch for override initiation, concealed temperature setpoint adjustment and telephone style jack for connection of a portable service terminal.

2.13.5 Supply sensors with the following accuracy:

2.13.5.1 Duct and water insertion sensors +/- 0.5% at 20°C (68°F)

2.13.5.2 Duct averaging sensors +/- 1.0% at 20°C (68°F)

2.13.5.3 Space sensors +/- 0.5% at 20°C (68°F)

2.14 ELECTRONIC HUMIDITY SENSORS

2.14.1 Provide humidity sensors with a solid state sensing element suitable for operating ranges of 10 to 100% RH and an accuracy of +/- 3% over a range of 5 to 95% RH.

2.14.2 Incorporate in the humidity sensors a transducing circuit for conversion of the sensed variable to a voltage level for digital conversion.

2.15 PRESSURE SENSORS

2.15.1 Provide pressure transmitters suitable for continuous contact with the material being measured (i.e., air, water, glycol, or steam as applicable).

2.15.2 Pressure transmitters shall have a linear output of 0-5V. Pressure transmitters shall have a span of not greater than twice the static pressure at maximum flow or differential pressure at shut-off as applicable.

2.16 AIRFLOW MONITORING STATIONS

2.16.1 Airflow measuring stations must be designed and built to comply with, and provide results in accordance with accepted practice as defined for system testing in the ASHRAE Handbook of Fundamentals, as well as the Industrial Ventilation Handbook.

2.16.2 Where required, incorporate air straightening to ensure an accurate flow profile.

2.16.3 Utilize total pressure and static pressure probes and incorporate averaging manifolds, internal piping, and connections for an external differential pressure/flow transmitter. Hot wire anemometer technology is also acceptable

2.16.4 Airflow stations incorporated into the flow channels of silencers must be a series of probes inserted and tubed together according to design criteria, to provide an acceptable airflow profile.

2.16.5 Connect air flow monitoring devices supplied as part of equipment such as air terminal units to the BAS as required based on the Sequences of Operation set out in Section 25 90 00.

2.17 PRESSURE SWITCHES

2.17.1 Supply pressure-sensing elements of the bourdon tube, bellows, or diaphragm type, with adjustable setpoint and differential.

2.17.2 Pressure switches to be snap action type rated at 120 Volts, 15 Amps AC or 24 Volts DC.

2.18 TEMPERATURE SWITCHES

2.18.1 Temperature sensing element shall be liquid, vapour, or bimetallic type.

2.18.2 Supply adjustable setpoint and differential.

2.18.3 Snap action type rated at 120 volts, 15 Amps, or 24 volts DC as required.

2.18.4 Sensors shall operate automatically and reset automatically. Temperature switches shall be of the following types:

2.18.4.1 Room Type suitable for wall mounting on standard electrical box with or without protective guard.

2.18.4.2 General Purpose Duct Type suitable for insertion into air ducts, insertion length of 450mm (18 inches).

2.18.4.3 Thermowell Type complete with compression fitting for 20mm (¾") NPT well mounting of length of 100 mm (4 inches). Immersion wells shall be stainless steel.

2.18.4.4 Strap-on-Type complete with helical screw stainless steel clamps.

2.19 PRESSURE ELECTRIC SWITCHES

2.19.1 Provide pressure electric switches with diaphragm operated S.P.D.T. snap acting contacts with electrical rating suitable for application.

2.19.2 Pressure electric switches must withstand up to 172 kPa (25 psig) and be provided with adjustable cut-in and cut-out settings between 21 and 138 kPa (3 and 20 psig).

2.20 CURRENT SENSING RELAYS

2.20.1 Supply current sensing relays in fan and pump motor starters to detect flow a required in the sequence of operation.

2.20.2 Supply current sensing relays complete with metering transformer ranged to match load being metered.

2.20.3 Provide adjustable latch level, a minimum differential of 10% of latch setting between latch level and release level, and an LED for local status indication.

2.20.4 Ensure relay contacts are compatible with control circuit voltage.

2.21 CARBON DIOXIDE SENSORS

2.21.1 Supply carbon dioxide sensors for air quality control purposes with the following characteristics:

2.21.1.1 Measurement Range – 0-2000 ppm CO_2

2.21.1.2 Accuracy +/- 100 ppm

2.21.1.3 Repeatability +/- 20 ppm

2.21.1.4 Drift +/- 100 ppm per year

2.21.1.5 Output Signal 0-10 VDC proportional over the 0-2000 ppm range

2.21.1.6 Response time 20 seconds maximum

2.21.1.7 Operating conditions 0-50°C (32-122°F), 10-100% RH non-condensing

2.21.2 Provide one single point calibration kit

2.22 CARBON MONOXIDE SENSORS

2.22.1 Supply carbon monoxide sensors in the garage area as manufactured by Vulcain, Enmet, or Air Test Technologies. Each sensor shall have two relays, one for energizing ventilation equipment, one for indicating high alarm. Relays shall be factory calibrated for 50 and 100 ppm CO. Time delays shall prevent equipment from energizing on a short increase in gas level. Both level alarms shall be wired to BAS for status indication.

2.22.2 Carbon monoxide detectors to be provided as part of the work of Section 23 09 26 - Garage Ventilation Control System.

2.23 LOW TEMPERATURE LIMIT THERMOSTATS

2.23.1 Where shown on the Drawings or described in the sequences of operation, install low temperature limit thermostats complete with 6.1m (20'-0") of sensing capillary sensitive to 400mm (16") and manual reset. Provide one limit thermostat for approximately every 6 sq. m (65 sq. ft.) of duct area.

2.24 HIGH TEMPERATURE LIMIT THERMOSTATS

2.24.1 Where shown on the Drawings or described in the Sequences of Operation in this Section below for individual systems, provide high limit thermostats to shut down respective fan system(s).

2.24.2 Provide a single rod and tube type manual reset limit thermostat set at 57.5°C (135°F).

2.25 WATER FLOW SWITCHES

2.25.1 Supply paddle actuated water flow switches with snap acting S.P.D.T. contacts rated at 16 Amps 120/1/60 AC full load.

2.26 AIR PROVING SWITCHES

2.26.1 Air proving and motor status shall be performed by an adjustable latch level current switch. Upon motor current rise above setpoint, switch shall activate and status shall be proven.

2.27 DAMPER STATUS SWITCHES

2.27.1 Damper status switches shall be lever operated, activated by damper blade movement, and mounted securely on damper frame.

2.27.2 Damper switch shall have contact rating of 5 Amperes at 120V AC and be C.S.A. approved.

2.28 OCCUPANCY SENSORS

2.28.1 Provide passive infrared sensors, which shall operate on 24 VDC, with a current draw of 26 mA. Sensors shall be sealed and gasketed and be moisture and dust proof. The passive infrared sensor shall utilize a temperature compensated dual element sensor and a multi-element Fresnel lens.

2.28.2 Provide isolated relay with normally open, normally closed, and common outputs for use with HVAC control.

2.29 CONTROL RELAYS

2.29.1 Supply and install load relays capable of switching 10 Amps at 120/1/60.

2.30 CONTROL TRANSFORMERS

2.30.1 Furnish and install control transformers as required. Control transformers shall be machine tool type, and shall be ULC and CSA listed. Primary and secondary sides shall have replaceable fuses in accordance with the NEC. Transformer shall be properly sized for application, and mounted in minimum NEMA 1 enclosure.

2.31 TIME DELAY RELAYS (TDR)

2.31.1 TDRs shall be capable of on or off delayed functions, with adjustable timing periods, and cycle timing light. Contacts shall be rated for the application with a minimum of two (2) sets of Form C contacts, enclosed in a NEMA 1 enclosure.

2.31.2 TDRs shall have silver cadmium contacts with a minimum life span rating of one million operations. TDRs shall have solid state, plug-in type coils with transient suppression devices.

2.31.3 TDRs shall be ULC and CSA listed, Crouzet type.

2.32 ELECTRIC PUSH BUTTON SWITCH

2.32.1 Switch shall be momentary contact, oil tight, push button, with number of N.O. and/or N.C. contacts as required. Contacts shall be snap-action type, and rated for minimum 120 VAC operation.

2.33 PILOT LIGHT

2.33.1 Panel-mounted pilot light shall be NEMA ICS 2 oil tight, transformer type, with screw terminals, push-to-test unit, LED type, rated for 120 VAC.

2.34 ALARM HORN

2.34.1 Panel-mounted audible alarm horn shall be continuous tone, 120 VAC Sonalert solid-state electronic signal.

2.35 ELECTRIC SELECTOR SWITCH (ESS)

2.35.1 Switch shall be maintained contact, NEMA ICS 2, oil-tight selector switch with contact arrangement, as required. Contacts shall be rated for minimum 120 VAC operation.

2.36 NAMEPLATES

2.36.1 Duct and pipe mounted sensors and panels shall be provided with minimum size 75mm x 25mm x 3.2mm (3" x 1" x 1/8") lamacoid nameplates, clearly identifying the equipment and functions with letter and number designation. Nameplates shall be mechanically secured and listed in the Operating and Maintenance manual.

2.37 TESTING EQUIPMENT

2.37.1 The BAS Contractor shall test and calibrate all signaling circuits of all field devices to ascertain that required digital and accurate analog signals are transmitted, received, and displayed at system operator terminals, and make all repairs and recalibrations required to complete test. The BAS Contractor shall be responsible for test equipment required to perform these tests and calibrations. Test equipment used for testing and calibration of field devices shall be at least twice as accurate as respective field device (e.g., if field device is +/- 0.5% accurate, test equipment shall be +/- 0.25% accurate over same range).

3 EXECUTION

3.1 PREPARATION

3.1.1 Examine areas and conditions under which control systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to the BAS Contractor.

3.2 GENERAL REQUIREMENTS

3.2.1 Installation shall meet or exceed all applicable federal, provincial, and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

3.2.2 Install systems and materials in accordance with manufacturer's instructions, roughing-in Drawings and details shown on Drawings. Install electrical components and use electrical products complying with requirements of the Ontario Electrical Safety Code and all local codes.

3.2.3 Install all equipment, accessories, conduits, and interconnecting wiring in a neat manner by skilled and qualified workmen using the latest standard practices of the industry.

3.2.4 Notify the Consultant in writing of any conflict between these specifications and manufacturer's instructions.

3.2.5 Retain, at no additional cost to the owner, original equipment suppliers to provide contacts that are required on the point schedules and in the software and sequences specified. Provide the necessary relays and transformers required to interconnect equipment.

3.2.6 All equipment installed shall be mechanically stable and, as necessary, fixed to wall or floor. Anti-vibration mounts shall be provided, if required, for the proper isolation of equipment.

3.2.7 Install equipment to allow for easy maintenance access. Ensure equipment does not interfere in any way with access to adjacent equipment and personal traffic in the surrounding space.

3.2.8 Install equipment in locations providing ventilation and ambient conditions for its specified function.

3.2.9 Install all electrical wiring in conformance with the requirements of the local electrical authority, the Ontario Building Code and, unless otherwise indicated in the Contract Documents, the Specification Sections of Division 26 – Electrical.

3.2.10 Install low voltage wiring in accordance with the control manufacturer's recommendations. Run all wiring in a protective conduit in areas where exposed or where required to meet with applicable codes. Plenum rated (FT6) type cables may be used in accordance with applicable codes, in concealed, accessible locations such as ceiling spaces and wall cavities.

3.2.11 Shield and ground communication trunk wiring at a single end. Do not splice trunk cables.

3.3 INSTALLATION OF CONTROLLED DEVICES AND SENSORS

3.3.1 Supply equipment to be installed under the work of other Divisions in accordance with their work schedule.

3.3.2 Coordinate final location of all sensors with the Consultant's field representative prior to installation.

3.3.3 Sensor assemblies and elements must be readily accessible. Provide access doors as required to allow for easy replacement and servicing.

3.3.4 Support field mounted transmitters and sensors on pipe stands or channel brackets.

3.3.5 Locate all sensing elements to correctly sense measured variable. Isolate elements from vibrations and temperatures, which could affect measurement.

3.3.6 Install temperature sensing elements with thermal paste to ensure accurate reading.

3.3.7 Install averaging type RTDs in serpentine configuration with adequate provision for the mechanical protection of the sensor. Support along its entire length.

3.3.8 Modifications to plenum and ductwork must achieve the intent of the Contract Documents and adhere to the following:

3.3.9 Mount sensors with extension necks such that access to sensors is not restricted by insulation.

3.3.10 Keep cutting to a minimum and perform in a neat and workmanlike manner.

3.3.11 Provide patches and access covers of the same material and thickness as adjoining ductwork. Provide necessary reinforcing and fastening materials.

3.3.12 Repair insulation to maintain integrity of insulation and vapor barrier jacket. Use hydraulic insulating cement to fill voids and finish with material matching or compatible with adjacent jacket material.

3.3.13 Provide gaskets, seals, and insulation to restore to, or exceed as found conditions in areas where the BAS Contractor has made modifications.

3.3.14 All damper actuators shall be rigidly mounted and supplied with heavy-duty linkage consisting of a crank arm, pushrod, and swivel ball joint to connect to the damper shaft. Secure linkages in such a manner as to prevent slipping under normal operating torque.

3.3.15 Where the point schedules indicate that auxiliary contact provision, provide all instrumentation, wiring, conduit, power supplies, and services as required to integrate these points into the BAS.

3.3.16 Provide interposing and motor control relays at the local item of equipment or at the associated MCC as applicable. Provide all relays, wiring, conduit, power supplies, and services as required integrating these points into the BAS.

3.3.17 Control Wiring:

3.3.17.1 The term "control wiring" is defined to include providing of wire, conduit, and miscellaneous materials as required for mounting and connection of electric control devices.

3.3.17.2 Install complete wiring system for electric control systems. Conceal wiring except in mechanical rooms and areas where other conduit and piping are exposed. Installation of wiring shall generally follow building lines. Install in accordance with the latest edition of the Ontario Electrical Safety Code and Division 26 - Electrical. Fasten flexible conductors bridging cabinets and doors, neatly along hinge side, and protect against abrasion. Tie and support conductors neatly.

3.3.17.3 Install control wiring conductors, without splices between terminal points, color-coded. Install in neat workmanlike manner, securely fastened.

3.3.17.4 Communication wiring, signal wiring and low voltage control wiring shall be installed separate from any wiring over 30V. Signal wiring shield shall be grounded at controller end only, unless otherwise recommended by the controller manufacturer.

3.3.17.5 All WAN and LAN communication wiring shield shall be terminated as recommended by controller manufacturer. All WAN and LAN communication wiring shall be labeled with a network number, device ID at each termination and shall correspond with the WAN

and LAN system architecture and floor plan submittals.

3.3.17.6 Install all control wiring external to panels in electric metallic tubing or raceway. Installation of wiring shall generally follow building lines. Provide compression type connectors. Install wiring in galvanized rigid steel conduit at all exterior locations and where subjected to moisture. Install in PVC Schedule 40 conduit if encased in concrete. All conduits penetrating partitions, walls or floors shall be sealed with a submitted and approved fire/smoke sealant material to prevent migration of air through the conduit system.

3.3.17.6.1 The BAS Contractor shall be fully responsible for noise immunity and rewire in conduit if electrical or RF noise affects performance.

3.3.17.6.2 Accessible locations are defined as areas inside mechanical equipment enclosures, such as heating and cooling units, instrument panels etc.; in accessible pipe chases with easy access, or suspended ceilings with easy access. Installation of wiring shall generally follow building lines.

3.3.17.6.3 Run in a neat and orderly fashion, bundled where applicable, and completely suspended (strapped to rigid elements or routed through wiring rings) away from areas of normal access. Tie and support conductors neatly with suitable nylon ties and not to exceed 1.52m (5 foot) intervals.

3.3.17.6.4 Conductors shall not be supported by the ceiling system or ceiling support system. Conductors shall be pulled tight and be installed as high as practically possible in ceiling cavities. Wiring shall not be laid on the ceiling or duct.

3.3.17.6.5 Conductors shall not be installed between the top cord of a joist or beam and the bottom of roof decking.

3.3.17.7 Communication cabling shall be provided in an Owner approved color dedicated to the BAS.

3.3.17.8 Number-code or color-code conductors appropriately for future identification and servicing of control system. Code shall be as indicated on approved installation drawings.

3.3.18 Install control valves so that actuators, wiring, and tubing connections are accessible for maintenance. Where possible, install with valve stem axis vertical, with operator side up. Where vertical stem position is not possible or would result in poor access,

valves may be installed with stem horizontal. Do not install valves with stem below horizontal, or down.

3.3.19 Averaging temperature sensors shall cover no more than 0.61 sq.m per linear meter (2 sq.ft per linear foot) of sensor length except where indicated. Sensor shall be installed in location where flow is sufficiently homogeneous and adequately mixed. Install averaging sensors in a serpentine configuration with adequate provision for the mechanical protection of the sensor. Support along its entire length.

3.3.20 Install airflow measuring stations per manufacturer's recommendations in an unobstructed straight length of duct (except those installations specifically designed for installation in fan inlet). For installations in fan inlets, provide on both inlets of double inlet fans and provide inlet cone adapter as recommended by AFM station manufacturer.

3.3.21 Install fluid flow sensors per manufacturer's recommendations in an unobstructed straight length of pipe.

3.3.22 Provide element guard for relative humidity sensors as recommended by manufacturer for high velocity installations. For high limit sensors, position remote enough to allow full moisture absorption into the air stream before reaching the sensor.

3.3.23 Water differential pressure transmitters shall be installed in a valve bypass arrangement to protect against over pressure damaging the transmitter. Establish required locations and coordinate installation of valve bypass with the respective Subcontractors.

3.3.24 Install steam differential pressure transmitters as shown on the Drawings per manufacturer's instructions.

3.3.25 Install pipe surface mount temperature sensors with thermally conductive paste at pipe contact point. Where sensor is to be installed on an insulated pipe, the BAS Contractor shall neatly cut insulation, install sensor, repair or replace insulation and vapor barrier, and adequately seal vapor barrier.

3.3.26 Where possible, install flow switches in a straight run of pipe at least 15 diameters in length to minimize false indications.

3.3.27 Adjust current switches for motor status monitoring so that setpoint is below minimum operating current and above motor no load current.

3.3.28 Supply Duct Pressure Transmitters:

3.3.28.1 Install pressure tips with at least four (4) 'round equivalent' duct diameters of straight duct with no takeoffs upstream. Install static pressure tips securely fastened with tip facing upstream in accordance with manufacturer's installation instructions. Locate the transmitter at an accessible location to facilitate calibration.

3.3.28.2 On VAV Systems, locate down-duct transmitter pressure tips approximately 2/3 of the hydraulic distance to the most remote terminal in the air system.

3.4 IDENTIFICATION OF EQUIPMENT

3.4.1 Identify each piece of equipment, including sensors, controlled devices, and control panels, with a nameplate identifying the equipment and functions with a letter and number designation.

3.4.2 Nameplates shall be minimum size 75mm x 25mm (3" x 1") and 3.2mm (1/8") thick laminated plastic with black face and white center and 6.4mm (1/4") deep engraved lettering. Nameplates shall be securely attached to the equipment.

3.4.3 Printed nametags are acceptable for cabinet mounted components providing they are securely attached.

3.5 ACCEPTANCE AND TESTING PROCEDURES

3.5.1 The BAS Contractor shall request completion acceptance in writing and advise the Consultant of situations that would prevent a complete testing of overall system performance.

3.5.2 Work and/or systems installed under this Division and under Divisions 21, 22 and 23 shall be fully functioning prior to Demonstration and Acceptance Phase. The BAS Contractor shall start, test, adjust, and calibrate all work and/or systems under this Contract, as described below:

3.5.2.1 Inspect the installation of all devices. Review the manufacturer's installation instructions and validate that the device is installed in accordance with them.

3.5.2.2 Verify proper electrical voltages and amperages, and verify that all circuits are free from faults.

3.5.2.3 Verify integrity/safety of all electrical connections.

3.5.2.4 Coordinate with the Subcontractor responsible for the TAB work to obtain control settings that are determined from balancing procedures. Record the following control settings as obtained from the Subcontractor responsible for the TAB work, and note any TAB deficiencies in the BAS Start-Up Report:

3.5.2.4.1 Optimum duct static pressure setpoints for VAV air handling units.

3.5.2.4.2 Minimum outside air damper settings for air handling units.

3.5.2.4.3 Optimum differential pressure setpoints for variable speed pumping systems.

3.5.2.4.4 Calibration parameters for flow control devices such as VAV terminal units and flow measuring stations.

3.5.2.5 The BAS Contractor shall provide a hand-held device as a minimum to the Subcontractor responsible for the TAB work to facilitate calibration. Connection for any given device shall be local to it (i.e. at the VAV terminal unit or at the thermostat). Hand-held device or portable operator's terminal shall allow querying and editing of parameters required for proper calibration and start-up.

3.5.2.6 Test, calibrate, and set all digital and analog sensing and actuating devices. Calibrate each instrumentation device by making a comparison between the BAS display and the reading at the device, using an instrument, which shall be at least twice as accurate as the device to be calibrated (e.g., if field device is +/-0.5 percent accurate, test equipment shall be +/-0.25 percent accurate over same range). Record the measured value and displayed value for each device in the BAS Start-up Report.

3.5.2.7 Check and set zero and span adjustments for all transducers and transmitters.

3.5.2.8 For dampers and valves:

3.5.2.8.1 Check for adequate installation including free travel throughout range and adequate seal.

3.5.2.8.2 Where loops are sequenced, check for proper control without overlap.

3.5.2.9 For actuators:

3.5.2.9.1 Check to insure that device seals tightly when the appropriate signal is applied to the operator.

3.5.2.9.2 Check for appropriate fail position, and that the stroke and range is as required.

3.5.2.9.3 For pneumatic operators, adjust the operator spring compression as required to achieve close-off. If positioner or volume booster is installed on the operator, calibrate per manufacturer's procedure to achieve spring range indicated. Check split-range positioners to verify proper operation. Record settings for each device in the BAS Pre-Commissioning Report.

3.5.2.9.4 For sequenced electronic actuators, calibrate per manufacturer's instructions to required ranges.

3.5.2.10 Check each digital control point by making a comparison between the control command at the CU and the status of the controlled device. Check each digital input point by making a comparison of the state of the sensing device and the Operator Interface display. Record the results for each device in the BAS Start-Up Report.

3.5.2.11 For outputs to reset other manufacturer's devices (for example, VSDs) and for feedback from them, calibrate ranges to establish proper parameters. Coordinate with representative of the respective manufacturer and obtain their approval of the installation.

3.5.3 Sensor Checkout and Calibration:

3.5.3.1 Verify that all sensor locations are appropriate and are away from causes of erratic operation. Verify that sensors with shielded cable are grounded only at one end. For sensor pairs that are used to determine a temperature or pressure difference, make sure they are reading within 0.1 degrees C (0.2 degrees F) of each other for temperature and within a tolerance equal to 2 percent of the reading of each other for pressure. Tolerances for critical applications may be tighter.

3.5.3.2 Calibrate all sensors using one of the following procedures:

3.5.3.2.1 Sensors without transmitters: Make a reading with a calibrated test instrument within 150mm (6 inches) of the site sensor at various points across the range. Verify that the sensor reading (via the permanent thermostat, gauge or BAS) is within the tolerances specified for the sensor. If not, adjust offset and range, or replace sensor. Where sensors are subject to wide variations in the sensed variable, calibrate sensor within the highest and lowest 20 percentage of the expected range.

3.5.3.2.2 Sensors with transmitters: Disconnect sensor. Connect a signal generator in place of sensor. Connect ammeter in series between transmitter and BAS control panel. Using manufacturer's resistance-temperature data, simulate minimum desired temperature. Adjust transmitter potentiometer zero until the ammeter reads 4 mA. Repeat for the maximum temperature matching 20 mA to the potentiometer span or maximum and verify at the OI. Record all values and recalibrate controller as necessary to conform to tolerances. Reconnect sensor. Make a reading with a calibrated test instrument within 150mm (6 inches) of the site sensor. Verify that the sensor reading (via the permanent thermostat, gauge or BAS) is within the tolerances specified. If not, replace sensor and repeat. For pressure sensors, perform a similar process with a suitable signal generator.

3.5.3.3 Sensors shall be within the tolerances specified for the device.

3.5.4 Coil Valve Leak Check:

3.5.4.1 Verify proper close-off of the valves. Ensure the valve seats properly seat by simulating the maximum anticipated pressure difference across the circuit. Demonstrate to the Owner the verification of zero flow by measuring the coil differential pressure. If there is pressure differential, close the isolation valves to the coil to ensure the conditions change. If they do, this validates the valve is not closing. Remedy the condition by adjusting the stroke and range, increasing the actuator size/torque, replacing the seat, or replacing the valve as applicable.

3.5.5 Valve Stroke Setup and Check:

3.5.5.1 For all valve and actuator positions checked, verify the actual position against the Operator Interface readout.

3.5.5.2 Set pumps to normal operating mode. Command valve closed, verify that valve is closed, and adjust output zero signal as required. Command valve open, verify position is full open and adjust output signal as required. Command the valve to various few intermediate positions. If actual valve position doesn't reasonably correspond, replace actuator or add pilot positioner (for pneumatics).

3.5.6 After completion of installation and in cooperation with Subcontractors responsible for the related work of other Specification Sections, adjust each control device and component to ensure that the operations are in accordance with the

Sequences of Operation specified in Section 20 95 00.

END OF SECTION

INDEX

1 **GENERAL**

1.1 GENERAL

1.1.1 Sections 20 00 00 and 25 00 00 – General Requirements shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools, equipment, training, commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 Operator Workstations.

1.2.1.2 Control System Servers.

1.2.1.3 Portable Operator Terminal / Remote Workstation.

1.2.2 Furnish and install all Operator Interfaces and Control System Servers as required for the BAS functions specified in the Contract Documents. All computers shall be warranted by the manufacturer for a period of one year after final acceptance.

2 **PRODUCTS**

2.1 GENERAL

2.1.1 All materials shall meet or exceed all applicable referenced standards, and conform to codes and ordinances of authorities having jurisdiction.

2.1.2 The make and model of control system server computers, personal computers (PC), notebook PC's, monitors, and printers shall comply with Owner's current standards for desktop personal computers as of the date of the Substantial Performance of the Work. Contact the Owner for the current computer hardware standards.

2.1.3 Operating system for operator workstation shall comply with the Owner's current standards for desktop personal computers as of the date of the Substantial Performance of the Work. Contact the Owner for the current computer software standards.

2.2 CONTROL SYSTEMS APPLICATION SERVER (CSS)

2.2.1 Provide Controls Systems Application Server to archive historical

data including trends, alarm and event histories and transaction logs.

2.2.2 Server shall be an IBM compatible computer platform. Minimum 2 GB RAM, 19" LCD monitor, and 500 GB hard-drive. DVD Read / Write drive shall be provided for system backup use.

2.2.3 One printer shall be provided for information summaries, custom reports, and graphical printing. The printer shall be capable of six (6) pages per minute at a resolution of 600 dpi, and use inkjet technology.

2.2.4 Equip this Server with the same software tool set that is located in the Primary Controls Systems Application Nodes for system configuration, custom logic definition, and for colour graphic configuration.

2.2.5 Access to all information on the Controls Systems Server shall be through the same Operator Interface functionality used to access individual nodes. When logged onto a Server the Operator will be able to also interact with any of the primary Nodes on the Controls Systems Application.

2.3 OPERATOR WORKSTATION (OWS)

2.3.1 The Operator Interface provided shall include the functionality to selectively combine data and information from any system element or component in the Controls Systems Application on a single Browser window display panel at the Operator's option. This shall include both current information and historical data stored on the Server.

2.3.2 The Controls Systems Application Operator Workstation (OWS) shall operate on Microsoft® Windows 8 or other approved platform, with the same hardware as described under the CSS.

2.3.2.1 The BAS Contractor shall provide a modem for connection to the Owner's paging service.

2.3.3 Operator Workstations shall be placed as indicated on the Drawings or as directed by the Owner.

2.3.4 Refer to Appendix A for further Operator Workstation requirements.

2.4 PORTABLE OPERATOR TERMINAL (POT) / REMOTE WORKSTATION

2.4.1 Portable Operator Terminal shall support system management by connection to the controllers and by connection via the Internet while serving as the remote workstation.

2.4.2 Provide one notebook personal computer (PC) that meets or exceeds the minimum requirements of the BAS software and meets or exceeds Owner's minimum requirements. Notebook PC shall contain a DVD-RW Drive.

2.4.3 Provide carrying case and extra battery.

2.4.4 Operating system for operator workstation shall be Microsoft Windows 8 Professional.

2.4.5 Provide additional hardware, video drivers, serial ports, etc., to facilitate all control functions and software requirements specified for the building automation system.

2.4.6 Provide all controller configurations, interface software, and/or plug-ins for all devices applicable. All shall be loaded and functional. Provide all required interface cables required to connect to all networks, routers, controllers, SDs, etc.

2.4.7 Wherever a POT connection point is not accessible in the same room as the device controlled, Contractor shall provide a wireless system, to permit configuration, testing, and operation.

2.4.8 BAS licensing for this POT shall allow unlimited access to all aspects of the any manufacturer's system including system access, workstations, points, programming, database management, graphics etc.

2.4.9 No restrictions shall be placed on the license.

2.4.10 All operator interfaces, programming environment, networking, database management and any other software used by the Contractor to install the system or needed to operate the system to its full capabilities shall be licensed and provided to the Owner.

2.5 <u>UNINTERRUPTABLE POWER SUPPLY</u>

2.5.1 Provide an uninterruptible power supply system (UPS) providing battery backup for each operator workstation, server and peripheral devices.

2.5.1.1 UPS shall protect against blackouts, brownouts, surges, and noise.

2.5.1.2 UPS shall include LAN port and modem line surge protection.

2.5.1.3 UPS shall be sized for a 7-minute full load runtime, 23-minute ½-load runtime, with a typical runtime of up to 60 minutes. Transfer time shall be 2-4 milliseconds.

2.5.1.4 UPS shall provide a 480 Joule suppression rating and current suppression protection for 36,000 Amps and provide 90 percent recharge capability in two to four hours. Suppression response time shall be instantaneous.

2.5.1.5 UPS low voltage switching shall occur when supply voltage is less than 94 Volts. UPS shall be provided with modem surge suppression and LAN port connections.

3 EXECUTION

3.1 INSTALLATION

3.1.1 Installation shall meet or exceed all applicable federal requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

3.1.2 All installation shall be in accordance with manufacturer's published recommendations.

3.1.3 Set up workstations and printers as indicated on the Drawings. Install all software and verify that the systems are fully operational.

3.1.4 No license, software component, key or any piece of information required for installing, configuring, operating, diagnosing and maintaining the system shall be withheld from the Owner.

3.1.5 Install electronic control system Operation and Maintenance Manuals, programming guides, network configuration tools, and control Shop Drawings etc. on each OWS and CSS. Provide interface or shortcuts to guide user to the appropriate information.

3.1.6 Set up portable operator terminal and configure it as the remote workstation. Install all software and verify that the system is operational.

END OF SECTION

Project Name: *UNIVERSITY OF TORONTO MISSISSAUGA*
Project No.: *2023-0059*
Section Name: ***Field Panels***
Section No.: ***25 14 00***
Date: *November 15, 2024*

INDEX

1 **GENERAL**

1.1 GENERAL

1.1.1 Sections 20 00 00 and 25 00 00 – General Requirements shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools, equipment, training, commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 Application Nodes (ANs)

1.2.1.2 Application Specific Controllers (ASCs)

1.2.2 Furnish and install DDC Control units and/or Smart Devices required to support specified building automation system functions.

2 **PRODUCTS**

2.1 GENERAL

2.1.1 All materials shall meet or exceed all applicable referenced standards, federal requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.2 CONTROLLERS – APPLICATION NODES (AN)

2.2.1 Controls AN shall provide both standalone and networked direct digital control of mechanical and electrical building systems as required by the Specifications. The primary AN shall support a minimum of [2,000] field points together with all associated features, sequences, schedules, applications as required for fully functional distributed processing operations.

2.2.2 A dedicated AN shall be configured and provided for each building.

2.2.3 Each AN shall retain program, control algorithms, and setpoint information for at least 72 hours in the event of a power failure and shall return to normal operation upon stable restoration of normal line power.

2.2.4 Each AN shall monitor and report its communication status to the Controls Systems Application. The Controls Systems shall provide a system advisory upon communication failure and restoration.

2.2.5 Provide a means to prevent unauthorized personnel from accessing setpoint adjustments and equipment control definitions at the AN.

2.2.6 The AN shall provide the functionality to download and upload configuration data, both locally at the AN and via the Controls Application networks.

2.2.7 The AN shall perform the functional monitoring of all Controls Application variables, both from real hardware points, software variables, and controller parameters such as setpoints.

2.2.8 The primary AN shall manage and direct all information traffic on the Tier 1 network, between the Tier 1 and Tier 2 networks and to the Server(s).

2.2.9 All AN on the Tier 1 network shall be equipped with all software and functionality necessary to operate the complete user interface, including graphics, via a Browser connected to the Node on the network or directly via a local port on the AN.

2.2.10 The AN shall be capable of direct connection to multiple field busses using different protocols simultaneously as indicated below. Should the AN not support multiple field busses then install multiple AN in parallel to achieve this functionality.

2.2.10.1 An RS-485 serial field bus such as MSTP or the manufacturer's open field bus.

2.2.10.2 A LON field bus for supervision and control of LON based controllers that conform to the Lon Talk standard.

2.2.11 The AN shall integrate data from both field busses into a common and conformal object structure. Data from both field busses shall appear in common displays throughout the Operator Interface in the same format. Conformal formatting shall be provided for each type of data not dependent on the type of field bus from which the data originated.

2.2.12 The AN shall be designed, packaged, installed, programmed and commissioned in consideration of their specific service and prevailing operating conditions. They shall be proven standard product of their original manufacturer and not a custom product for this Project.

2.2.13 A failure at an AN shall not cause failures or non-normal operation

at any other system AN other than the possible loss of active real-time information from the failed AN.

2.2.14 Ancillary AN equipment, including interfaces and power supplies, shall not be operated at more than 80% of their rated service capacity.

2.2.15 Each AN shall report its communication status to the Application. The Application shall provide a system advisory upon communication failure and restoration.

2.2.16 The AN shall incorporate the ability to download and upload configuration data, both locally at the AN and via the Application communications network.

2.3 APPLICATION SPECIFIC CONTROLLERS (ASCS)

2.3.1 Each ASC shall be a microprocessor-based, multi-tasking, real-time digital control processor. Each ASC shall operate as a stand-alone controller capable of performing its specified control sequences.

2.3.2 ASCs shall support all the necessary point inputs and outputs to perform the specified control sequences in a totally stand-alone fashion.

2.3.3 ASCs shall have a library of control processes to perform the sequence of operation specified in the "Execution" portion of this specification. Control processes shall include:

2.3.3.1 Two Position Control

2.3.3.2 Proportional, Integral, plus Derivative Control

2.3.3.3 Industry standard VAV terminal box control process

2.3.3.4 Industry standard fan coil control process

2.3.3.5 Industry standard heat pump control process

2.3.3.6 Industry standard AC system control process

2.3.3.7 Industry standard AHU system control process

2.3.4 Each ASC shall have sufficient memory to support its own operating system and databases, including control processes, energy management applications, operator I/O and local alarm

management.

2.3.5 Each ASC shall perform its own limit and status monitoring and analysis to maximize network performance by reducing unnecessary communications.

2.3.6 Powerfail Protection

2.3.6.1 All controller setpoints, proportional bands, control algorithms, and any other programmable parameters shall be stored such that a power failure of any duration does not necessitate reprogramming the ASC.

2.3.6.2 All controller memory containing program configuration and control parameters shall be either non-volatile EEPROM/EPROM memory or shall be provided with battery back-up sufficient to sustain the contents of RAM memory for a minimum of one (1) year. Alternatively, provide 72-hour battery backup for program & data memory.

2.3.7 Configuration and Download

2.3.7.1 The ASCs shall have the capability of receiving configuration and program loading by all of the following:

2.3.7.1.1 Locally, via a direct portable laptop service tool;

2.3.7.1.2 Over the network, from the portable laptop service tool;

2.3.7.1.3 From the Operator Workstation, via the communication networks.

3 EXECUTION

3.1 PREPARATION

3.1.1 Examine areas and conditions under which control systems are to be installed. Do not proceed with the Work until unsatisfactory conditions have been corrected in manner acceptable to the BAS Contractor.

3.2 INSTALLATION

3.2.1 Installation shall meet or exceed all applicable federal requirements, referenced standards, and conform to codes and ordinances of authorities having jurisdiction.

3.2.2 All installation shall be in accordance with manufacturer's

published recommendations.

3.2.3 All equipment installed shall be mechanically stable and, as necessary, fixed to wall or floor. Anti-vibration mounts to be provided, if required, for the proper isolation of equipment.

3.2.4 Install equipment to allow for easy maintenance access. Ensure equipment does not interfere in any way with access to adjacent equipment and personal traffic in the surrounding space.

3.2.5 Install equipment in locations providing ventilation and ambient conditions for its specified function.

3.3 CONTROLLER QUALITY AND LOCATION

3.3.1 Digital Control Stations (DCS) are referenced to indicate allocation of points to each DCS and DCS location. Digital control stations shall consist of one or multiple controllers to meet requirements of the Division 25 Specification Sections.

3.3.2 Where a DCS is referenced, the BAS Contractor shall provide at least one (1) controller, and additional controllers as required, in sufficient quantity to meet the requirements of the Division 25 Specification Sections. Restrictions in applying controllers are specified under this Section. The BAS Contractor shall extend power to the DCS from an acceptable power panel. If the BAS supplier wishes to further distribute panels to other locations, the BAS Contractor is responsible for extending power to that location also. Furthermore, the BAS Contractor is responsible for ensuring adequate locations for the panels that do not interfere with other requirements of the Project and maintain adequate clearance for maintenance access.

3.3.3 The BAS Contractor shall locate DCS's as referenced in the Contract Documents. It is the BAS Contractor's responsibility to provide enough controllers to ensure a completely functioning system, according to the point list and sequence of operations.

3.3.4 The BAS Contractor shall provide a minimum of the following:

3.3.4.1 One DCS (including at least one controller) for each air handler located in applicable mechanical room

3.3.4.2 One DCS (including at least one controller) for each critical fan system

3.3.4.3 One DCS (including at least one controller) for each pumping system

3.3.4.4 One DCS (including at least one controller) for each Domestic Hot Water System

3.3.4.5 One controller for each piece of terminal equipment located at the equipment.

3.4 SURGE PROTECTION

3.4.1 The BAS Contractor shall furnish and install any power supply surge protection, filters, etc. as necessary for proper operation and protection of all BCs, AAC/ASCS, routers, gateways, and other hardware and interface devices. All equipment shall be capable of handling voltage variations 10 percent above or below measured nominal value, with no effect on hardware, software, communications, and data storage.

3.5 CONTROL POWER SOURCE AND SUPPLY

3.5.1 The BAS Contractor shall extend all power source wiring required for operation of all equipment and devices provided under this Section.

3.5.2 General requirements for obtaining power include the following:

3.5.2.1 In the case where additional power is required, obtain power from a source that feeds the equipment being controlled such that both the control component and the equipment are powered from the same panel. Where equipment is powered from a 600V source, obtain power from the electrically most proximate 120V source fed from a common origin.

3.5.2.2 Where control equipment is located inside a new equipment enclosure, coordinate with the equipment manufacturer and feed the control with the same source as the equipment. If the equipment's control transformer is large enough and is the correct voltage to supply the controls, it may be used. If the equipment's control transformer is not large enough or of the correct voltage to supply the controls, provide separate transformer

3.5.2.3 Where a controller controls multiple systems on varying levels of power reliability (normal, emergency, and/or interruptible), the controller shall be powered by the highest level of reliability served. Furthermore, the controller in that condition shall monitor each

power type served to determine so logic can assess whether a failure is due to a power loss and respond appropriately. A three-phase monitor into a digital input shall suffice as power monitoring.

3.6 IDENTIFICATION OF EQUIPMENT

3.6.1 Identify each piece of equipment, including sensors, controlled devices, and control panels, with a nameplate identifying the equipment and functions with a letter and number designation.

3.6.2 Nameplates shall be minimum size 75mm x 25mm (3" x 1") and 3.2mm (1/8") thick laminated plastic with black face and white center and 6.4mm (1/4") deep engraved lettering. Nameplates shall be securely attached to the equipment.

3.6.3 Printed nametags are acceptable for cabinet mounted components providing they are securely attached.

END OF SECTION

Project Name: *UNIVERSITY OF TORONTO MISSISSAUGA*
Project No.: *2023-0059*
Section Name: ***Software and Programming***
Section No.: ***25 15 00***
Date: *November 15, 2024*

INDEX

1 GENERAL

1.1 GENERAL

1.1.1 Sections 20 00 00 and 25 00 00 – General Requirements shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, including calibration, commissioning, software programming and data base generation, generation of colour graphics and additional work necessary to provide a complete and fully operating system.

1.3 LICENSING

1.3.1 Provide or upgrade all licensing for all software packages at all required workstations. BAS licensing shall allow unlimited simultaneous users for access to all aspects of the system including system access, workstations, points, programming, database management, graphics etc. No restrictions shall be placed on the licensing. All operator interfaces, programming environment, networking, database management, and any other software used by the Contractor to install the system or needed to operate the system to its full capabilities shall be licensed and provided to the Owner.

1.3.2 All software should be available on all Operator Workstations (OWS) provided, and on all Portable Operator Terminals. Hardware and software keys to provide all rights shall be installed on all workstations. At least two (2) sets of compact discs or USB drives shall be provided with backup software for all software provided, so that the Owner may reinstall any software as necessary. Include all licensing for workstation operating systems, and all required third-party software licenses.

1.3.3 Provide licensing and original software copies for each OWS.

1.3.4 Provide licensing and original software copies for each remote graphic workstation. Licenses for remote graphic workstations shall allow for access to any Site and shall not be restricted to accessing only the LANs included in this Project.

1.3.5 In the last month of the Warranty Period, upgrade all software and firmware packages to the latest release (version) in effect at the end of the Warranty Period.

2 PRODUCTS

2.1 GENERAL

2.1.1 All materials shall meet or exceed all applicable referenced standards, federal, provincial, and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.2 OPERATOR INTERFACES

2.2.1 The Controls Systems Operator Interfaces shall be user friendly, readily understood and shall make maximum use of colours, graphics, icons, embedded images, animation, text based information and data visualization techniques to enhance and simplify the use and understanding of the displays by authorized users at the Operator's Workstation (OWS).

2.2.2 User access shall be protected by a flexible and Owner redefinable software-based password access protection. Password protection shall be multi-level and partitionable to accommodate the varied access requirements of the different user groups to which individual users may be assigned. Provide the means to define unique access privileges for each individual authorized user. Provide the means to on-line manage password access control under the control of a project specific Master Password. Provide an audit trail of all user activity on the Controls Systems including all actions and changes.

2.2.3 The Operator Interface shall incorporate comprehensive support for functions including, but not necessarily limited to, the following:

2.2.3.1 User access for selective information retrieval and control command execution.

2.2.3.2 Monitoring and reporting.

2.2.3.3 Alarm and non-normal condition annunciation.

2.2.3.4 Selective operator override and other control actions.

2.2.3.5 Information archiving, manipulation, formatting, display, and reporting.

2.2.3.6 Controls Systems internal performance supervision and diagnostics.

2.2.3.7 On-line access to user HELP menus.

2.2.3.8 On-line access to current as-built records and documentation. At minimum, one (1) copy of all record documentation shall be stored on a designated OWS or Server and be accessible to the Owner.

2.2.3.9 Means for the controlled re-programming, re-configuration of systems operation and for the manipulation of database information in compliance with the prevailing codes, approvals, and regulations for the component applications and elements.

2.2.3.10 Means to archive all Controls Systems Contract Project specific configuration databases, software programs, and other pertinent operational data such that any component of the software and project specific operational databases may be reloaded on Site from archived data.

2.2.3.11 Provide on-line reports and displays making maximized use of simple English language descriptions and readily understood acronyms, abbreviations, icons and the like to assist user understanding and interpretation. All text naming conventions shall be consistent in their use and application throughout the Controls Systems.

2.3 OPERATOR WORKSTATIONS

2.3.1 The Operator Interface provided shall include the functionality to selectively combine data and information from any system element or component in the Controls Systems Application on a single Browser window display panel at the Operator's option. This shall include both current information and historical data stored on the Server.

2.3.2 Each Controls Systems Application fixed and portable OWS shall be on-line configurable for specific functionalities and associated groups of system points and elements.

2.3.3 Navigation Trees

2.3.3.1 Provide the capability to display multiple navigation trees that aid the operator in navigating throughout all systems and points connected. At minimum, provide a tree that identifies all systems on the Controls Systems networks.

2.3.3.2 Provide the capability for the Operator to add custom trees. The Operator shall be able to define any logical grouping of systems or points and arrange them on the tree in any selected order. Provide the capability to nest groups within other groups. Provide at

minimum for five levels of nesting.

2.3.3.3 The navigation trees shall be “dockable” to other displays in the Operator interface including graphic displays. The trees shall appear as part of the display and may be individually detached and minimized to the Windows task bar or closed. Provide for a single keystroke to reattach the navigation tree to a primary display.

2.3.4 Divisible Display Windows

2.3.4.1 Provide for the operator to divide the display area within a single Browser window into multiple display panels. The content of each display panel can be any of the standard summaries and graphics provided in the Controls Systems Application.

2.3.4.2 Provide each display panel with minimize, maximize, and close icons.

2.3.5 Alarms

2.3.5.1 Alarms shall be routed directly from primary Controls Systems Application Nodes to OWS and Server. Provide for specific alarms from specific points to be routed to selectable OWS and Server. The alarm management portion of the Controls Systems software shall, at minimum, provide the following functions:

2.3.5.2 Log date and time of alarm occurrence.

2.3.5.3 Generate a “Pop-Up” window on the Browser display panel, with audible alarm, informing the Operator that an alarm has been received.

2.3.5.4 Allow an Operator, with the appropriate password, to acknowledge, temporarily silence or cancel an alarm.

2.3.5.5 Provide an audit trail on hard drive for alarms by recording user acknowledgement, deletion, or cancelling of an alarm. The audit trail shall include the ID of the user, the alarm, the action taken on the alarm and a time/date stamp.

2.3.5.6 Provide the ability to direct alarms to an e-mail address or alphanumeric pager. This must be provided in addition to the pop-up window described herein. Controls Systems that use e-mail and pagers as the exclusive means of annunciating alarms are not acceptable.

2.3.5.7 Provide for any attribute of any object in the Controls Systems to

be designated to report as an alarm.

2.3.5.8 The Controls Systems Application shall annunciate systems diagnostic alarms indicating system failures and non-normal operating conditions.

2.3.5.9 The Controls Systems Application shall annunciate controls alarms at minimum as required by Part 3.

2.3.5.10 Provide the on-line means to display alarms within the Browser windows by date/time of occurrence, priority class, point designation, value, or other defined text keywords.

2.3.6 Operator Transaction Archiving

2.3.6.1 Provide the means to automatically archive all Operator activities on the Controls Systems Application and for the recall of same for reporting.

2.3.6.2 Provide the means to sort and report archived activities by Operator, date/time, activity type and system area.

2.3.6.3 Provide access protection to preclude the unauthorized removal or tampering with archived records.

2.3.6.4 Provide management support facilities for the deletion and re-initializing of archived record logs under Master Password control or equal means.

2.3.7 Reports

2.3.7.1 Reports shall be generated and directed to one or more of the following: User interface displays, printers archived at the Owner's defined option. As a minimum, the Controls Systems Application shall provide the following reports:

- All points in the Controls Systems Application.
- All points in a specific Controls Systems.
- All points in a user-defined group of points.
- All points currently in alarm.
- All points locked out.
- All Controls Systems Application schedules.

• All user defined and adjustable variables, schedules, interlocks, diagnostics, systems status reports, and the like.

2.3.7.2 Provide all applicable original manufacturers standard reports for the Controls Systems.

2.3.8 Dynamic Colour Graphics

2.3.8.1 Provide for any number of real-time colour graphic displays shall be able to be generated and displayed in the Controls Systems Application limited only by memory data storage capacity.

2.3.8.2 Graphics shall be based on Scalar Vector Graphic (SVG) technology.

2.3.8.3 Values of real-time attributes displayed on the graphics shall be dynamic and updated on the displays.

2.3.8.4 The graphic displays shall be able to display and provide animation based on real-time data that is acquired, derived, or entered into the operating Controls Systems.

2.3.8.5 Provide for the Owner to be able to change values (setpoints) and states in system controlled equipment directly from the graphic display.

2.3.8.6 Provide a graphic editing tool that allows for the creation and editing of graphic files. It shall be possible to edit the graphics directly while they are on line, or at an off line location for later downloading to the AN.

2.3.8.7 Provide a complete user expandable symbol library containing all of the basic symbols used to represent components of a typical system. Implementing these symbols in a graphic shall involve dragging and dropping them from the library to the graphic.

2.3.9 Schedules

2.3.9.1 Provide multiple schedule input forms for automatic time-of-day scheduling and override scheduling of operations. At a minimum, the following spreadsheet types shall be accommodated:

• Weekly schedules.

• Temporary override schedules.

• Special “Only Active If Today Is A Holiday” schedules.

- Monthly schedules.

2.3.9.2 Schedules shall be provided for each group, system, and sub-system in the Controls Systems Application. It shall be possible to include all or any commandable points residing within the Controls Systems in any custom schedule. Each point shall have a unique schedule of operation relative to the system use schedule, allowing for sequential starting and control of equipment within the system. Scheduling and rescheduling of points shall be accomplished easily via the system schedule spreadsheets.

2.3.9.3 Multiple monthly calendars for a 12-month period shall be provided that allow for simplified scheduling of holidays and special days in advance. Holidays and special days shall be user-selected with the pointing device or keyboard, and shall automatically reschedule equipment operation as previously defined on the weekly schedules.

2.3.10 Historical Trending And Data Collection

2.3.10.1 Trend and store point history data for all actual and virtual (software) points and values as required by the Owner.

2.3.10.2 The trend data shall be stored in a manner that allows custom queries and reports using industry-standard software tools.

2.3.10.3 At a minimum, provide the capability to perform statistical functions on the historical database:

- Average.
- Arithmetic mean.
- Maximum/minimum values.
- Range – difference between minimum and maximum values.
- Standard deviation.
- Sum of all values.
- Variance.

2.3.11 Operator Access Security (Combined Password and User ID)

2.3.11.1 Provide for Operator access into the Controls Systems via the use of on-line Owner defined software Password and User Identification (ID) pairs, unique for each Operator and unique throughout the Controls Systems Application, to supplement

standard password access control.

2.3.11.2 Stored password/user ID definitions shall be stored in encrypted formats whether at the Controls Server or at the application node.

2.3.11.3 Password logins shall not be echoed on any screen or printer except during Master Password definition processes. An Operator defining a password shall be required to re-enter to confirm authenticity.

2.3.11.4 Operator access privileges shall be definable in terms of functions and Project areas.

2.3.11.5 As part of the access privileges definition for each user the Owner shall be able to define at minimum the following:

- Access times by day.
- Permanent or temporary, with expiry date, password.
- Number of incorrect access attempts allowed before the password is disabled.
- Whether or not the Operators are able to redefine their own password.
- A field for the Operator's e-mail address.
- A field for the Operator's contact phone number.
- Definition of the Operator's access privilege functionalities including viewing only, full control, selected functions, etc.

2.3.12 Texting/E-mail Notification

2.3.12.1 Provide the means of automatic alphanumeric notification of personnel for Owner defined events.

2.3.12.2 The Controls System shall support both numeric and alphanumeric notification, using Alphanumeric, PET, or IXO Protocol at the Owner's option and/or service by the owners wireless service provider.

2.3.12.3 Users shall have the ability to modify the phone number or message to be displayed on the pager through the Controls System software.

3 **EXECUTION**

3.1 SYSTEM CONFIGURATION

3.1.1 Contractor shall thoroughly and completely configure BAS system software, supplemental software, network communications, CSS, OWS, remote operator workstation, portable operators terminal, printer, and remote communications.

3.2 OPERATOR INTERFACES

3.2.1 Set up workstations and printers as indicated on the Drawings. Install all software and verify that the systems are fully operational.

3.2.2 No license, software component, key or any piece of information required for installing, configuring, operating, diagnosing and maintaining the system shall be withheld from the Owner.

3.2.3 Install electronic control system Operation and Maintenance Manuals, programming guides, network configuration tools, and control Shop Drawings etc. on each OWS and CSS. Provide interface or shortcuts to guide user to the appropriate information.

3.2.4 Set up portable operator terminal and configure it as the remote workstation. Install all software and verify that the system is operational.

3.3 GRAPHIC SCREENS

3.3.1 Floor Plan Screens: The Contract Document Drawings will be made available to the Contractor in AutoCAD format upon request. These Drawings may be used only for developing backgrounds for specified graphic screens; however the Owner does not guarantee the suitability of these Drawings for the Contractor's purpose. Graphic Screens shall be submitted for approval.

3.3.1.1 Provide graphic floor plan screens for each floor of each building.

3.3.1.1.1 Indicate the location of all equipment that is not located on the equipment room screens.

3.3.1.1.2 Indicate the location of temperature sensors associated with each temperature-controlled zone (i.e., VAV terminals, fan-coils, single-zone AHUs, etc.) on the floor plan screens.

3.3.1.1.3 Display the space temperature point adjacent to each temperature sensor symbol. Use a distinct line symbol to demarcate each terminal unit zone boundary. Use distinct colors to demarcate each air handling unit zone.

3.3.1.1.4 Mechanical floor plan Drawings will be made available to the Contractor upon request for the purpose of determining zone boundaries. Indicate room numbers as provided by the Owner.

3.3.1.1.5 Provide a drawing link from each space temperature sensor symbol and equipment symbol shown on the graphic floor plan screens to each corresponding equipment schematic graphic screen.

3.3.1.2 Provide graphic floor plan screens for each mechanical equipment room and a plan screen of the roof. Indicate the location of each item of mechanical equipment. Provide a drawing link from each equipment symbol shown on the graphic plan view screen to each corresponding mechanical system schematic graphic screen.

3.3.1.3 If multiple floor plans are necessary to show all areas, provide a graphic building key plan. Use elevation views and/or plan views as necessary to graphically indicate the location of all of the larger scale floor plans. Link graphic building key plan to larger scale partial floor plans. Provide links from each larger scale graphic floor plan screen to the building key plan and to each of the other graphic floor plan screens.

3.3.1.4 Provide a graphic site plan with links to and from each building plan.

3.3.2 System Schematic Screens: Provide graphic system schematic screen for each HVAC subsystem controlled with each I/O point in the Project appearing on at least one graphic screen. System graphics shall include flow diagrams with status, setpoints, current analog input and output values, operator commands, etc. as applicable. General layout of the system shall be schematically correct. Input/output devices shall be shown in their schematically correct locations. Include appropriate engineering units for each displayed point value. Verbose names (English language descriptors) shall be included for each point on all graphics; this may be accomplished by the use of a pop-up window accessed by selecting the displayed point with the mouse. Indicate all adjustable setpoints on the applicable system schematic graphic screen or, if space does not allow, on a supplemental linked-setpoint screen.

3.3.2.1 Provide graphic screens for each air handling system. Indicate outside air temperature and enthalpy, and mode of operation as applicable (i.e., occupied, unoccupied, warm-up, cool-down). Link screens for air handlers to the heating system and cooling system

graphics. Link screens for supply and exhaust systems if they are not combined onto one screen.

3.3.2.2 Provide a graphic screen for each zone. Provide links to graphic system schematic screens of air handling units that serve the corresponding zone.

3.3.2.3 Provide a cooling system graphic screen showing all points associated with the chillers, cooling towers and pumps. Indicate outside air dry-bulb temperature and calculated wet-bulb temperature. Link screens for chilled water and condenser water systems if they cannot fit onto one cooling plant graphic screen.

3.3.2.4 Provide a heating system graphic screen showing all points associated with the boilers, and pumps. Indicate outside air dry-bulb temperature. Link screens for secondary heating water systems if they cannot fit onto one heating plant graphic screen.

3.3.2.5 Link screens for heating and cooling system graphics to utility history reports showing current and monthly electric uses, demands, peak values, and other pertinent values.

3.3.3 Bar Chart Screens: On each graphic Bar Chart Screen, provide drawing links to the graphic air handling unit schematic screens.

3.3.3.1 Provide a graphic chilled water valve screen showing the analog output signal of all chilled water valves in a bar chart format, with signals expressed as percentage of fully open valve (percentage of full cooling). Indicate the discharge air temperature and setpoint of each air handling unit, cooling system chilled water supply and return temperatures, and the outside air temperature and humidity on this graphic. Provide drawing links between the graphic cooling plant screen and this graphic screen.

3.3.3.2 Provide a graphic heating water valve screen showing the analog output signal of all air handling unit heating water valves in a bar chart format, with signals expressed as percentage of fully open valve (percentage of full heating). Indicate the temperature of the controlled medium (such as AHU discharge air temperature or zone hot water supply temperature) and the associated setpoint and the outside air temperature and humidity. Provide drawing links between the graphic heating plant screen and this graphic screen.

3.3.4 Alarms: Each programmed alarm shall appear on at least one graphic screen. In general, alarms shall be displayed on the

graphic system schematic screen for the system that the alarm is associated with (for example, chiller alarm shall be shown on graphic cooling system schematic screen). For all graphic screens, display analog values that are in a 'high alarm' condition in a red color, 'low alarm' condition in a blue color. Indicate digital values that are in alarm condition in a red color.

END OF SECTION

Project Name: *UNIVERSITY OF TORONTO MISSISSAUGA*
Project No.: *2023-0059*
Section Name: ***Communication Devices***
Section No.: ***25 30 00***
Date: *November 15, 2024*

INDEX

1 **GENERAL**

1.1 GENERAL

1.1.1 Sections 20 00 00 and 25 00 00 – General Requirements shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools, equipment, training, commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 Local Supervisory LAN Gateways/Routers.

1.2.2 Provide all interface devices and software to provide an integrated system connecting ANs, ASCs and Gateways to the Owner's Wide Area Network (WAN).

2 **PRODUCTS**

2.1 GENERAL

2.1.1 All materials shall meet or exceed all applicable referenced standards, federal requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.2 LOCAL SUPERVISORY LAN GATEWAY/ROUTERS

2.2.1 The Supervisory Gateway shall be a microprocessor-based communications device that acts as a gateway/router between the Supervisory LAN CSSs or OWS and the Primary LAN.

2.2.2 The gateway shall perform information translation between the Primary LAN and the Local Supervisory LAN, which is 100 Mbps Ethernet TCP/IP and shall use BACnet over IP.

2.2.3 The gateway shall contain its own microprocessor, RAM, battery, real-time clock, communication ports, and power supply as specified for an AN in Section 25 14 00 – Field Panels. Each gateway/router shall be mounted in a lockable enclosure unless it is a PC that also serves as an OWS.

2.2.4 The gateway/router shall allow centralized overall system supervision, operator interface, management report generation, alarm annunciation, acquisition of trend data, and communication with control units. It shall allow system operators to perform the

following functions from the CSS, OWSs, and POTs:

2.2.4.1 Configure systems.

2.2.4.2 Monitor and supervise control of all points.

2.2.4.3 Change control setpoints.

2.2.4.4 Override input values.

2.2.4.5 Override output values.

2.2.4.6 Enter programmed start/stop time schedules.

2.2.4.7 View and acknowledge alarms and messages.

2.2.4.8 Receive, store and display trend logs and management reports.

2.2.4.9 Upload/Download programs, databases, etc. as specified.

2.2.5 Upon loss of power to the gateway, the battery shall provide for minimum 100 hour backup of all programs and data in RAM.

2.2.6 The gateway shall be transparent to control functions and shall not be required to control information routing on the Primary LAN.

3 EXECUTION

3.1 PREPARATION

3.1.1 Examine areas and conditions under which control systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Subcontractor responsible for the installation of the BAS under the work of Division 25.

3.2 INSTALLATION

3.2.1 Installation shall meet or exceed all applicable federal, provincial, and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

3.2.2 All installation shall be in accordance with manufacturer's published recommendations.

3.2.3 Provide all interface devices and software to provide an integrated system.

3.2.4 Closely coordinate with the Owner, or designated representative, to establish IP addresses and communications to assure proper operation of the BAS with Owner's WAN.

END OF SECTION

INDEX

1 **GENERAL**

1.1 GENERAL

1.1.1 Sections 20 00 00 and 25 00 00 – General Requirements shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Refer to the below sequence of operation and associated control schematics for the required number of control loops. Provide all hardware and software necessary to achieve specified control. The sequence of events required for each control loop is described for each system in the control sequence.

1.2.2 Revise the controls shop drawing sequences of operation and create an “As-built or As Functioning Sequence of operation “to be included into the Operations and Maintenance Manuals.

1.2.3 The operators’ workstation to include a Sequence of Operation tab to provide a narrative to the operator regarding equipment / system operation.

2 **PRODUCTS**

Not used.

3 **EXECUTION**

3.1 GENERAL

3.1.1 When motorized equipment is operating, BAS shall totalize runtime in hours for use in maintenance operations.

3.1.2 Where parallel or duplex equipment is provided, BAS shall alternate lead equipment such that runtime is equalized.

3.1.3 Provide adjustable time delay between damper or valve opening and equipment start/stop to avoid operation with a closed system.

3.1.4 Select components to fail safe. Priority in descending order is: life safety, protection of equipment, and comfort.

3.1.5 Schedule operation of systems according to schedules provided by the Owner, and/or optimal start/stop program, and/or Operator keyboard entry.

3.1.6 All low limit thermostats (freezestats), in addition to providing a DI control point, shall be hardwired to the equipment starter to shut down the system upon sensing an air temperature below 2°C (36°F).

3.1.7 Shut down fans upon detection (via BAS sensors) of supply or return air temperatures in excess of 67°C (135°F).

3.1.8 Co-ordinate the provision of duct mounted smoke detectors by Division 26 - Electrical. Detectors shall be hardwired to the respective fan starter to shut the fan down upon detection of smoke.

3.1.9 Co-ordinate fire alarm system fan shutdown where provided via the BAS with Division 26 - Electrical.

3.1.10 Fan systems shall not be started if motorized damper end switch indicates that the damper is not fully open. Alarm abnormal status of damper to BAS and start standby system if applicable.

3.1.11 Unscheduled shutdown of either the supply or return fan shall result in a system shutdown, and an abnormal status alarm condition at the BAS, and start-up of the standby system if applicable.

3.1.12 Static pressure control on all VAV air systems shall be sensed at a position 2/3 downstream of the supply fan. Shut system down if static pressure exceeds 498 Pa (2” w.c.)

3.1.13 Airside free cooling control shall be enabled based on enthalpy control.

3.1.14 All noted setpoints shall be operator-adjustable, and subject to tuning during system commissioning.

3.1.15 Status of motors shall be by current draw unless noted otherwise in the Contract Documents.

3.2 LIFE SAFETY INTERFACE

3.2.1 Division 26 – Electrical shall monitor and control all mechanical systems dedicated to life safety, notably the smoke control systems.

3.3 DEDICATED OUTDOOR AIR HANDLING UNITS (HEAT RECOVERY, HEAT PUMP)

3.3.1 Supply Fan Control:

3.3.2 Upon a start command the isolation damper shall open. When open status is achieved, the variable speed supply fan shall be started based on occupancy and demand control ventilation. After the start command is sent, the outside air damper will open, and the unit will start when he damper end switch has be proven open status. When the supply fan status indicates the fan has started, the control sequence shall be enabled. Upon a loss of airflow, the supply fan will attempt to automatically restart until a positive status is received.

3.3.3 Exhaust Fan Control:

3.3.4 After the supply fan has been started, the isolation damper will open, and the exhaust fan will start when the damper end switch has proven open status.

3.3.5 Temperature Control:

3.3.6 The unit will control to maintain constant discharge air temperature. The setpoint shall be adjustable.

3.3.7 Unit Protection:

3.3.8 Low Temperature alarm

3.3.9 Additional points monitored:

3.3.10 Exhaust Fan Status/Speed

3.3.11 Fan Filter Status

3.3.12 Supply Air Static Pressure

3.3.13 Supply Fan Status/Speed

3.3.14 Return Air CO2 Sensor

3.4 <u>LABORARY VENTILATION SYSTEM</u>

3.4.1 Laboratory hood, exhaust fan, and supply fan shall be interlocked together upon activation of the system from the laboratory fume hood controls.

3.4.2 Supply fan, exhaust fan, and electric duct heater status shall be monitored by the BAS.

3.4.3 Alarm at BAS if the fan status does not match fan command after 2 minutes.

3.5 VAV BOXES (DEMAND CONTROL VENTILATION)

3.5.1 Modulate the damper to maintain the airflow setpoint as measured by the flow transducer. The airflow setpoint shall be changed based on the carbon dioxide sensors located in the zones. As the zone CO2 levels decrease, the airflow setpoint is increased. Maximum and minimum airflows are indicated on the Drawings. Program all setpoints prior to air balancing.

3.5.2 The VAV boxes shall be equipped with an air-flow monitoring device interface with the BAS

3.6 PERIMETER BASEBOARD HEATERS

3.6.1 Perimeter baseboard heaters shall be controlled by the BAS. Provide solid state relay to pulse width modulate based on demand.

3.6.2 Setpoints shall be adjustable.

3.7 VARIABLE REFRIGERANT FLOW SYSTEM

3.7.1 VRF systems shall be monitored by the building automation system.

3.7.2 Temperature setpoints shall be adjustable for each indoor unit

3.8 IT ROOM AC UNIT

3.8.1 The mechanical cooling shall be cycled by switching the fan from low speed to high speed and cycling the DX cooling as required to maintain room setpoint temperature of 23.9°C (75°F).

3.8.2 Monitor the unit for temperature, status, and alarm.

3.9 MECHANICAL ROOM VENTILATION

3.9.1 Through a DDC controller, a space temperature sensor shall sequence the unit heaters, and the supply and exhaust fans to maintain space setpoint temperature according to the following schedule:

- Unit heaters on below 18.9°C (65°F)

- Unit heaters off above 20°C (68°F)
- exhaust fans on above 23.9°C (75°F)

3.10 MISCELLANEOUS EXHAUST FANS

3.10.1 When exhaust fan is off, close respective damper.

3.10.2 When exhaust fan is activated based on time of day schedule, open damper before starting fan.

3.11 UNIT HEATERS

3.11.1 The BAS will control the unit heater using space temperature sensors

3.11.2 Set all thermostats at 20°C (68°F). Deadband shall be 1.1°C (2°F). Unit heater shall shut off at 21.1°C (70°F). All setpoints shall be adjustable.

3.11.3 Unit heaters in the apparatus bay shall be interlocked with apparatus bay door contacts and deactivate when doors are open.

3.12 DOMESTIC HOT WATER PLANT

3.12.1 Monitor recirculator pump for status and alarm

3.12.2 Refer to domestic hot water flow diagrams and for additional details.

3.12.3 Boiler shall initiate at low fire, and stage up to high fire to maintain domestic hot water temperature at setpoint of 60.0°C (140°F).

3.12.4 Each boiler control panel shall control capacity of each boiler to maintain domestic hot water temperature at setpoint of 60.0°C (140°F).

3.13 GARAGE EXHAUST SYSTEM

3.13.1 Diesel engine emissions (Nitrogen Dioxide)

3.13.2 Low Level Alarm

3.13.3 If any NO2 sensor (or group of sensors as programmed) detect 0.72 PPM Nitrogen Dioxide gas, Low Alarm relay is activated by the main gas detection control panel, exhaust fan operates and intake air damper opens. Low Alarm indicator lights on the main

Gas detection control panel LED lights for point in alarm.

3.13.4 High Level Alarm

3.13.5 If hazardous NO2 gas concentrations are not cleared after 30 minutes or if NO2 gas concentration continues to rise and any sensor detects a Nitrogen Dioxide concentration of 2.0 PPM gas, High Alarm relay is activated, High Alarm indicator lights on the main Gas detection control panel and panel audible alarm is activated, Audible Alarm to sound and contacts continue to operate the ventilation exhaust fan.

3.13.6 Gasoline engine emissions (Carbon Monoxide)

3.13.7 Low Level Alarm

3.13.8 If any CO sensor (or group of sensors as programmed) detect 25 PPM Carbon Monoxide gas, Low Alarm relay is activated by the main gas detection control panel, exhaust fan operates and intake air damper opens. Low Alarm indicator lights on the main Gas detection control panel LED lights for point in alarm.

3.13.9 High Level Alarm

3.13.10 If hazardous CO gas concentrations are not cleared after 30 minutes or if CO gas concentration continues to rise and any sensor detects a Carbon Monoxide concentration of 100 PPM gas, High Alarm relay is activated, High Alarm indicator lights on the main Gas detection control panel and panel audible alarm is activated, Audible Alarm to sound and contacts continue to operate the ventilation exhaust fan.

3.14 MISCELLANEOUS CONTROL POINTS

3.14.1 Monitor the following additional points via the BAS.

MISCELLANEOUS CONTROL POINTS			
DESCRIPTION	**LOCATION**	**TYPE**	**REMARKS**
CO Monitoring System	CO Control Panels	DI	Alarm High Level
Generator Transfer Switch	Transfer Switch	DI	Alarm Emergency Power Supply Position

MISCELLANEOUS CONTROL POINTS			
DESCRIPTION	**LOCATION**	**TYPE**	**REMARKS**
Sump Pumps	Sump Pump Control Panel	DI	Alarm High Level (6x)
Water Check Meters	Meter Panel	DI	Pulse Counter for Consumption (2x)

END OF SECTION

Design Standard DSM-03

BUILDING AUTOMATION SYSTEMS

Revision 1.1
July 2018

UTM Construction Standards

Renovations & New Construction

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Version	**Revision 1**
Effective Date	27-07-2018
Approved By	
	Senior Project Manager, Mechanical & Electrical
Approved By	
	Manager, Mechanical Operations
Reviewed By	
	Acting Director, Utilities & Operations

1. INTRODUCTION

1.1. General

1.1.1. This Building Automation Systems (BAS) Design Standard has been developed to establish the University's minimum expectations and requirements for new BAS installations on campus

1.1.2. This Standard is based on current Codes and Standards, Industry Best Practices and the University's preferred approach to standardizing design from the perspective of system configuration and performance, operating flexibility and efficiency, maintenance practices and protocols and inventory management

1.1.3. This document is a living document that will be reviewed and updated regularly to ensure that it remains current and relevant with evolving technology. Please ensure to use the latest version.

1.2. Definitions & Acronyms:

1.2.1. UTM : University of Toronto Mississauga

1.2.2. FM&P: Facilities Management and Planning

1.2.3. I&ITS: Information & Instructional Technology Services

1.2.4. BAS: Building Automation System

1.2.5. UTM FM&P Designate: The Director, Utilities & Operations, Facilities Management and Planning Design, unless otherwise indicated.

1.3. Compliance Criteria

1.3.1. Full compliance is mandatory on projects involving new construction.

1.3.2. Full compliance is mandatory for new BAS installation within projects involving significant renovations.

1.3.3. Compliance is recommended to the extent practical and feasible for all projects involving minor renovations and rework of existing BAS infrastructure

1.3.4. Any deviations from the minimum requirements outlined in this Standard must be approved by UTM FM&P Designate, before the completion of Schematic Design..

1.4. Responsibility of the Designer

1.4.1. The System Designer remains responsible for ensuring any proposed design solution is in full compliance with applicable Codes & Standards in force at the time of the design.

1.4.2. Any conflict between applicable Codes & Standards and this Standard shall be identified and presented to the UTM FM&P Designate, together with proposed measures for addressing the conflict.

1.5. Design Innovation

1.5.1. This Standard is not intended to preclude or constrain an Innovative Approach to Design. It however remains the responsibility of the Designer to demonstrate that any proposed design innovations are in general compliance with the design intent outlined in this Standard.

1.5.2. All proposed Design Innovation shall be tabled for consideration by the UTM FM&P Designate, before the completion of Schematic Design.

1.6. Related Documents (consultant to ensure referring to the latest editions)

1.6.1. Electrical Power Systems Standard DSE-01
1.6.2. Electrical Lighting Systems Standard DSE-02
1.6.3. Fire Alarm Systems Standard DSE-03
1.6.4. HVAC Systems Standard DSM-01
1.6.5. Plumbing Systems Standard DSM-02
1.6.6. Fire Protection Systems Standard DSM-04
1.6.7. Energy Management Control System Installations Master Specs (Integrated Automation)
1.6.8. Metering System Standards

1.7. Standards and References (consultant to ensure referring to the latest editions)

1.7.1. Ontario Building Code
1.7.2. ASHRAE Standard ANSI/ASHRAE 135 - BACnet
1.7.3. ASHRAE Guideline 13, Specifying Direct Digital Control Systems.
1.7.4. ANSI/TIA/EIA862 Building Automation Systems Cabling Standard for Commercial Buildings.
1.7.5. Federal Communication Commission (FCC) Rules and Regulations, Part 15, Subpart J for computing devices
1.7.6. Public Health Agency of Canada - Laboratory Biosafety Guidelines
1.7.7. Canadian Council for Animal Care Guidelines
1.7.8. LEED Guidelines

The Design Team is required to read and comply with the full Design standard as it applies to this project. A completed copy of this checklist must be submitted by the Design Team to the University's Project Manager at the end of the Design Development Phase. In all cases, if a "does not comply" has been noted, please indicate why. Attach additional sheets as necessary

2. DESIGN STANDARDS

	C	NC	N/A
2.1. General Requirements			
2.1.1. Overarching Design Principles			
2.1.1.1. All new BAS installations shall be designed as an integrated, open protocol, BACnet compliant system to ANSI/ASHRAE Standard 135.	X	☐	☐
2.1.1.2. All BAS installation in new projects involving significant renovations shall be designed as an integrated, open protocol, BACnet compliant system to ANSI/ASHRAE Standard 135; any proposed deviations shall be presented to the UTM FM&P Designate for approval during the Schematic Design Phase. BAC-Net Device Instance Numbering to be coordinated with UTM existing network to ensure no duplication.	X	☐	☐
2.1.2. Interfacing Standards:			
2.1.2.1. Input/output devices to use ASCII (American Standard for Communication and Information Interchange) code and standard EIA (Electronic Industry Association) interfaces.	X	☐	☐
2.1.2.2. CSA T530: Building Facilities, Design Guidelines for Telecommunications (same as EIA/TIA 569).	X	☐	☐
2.1.2.3. IEEE 802.3 Ethernet 10Base-T LAN	X	☐	☐
2.1.3. All Components and Equipment shall be designed and selected to provide the requisite level of function and performance when operating in following minimum ambient condition ranges:	X	☐	☐
2.1.3.1. Temperature: 0°to 40°C (32° to 104°F) for Indoor Installation / -30°to 40°C (-22° to 104°F) for Outdoor Installation	X	☐	☐
2.1.3.2. Relative Humidity: 10% to 90% non-condensing	X	☐	☐
2.1.3.3. Withstand VHF, UHF, FM, AM or background RFI as generated by commercial or private, portable or fixed transmitters that meet regulatory codes	X	☐	☐
2.1.4. All equipment, components& devices shall be designed to operate on an electrical power service rated at 120 VAC +/- 10%, 60 Hz nominal.	X	☐	☐
2.1.4.1. Components installed within Motor Control Devices to be designed to operate with transient electrical fields occurring within these devices	X	☐	☐

Complete and submit by the end of Design Development Phase (C: Complies, NC: Does not comply, N/A: Not applicable)

	C	NC	N/A
2.1.5. Licenses and Ownership			
2.1.5.1. Ownership of, and licenses for, all hardware and software originally installed or required for ongoing system operation, maintenance and modification to be registered, without restrictions, in Owner's name.	☒	☐	☐
2.1.5.2. Licensing to permit an unlimited number of users to access system without additional fees.	☒	☐	☐
2.1.5.3. As of last month of the warranty period, software is to be upgraded to current version or release at no cost to the Owner.	☒	☐	☐
2.2. BAS Architecture – Individual Buildings			
2.2.1. BAS Network Architecture			
2.2.1.1. Dedicated LAN for BAS	☒	☐	☐
2.2.1.2. BAS communication architecture to consist of at least two tiers with each tier using local area networks.	☒	☐	☐
2.2.1.2.a. Tier 1: Building Controller network;			
• High level network providing communication between Building Control Unit's (BCU's) and workstations	☒	☐	☐
• Ethernet communications (ISO 8802-3/IEEE 802-3), using high speed local area network communications. TCP/IP to be used as communication protocol on first tier network.	☒	☐	☐
• Shall be designed with an expansion capacity of at 10 additional BCU/Routers over and above those required to complete the original installation.	☒	☐	☐
2.2.1.2.b. Tier 2: Equipment Controller network;			
• Lower level network providing communications between Equipment Control Units (ECU's) and BCU's.	☒	☐	☐
• Open, peer-to-peer control networks to interconnect BAS controllers (Building Control Units, BCU's, and/or Equipment Control Units, ECU's) on ring or star topology bus.	☒	☐	☐
• Peer-to-peer configuration means units exist and speak equally on same bus.	☒	☐	☐
• Controllers in peer-to-peer configuration can share data without assistance from Operator Interface.	☒	☐	☐
2.2.1.3. System architecture to be modular, permitting stepped expansion of application software, system peripherals, and field hardware	☒	☐	☐
2.2.1.4. Use of non-networked stand-alone control devices is not permitted.	☒	☐	☐
2.2.2. Control System:			
2.2.2.1. High-speed, peer-to-peer network comprising microprocessor based Direct Digital Control (DDC) controllers with a web-based operator interface,	☒	☐	☐

Complete and submit by the end of Design Development Phase (C: Complies, NC: Does not comply, N/A: Not applicable)

	C	NC	N/A
2.2.2.2. Each system controlled or monitored through the BAS, building floor plan, and control device to be displayed through point-and-click graphics,	X	☐	☐
2.2.2.3. Web server with network interface card to gather data from this system and generate web pages that can be accessed through conventional web browser on any PC connected to network,	X	☐	☐
2.2.2.4. Operators to access this system through web browser, and browser interface to perform normal operator functions.	X	☐	☐
2.2.2.5. OEM Controller integration			
2.2.2.5.a. BAS to incorporate hardware and software to allow bi-directional data communications between BAS and 3rd party manufacturers' control panels.	X	☐	☐
2.3. BAS Functional Requirements			
2.3.1. Functional requirements shall be defined through the use of Control Sequences & Schematics and Points List used in combination.	X	☐	☐
2.3.1.1. Control sequences shall be developed based on overarching criteria defined under Clause 2.11.	X	☐	☐
2.3.2. Controllers			
2.3.2.1. Designed to operate with local closed loop programming, independent from server, if peer-to-peer communication is interrupted.	X	☐	☐
2.3.3. Central BAS Web Server			
2.3.3.1. Designed to perform global application programs and data consolidation including:	X	☐	☐
2.3.3.1.a. Communications with controllers,	X	☐	☐
2.3.3.1.b. Host software routines for:			
• BAS Server operation,	X	☐	☐
• Database creation and data storage,	X	☐	☐
• Web based Graphical User Interface (GUI) with graphics generation and display,	X	☐	☐
• Reporting	X	☐	☐
2.3.3.2. Establish in consultation with UTM FM&P Designate prior to completion of the Schematic Design whether the BAS is to utilize a Standalone Server or reside on a Central Mapus Server.	X	☐	☐
2.4. BAS Client Workstation			
2.4.1. Resides on the Tier I network.	X	☐	☐
2.4.2. Selected as Industry standard hardware. Confirm specs and configuration with FM&P Designate prior purchase, supply or installation.	X	☐	☐

Complete and submit by the end of Design Development Phase (C: Complies, NC: Does not comply, N/A: Not applicable)

	C	NC	N/A
2.4.2.1. Hard disk to be capable of storing system software, one year archive of trend data, and system database that is not less than twice size of database at initial system acceptance	X	☐	☐
2.4.2.2. Minimum workstation configuration;			
2.4.2.2.a. Intel quad core (i7) 2.5 Ghz processor,	X	☐	☐
2.4.2.2.b. Windows 10 Professional Operating System with current service packs, (64-bit)	X	☐	☐
2.4.2.2.c. Memory: 32 Gigabyte (GB) DDR4 SDRAM at 2GHz RAM,	X	☐	☐
2.4.2.2.d. Minimum 6 USB - 3 slots	X	☐	☐
2.4.2.2.e. 500 MB AGP local bus, Graphics card, minimum 1600 x 1200, 16-bit colour resolution,	X	☐	☐
2.4.2.2.f. Mouse,	X	☐	☐
2.4.2.2.g. Minimum four PCI slots,	X	☐	☐
2.4.2.2.h. AGP slot,	X	☐	☐
2.4.2.2.i. 10/100/1000 Mbps Ethernet Network Interface Card(s) ,	X	☐	☐
2.4.2.2.j. SSD 1 TB SCSI hard drives with RAID5 configuration	X	☐	☐
2.4.2.2.k. DVD-RW	X	☐	☐
2.4.2.2.l. Built-in speakers to annunciate alarms,	X	☐	☐
2.4.2.2.m. Norton or McAfee Antivirus software, latest version,	X	☐	☐
2.4.2.2.n. Uninterruptible Power Supply (UPS): 15 minute, minimum 500 Watts, while supporting PC and monitor,	X	☐	☐
2.4.2.2.o. Redundant power supplies and fans,	X	☐	☐
2.4.2.2.p. Hardware watchdog monitoring card,	X	☐	☐
2.4.2.2.q. Suitable for mounting in 425 mm (19 in) rack	X	☐	☐
2.5. BAS Server – Individual Buildings for BAS residing on a Central Campus Server			
2.5.1. A dedicated BAS Server is not required; rather the BAS software shall be installed on a designated Campus Server residing on a Tier I network.	X	☐	☐
2.5.1.1. Minimum performance levels for the server shall be estimated before completion of the Design Development Phase and submitted to the UTM FM&P Designate.	X	☐	☐
2.5.1.2. Performance levels for the server shall be validated by the chosen BAS vendor and finalized within 60 days of commencement of the Construction Phase	X	☐	☐
2.6. Main Operator Workstation – Individual Buildings	X	☐	☐

Complete and submit by the end of Design Development Phase (C: Complies, NC: Does not comply, N/A: Not applicable)

	C	NC	N/A
2.6.1. A dedicated Main Operator Workstation (OWS) shall be provided in each building. This may be located in the Main Mechanical Room. In addition one (1) designated and dedicated BAS Interface shall be provided in each Mechanical Room / Equipment Room to allow access to the BAS Graphics using a portable device.			
2.7. Internet Appliances			
2.7.1. BAS architecture and software to incorporate thin client design software to allow use of web appliances such as Tablets and web-enabled cellular telephones	X	☐	☐
2.8. Fibre Optic Cable			
2.8.1. Duplex 900 mm tight-buffer construction designed for intra-building environments	X	☐	☐
2.8.2. UL listed sheath OFNP meeting requirements of FDDI, ANSI X3T9.5 PMD for 62.5/125mm.	X	☐	☐
2.8.3. Field terminations made using ST type connectors with ceramic ferrules and metal bayonet latching bodies.	X	☐	☐
2.9. Routers and Bridges			
2.9.1. Selected as Industry standard hardware			
2.9.1.1. Central system to use an Ethernet Local Area Network (LAN) for communication.	X	☐	☐
2.9.1.2. Communication between central server and controllers to be IP.	X	☐	☐
2.9.1.3. Router to bridge IP and data link (BACNet, MS/TP, MODBUS) to be used between controllers if required.	X	☐	☐
2.9.1.4. Router to use FLASH memory and allow firmware updates to be performed from remote work station.	X	☐	☐
2.10. BAS Software			
2.10.1. System software to support alternate operating systems, such as Red Hat Linux, or Sun Solaris.	X	☐	☐
2.10.2. Software to be completely web based without need for interface/translation devices or need to load software individually on each computer.	X	☐	☐
2.10.3. System and software to be capable of remote access, for multiple users, through internet connections.	X	☐	☐
2.10.4. Graphic files to be created with use of graphics generation package furnished with system.	X	☐	☐
2.10.5. Software to support concurrent operation of multiple standard and non-standard protocols including but not limited to:	X	☐	☐
2.10.5.1. BACnet			
2.10.5.2. MODBUS			

Complete and submit by the end of Design Development Phase (C: Complies, NC: Does not comply, N/A: Not applicable)

	C	NC	N/A
2.10.5.3. LONTalk			
2.10.5.4. OPC			
2.10.5.5. SNMP			
2.10.6. Operator Interface designed to operate through standard desktop or laptop personal computers without requiring purchase of special software from BAS manufacturer.	☒	☐	☐
2.10.6.1. Interface on these personal computers to be standard Web Browser by Microsoft, Chrome or Firefox.	☒	☐	☐
2.10.7. System software to support automatic email notification	☒	☐	☐
2.11. Control Sequences - Overarching Criteria			
2.11.1. Control sequences shall be developed with consideration to the overarching criteria listed below. Where criteria have not been defined, develop control sequences based on guidelines published in the ASHRE Handbook and/or following Industry Best Practices.	☒	☐	☐
2.11.2. Minimum Requirements			
2.11.2.1. Occupancy Sensors for terminal unit set-back controls	☐	☐	☒
2.11.2.2. Occupancy sensors to control AHU(s) dedicated to an individual classroom.	☐	☐	☒
2.11.2.3. Standalone local washroom exhaust fan interfaced with the light switch and an Off-Timer	☒	☐	☐
2.11.2.4. Control Valve sequences shall incorporate a feedback loop to detect leakage past valve when in “Closed Position”	☐	☐	☒
2.11.2.5. Supply Air Temperature Reset based on Terminal Unit Damper Position (for VAV Systems) and Reheat Valve Position.	☒	☐	☐
2.11.2.6. Mixed Air Temperature as a means of controlling Fresh Air Damper.	☐	☐	☒
2.11.3. Mode Control			
2.11.3.1. To prevent the various control components (valves and dampers) from competing with one another, they are operated in sequence (based on heating or cooling demand). This sequence is determined by a "mode"; various modes are described below. In each mode the Primary Heating Valve (PHT) Low Limit (LL) controller will always be active and will keep the heating valve from closing when the PHT is below its low limit set point. In each modes the Mixed Air Temperature (MAT) LL controller will be active and will close the dampers (even below the min fresh air setting) when the MAT is below its low limit set point.	☒	☐	☐
2.11.3.2. Mode 0: Shutdown	☒	☐	☐
2.11.3.2.a. Fans will stop	☒	☐	☐

		C	NC	N/A
2.11.3.2.b.	Dampers will close	X	☐	☐
2.11.3.2.c.	Cooling valves will close	☐	☐	X
2.11.3.2.d.	Humidity valves will close	☐	☐	X
2.11.3.2.e.	If outside air is colder than the MAT LL Set Point then the heating valve will modulate to control the MAT at the LL Set Point, otherwise the heating valve will close.	☐	☐	X
2.11.3.3. Mode 1: Startup		X	☐	☐
2.11.3.3.a.	This mode is only necessary when the ambient temperature is close to freezing (adjustable, pre-set to 3ºC).	X	☐	☐
2.11.3.3.b.	On 100% Fresh Air units the heating valve will fully open (on cold days) to preheat the coil before the fan starts (this is necessary since the coils may not respond fast enough when a cold PHT leaving temperature is detected, resulting in a unit trip on a freezestat input). Once the fan starts the heating valve will ramp down to the achieve the desired temperature set-point.	☐	☐	X
2.11.3.3.c.	On mixed air units the outside dampers will remain closed on days with the ambient temperature is close to freezing (adjustable, pre-set to 3ºC) to remove any residual heat that may have accumulated in the duct when the unit is offline. After the morning warm-up the dampers will slowly ramp open to achieve the desired control set-point, supply air temperature or carbon dioxide levels.	☐	☐	X
2.11.3.3.d.	After the morning warm-up period the system will switch out of startup mode.	X	☐	☐
2.11.3.4. Mode 2: Damper		☐	☐	X
2.11.3.4.a.	The heating coil control valve will modulate to maintain the PHT LL set point.	☐	☐	X
2.11.3.4.b.	Cooling coil valve will be closed.	☐	☐	X
2.11.3.4.c.	Damper will modulate to maintain the Supply Air Temperature (SAT) SP	☐	☐	X
2.11.3.5. Mode 3: Heating		☐	☐	X
2.11.3.5.a.	Cooling coil valve will be closed.	☐	☐	X
2.11.3.5.b.	Damper will be at minimum.	☐	☐	X
2.11.3.5.c.	The heating coil valve will modulate to maintain the SAT at set point.	☐	☐	X
2.11.3.6. Mode 4: F/B Damper or Reheat		☐	☐	X
2.11.3.6.a.	The damper will be at minimum position.	☐	☐	X
2.11.3.6.b.	The cooling coil will be closed.	☐	☐	X

Complete and submit by the end of Design Development Phase (C: Complies, NC: Does not comply, N/A: Not applicable)

	C	NC	N/A
2.11.3.6.c. When this mode is active the heating coil valve will be open at least 75% and the damper will modulate the air around the coil. If the air is being all directed to the coil then the heating coil valve will ramp open further.	☐	☐	☒
2.11.3.7. Mode 5/6: Heating Stage 1 and Stage 2	☐	☐	☒
2.11.3.7.a. The damper will be at minimum position.	☐	☐	☒
2.11.3.7.b. The cooling coil valve will be closed.	☐	☐	☒
2.11.3.7.c. This mode is used for on/off heating stages (gas or electric).	☐	☐	☒
2.11.3.8. Mode 7: Cooling	☐	☐	☒
2.11.3.8.a. The damper will be at maximum (economizer/enthalpy control may close this to minimum position).	☐	☐	☒
2.11.3.8.b. Heating coil valve will be closed (PHT LL always active).	☐	☐	☒
2.11.3.8.c. The cooling coil valve will modulate to maintain the SAT at set point.	☐	☐	☒
2.11.3.9. Mode 8/9: DX Stage 1 and Stage 2	☐	☐	☒
2.11.3.9.a. The damper will be at maximum (economizer/enthalpy control may close this to minimum position).	☐	☐	☒
2.11.3.9.b. Heating coil valve will be closed (PHT LL always active).	☐	☐	☒
2.11.3.10. .Mode10: Dehumidification	☐	☐	☒
2.11.3.10.a. This mode is rarely used (it requires a cooling coil before a reheat coil).	☐	☐	☒
2.11.3.10.b. If a temperature sensor is installed after the cooling coil then the cooling coil control valve will be modulated to maintain the coil discharge temperature at the dew point. If no temperature sensor is installed after the cooling coil then the cooling coil valve will be 100% open.	☐	☐	☒
2.11.3.10.c. The reheat coil valve will be modulated to maintain the SAT at its set point.	☐	☐	☒
2.11.4. Mixed Air Handling Units			
2.11.4.1. To prevent a large in-rush current draw the fans within a building or across the campus are staggered using the following formula. Delay time (in seconds) = (Building number) + 10 * (fan number). Lag fans (when controlled by the automation system) will start 5 seconds after the lead fan.	☒	☐	☐
2.11.4.2. When the unit is off, the dampers will be closed and the heating valve will be used to maintain the MAT at its low limit set point (cold side of the coil). If the outside air temperature is below the MAT LL SP then a morning warm-up flag will be enabled.	☐	☐	☒
2.11.4.3. On system startup, if the morning warm-up is enabled then the dampers will remain closed during the warm-up period. Once the	☐	☐	☒

	C	NC	N/A
warm-up period is over the dampers will ramp open to their control point.			
2.11.4.4. The system will operate according to the "Mode Control" as outlined above.	X	☐	☐
2.11.5. Fresh Air Handling Units			
2.11.5.1. To prevent a large in-rush current draw the fans within a building or across the campus are staggered using the following formula. Delay time (in seconds) = (Building number) + 10 * (fan number). Lag fans (when controlled by the automation system) will start 5 seconds after the lead fan.	X	☐	☐
2.11.5.2. When the unit is off, the dampers will close automatically and the heating valve will be used to maintain the PHT at its low limit set point (cold side of the coil is preferable if a sensor is available). If the outside air temperature is below the MAT LL SP then a morning warm-up "Heat Blast" flag will be enabled.	X	☐	☐
2.11.5.3. The "Heat Blast" will just open the heating coil 100% for 2 minutes before the fan is given a start command. Once the fan is running the heating valve will ramp down to the control point.	☐	☐	X
2.11.5.4. The system will operate according to the "Mode Control" as outlined above.	X	☐	☐
2.11.6. Variable Air Volume Units (VAV's)			
2.11.6.1. VAV's will maintain space temperature by adjusting the volume of air into the space while keeping it between an operator adjustable minimum and maximum volume.	☐	☐	X
2.11.6.2. If a reheat coil is installed then a discharge temperature sensor after the coil must be provided to identify any leaking valve.	☐	☐	X
2.11.6.3. If the space temperature is below the set point then the VAV will switch to reheat mode in which case the volume of air will increase to a heating set point (minimum air volume may be too little to allow the warm air from reaching the occupants); this is typically 10% of the span between minimum and maximum and then added to the minimum.	☐	☐	X
2.11.6.4. A demand limit variable is generated which can be used by the AHU to adjust the duct pressure and supply air temperature (we can't just use the space temperature and set point since we won't be able to determine if the VAV had more capacity to satisfy the space temperature). A value of 0% indicates the AHU should increase the supply air temperature while a value of 100% indicates that the temperature should be lowered. The AHU will only use this information if it has feedback from most of the spaces it affects.	X	☐	☐
2.11.7. Exhaust Fans			
	X	☐	☐

Complete and submit by the end of Design Development Phase (C: Complies, NC: Does not comply, N/A: Not applicable)

	C	NC	N/A
2.11.7.1. Exhaust fans will typically operate based on a predefined Occupancy Schedule.	X	☐	☐
2.11.8. Standard Reset Schedules	☐	☐	X
2.11.8.1. Air handlers will use a standard outdoor air temperature reset schedule unless there is a calculated reset based on the return air temperature (typically permitted only if an AHU serves limited zones).			

Outside Air Temperature °C	Supply Air Temperature Set-point °C
30	18
20	15
10	18

2.11.8.2. In the winter it may be possible to throttle (close) a heating valve to a point which causes an air handling unit to trip on a freezestat. To minimize this occurrence a minimum position for the heating valve is calculated from the outdoor air temperature.	☐	☐	X

Outside Air Temperature (°C)	Supply Air Temperature Set-point (°C)
5	0
-15	20

2.11.8.3. The return air humidity set point is also adjusted by an outdoor air temperature reset schedule.	☐	☐	X

Outside Air Temperature (°C)	Supply Air Temperature Set-point (°C)
-25	10
15	40

2.11.9. Heat Reclaim			
2.11.9.1. Plate heat exchanger for air to air systems will use a bypass damper when the exhaust air "ices up" and the pressure increases across the exhaust plates.	X	☐	☐
2.11.9.2. "Run around" glycol loops heat reclaim systems will be disabled in the when the energy required to run the pumps is greater than the heat reclaimed (typically OAT > 10 ºC).	☐	☐	X
2.12. Lighting Controls			

	C	NC	N/A
2.12.1. A Stand-Alone Programmable Lighting Control System with a BACNet MSTP interface will be provided for all New Construction as called for under Electrical Lighting Systems Standards DSE-02. This Lighting Control system shall be interfaced with the Building Automation System and the following elements incorporated into the BAS Graphics	☐	☐	☒
2.12.1.1. Floor Plan showing the different Lighting Zones	☐	☐	☒
2.12.1.2. Map all the Lighting Control Points	☐	☐	☒
2.12.1.3. Set up Lighting Control Schedules	☐	☐	☒
2.13. BAS Graphics			
2.13.1. BAS workstation to include graphic for each zone, mechanical system with links to navigate between floor plans graphic to indicate location of all BAS devices, power transformers, temperature/humidity/CO2/pressure sensors. Sequence of operation of every system to be linked to the graphics	☒	☐	☐
2.13.2. At a minimum BAS graphics shall display the following:	☒	☐	☐
2.13.2.1. Facility Site Graphic	☒	☐	☐
2.13.2.2. Individual Graphics for each System	☒	☐	☐
2.13.2.3. Terminal Unit & Equipment Floor Plan	☒	☐	☐
2.13.2.3.a. Room Number and Area designation for each Terminal Unit & piece of Equipment	☒	☐	☐
2.13.2.4. A Main Page in Tabular Format displaying, as applicable, the following information for each piece of equipment/system	☒	☐	☐
2.13.2.4.a. Command Status	☒	☐	☐
2.13.2.4.b. State Status	☒	☐	☐
2.13.2.4.c. Current Set-Points	☒	☐	☐
2.13.2.4.d. Current Speed	☒	☐	☐
2.13.2.4.e. Current Temperatures	☒	☐	☐
2.13.2.4.f. Alarm Condition, if any, displayed in a different color.	☒	☐	☐
• Alarms to be assigned a Priority Ranking and include Descriptor identifying relevant equipment and its location. (eg. E1 BLDG 040 P4 Condensate Pump failed to start <Room 008>	☒	☐	☐
2.13.2.4.g. Area served by Equipment/System with a link to the individual graphic for the said Equipment/System	☒	☐	☐
2.13.3. Graphics shall be developed using a standard library of image files and industry standard symbols.	☒	☐	☐
2.13.4. Graphics to have link to sequence of operation for the system in word/notepad format. PDF format to be stored on server for future reference.	☒	☐	☐

Complete and submit by the end of Design Development Phase (C: Complies, NC: Does not comply, N/A: Not applicable)

	C	NC	N/A
2.14. BAS Communication Wiring			
2.14.1. Wiring shall be installed in conduit, raceways and enclosures separated from other wiring.	X	☐	☐
2.14.1.1. Conduit:			
2.14.1.1.a. thin wall (EMT) conduit up to and including 32mm (1/1/4 in) size for exposed wiring up to 3 m (10 ft) above floor level,	X	☐	☐
2.14.1.1.b. rigid galvanized steel conduit in locations accessible to public, subject to mechanical injury, or outdoors; and for conduit 40mm (1 ½ in) size and larger,	X	☐	☐
2.14.1.1.c. watertight compression fittings in exterior location	X	☐	☐
2.14.1.2. Lightning arrester shall be provided according to manufacturer's recommendations between the communication cable and ground wherever cable enters or exits building.	X	☐	☐
2.14.1.3. Each run of communication wiring to be continuous length without splices.	X	☐	☐
2.14.2. Flexible conduits shall be provided for the last 450 mm (18 in.) of conduit runs to vibrating or rotating equipment	X	☐	☐
2.14.3. Flexible conduits shall be provided for the last 450 mm (18 in.) of conduit runs to field sensors; a junction box / enclosure shall be provided for terminations.	X	☐	☐
2.14.4. Wiring within BCU's, ECU's and Field Panels (Cabinets) shall be installed in a plastic tray with a removable cover. Wiring shall be terminated at field-removable, modular terminal strips.	X	☐	☐
2.14.5. Wiring to field sensors shall not be daisy-chained.	X	☐	☐
2.15. Power Supplies and Line Filtering			
2.15.1. Power Supplies:	X	☐	☐
2.15.1.1. where Essential Power is available in a building, all Tier I devices shall be fed off an Essential Power source.	X	☐	☐
2.15.1.2. power supplies to all BCU's and all ECU's/Control Elements associated with equipment fed off an Essential Power source shall be extended from an Essential Power source, preferably the same Essential Power source feeding the equipemt in question.	X	☐	☐
2.15.1.2.a. an On-Board UPS Power source with a minimum 12 hour battery life shall be provided withing each BCU & ECU.	X	☐	☐
2.15.1.3. control transformers shall be UL listed ,	X	☐	☐
2.15.1.4. line voltage units shall be CSA listed,	X	☐	☐
2.15.1.5. provided with over-current protection in primary and secondary circuits,	X	☐	☐
2.15.1.6. sized to limit connected loads to 80% of rated capacity.	X	☐	☐

Complete and submit by the end of Design Development Phase (C: Complies, NC: Does not comply, N/A: Not applicable)

	C	NC	N/A
2.15.2. DC power supplies:			
2.15.2.1. output to match equipment current and voltage requirements,	X	☐	☐
2.15.2.2. units to be full-wave rectifier type with output ripple of 5.0 mV maximum peak-to-peak. Regulation to be 1.0% line and load combined, with 100-microsecond response time for 50% load changes,	X	☐	☐
2.15.2.3. units shall have built-in over-voltage and over-current protection and to be able to withstand 150% current overload for at least three seconds without trip-out or failure,	X	☐	☐
2.15.2.4. units shall be capable of operation between 0°C and 50°C (32°F and 120°F). EM/RF to meet FCC Class B and VDE 0871 for Class B and MILSTD 810C for shock and vibration.	X	☐	☐
2.15.3. Power Line Filtering:			
2.15.3.1. Shall be provided to afford internal or external transient voltage and surge suppression for workstations and control modules,	X	☐	☐
2.15.3.2. surge protection:	X	☐	☐
2.15.3.2.a. dielectric strength of 1000 V minimum,	X	☐	☐
2.15.3.2.b. response time of 10 nanoseconds or less,	X	☐	☐
2.15.3.2.c. transverse mode noise attenuation of 65 dB or greater,	X	☐	☐
2.15.3.2.d. common mode noise attenuation of 150 dB or greater at 40-100 Hz.	X	☐	☐
2.16. Automatic Control Valves			
2.16.1. Performance:	☐	☐	X
2.16.1.1. General:			
2.16.1.1.a. Straight through water valves shall be single seated type with equal percentage flow characteristics and minimum resolution of 40:1 or greater.	☐	☐	X
2.16.1.1.b. designed to close at a differential pressure of 280 kPa (40 psi), with an inlet pressure of 1035 kPa (150 psi).	☐	☐	X
2.16.1.1.c. three-way mixing water valves: linear for each port giving constant total flow.	☐	☐	X
2.16.1.1.d. modulating steam valves: modified linear flow characteristics.	☐	☐	X
2.16.1.2. Steam Valves, Pressure Drop,.	☐	☐	X
2.16.1.2.a. modulating, 100 kPa (15 psig) or less steam supply pressure: maximum 80% of inlet gauge pressure.	☐	☐	X
2.16.1.2.b. two position, 100 kPa (15 psig) or less steam supply pressure: maximum 15 kPa (2 psig).	☐	☐	X

	C	NC	N/A
2.16.1.2.c. modulating, greater than 100 kPa (15 psig) steam supply pressure: 42% of the inlet absolute pressure.	☐	☐	☒
2.16.1.3. Water Valves, Pressure Drop			
2.16.1.3.a. two position: maximum 10% of system pump head.	☐	☐	☒
2.16.1.3.b. modulating, two-way: maximum of 36 kPa (12 ft) pressure drop.	☐	☐	☒
2.16.1.3.c. modulating, three-way: maximum of 60 kPa (20 ft) pressure drop	☐	☐	☒
2.16.2. Proportional valves - Globe:	☐	☐	☒
2.16.2.1. Body:	☐	☐	☒
2.16.2.1.a. carbon steel, bolted body.	☐	☐	☒
2.16.2.1.b. maximum allowable water pressure: 860 kPa (150 psi)	☐	☐	☒
2.16.2.1.c. maximum working temperature: 216°C (260°F).	☐	☐	☒
2.16.2.2. Trim:	☐	☐	☒
2.16.2.2.a. stem guided plug,	☐	☐	☒
2.16.2.2.b. V-port cage, equal percentage,	☐	☐	☒
2.16.2.2.c. T316 stainless steel	☐	☐	☒
2.16.2.2.d. threaded seat ring, T316 stainless steel.	☐	☐	☒
2.16.2.2.e. disc, seals, and other valve components suitable for clean water.	☐	☐	☒
2.16.2.3. .ANSI Class IV leakage.	☐	☐	☒
2.16.3. Actuators:	☐	☐	☒
2.16.3.1. Electric or electronic action	☐	☐	☒
2.16.3.2. electronic interface control board, solid state drive, reversible motor, oil immersed gear train	☐	☐	☒
2.16.3.3. spring return mechanism to return valve to “normal” position on power failure (i.e. Normally Open (NO), or Normally Closed (NC)),	☐	☐	☒
2.16.3.4. manual override for valves over NPS 2½.	☐	☐	☒
2.16.3.5. Valve positioners:	☐	☐	☒
2.16.3.5.a. microprocessor based digital valve controllers,	☐	☐	☒
2.16.3.5.b. HART communications protocol,	☐	☐	☒
2.16.3.5.c. two independent adjustable travel position switches and wiring to BAS for indication of valve position.	☐	☐	☒
2.16.3.5.d. to be provided on automatic valves NPS 2½ and larger.	☐	☐	☒
2.16.3.6. general purpose, drip proof NEMA 2 die-cast housing with corrosion resistant steel cover for indoor applications, watertight NEMA 4 enclosure for outdoor use,	☐	☐	☒

Complete and submit by the end of Design Development Phase (C: Complies, NC: Does not comply, N/A: Not applicable)

	C	NC	N/A
2.17. Automatic Dampers			
2.17.1. Multi-leaf Dampers for general service	X	☐	☐
2.17.1.1. Shall be parallel blade type for two-position OPEN/CLOSED service	X	☐	☐
2.17.1.2. Shall be parallel blade or opposed blade type for modulating service	X	☐	☐
2.17.1.3. Performance:	X	☐	☐
2.17.1.3.a. leakage in closed position: maximum 2% of rated air flow at 500Pa (2 in wg) differential across assembly,	X	☐	☐
2.17.1.3.b. pressure drop in open position: maximum 50 Pa (0.2 in wg) differential at 5 m/s (1000 fpm).	X	☐	☐
2.17.1.4. Frame & Blade Construction :	X	☐	☐
2.17.1.4.a. insulated or non-insulated depending upon service. Thermal breaks in insulated frame construction.	X	☐	☐
2.17.1.4.b. extruded aluminum for general applications; formed stainless steel for corrosive environments.	X	☐	☐
2.17.1.4.c. extruded aluminum, thermally broken,	X	☐	☐
2.17.1.4.d. seals: extruded vinyl seals, and spring stainless steel side seals,	X	☐	☐
2.17.1.4.e. maximum blade width: 125 mm (5 in),	X	☐	☐
2.17.1.4.f. maximum blade length: 1200 mm (4 ft).	X	☐	☐
2.17.1.4.g. self-lubricated bronze bearings.	X	☐	☐
2.17.1.4.h. blade linkage with steel tie rods, brass pivots and steel brackets.	X	☐	☐
2.17.1.5. Damper Actuator (Operator)	X	☐	☐
2.17.1.5.a. Electric or electronic action	X	☐	☐
2.17.1.5.b. electronic interface control board, solid state drive, reversible motor, oil immersed gear train	X	☐	☐
2.17.1.5.c. spring return mechanism to return valve to “normal” position on power failure (i.e. Normally Open (NO), or Normally Closed (NC)),	X	☐	☐
2.17.1.5.d. manual override.	X	☐	☐
2.17.1.5.e. Damper positioners: microprocessor based digital damper controllers c/w	X	☐	☐
2.17.1.5.f. HART communications protocol two independent adjustable travel limit switches with wiring to BAS for indication of damper position and alarm annunciation in the event position is not positively verified.	X	☐	☐
2.17.1.5.g. general purpose, drip proof NEMA 2 die-cast housing with corrosion resistant steel cover for indoor applications, watertight NEMA 4 enclosure for outdoor use,	X	☐	☐

	C	NC	N/A
2.17.2. Isolation / Control Valves Type for Isolation Service:	X	☐	☐
2.17.2.1. Single blade type for modulating and two position, OPEN/CLOSED, service..	X	☐	☐
2.17.2.2. Performance:	X	☐	☐
2.17.2.2.a. leakage in closed position: maximum 0.01% of rated air flow at 7 kPa (28 in wg) differential across assembly,	X	☐	☐
2.17.2.2.b. linear characteristic with 20:1 turndown,	X	☐	☐
2.17.2.2.c. sized using Cv numbers in 65% open position for pressure drop of less than 150 Pa (0.6 in wg) differential at 5 m/s (1000 fpm),	X	☐	☐
2.17.2.3. Construction:	X	☐	☐
2.17.2.3.a. 316L stainless steel construction for Body, Trim, Shaft and all elements exposed to the air stream	X	☐	☐
2.17.2.3.b. teflon packing glands	X	☐	☐
2.17.2.3.c. seat: elastomer seat compatible with paraformaldehyde and ethylene gas	X	☐	☐
2.17.2.3.d. flanged gasketed connections for 7 kPa (28 in wg) service	X	☐	☐
2.17.2.4. Damper Actuator (Operator)	X	☐	☐
2.17.2.4.a. Electric or electronic action	X	☐	☐
2.17.2.4.b. electronic interface control board, solid state drive, reversible motor, oil immersed gear train	X	☐	☐
2.17.2.4.c. spring return mechanism to return valve to “normal” position on power failure (i.e. Normally Open (NO), or Normally Closed (NC)),	X	☐	☐
2.17.2.4.d. manual override.	X	☐	☐
2.17.2.4.e. Damper positioners: microprocessor based digital damper controllers c/w	X	☐	☐
2.17.2.4.f. HART communications protocol two independent adjustable travel limit switches with wiring to BAS for indication of damper position.	X	☐	☐
2.17.2.4.g. general purpose, drip proof NEMA 2 die-cast housing with corrosion resistant steel cover for indoor applications, watertight NEMA 4 enclosure for outdoor use,	X	☐	☐
2.18. Cleanroom and Laboratory Pressure Monitor			
2.18.1. Space pressure measurement, referenced to adjacent space, designed, tested, and packaged by a single manufacturer.	☐	☐	X
2.18.1.1. Standard of Acceptance	☐	☐	X
2.18.1.1.a. Tek-Air model Iso-Tek	☐	☐	X
2.18.1.1.b. TSI	☐	☐	X

Complete and submit by the end of Design Development Phase (C: Complies, NC: Does not comply, N/A: Not applicable)

	C	NC	N/A
2.18.1.1.c. Honeywell	☐	☐	☒
2.18.1.1.d. Phoenix Controls	☐	☐	☒
2.18.2. Monitor unit construction:	☐	☐	☒
2.18.2.1. industrial grade metal case mounted on an electrical junction box,	☐	☐	☒
2.18.2.2. local digital display control unit;	☐	☐	☒
2.18.2.2.a. Range: -50 to + 50 Pa (-0.19999 to +0.19999 in.wg.)	☐	☐	☒
2.18.2.2.b. Resolution: 5% of reading,	☐	☐	☒
2.18.2.2.c. Display updated every second,	☐	☐	☒
2.18.2.2.d. Spill-proof membrane keypad for programming,	☐	☐	☒
2.18.2.2.e. Local calibration protected by pass-code.	☐	☐	☒
2.18.2.3. Indicating lights:	☐	☐	☒
2.18.2.3.a. Low pressure alarm	☐	☐	☒
2.18.2.3.b. Normal	☐	☐	☒
2.18.2.3.c. High pressure alarm	☐	☐	☒
2.18.2.3.d. Audible Mute	☐	☐	☒
2.18.2.4. Audible alarm annunciates when pressure in monitored room is in alarm condition.	☐	☐	☒
2.18.2.4.a. Adjustable time-delay on alarm initiation for door opening,	☐	☐	☒
2.18.2.5. Remote alarm annunciation:	☐	☐	☒
2.18.2.5.a. High pressure alarm contact - contacts normally open.	☐	☐	☒
2.18.2.5.b. Low pressure alarm contact - contacts normally open	☐	☐	☒
2.18.3. Pressure Sensor:	☐	☐	☒
2.18.3.1. two velocity sensing elements mounted in-line to each other, with temperature compensating element;	☐	☐	☒
2.18.3.1.a. Pressure measurement accuracy: -50 to + 50 Pa (-0.19999 to +0.19999 in.wg.)	☐	☐	☒
2.18.3.1.b. temperature compensation range: 12.7 to 35 °C (55 to 95 °F)	☐	☐	☒
2.18.3.2. Alarm setpoints:	☐	☐	☒
2.18.3.2.a. Low pressure: 2.5 Pa (0.01 in.wc.) relative to adjacent space,	☐	☐	☒
2.18.3.2.b. Resettable to any point over sensing range.	☐	☐	☒
2.19. Building Pressure Control			
2.19.1. A dynamic Building Pressure Control System shall be provided to maintain the building pressurized relative to the outside.	☐	☐	☒
2.19.1.1. Building reference pressure shall be measured on the 2nd Floor	☐	☐	☒

Complete and submit by the end of Design Development Phase (C: Complies, NC: Does not comply, N/A: Not applicable)

	C	NC	N/A

2.20. Sensors and Instrumentation

2.20.1. All field sensors and instrumentation shall meet the minimum performance requirements tabulated below. ☒ ☐ ☐

Sensor / Device	Range	Accuracy	Remarks			
Temperature Sensor	To suit application	±0.25°C (±0.50°F)	RTD type	☒	☐	☐
Humidity Sensor	10 to 100% RH	± 3%	Electronic type	☒	☐	☐
Low Limit Sensor (Freezestat)	1.7°C to 7.2°C (35°F to 45°F) Field Adjustable		3 attempts at Automatic Reset before lockout	☒	☐	☐
Static Pressure Sensor	To suit application	±1%	Electronic type	☒	☐	☐
Differential Pressure Sensor	To suit application	±1%	Electronic type	☒	☐	☐
Air Flow Measuring Devices	To suit application	± 1%	Multiple-head Pitot Tube Type or Thermal Anemometer Probe Type	☒	☐	☐
Liquid Flow Switch	Flow velocity to suit application	-	Differential Pressure Activated Paddle Type	☐	☐	☒
Air Proving Switch	Flow velocity to suit application	-	Differential Pressure Activated Diaphragm Type	☒	☐	☐
Gas Detection Sensors	To suit application	± 3%	Electrochemical Type	☐	☐	☒

3. INSTALLATION STANDARDS

3.1. General

3.1.1. Install Building Control Units, Equipment Control Units and Field Panels on a galvanized steel, floor mounted support frame, with a painted non-combustible backboard. ☒ ☐ ☐

3.1.1.1. No equipment shall be installed in the ceiling space or at an elevation inaccessible for normal & ready access from the finished floor. ☒ ☐ ☐

3.1.2. All campus network drops required to complete the BAS installation shall be provided by the BAS Contractor. ☒ ☐ ☐

3.1.2.1. Extend network a connection(s) from the nearest IT/Communications Closet; coordinate this activity with the Electrical/Communications contractor. ☒ ☐ ☐

3.2. Air Handling Units

3.2.1. At a minimum instrumentation shall be provided at each Air Handling Unit to monitor the following: ☒ ☐ ☐

3.2.1.1. Outside Air Temperature (may be common to a building) ☒ ☐ ☐

3.2.1.2. Return Air Temperature

Complete and submit by the end of Design Development Phase (C: Complies, NC: Does not comply, N/A: Not applicable)

	C	NC	N/A
3.2.1.3. Heating Coil Temp	X		
3.2.1.4. Cooling Coil Temp	X		
3.2.1.5. Mixed Air Temperature	X		
3.2.1.6. Filter Pressure Drop across each bank of filters	X		
3.2.1.7. Air Temperature Upstream & Downstream of all Coils	X		
3.2.1.8. Supply Air Relative Humidity	X		
3.2.1.9. Supply Air Static Pressure	X		
3.2.1.10. Supply Fan Speed (where fan is equipped with a Variable Frequency Drive)	X		
3.2.1.11. Return Air Relative Humidity	X		
3.2.1.12. Return Fan Speed (where fan is equipped with a Variable Frequency Drive)	X		
3.2.1.13. Return Air CO2 sensor.	X		
3.3. Terminal Units			
3.3.1. Terminal units shall be equipped with an Air-flow Monitoring device interfaced with the BAS.	X		
3.4. Reheat Coils			
3.4.1. Provide an air temperature sensor downstream of the reheat coil.			X
3.5. Heating & Cooling Coils			
3.5.1. Provide a water temperature sensor on the inlet and outlet of each coil installed within an air handling unit.			X
3.5.2. Provide an air temperature sensor on the upstream and downstream of each coil installed within an air handling unit.			X
3.6. Identification			
3.6.1. Point Object Numbering systems shall include the Building Number as a prefix to all object identifiers. (eg. <326.AHU1.SAT> is Building 326 Air Handling Unit 1 Supply Air Temperature0	X		
3.6.2. Equipment numbering strategy shall be presented for review/approval by the UTM FM&P Designate.	X		
3.6.3. Identification – Wiring	X		
3.6.3.1. All wires shall be tagged at both ends. The tagging shall identify the device a wire is connected to. Use of the point object name is an acceptable means of device identification.	X		
3.6.3.2. All junction boxes shall be tagged “BAS” with a sequential number suffix.	X		

Complete and submit by the end of Design Development Phase (C: Complies, NC: Does not comply, N/A: Not applicable)

	C	NC	N/A
3.6.4. Identification – Control Devices 3.6.4.1. Control Devices to be labelled using a Blue Flag Tie-Marker such as Nelco PT#N-9L or equivalent. Labels to be White or Yellow with large Black text.	☒	☐	☐

4. VERSION CONTROL SUMMARY

Revision No.	Effective Date	Section / Page	Brief Description of Revision
Revision 0	31-01-2015	Entire Standard	Initial Release
Revision 1	07-01-2018	Entire Standard	New and revised items. New document configuration

DIVISION 26 – GENERAL ELECTRICAL

SPECIFICATIONS

FOR THE

UNIVERSITY OF TORONTO MISSISSAUGA - PRE-ENGINEERED BUILDING

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DISCIPLINES
MECHANICAL
ELECTRICAL
FIRE PROTECTION
LIGHTING DESIGN
COMMUNICATIONS & AV
SECURITY & RISK
COMMISSIONING
ENERGY SERVICES

Our Project No. 2023-0059

SEAL:

LICENSED PROFESSIONAL ENGINEER
A. TAN
100087772
15-Nov-2024
PROVINCE OF ONTARIO

November 15, 2024
Issued for Tender

SECTION 26 05 00 COMMON WORK RESULTS FOR ELECTRICAL

APPENDICES

1 GENERAL

1.1 GENERAL

1.1.1 This Section covers items common to Sections of Division 26. This section supplements requirements of Division 1.

1.1.2 Comply with General and Supplementary Conditions of Contract.

1.1.3 Conditions and Division 01 General Requirements. This Section covers items common to Sections of Division 26.

1.1.4 Where conflict occurs between Codes, Specification and Drawings, plan and riser, the maximum condition is to govern, and the Tender is to be based on whichever indicates the greater cost.

1.1.5 Provide all materials, equipment, labor and services to complete the installation, wiring, testing and commissioning of the complete and functioning electrical systems, including but not limited to the scope of work specified in this section.

1.2 INTENT

1.2.1 The General Requirements apply to all Sections of this Division.

1.2.2 The extent of the work shall comprise the whole management, programming, labour and materials required to form a complete installation, together with such tests, adjustments and commissioning as prescribed in subsequent clauses and otherwise as may be required in order to provide an effective working installation to the satisfaction of the Engineer.

1.2.3 This specification covers the design of details, supply, installation and testing of all necessary equipment required for the complete Electrical Engineering Services as described in the Contract Documents and incorporates standard descriptions for equipment and the installation to be provided under this Contract. The clauses shall be read in conjunction with all other Contract Documents.

1.2.4 Provide all items, articles, materials, operations and methods listed, mentioned and scheduled in the contract documents. Include all labour, equipment, tools, scaffolds and other incidentals necessary and required for the complete installation.

1.2.5 Consider the specifications as an integral part of the drawings which accompany them. Do not use the drawings or the specifications alone. Consider any item or subject omitted from one, mentioned or reasonably implied in the other, as properly and sufficiently specified and provides same under the work of this division.

1.2.6 Each Contractor is considered to be an expert in their field.

1.3 WORK INCLUDED

1.3.1 Work to be done under this section to include furnishing of labour, materials and equipment required for installation, testing and putting into proper operation complete Electrical systems as shown, as specified, as intended, and as otherwise required. Complete systems to be left ready for continuous and efficient satisfactory operation.

1.4 CODES, PERMITS, FEEDS, AND INSPECTION

1.4.1 All work shall meet or exceed the latest requirements of the Ontario Electrical Safety Code and its supplement, local inspection bulletins, and all authorities having jurisdiction.

1.4.2 Obtain all permits and arrange for inspection of all work and pay all fees in this regard. On completion of the work, deliver the final unconditional “Certificate of Approval of the Electrical Inspection Authority” to the Consultant.

1.4.3 Before proceeding with any work, submit the required number of sets of plans and specifications to the Electrical Inspection Authority for approval and pay all costs in this regard. Bring any additional requirements or changes required by the Electrical Inspection Authority to the attention of the Consultant immediately.

1.4.4 It is hereby agreed that all requirements have been examined and checked with the Electrical Inspection Authority and CSA, and a complete installation in accordance with these requirements will be provided at the Tender Price.

1.4.5 Keep a permanent record of each inspection made by the Electrical Inspection Authority showing the date, inspector's name, scope of the inspection, and statement of special decisions or permissions granted. Make these records available to the Consultant at any time, and turn them over to them after the completion of the work.

1.4.6 Provide partial inspection and approval reports as required to suit phasing and partial occupancy requirements.

1.4.7 Abbreviations for electrical terms shall be as per CSA Z85-1983.

1.5 SCOPE OF WORK

1.5.1 The scope of the contract works shall include but not limited to the supply, delivery, off-loading, erection, setting-to-work, testing and commissioning and handing over of the electrical building services installation outlined below and described in more detail elsewhere in the specification and indicated on the drawings all in accordance with the contract documentation.

1.5.2 The Contractor shall be responsible to review and fully understand the specification and the scope of work. Furthermore, the Contractor shall be responsible to provide all conduit, wiring, power supply, accessories and supplementary component, necessary for the safe and proper operation of the various systems.

1.5.3 The Contractor shall be responsible as follows:

1.5.3.1 Visit the site to familiarize themselves with the scope of work.

1.5.3.2 Preparation of shop drawings and obtaining approval from the various authorities prior to execution of work.

1.5.3.3 Obtaining all materials and work approval during execution and on completion of works.

1.5.3.4 All costs and charges required by the various local authorities and any related to the connection of permanent power supply and kWH meters including the provision of the tenants kWH meters shall be included in the scope of work except the power connection charges which shall be paid by the Client.

1.5.4 High Voltage Installation:

1.5.4.1 Liaise and coordinate with the Local Authority Distribution Company and provide all assistance to facilitate the installation of all Local Authority Distribution Company supplied, installed and commissioned Transformers.

1.5.4.2 Provide transformer grounding system.

1.5.4.3 Include for lay in duct bank and termination of the interconnecting cabling from the secondary side of the transformers to the LV switchgear.

1.5.5 Low Voltage Installation:

1.5.5.1 Supply and installation of all switchboards, distribution panels, and panelboards, as identified in Construction Documents.

1.5.5.2 Temporary generators, fuel, temporary connections and restoration to the adjacent buildings as identified on the site plan and electrical drawings.

1.5.5.3 Battery units, remote heads and exit signs.

1.5.5.4 Busbars with fully rated neutral and earth integral and MCCB tap off units where indicated.

1.5.5.5 Main and sub-main distribution cables and system wiring.

1.5.5.6 Emergency power off system and trip facilities including battery-tripping units.

1.5.5.7 ACB/MCCB protection settings.

1.5.5.8 Standalone UPS as indicated on drawings.

1.5.5.9 All associated noise and vibration control measures including attenuators and anti-vibration mounts;

1.5.6 Grounding and Bonding:

1.5.6.1 Supply and installation of all main and supplementary earth bars in all plant rooms and risers as indicated in the tender drawings.

1.5.6.2 Equipment bonding.

1.5.6.3 Circuit protective conductors.

1.5.6.4 Cableways and interconnecting cabling for the above.

1.5.7 Lighting Installation:

1.5.7.1 The Electrical Contractor shall be responsible for the supply and installation of all luminaires as indicated on the tender drawings and described in this specification. The complete lighting installation shall include but not be limited to:

1.5.7.1.1 All luminaires as specified on the drawings and in the contract documentation, which shall include both Electrical Consultant specification and specialist lighting designer's specifications.

1.5.7.1.2 All luminaire fixings.

1.5.7.1.3 Power supplies, cabling and conduit.

1.5.7.1.4 Lighting control system as described and detailed on the drawings and later in this specification.

1.5.8 Small Power Installation:

1.5.8.1 The Electrical Contractor shall be responsible for the supply and installation of the small power services as detailed on the tender drawings. This shall include but not be limited to the following:

1.5.8.1.1 General purpose socket outlets in all areas.

1.5.8.1.2 Single phase and three phase power points for laboratory equipment as indicated on the tender drawings.

1.5.8.1.3 Power supplies to power assisted doors.

1.5.8.1.4 Power supplies entrance doors.

1.5.8.1.5 Power supplies to motorised dampers.

1.5.8.1.6 Power supplies to fan coil units.

1.5.8.1.7 Power supplies to meeting room equipment.

1.5.8.1.8 Power supplies to Public Address System.

1.5.9 Fire Detection and Alarm System:

1.5.9.1 An analogue addressable main fire alarm control panel and distributed fire alarm panels.

1.5.9.2 Provision of automatic fire detectors and manual call points;

1.5.9.3 Fire Alarm initiation and notification.

1.5.9.4 Field wiring and cable management system.

1.5.9.5 Fire alarm interface units to other systems such as mechanical plant, lifts and security system.

1.5.9.6 Interface to access control system

1.5.9.7 Interface to background music system

1.5.9.8 Interface to third party remote monitoring system

1.5.9.9 Link to existing/site wide fire alarm systems at the Central Utilities Plant (CUP);

1.5.9.10 All associated cabling and conduit with the above.

1.5.9.11 Surge protection devices to all Main Switchboard and Distribution Panels.

1.6 RELATION TO WORK OF OTHER DIVISIONS

1.6.1 Examine the Work of other Divisions upon which the Work of this Division depends for proper completion. Contractor shall report any defect or variance to the Engineer. Do not commence work under this Division until such defects have been resolved.

1.6.2 Coordinate the work of the Electrical Division with the Work of the other Divisions in such a manner that there is no interference and conflicts. In areas where conduits and equipment called for in the Electrical Division will be installed in conjunction with pipes, ductwork and equipment called for in other Divisions, Contractor shall coordinate the work to ensure proper installation, clearances, access, and the best use of the space.

1.6.3 Coordinate with other Divisions excavation, backfilling, form work, shoring and concrete work for maintenance holes, cable pits, equipment bases, concrete pads, earth wells and pits, lighting pole bases and all other work of this Division, to be carried out under the appropriate Divisions of this Specification.

1.6.4 Verify in the field all dimensions, locations and clearances affecting the work of this Division.

1.6.4.1 Coordinate with pre-engineered buildng contractor for all mounting points and weights of equipment that have to be mounted on the

structure. Where possible, avoid supporting electrical equipment from the pre-engineered structure.

1.7 CONTRACT DOCUMENTS

1.7.1 The drawings for the electrical work are performance drawings and diagrammatic, intended to convey the scope of the work and indicate general arrangement and approximate location of apparatus, fixtures and conduit runs. The drawings do not intend to show architectural and structural details.

1.7.2 Do not scale drawings. Obtain information involving accurate dimensions shown on architectural and structural drawings, or by site measurements. Consult general construction drawings, as well as detail drawings to become familiar with all conditions affecting work, and verify spaces in which the work will be installed.

1.7.3 Make, at no additional cost, any changes or additions to materials and/or equipment necessary to accommodate structural conditions (runs around beams, columns, etc.).

1.7.4 Alter, at no additional cost, the location of materials and/or equipment as directed, provided that the changes are made before installation and any such outlet is not relocated in excess of 3m (10') in any direction.

1.7.5 Install all ceiling mounted components (luminaires, speakers, bells, etc.) in accordance with reflected ceiling drawings, approved by the Consultant.

1.7.6 Leave space clear and install all work to accommodate future materials and/or equipment as indicated, and to accommodate equipment and/or material supplied by another division of work or contract. Verify spaces in which work is to be installed. Install all conduit runs, etc., to maintain headroom and clearances and to conserve space in shafts and ceiling spaces.

1.7.7 Confirm on the site the exact location of outlets for equipment supplied under other divisions of work or contracts.

1.7.8 Confer with all trades installing equipment which may affect the work of this division, and arrange equipment in proper relation to equipment installed under all divisions of the contract.

1.7.9 Timeously furnish all items to be built in, complete with all pertinent information, commensurate with the progress of the work.

1.7.10 Store materials neatly and out of the way and clean up daily all refuse caused by the work.

1.7.11 Relocate equipment and/or material installed, but not coordinated with the work of other divisions, as directed by the Consultant at no extra cost.

1.7.12 Where discrepancies are found within the Contract Documents, the maximum conditions will govern.

2 PRODUCTS

2.1 MATERIALS

2.1.1 Contactor shall arrange and format the submittals for the materials and related drawings to the Engineer for approval and to include the necessary details as requested by the Engineer.

2.1.2 The contractor shall specify items/materials from the list of approved suppliers/manufacturers or equal and approved. However this shall be limited to a single alternative and should this be rejected the contractor is obliged to revert to the list of approved suppliers/manufacturers

2.1.3 Materials and equipment shall be:

2.1.3.1 New and free of all defects,

2.1.3.2 Designed, manufactured and tested in accordance with the latest issues of all applicable CSA and other applicable industry standards,

2.1.3.3 Certified by CSA or acceptable to the authorities having jurisdiction, including special inspection if required.

2.1.3.4 All electrical equipment shall be designed for operating in a 50°C ambient temperature with 100% relative humidity. Copies of test certificates shall be provided prior to ordering equipment.

2.1.3.5 Where more than one of any item is required, all shall be of the same type and manufacture.

2.1.3.6 The products of the specified manufacturers are acceptable only when these products comply with or are modified as necessary to comply with the requirements of the contract documents.

2.1.3.7 Items of equipment or material, which are not specifically defined

herein, shall conform to the general standard of quality established herein.

3 EXECUTION

3.1 GENERAL

3.1.1 Contractor shall submit detailed method statement for installation of each system to the engineer approval. Execution of work shall be carried out strictly in accordance with the engineer approved shop drawings and method statements.

3.1.2 All systems shall be segregated from each other. Contractor shall provide narrative and schematics on methods and procedures for system segregation. Narrative shall include bundling, separation, color coding, and installation of each system installed by the electrical Contractor. Narrative shall be approved by the Engineer and owner prior to commencement of work.

3.2 ACCESS PANELS AND DOORS

3.2.1 Provide all access panels and/or doors to facilitate the maintenance and/or servicing of all electrical equipment installed in concealed spaces.

3.2.2 Indicate on the "as-built" drawings the location of these panels and doors.

3.2.3 Doors and panels in fire rated enclosures shall be ULC listed sandwich doors and shall have the same rating as the enclosure.

3.2.3.1 Doors shall have concealed hinges and screwdriver operated lock. Doors shall be as follows:

3.2.3.2 Concrete Block and Drywall: 12 gauge prime painted steel door.

3.2.3.3 Plaster and Acoustic Tile: recessed dish shaped door to accept ceiling tile or welded metal lath for plaster.

3.2.4 All access doors and locations shall be to the Consultant's approval.

3.3 CARE, OPERATION AND START-UP

3.3.1 Instruct Consultant and operating personnel in the operation, care and maintenance of equipment.

3.3.2 Arrange and pay for services of manufacturer's factory service engineer to supervise start-up of installation, check, adjust, balance and calibrate components.

3.3.3 Provide these services for such period, and for as many visits as necessary to put equipment in operation, and ensure that operating personnel are conversant with all aspects of its care and operation.

3.4 COMPLETION

3.4.1 Clean all fixtures and equipment. Polish all plated surfaces.

3.4.2 Set all relays to operating condition.

3.4.3 Remove all temporary protection and covers.

3.4.4 Vacuum clean the inside of switchgear, panelboards, motor control centre, and fire alarm control panel and annunciators. Ensure that they are free from debris and dust.

3.4.5 Change all lamps. All lamps are to be new at time of system acceptance.

3.4.6 Leave electrical work in as-new working order.

3.5 CONSTRUCTION AND INTERFERENCE DRAWINGS

3.5.1 Prepare fully dimensioned drawings showing sleeves and openings through structure. Indicate locations and weights on all load points.

3.5.2 Prepare drawings of pits, curbs, sills, equipment bases, anchors, inertia slabs, etc.

3.5.3 Prepare fully dimensioned construction drawings of Products and services in electrical rooms, service and ceiling spaces, and all other critical locations. Co-ordinate the Work with all other Divisions. Base drawings on reviewed shop drawings and indicate all details pertaining to access, clearances, cleanouts, sleeves, electrical connections, drain locations and elevations of pipes, ducts and conduits.

3.5.4 Submit construction/interference drawings prior to commencement of work.

3.5.5 Provide AutoCAD files indicating all electrical equipment mounted on or above the ceilings or at ceiling level in areas without ceilings

to the mechanical contractor for preparation of interference drawings. Items to be coordinated include all electrical equipment that may interfere with installation of the work of other trades including outlet box locations, hangers and supports, cable trays, luminaires, etc. Indicate depths of luminaires or other recessed electrical equipment to assist in the coordination of services

3.5.6 Submit drawings coordinated and approved by all trades, to the Consultant and include one complete set in each operating and maintenance manual.

3.5.7 Construction drawings are prepared for construction and record purposes only and are not part of the contract documents or shop drawings.

3.6 CUTTING AND PATCHING

3.6.1 Do all cutting and patching required for the installation of new equipment and surface restoration after the removal of existing equipment. Work will be carried out by others at this Contractor's cost. For patching use materials equal to those comprising the surrounding area.

3.6.2 Inform other Division Contractors in sufficient time with regard to required openings. Where this requirement is not met, bear the cost of all cutting and patching.

3.6.3 In existing work and work already finished, cutting and patching will be carried out by the General Contractor at the Electrical Contractors' expense.

3.6.4 Be aware of fire rated partitions, minimize the area affected by the work, and return all surfaces to a condition encountered before the work. Acceptance of the finished work is at the sole discretion of the Consultant.

3.6.5 Painting of finished surfaces will be by the General Contractor to match adjacent surfaces.

3.7 EQUIPMENT SUPPORTS, ANCHORS AND HANGERS

3.7.1 Provide all supports required for the erection and support of the electrical work.

3.7.2 Support all suspended equipment from the bottom.

3.7.3 Provide all lintels where required.

3.7.4 Suspend all hangers directly from the structure using approved inserts or beam clamps.

3.7.5 Do not use pipe hooks or perforated straps.

3.7.6 Hangers shall be spaced such that there is a hanger within 610mm (24”) of every bend and that the maximum spacing does not exceed the limits as per the local standard requirement.

3.7.7 Vertical pipes shall be supported at each floor slab and at the top and bottom of each riser.

3.7.8 Support all conduit or cable at equipment mounted on spring isolators, with spring hangers for at least 4572mm (15’).

3.7.9 Do not support any conduits from ductwork, pipes etc.

3.8 EXCAVATION AND BACKFILL

3.8.1 All excavation and backfilling will be carried out by this Contractor.

3.8.2 Conform to the performance standards of Division 02.

3.8.3 All rough excavation, i.e., excavation to within 152mm (6") of final elevation, will be done by Division 02.

3.8.4 All final backfilling, i.e., backfilling from a location 305mm (12") above the electrical equipment or service, to grade, will be done by Division 02.

3.8.5 Do all final excavation, i.e., excavation of the last 152mm (6") to final elevation, and all initial backfilling, i.e., backfilling of the first 305mm (12") above the electrical equipment or service.

3.8.6 Conform to the performance standards of Division 02 with respect to all excavation and backfilling.

3.8.7 Obtain approval from the Consultant before backfilling.

3.8.8 After backfilling and compaction, return the surface to match the original condition, or as directed by the Consultant.

3.9 EXPANSION JOINTS AND LOOPS

3.9.1 Supply and install expansion joints or loops in conduits crossing expansion joints in the structure without imposing undue stress on structure, apparatus or conduit.

3.10 EXISTING CONDITIONS

3.10.1 Visit the site and examine the existing conditions affecting the work of this Division.

3.10.2 No claim for extra payment shall be made for extra work made necessary by circumstances encountered due to conditions which were visible upon, or reasonably inferable from an examination of the site prior to submission of the Bid.

3.11 EXPEDITING

3.11.1 Continuously check and expedite delivery of equipment and materials.

3.11.2 As required, inspect equipment, etc. at the source of manufacture.

3.11.3 Continuously check and expedite the flow of necessary information to and from all parties involved.

3.11.4 Immediately inform the Construction Manager and the Consultant where information is required from them, and attend to any request for information, details, dimensions, etc. from them.

3.12 FIELD QUALITY CONTROL

3.12.1 Carefully check each piece of apparatus for completeness of connections, accessories, wiring and controls and place in operation, test and adjust.

3.12.2 Obtain written permission to start and test permanent equipment and systems.

3.12.3 Operate each piece of equipment, including motors and controls, continuously for minimum 2 hours in the presence of the Engineer.

3.12.4 Correct defects; repeat tests until no defects are disclosed; leave equipment clean and ready for use.

3.12.5 After completion of initial trial test, execute Reliability Tests for plant and equipment. Give Engineer 7 days' notice before commencing tests.

3.12.6 Each reliability test shall last for 30 consecutive days during which time the whole of the plant being tested shall operate continuously without adjustment or repair.

3.12.7 Repeat reliability test after repairs and adjustments (other than normal running adjustments) have been carried out, until system runs as intended.

3.12.8 Run systems under full summer and winter load conditions.

3.12.9 The Electrical Contractor is responsible for the following tests:

3.12.9.1 Power distribution system including phasing, voltage, grounding and load balancing.

3.12.9.2 Circuits originating from branch distribution panels.

3.12.9.3 Lighting and its control.

3.12.9.4 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.

3.12.9.5 Systems: fire alarm system, communications.

3.12.9.6 Furnish manufacturer's certificate or letter confirming that entire installation as it pertains to each system has been installed to manufacturer's instructions.

3.12.9.7 Insulation resistance testing.

3.12.9.8 Megger circuits, feeders and equipment up to 350 V with a 500 V instrument.

3.12.9.9 Megger 350-600 V circuits, feeders and equipment with a 1000 V instrument.

3.12.9.10 Check resistance to ground before energizing.

3.12.9.11 Any tests and commissioning work identified in the individual sections of this Electrical Specifications.

3.12.10 Carry out tests in presence of Consultant.

3.12.11 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.

3.12.12 Submit test results for Consultant's review.

3.13 FIELD REVIEW

3.13.1 The Consultants will make periodic visits to the site during

construction to ascertain reasonable conformity to plans and specifications. The Consultant is not responsible for quality control. The Contractor shall maintain their own quality control and will be responsible for the execution of their work in conformity with the contract documents and the requirements of the Authorities.

3.13.2 The Owner and Consultant shall have access to the site at all times for periodic inspections. Maintain a complete set of contract documents on site for field reference by the Consultant.

3.13.3 Provide all gauges, instruments, and other equipment necessary for field review by the Consultant.

3.13.4 Application for final review will be considered when the Work has been completed and written declarations submitted that all commissioning, adjustment, set up and documentation is complete. Final review will be completed when:

3.13.4.1 All reported deficiencies have been corrected.

3.13.4.2 All systems have been tested, commissioned and are operational.

3.13.4.3 The Owner has been instructed in the operation and maintenance of all equipment.

3.13.4.4 All reports have been submitted and reviewed.

3.13.4.5 All instruction manuals have been submitted and reviewed.

3.13.4.6 All directories and nameplates are in place.

3.13.4.7 Cleaning up is finished in all respects.

3.13.5 All spare parts and replacement parts specified have been provided.

3.13.6 All record drawings have been submitted and reviewed.

3.14 FINISHES

3.14.1 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.

3.14.2 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.

3.14.3 Clean and prime exposed non-galvanized hangers, racks and fastenings to prevent rusting.

3.15 FIRE RATING

3.15.1 All feeder conduits for the following systems shall be 2 (two) hours fire rated MI cable:

3.15.1.1 Fire Alarm System

3.15.1.2 All life safety systems

3.16 FIRE SEALS

3.16.1 Where cables, bus ducts, cable tray, or conduits pass through non-fire rated floors, walls or roof, provide internal and external sealing thereto.

3.16.2 For non-fire rated locations, sealant shall be silicone.

3.16.3 For fire rated locations, the sealant shall be fire stop and shall meet the requirements of authorities and to U.L, and CSA standards with regard to the type of assembly and fire separation.

3.17 GROUNDING AND BONDING

3.17.1 The whole of the installation covered by this specification shall be efficiently bonded back to the main switchboards through the metal sheathing of cables or thru a separate grounding conductor as indicated on drawings. The steel conduit, the conduit system and earth wires, all in accordance with the OESC and IEEE recommended practices. All prices shall be inclusive of the cost of this bonding.

3.17.2 All grounding installations, size of grounding conductors and bonding shall be in accordance with the OESC.

3.17.3 The grounding continuity of each metal sheathed cable shall be maintained by efficient bonding between the cable sheath, the gland and the metal case of switchgear or other metal-clad accessory or appliance at which the cable terminates.

3.17.4 All wires and cables shall be protected against mechanical stresses and corrosion.

3.17.5 All joints between wires and grounding metal work shall be mechanically sound before soldering.

3.17.6 Where separate pieces of apparatus connected to different phase are, of necessity erected or positioned less than two meters apart, an equipotential bonding strip 2.5mm x 35mm tinned copper tape shall be installed between such pieces of apparatus.

3.17.7 The main earth electrode resistance shall be less than one ohm. If this value cannot be obtained by driving copper clad steel rods, the Contractor shall provide bore holes until the damp soil is reached for installation of rods. Provide additional Earthing electrodes to meet code requirements.

3.18 HOISTING AND MOVING

3.18.1 Carefully study the architectural and structural drawings with particular reference to the portions of the structure which are reinforced to withstand the forces applied during the transporting of heavy equipment across that structure.

3.18.2 Devise methods and schedules for the hoisting and transportation of equipment from grade to roof and then into the building, to ensure that no damage occurs to the structure, finish, or any other part of the building. Ensure that the schedule meets with the approval of the Construction Manager.

3.19 INSERTS, SLEEVES, AND ESCUTCHEONS

3.19.1 Supply, locate and set all inserts, anchor bolts and sleeves in time when walls, floors and roof are erected.

3.19.2 Use only factory made threaded or toggle type inserts, properly sized for the load to be carried.

3.19.3 Provide a dimensioned sleeving layout to the Construction Superintendent indicating sizes of sleeves and other structural openings.

3.19.4 Do all drilling for hangers, rods and inserts, etc., not placed at time of building erection. Do not use powder actuated tools, except on written permission by the Consultant.

3.19.5 Pipe sleeves shall be standard weight steel pipes, machine cut flush with finished structure.

3.19.6 Sleeves in waterproof floors shall extend in 102mm (4”) above the floor (mechanical rooms, kitchens, etc.).

3.19.7 Cover exposed sleeves in finished areas with satin finished chrome

or stainless steel escutcheon plates with set screws.

3.19.8 Provide sleeves in below grade wall with waterproofing flange.

3.19.9 In mechanical rooms and on top of shafts the concrete division shall provide 102mm (4") high (minimum) concrete curbs.

3.19.10 Seal all unused sleeves and openings around conduits and ducts with resilient non combustible material. In waterproof sleeves provide additional silicon base seal.

3.19.11 Provide and install steel bumper guards around all piping, ductwork, etc., susceptible to being damaged.

3.19.12 All conduits, etc., which pierce quarry tile and/or ceramic tile must be sealed and made watertight.

3.20 INSTALLATIONS

3.20.1 All electrical wiring and cables shall be installed in conduit or approved electrical raceways in compliance with the OESC.

3.20.2 All work shall be executed in a professional manner and shall conform to the highest standards applicable.

3.20.3 Install equipment in accordance with the general arrangement drawings. Unless actual dimensions are indicated, take such dimensions from final reviewed shop drawings and at the site.

3.20.4 Coordinate with the type of concrete floors/slab construction including the finish concrete surface. Ensure co-ordination with relevant divisions for the installation of all electrical equipment to be installed under this Division is installed prior to the casting of concrete slabs.

3.20.5 Line up exposed conduit parallel or at right angles to building lines. Set, plumb and level equipment accurately, install hanger rods plumb and without offsets, install rows of fixtures accurately in line and level.

3.20.6 Flush-mount boxes, panels, cabinets and electrical devices in finished areas and provide suitable flush trims and doors or covers, unless specifically noted otherwise.

3.20.7 All areas shall be considered finished areas except the pump rooms, mechanical rooms, chiller yard, energy transfer station and areas exposed to weather.

3.20.8 The locations of switches, outlets and control devices are shown diagrammatically only. Mount switches and other controls as close to doorjambs and other openings as possible, maintaining a minimum of 100mm from trims of doors except where installed in doorframes of metal partitions. Ensure that these locations meet with the approval of the Engineer. Check all door swings and install switches on strike side of door. Mount to code requirements.

3.20.9 Where the location of any item is shown on the architectural details or elevations, this location shall govern. No change to the contract sum shall be allowed for the relocation of any equipment improperly installed because of the failure to check all such details prior to the installation of the equipment. Notify the Engineer where details differ.

3.21 MATERIALS, WORK AND SUPERVISION

3.21.1 It is a requirement of the specification that the finished appearance of the project in public areas is of a high architectural standard but not limited to all panels, covers, trim panels, finishes and the like shall be included to provide this required appearance to the satisfaction of the Engineer.

3.21.2 The whole of the equipment supplied shall be of proven design and of high class durable finish and suitable for installation in a modern building which will be subjected to excessively heavy usage.

3.21.3 The Contractor shall be responsible for ensuring that the components of each system are mutually compatible and integrated to form fully efficient systems complying with the Drawings and specifications.

3.21.4 All articles and materials specified to conform to CSA Standards shall be clearly and indelibly marked and stamped with the CSA Standard number specified and other details required by the regulations, except where marking is impracticable when the relevant advice/delivery notes shall include the CSA Standard number with which they are to comply.

3.21.5 All materials and work shall be to the satisfaction of the Engineer, particular attention shall be paid to a neat orderly well-arranged installation, carried out in a methodical competent manner.

3.21.6 The Contractor shall produce dimensional layout showing the exact location and elevation for the various outlets and shall be responsible to submit drawings/ proposed material in a format to

the Engineer's instruction.

3.21.7 The Contractor shall maintain a competent supervising Engineer for the work on site throughout the whole of the time for the completion of the Contract. The Engineer shall give prior approval to the appointment of this supervising Engineer and shall have the authority to withdraw this approval at any time.

3.21.8 No person shall be allowed to execute any type of work, which is normally carried out by a skilled tradesperson unless he is thoroughly experienced and proficient in the trade concerned. The Engineer shall have the option to require a tradesperson to demonstrate their proficiency to the satisfaction of the Engineer.

3.22 TESTING AND COMMISSIONING ON SITE

3.22.1 Upon completion of the installation or part of the installation, the Contractor shall carry out and be responsible for the testing and commissioning all equipment and integral systems, in stages if required, to ensure that it is in proper working order and capable of performing all of its functions in accordance with the specification and to the satisfaction of the Engineer. Site Acceptance Testing inclusive of Individual System Testing, and Factory Acceptance Testing to the satisfaction of the commissioning authority and jurisdiction authority, shall be provided.

3.22.2 The Contractor shall be fully responsible for all equipment until each item of equipment or system or part thereof has been tested, commissioned and accepted by the Engineer.

3.22.3 Any equipment damaged in commissioning shall be replaced with new equipment by the Contractor at their own expense and the equipment or system concerned shall be re-tested and commissioned. No instruction or action of the Engineer shall relieve the Contractor of this responsibility.

3.22.4 The Contractor shall give to the Engineer in writing at least ten days' notice of the date after which he will be ready to make the specified tests on completion of installation. Unless otherwise agreed the tests shall take place within seven days after the said date on such day or days as the Engineer shall in writing notify the Contractor. The tests shall as far as possible be carried out under normal working conditions to the satisfaction of the Engineer and shall extend over such periods as he may direct.

3.22.5 The Contractor shall provide all skilled labor, supervision,

apparatus and instruments required for commissioning and testing and within a reasonable time thereafter furnish to the Engineer six certificates of all tests performed and accepted, signed by the Engineer, the Contractor and an authorized person acting on behalf of Local Authority Distribution Company, as prescribed in the appropriate Regulations and Specifications.

3.22.6 If any part of the equipment fails to pass the specified tests, further tests shall, if required by the Engineer, be repeated. The Contractor shall, without delay, put in hand such modifications as are necessary to meet the requirements as described in the Contract and any expense which the Employer may have incurred by reason of such further tests may be deducted from the Contract Price.

3.22.7 The Contractor shall include for submission of working drawings for the electrical installation to the Local Authority Distribution Company for approval and shall allow for the procurement of the Local Authority Distribution Company test certificate upon completion of the building following inspection of the electrical installation by Local Authority Distribution Company. Acceptance shall not in any way absolve the Contractor of their responsibility for the performance of the equipment after erection as a complete working system in all respects.

3.23 LOAD BALANCE

3.23.1 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.

3.23.2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.

3.23.3 Submit, at completion of work, report listing phase and neutral currents on panelboards, dry-core transformers and motor control centers, operating under normal load. State hour and date on which each load was measured, and voltage at time of test.

3.24 LOCATION OF OUTLETS

3.24.1 Locate outlets in accordance with Division 01.

3.24.2 Do not install outlets back-to-back in wall; allow minimum 6” horizontal clearance between boxes.

3.24.3 Change location of outlets at no extra cost or credit, providing distance does not exceed 3600mm (12'), and information is given before installation.

3.24.4 Locate light switches on latch side of doors. Locate disconnect devices in mechanical and elevator machine rooms on latch side of floor.

3.25 MANUFACTURERS AND CSA LABELS

3.25.1 Visible and legible after equipment is installed.

3.26 MECHANICAL EQUIPMENT AND WORK

3.26.1 Read together with Divisions 21, 22, 23, & 25 Mechanical and adhere to its requirements. Supply and install all electrical apparatus which is required and is not covered by Divisions 21, 22, 23, & 25 Mechanical.

3.26.2 Motors:

3.26.2.1 Supply and installation of all motors for electrical equipment will be by the Mechanical Contractor.

3.26.3 Except where noted otherwise, all motors will have the following characteristics:

3.26.3.1 1/2 HP and smaller, 120V, 1 PH, 60 Hz

3.26.3.2 1 HP and larger, 600V, 3 PH, 60 Hz

3.26.3.3 The Mechanical Contractor will submit an accurate schedule of all motors. Include for each motor, the HP, rpm, nameplate current, voltage, phase, equipment served, location, electrical characteristics and identification number. Schedule to be reviewed by Division 26 and the Consultant.

3.26.4 Contactors and Control Devices:

3.26.4.1 Supply and installation of all automatic devices controlling mechanical equipment supplied under the Mechanical Division will be by the Mechanical Contractor.

3.26.4.2 Mechanical Contractor shall provide all starters, contactors, MCC's etc., for all equipment supplied by Division 25 such as chillers, boilers, rooftop air conditioning, fans, pumps and heating units, electric reheat coils, etc., as specified in the respective section

(See Motor Control Schedule). Division 26 Electrical shall provide disconnect switches for this equipment as required by code. Weatherproof switches shall be provided for all outdoor units.

3.27 MOTOR AND EQUIPMENT WIRING

3.27.1 Provide power wiring connection and, fittings external to all motors, machines, starters, control panels, etc., supplied under this and all other contracts except as noted herein. All line and load side wiring shall be by the Electrical Contractor.

3.27.2 Power wiring will include but not be limited to all raceways, conduits, lugs, fittings, disconnect switches, auxiliary devices for 3 phase 600 V, and 3 phase 208 V motors and 1 phase 240 V, 1 phase 208 V, and 1 phase 120 V motors. All wiring to be in accordance with the manufacturer's instructions.

3.27.3 All starters, motor control centres, etc., along with line and load side power wiring will be by the mechanical division. This also applied to the packaged units.

3.27.4 Packaged units will have integral starters and only power feeders need be provided. The packaged unit starters will be by Mechanical Contractor. The main disconnect switch will be provided by this contractor.

3.27.5 The equipment of the mechanical contract shall generally have all control wiring provided by that contract in accordance with the methods and materials specified under Division216. Exceptions to this include equipment provided by this contract which must interface into the mechanical contract control circuit. This contract shall wire devices into the mechanical contract control circuit and co operate with Mechanical Contractor regarding testing, locations, etc. Examples of this interface include fire alarm systems interconnection, low voltage switching system interconnection, security system interconnection, etc.

3.27.6 Where control devices are line voltage, receive these devices from the Contractor providing that system, install all power wiring to the devices and install the devices.

3.27.7 The use of "lock off stop" devices will not be permitted. Provide disconnect switches for all motors that are 30' (9 m) or greater away from the motor starter or if the distance is less, provide disconnect switches for the motors where the motor starter is not visible.

3.27.8 All two (2) speed and delta wye motors shall have an adequate number of properly sized feeders between the starters and motors to allow for operation. Note that all remote disconnect switches located adjacent to 2 speed motors and delta wye shall be 6 pole with an auxiliary contact.

3.27.9 Control wiring shall be provided by this contract for the work of all contracts other than Division 15 contracts as noted on the drawings and called for herein. Control wiring includes the wiring of all control devices that are connected into control circuits of motor starters and into motor power feeders. Wiring shall be in accordance with manufacturers wiring diagrams and instructions. This includes production equipment, computer equipment, overhead doors, dock levelers, elevating docks, security systems, ASRS door controls, C.I.M. systems, etc.

3.27.10 Load side wiring for remote VFD and soft-start drives shall be provided by the Mechanical Contractor. Load side wiring for VFD's shall be drive RX type cable appropriately sized. Any disconnects provided on the load size of VFDs shall have auxiliary contacts interlocked with shunt trip of VFD.

3.27.11 Power for building automation or like control system panels shall be provided by this contractor. The drawing package will indicate a branch circuit and junction box in each mechanical area. This contractor shall provide wiring to the respective control panel locations as located by the controls contractor. Final connections are not indicated on the electrical drawings, however remain part of this contract.

3.28 MOUNTING HEIGHTS

3.28.1 Mounting height of equipment is from finished floor to centerline of equipment unless specified or indicated otherwise.

3.28.2 If mounting height of equipment is not specified or indicated, verify before proceeding with installation.

3.28.3 Refer to architectural drawings for mounting height of devices and equipment. Should there be a discrepancy between the mounting height noted in electrical and architectural construction documents, obtain clarification from the consultants prior to proceeding with the rough-ins.

3.28.4 Mounting height of the control devices (ie. switches, thermostats, intercom, etc.) located in designated barrier-free spaces or the

barrier-free path of travel shall conform to the requirement of OBC article 3.8.1.5 (1).

3.28.5 Install electrical equipment at following heights unless indicated otherwise:

3.28.5.1 Local switches: 1,100 mm.

3.28.6 Wall receptacles: 450 mm

3.28.6.1 General: 300mm.

3.28.6.2 Above top of continuous baseboard heater: not permitted

3.28.6.3 Above top of counters or counter splash backs: 150mm.

3.28.6.4 In mechanical rooms: 1200mm.

3.28.6.5 Panelboards: as required by Code or as indicated.

3.28.6.6 Telephone and interphone outlets: 300mm.

3.28.6.7 Wall mounted telephone and interphone outlets: 1100mm.

3.28.6.8 Television outlets: 305mm.

3.28.6.9 Wall mounted speakers: 2100mm.

3.28.6.10 Doorbell pushbuttons: 1100mm.

3.28.7 Fire Alarm Devices:

3.28.7.1 Mounting height of the fire alarm devices shall conform to the latest requirement of CAN/ULC-S524.

3.28.7.2 Fire alarm manual pull stations: 1200mm and maximum 600mm from door latch.

3.28.7.3 Wall mounted fire alarm speakers: Minimum 2300mm above the finished floor and at least 150mm below the ceiling.

3.28.7.4 Wall mounted visual strobe lights: Mounted at not less than 2000mm and not more than 2400mm above the finished floor.

3.29 <u>OCCUPANCY REQUIREMENTS FOR FINAL</u>

3.29.1 The following are the Occupancy requirements for full occupancy of areas.

3.29.2 Occupancy will be provided as requirement for turnover of work that has been completed and areas as required by the Owner in order to maintain function of the building and there operations. Warranties will be as per the signed contract.

3.29.3 The requirements below shall be completed two weeks prior to the scheduled turn over date and all required documentation shall be submitted to the Owner and the Consultant for review and comments. At a minimum the above must be submitted two week prior to the scheduled turn-over date.

3.29.4 Provide a copy of the ESA Completion and Final Clearance Certificate.

3.29.5 Provide a letter confirming that fire proofing has been installed in area(s) that are to be occupied.

3.29.6 Distribution Equipment labelling has been completed.

3.29.7 Staff trainings as well as required Practical Training have been completed to the Owners and that of the Consultants' requirements and satisfaction. Provide a list of Names of the Attendees.

3.29.8 Provide a letter confirming that the Labelling of Emergency Power Light Fixtures has been completed.

3.29.9 Submission of the Project Field Working and Record Drawings for the area(s) to be occupied has been completed and they have been reviewed and accepted.

3.29.10 Recording and provision of Fire Alarm System Hex address for the fire alarm system are shown on the Record Drawings and installed within the panels.

3.29.11 Provide a letter Panel schedules are typed confirming that the Emergency lighting has been tested and the light levels that are present meet Building Code Requirements.

3.29.12 Infrared Thermo Scan has been completed and test reports submitted for review – for modified or new electrical distribution equipment.

3.29.13 Provision of Record Single Distribution Diagram(s) in main electrical and secondary electrical rooms that reflect the installation of the distribution systems.

3.29.14 Short Circuit Protection & Coordination and Arc Flash Studies have been completed and submitted and been reviewed by the Electrical Consultant.

3.29.15 Provide a letter confirming that the power distribution for both distribution protection equipment has been adjusted to the setting as recommended in the coordination study.

3.29.16 Provide a letter confirming that the Arc Flash Labelling has been installed on the Electrical Distribution Systems.

3.29.17 Lighting test reports for Emergency Lighting (including areas covered by Battery Units) have been submitted and meet Building Code Requirements.

3.29.18 Provide a completed Fire alarm verification report with no deficiencies. Should the Fire Alarm Vendor have recommendations regarding the system that do not affect the verification document this is to be submitted for review by means of a separate letter.

3.29.19 Conduct Audibility Test's for the fire alarm system and provide separate letter that audibility requirements have been met as per the Building Code Requirements.

3.29.20 Provide a certificate from 3rd party monitoring company confirming interface of fire alarm system.

3.29.21 Provide a letter confirming interface of the fire alarm system to Mechanical equipment has been completed and tested and is operating as per the design and code requirements.

3.29.22 The Fire Alarm Graphic – Has been Reviewed by Local Fire Department and Accepted.

3.29.23 Removal all temporary wiring.

3.30 OPERATION AND MAINTENANCE MANUALS

3.30.1 Submit operation and maintenance manuals in accordance with Division 01.

3.30.2 Include the following information in the Operation and Maintenance manuals:

3.30.2.1 Names and address of local suppliers for the items included.

3.30.2.2 Details of design elements, construction features, component function and maintenance requirements, to permit effective start-up, operation, maintenance, repair, modification, extension and expansion of any portion or feature of the installation.

3.30.2.3 Technical data, product data, supplemented by bulletins, component illustrations, exploded views, technical descriptions of items and parts lists. Advertising or sales literature is not acceptable.

3.30.2.4 Review information provided in the maintenance instructions and manuals with the Owners' operating personnel to ensure a complete understanding of the electrical equipment and systems and their operation.

3.31 PERMITS, FEES, AND INSPECTION

3.31.1 Submit to Electrical Inspection Department and Supply Authority necessary number of drawings and specifications for examination and approval prior to commencement of work.

3.31.2 Pay associated fees.

3.31.3 Consultant will provide drawings and specifications required by Electrical Inspection Department and Supply Authority at no cost. Drawings are to be submitted by the Electrical Contractor.

3.31.4 Notify Consultant of changes required by Electrical Inspection Department prior to making changes.

3.31.5 Furnish Certificates of Acceptance from Electrical Inspection Department authorities having jurisdiction on completion of work to Consultant.

3.32 PLYWOOD

3.32.1 Supply and install all plywood backboards required for the work of this Division. Plywood to be highest quality fire retardant fir, 1219mm (4'-0") wide x 2438mm (8'-0") high, 19mm (¾") thick unless otherwise specified. Prime and paint backboards on both sides with fire retardant paint, equal to CGSB Spec. #1-GP-151M, of a colour to match the equipment and services mounted thereon

as defined in "Finishes" above.

3.33 PROGRESS PAYMENTS

3.33.1 Submit a complete breakdown of the Contract with each progress billing, indicating percentage of work complete, in a form acceptable to the Owner/Consultant.

3.33.2 The contractor shall provide a work breakdown structure to include an itemized list of work and associated cost structure for consultant review prior to the first billing.

3.33.3 The work breakdown separate supply and installation where material cost exceeds $30,000.

3.33.4 Progress draw breakdowns shall include both dollar value and percentage value for the following: Contract Value, current billing, previous billing, balance to complete and complete to date categories.

3.33.5 The contractor may claim a maximum of 95% against the supply category until such time as the system is installed and is fully functional.

3.33.6 Where indicated as a separate category, any systems requiring programming or manufacturer start-up shall be subject to a minimum 10% hold in addition to the above, until such time as the system is fully functional.

3.33.7 Where not indicated as a separate category, any systems requiring testing or test results shall be subject to a minimum 10% hold in addition to the above, until such time as the system is fully functional.

3.34 PROTECTION

3.34.1 Protect building and structure from damage due to carrying out this work.

3.34.2 Protect all electrical work from damage. Keep all equipment dry and clean at all times.

3.34.3 Cover all opening in equipment and materials.

3.34.4 Be responsible for and make good any damage caused directly or indirectly to any walls, floors, ceilings, woodwork, brickwork, finishes, etc.

3.35 RECORD OF DRAWINGS

3.35.1 The Consultant will provide the Contractor with one (1) disk containing all drawings relating to the work of this Contract in AutoCAD format. The contractor shall clearly mark, as the job progresses, all changes and deviations from that shown on contract drawings. Drawings shall be kept up-to-date during construction and in addition to field measurements shall include variation orders, field instructions and all other changes. After inspection and approval of service lines in trenches, the contractor shall take as-built measurements, including all depths, prior to backfilling operations. It will not be sufficient to check off line locations. Definite measurements shall be taken for each service line. The location of buried duct banks, etc. shall be shown on the drawings from fixed points. On completion of the building, the contractor shall forward to the Consultant the two sets of drawings indicating all such changes and deviations for review. Include in the tender price, the cost for the production of CAD diskette record drawings by the Consultant's staff.

3.36 SHOP DRAWINGS

3.36.1 Refer to article on shop drawings in Division 01.

3.36.2 Shop drawings shall indicate clearly the materials and/or equipment actually being supplied, all details of construction, accurate dimensions, capacity, operating characteristics and performance. Each shop drawing shall give the identifying number of the specific piece of equipment etc. for which it was prepared (e.g. panel #2A).

3.36.3 Each shop drawing for non-catalogue items shall be prepared specifically for this project. Shop drawings and brochures for catalogue items shall be marked clearly to show the items being supplied.

3.36.4 Shop drawings for any equipment to be supported from the pre-engineered structure shall be complete with final installed weight and reviewed by the pre-engineered structure contractor.

3.36.5 Each shop drawing or catalogue sheet shall be stamped and signed by the contractor to indicate that he has checked the drawing for conformance with all requirements of the drawings and specifications, that he has coordinated this equipment with other equipment to which it is attached and/or connected thereto and that he has verified all dimensions to ensure the proper installation of equipment within the available space and without interference with the work of other trades. Ensure that mechanical co-ordination is complete before submitting drawings for review.

3.36.6 Installation of any equipment shall not start until after final review of shop drawings has been obtained.

3.36.7 When requested, shop drawings shall be supplemented by data explaining the theory of operation.

3.36.8 The General Requirements Division shall apply except as amended above.

3.37 SINGLE LINE ELECTRICAL DIAGRAMS

3.37.1 Provide single line electrical diagrams under plexiglass as follows:

3.37.1.1 Electrical distribution system: locate in main electrical room.

3.37.1.2 Provide fire alarm riser diagram, plan and zoning of building under plexiglass at fire alarm control panel and annunciator.

3.37.1.3 Drawings: 610mm x 910mm (2’ x 3’) minimum size.

3.38 TEMPORARY SERVICES

3.38.1 Temporary electrical service shall be provided by this contractor, unless otherwise noted. Coordinate with General Contractor for further detail.

3.38.2 Do not use any of the permanent electrical systems during construction, unless specific written approval is obtained from the Consultant or unless allowed elsewhere in the contract documents.

3.38.4 The use of permanent facilities for temporary construction service shall not affect in any way the commencement period in which correction after completion is the Contractor's responsibility. Such period will commence only when the overall project is completed and certificates are issued.

3.39 VALUATION OF CHANGES

3.39.1 Refer to and conform to the requirements set out in Division 01 and Electrical Tender Form.

3.39.2 Submissions will be scrutinized by the Consultant and therefore require complete detailed itemization of all material, labour, unit prices and overhead and profit mark-ups.

3.40 WORK ASSOCIATED WITH OTHER TRADES OR PARTIES

3.40.1 Some works and/or provisions associated with the Electrical Services shall be performed by other trades or parties. Liaise and co-ordinate with other trades to ensure that all requirements are provided as required for the completeness and proper operation of the equipment or system.

3.41 TAGS AND DIRECTORY

3.41.1 After finished painting is completed, identify each main feeder cable and conduit service. Locate identification:

3.41.1.1 Behind each access door.

3.41.1.2 At each change of direction and at junction boxes.

3.41.1.3 At not more than 12 meters (40’) apart in straight runs of exposed conduit, but on both sides of sleeves.

3.41.1.4 At not more than 12 meters (40’) apart in straight runs of conduit behind removable enclosures such as lay in type ceiling, cut on both sides of sleeves.

3.41.1.5 Use stencils and stencil paint or use lamacoid plates on all conduit and ductwork.

3.41.1.6 Use letters of minimum 25mm (1”) high.

3.41.1.7 The identification shall describe system voltage and services; e.g. "120/208 Volt lighting fed from panel 2A".

3.41.2 Conduits and outlet boxes for the various systems shall be identified by the use of distinctive colour paints. Identification of raceways shall consist of painted junction box covers and pointed conduit couplings. The following colours shall be used:

3.41.2.1 120/208 Volt System – Orange

3.41.2.2 600 Volt System – Blue

3.41.2.3 Telephone Conduit System – Green

3.41.2.4 Intercom and Low Voltage Signal Systems – Black

3.41.2.5 Emergency System – Yellow

3.41.2.6 Fire Alarm System – Red

3.41.3 All high voltage raceways shall be labelled "DANGER 13.8 kV" in accordance with OESC, at 3' (3 m) intervals along raceway.

3.41.4 Have the manufacturers nameplate affixed to each item of all equipment showing the size, name of equipment, serial number and all information usually provided, including voltage, frequency, # of phases, horsepower, etc., and the name of the manufacturer and their address. Ensure that all stamped, etched and engraved lettering on plates is perfectly legible. Ensure that nameplates are not painted over. Where apparatus is to be concealed, attach the nameplate in an approved location on the equipment support or frame.

3.41.5 Identify all equipment with the corresponding remote controls.

3.41.6 Ensure that panels and other apparatus which have exposed faces in finished areas do not have any visible trademarks or other identifying symbols. Mount nameplates behind doors.

3.41.7 All outlet boxes provided in the ceiling space for future lighting and/or power connections shall be identified on the box cover with brady self-sticking markers indicating circuits contained in the box.

3.42 <u>TRIAL USAGE AND INSTRUCTION TO OWNER</u>

3.42.1 The Owner has the privilege of the trial usage of electrical systems or parts thereof for the purpose of testing and learning the operational procedures.

3.42.2 Carry out the trial usage over a length of time as deemed

reasonable by the Consultant at no extra cost.

3.42.3 Carry out the operations only with the express knowledge and under supervision of the construction manager who shall not waive any responsibility because of the trial usage.

3.42.4 Trial usage shall not be construed as acceptance by the Owner.

3.42.5 Instruct the Owner's representative in all aspects of the operation of systems and equipment.

3.42.6 Arrange for and pay for services of service engineers and other manufacturer's representatives required for instruction on specialized portions of the installation.

3.42.7 Submit to the Consultant at the time of final inspection, a complete list of systems stating for each system.

3.42.8 Date instructions were given to the Owner's staff.

3.42.9 Duration of instruction.

3.42.10 Name of persons instructed.

3.42.11 Other parties present (manufacturer's representative, Consultants, etc.).

3.42.12 Signature of the Owner's representatives stating that they properly understood the system installation, operating and maintenance requirements.

3.43 VIBRATION ISOLATION

3.43.1 Provide vibration isolation control as necessary so as to prevent transmission of objectionable vibration to the building structure, and from one area to another.

3.43.2 Provide all steel bases and concrete inertia pads. Install all bases to clear the sub-base (housekeeping pads) by minimum 25mm (1”) for steel bases, and 50mm (2”) for concrete bases.

3.43.3 All floor mounted equipment shall be erected on 102mm (4”) high reinforced concrete pads. Concrete pads shall be of similar dimensions to that of the foot print of the equipment. Wherever vibrations eliminating devices and/or concrete inertia blocks are specified, these items shall, in all cases, be mounted upon the 102mm (4”) high reinforced concrete pads; unless specified to the

contrary.

3.43.4 All concrete foundations and supports shall be provided by this division. This contractor shall provide dimensioned drawings and details of all such work required and shall submit same to the Consultant for approval.

3.44 FLASHING

3.44.1 Provide galvanized or aluminum sleeves for piping through roof.

3.44.2 Ensure that the flashing suits roof and extends minimum 450mm (18") on all sides. Leave flashing as directed by the Contractor, to be built into roofing, rendering a watertight connection.

3.44.3 Provide counter flashing on diesel and boiler exhaust stacks, ducts, and pipes passing through roofs to fit over flashing or curb. Coordinate with Roofing Contractor.

3.45 WARNING SIGNS

3.45.1 As specified and to meet requirements of Electrical Inspection Department, Local Authority and Consultant.

3.45.2 Decal signs, minimum size 175mm x 250mm (8” x 10”).

3.46 VOLTAGE RATINGS

3.46.1 Operating voltages: to CAN3-C235-83.

3.46.2 Motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard. Equipment to operate in extreme operating conditions established in above standard without damage to equipment

3.47 WORK

3.47.1 Install conduits and pipes parallel and perpendicular to the building planes and concealed in chases, behind furring or above ceiling, except in unfinished areas. Install all exposed systems neatly and grouped together, to present a neat appearance.

3.47.2 Install meters and switches to permit easy reading.

3.47.3 Install all equipment and apparatus requiring maintenance, adjustment or replacement with sufficient clearance for servicing.

3.47.4 Install control devices to guarantee proper sensing. Shield element from direct radiation and avoid placing them behind any obstruction.

3.47.5 Include in the work all requirements of the manufacturer and as shown on the shop drawings.

3.47.6 Replace any work unsatisfactory to the Consultant/Owner without extra cost.

END OF SECTION

1 **GENERAL**

1.1 GENERAL

1.1.1 Provide plywood backboards for mounting of all electrical, telecommunications, and security equipment unless noted otherwise on the drawings. Do not mount equipment directly to wall.

2 **PRODUCTS**

2.1 BACKBOARDS

2.1.1 Construct plywood backboards from 19mm thick fir plywood, good one (1) side.

2.1.2 Use fire retardant backboards, pressure impregnated with fire retardant chemicals, and stamp.

2.1.3 Conform to CSA 080.

3 **EXECUTION**

3.1 INSTALLATION

3.1.1 Construct each backboard in a rectangular shape of the size as indicated. Where no size is indicated, provide a backboard minimum 100mm wider and 100mm higher than the equipment. Where more than one (1) piece of equipment is installed on the backboard, construct the backboard of a size to suit the maximum vertical and horizontal dimensions of the equipment.

3.1.2 Fastenings:

3.1.3 Fasten each backboard to a wall or to a support structure using cadmium plated hardware. Provide a flat washer under the head of each fastener. Recess the head of the mounting bolt where equipment, including future equipment, is to be installed.

3.1.4 Use expansion shields, toggle bolts or other types of wall fastenings to suit the wall type, Align the mounting bolts with the wall studs for stud type walls.

3.1.5 Install fastenings a maximum 500mm apart in both the vertical and horizontal directions.

3.1.6 When installing equipment heavier than 50kg, fasten the equipment through the backboard directly to the wall or support structure.

END OF SECTION

1 **GENERAL**

1.1 REFERENCE

1.1.1 Comply with the requirements of Section 26 05 00 Common Work Results – Electrical.

1.1.2 Section 26 05 24 – Wiring Methods.

1.1.3 Conform to relevant sections of specifications for this and other Divisions.

1.2 PRODUCT DATA

1.2.1 Submit product data in accordance with Section 26 05 00 Common Work Results – Electrical.

1.3 STANDARDS

1.3.1 TECK 90 cables to CSA Standard C22.2 No.131-M89.

1.3.2 Thermostat Insulated Wires and Cables to CSA Standard C22.2 No. 38-M1986.

1.3.3 Armoured Cable to CAN/CSA-C22.2 No. 51-M89.

1.3.4 Thermoplastic Insulated Wires and Cables to CSA Standard C22.2 No. 75- M1983 (R1992).

1.3.5 All cables installed in areas requiring fire rating shall conform to test FT-4.

1.3.6 All cables installed in spaces designated as a return air plenum shall conform to test FT-6 or be installed in continuous conduit system.

2 **PRODUCTS**

2.1 BUILDING WIRES

2.1.1 Conductors

2.1.1.1 Copper conductors, of the size as indicated, having a minimum conductivity of 98 percent.

2.1.1.2 Aluminum conductors are not acceptable.

2.1.1.3 Stranded copper conductors shall be provided for all wires sizes with ampacity greater than #8 AWG.

2.1.1.4 The minimum wiring size that shall be permitted for this project is No. 12 AWG.

2.1.1.5 Conductors shall be minimum No. 12 AWG, size conductor for maximum 2% voltage drop to the furthest outlet on a fully loaded branch circuit.

2.1.1.6 The following shall be used with respect to branch circuit wire sizing for voltage drop from the circuit's associated panel board:

2.1.1.6.1 Conductors shall be minimum No. 12 AWG for maximum 2% voltage drop to the furthest outlet/load on a fully loaded branch circuit, where circuit is 20m in length.

2.1.1.6.2 Conductors shall be minimum No. 10 AWG for maximum 2% voltage drop to the furthest outlet/load on a fully loaded branch circuit, where the circuit is less than 30m in length but more than or equal to 20m in length.

2.1.1.6.3 Conductors shall be minimum No. 8 AWG for maximum 2% voltage drop to the furthest outlet/load on a fully loaded branch circuit, where the circuit is less than 45m in length but more than or equal to 30m in length.

2.1.1.6.4 Conductors shall be minimum No. 6 AWG for maximum 2% voltage drop to the furthest outlet/load on a fully loaded branch circuit, where the circuit is less than 60m in length but more than or equal to 45m in length.

2.1.1.7 The Electrical Contractor shall up-size feeder and branch circuit wiring and associated conduit as required to meet the requirements of the code with respect to acceptable voltage drop.

2.1.2 Insulation

2.1.2.1 RW90 is specified for use throughout. RW90 cable shall have thermosetting polyethylene insulation rated at a minimum of 300V for 120/208V wiring and 600V for 347/600V wiring.

2.1.3 Colour Coding:

2.1.3.1 120/208V circuits:

2.1.3.1.1 Two conductor, 1 phase: 1 black, 1 white

2.1.3.1.2 Three conductor, 1 phase: 1 red, 1 black, 1 white

2.1.3.1.3 Three conductor, 3 phase: 1 red, 1 black 1 blue

2.1.3.1.4 Four conductor, 3 phase: 1 red, 1 black, 1 blue, 1 white

2.1.3.1.5 Ground wires: Green

2.1.3.2 347/600V, circuits:

2.1.3.2.1 Two conductor, 1 phase: 1 orange, 1 white

2.1.3.2.2 Three conductor, 1 phase: 1 orange, 1 brown, 1 white

2.1.3.2.3 Three conductor, 3 phase: 1 orange, 1 brown, 1 yellow

2.1.3.2.4 Four conductor, 3 phase: 1 orange, 1 brown, 1 yellow, 1 white

2.1.3.2.5 Ground wires: Green

2.1.4 Manufacturers:

2.1.4.1 Acceptable manufacturers are:

2.1.4.1.1 Canada Wire and Cable Limited

2.1.4.1.2 General Cable

2.1.4.1.3 SouthWire

2.1.4.1.4 Nexans

2.2 <u>TYPE TECK 90 CABLE</u>

2.2.1 Conductors

2.2.1.1 Copper conductors shall be of the sizes indicated, having a minimum conductivity of 98 percent.

2.2.1.2 Each cable shall have a grounding conductor.

2.2.2 Insulation

2.2.2.1 Chemically cross-linked thermosetting polyethylene insulation rated at a minimum of 1000V, type RW 90.

2.2.3 Inner jacket

2.2.3.1 Polyvinyl chloride inner jacket.

2.2.4 Armour

2.2.4.1 Interlocking aluminum armour.

2.2.5 Overall jacket

2.2.5.1 Thermoplastic polyvinyl chloride LFS/LGE overall jacket for fire protection and low acid gas evolution, meeting the requirements of the Vertical Tray Fire Test to CSA Standard C22.2 No. 0.3-92 with a maximum flow travel of 1200 mm. (Conform to FT4).

2.2.6 Fastenings

2.2.6.1 One hole malleable iron straps to secure surface mounted cables.

2.2.6.2 12-gauge galvanized steel channel type supports for two or more cables at 1500 mm centres.

2.2.6.3 1/4" diameter threaded rods to support the suspended channels.

2.2.7 Connectors

2.2.7.1 Watertight TECK connectors, T & B series 10464 and 10470.

2.2.8 Manufacturers

2.2.8.1 Acceptable manufacturers are:

2.2.8.1.1 Nexans;

2.2.8.1.2 General Cable;

2.2.8.2 Southwire;

2.2.8.3 United Wire and Cable.

2.3 ARMOURED CABLES

2.3.1 AC90 Cable:

2.3.1.1 Conductors: Copper conductors, of the sizes as indicated, having a minimum conductivity of 98%.

2.3.1.2 Insulation: Chemically cross-linked thermosetting polyethylene insulation rated at a minimum of 600 V.

2.3.1.3 Armour: Interlocking armour fabricated from aluminum strip.

2.3.1.4 Shall be provided with an integral insulated ground wire.

2.3.1.5 Colour Coding:

2.3.1.5.1 2 conductor, 1 phase: 1 black, 1 white

2.3.1.5.2 3 conductor, 1 phase: 1 black, 1 red, 1 white

2.3.1.5.3 Ground wire: green

2.4 MINERAL-INSULATED CABLES

2.4.1 Conductors: Solid bare soft-annealed copper conductors, of the sizes as indicated.

2.4.2 Insulation Compressed powered magnesium oxide insulation to form a compact homogeneous mass throughout the entire length of the cable.

2.4.3 Sheath:

2.4.3.1 An annealed seamless copper sheath, Type MI, rated 600 V, 250 C.

2.4.3.2 Termination Kits: Provide copper termination kits at each end of each cable.

2.4.4 Manufacturers: Acceptable manufacturers for MI cable are:

2.4.4.1 Pyrotenax of Canada Limited.

2.5 CONTROL CABLES

2.5.1 300V control cable: Stranded annealed copper conductors sized as indicated, with TWH thermoplastic insulation with a shielding of 100% coverage of aluminum polyester tape and drain wire over each group and overall conductors, and an overall jacket of PVC.

2.5.2 300V cables shall conform to CSA standards CAN 3-C21.2 M86.

2.5.3 Custom control cables shall be designed and assembled in the configurations as indicated.

2.5.4 Each conductor shall be black and number coded, pairs shall be black and white and number coded.

2.5.5 Manufacturers: Acceptable manufacturers are:

2.5.5.1 Nexans

2.5.5.2 General Cable

2.5.5.3 Southwire

2.5.5.4 United Wire and Cable

2.5.5.5 Delco

2.5.5.6 Belden

2.6 DRIVE RX CABLES FOR VARIABLE FREQUENCY DRIVES (VFD) APPLICATIONS

2.6.1 All Variable Frequency Drives both unit and remote mounted shall use Drive RX cables between the VFD unit and the motor served by the VFD.

2.6.2 Drive RX cables shall be copper conductor with 1000 volt insulation rating and include three grounds and have an aluminum sheath continuously corrugated and have a PVC jacket.

2.6.3 Drive Rx cabling shall comply with C.S.A. Standard C22.2 No. 123-96 (R001).

2.6.4 Manufacturers: Acceptable manufacturers are:

2.6.4.1 Nexans

3 **EXECUTION**

3.1 INSTALLATION

3.1.1 Install grounding, grounded and neutral conductors without any fuses, switches or breakers of any kind unless otherwise indicated.

3.1.2 Ground the grounded or neutral conductor at the source of supply as indicated and isolate the grounded or neutral conductor at all other locations.

3.1.3 Do not use any grounded or neutral conductors as a grounding conductor.

3.1.4 Do not use any grounding conductor as a grounded or neutral

conductor.

3.1.5 Do not splice any wiring in any raceway. Make splices only at junction boxes.

3.1.6 Provide sufficient slack at the connection points of conductors to permit proper connections to be made.

3.1.7 Do not install any conductors in any raceway until the raceway is complete and cleared of all obstructions.

3.1.8 Install all conductors in any one conduit at the same time taking care not to twist the conductors.

3.1.9 Use wire pulling lubricants that will not shorten the life of the insulation.

3.1.10 Do not install any wires or cables at temperatures above or below those which will cause damage to the wires or cables.

3.2 INSTALLATION OF BUILDING WIRES

3.2.1 Install wiring as follows:

3.2.1.1 In conduit systems in accordance with Section 26 05 34.

3.3 INSTALLATION OF TECK 90 1000 V

3.3.1 Install cables as indicated.

3.3.2 Group cables wherever possible on channels.

3.3.3 Terminate cables in accordance with Section 26 05 20.

3.4 INSTALLATION OF ARMOURED CABLE

3.4.1 Group cables wherever possible.

3.4.2 Terminate cables in accordance with Section 26 05 20.

3.4.3 Shall only be permitted for the final connection to light fixtures and the length of the drop shall not exceed 3 meters. BX shall not be permitted for any other use on this project.

3.4.4 Do not run BX cable in vertical cavity of wall space.

3.5 INSTALLATION OF MINERAL INSULATED CABLE

3.5.1 Install cable exposed, as indicated securely supported by stainless steel straps. Strap cable every 4 feet along the length of the cable with stainless steel straps.

3.5.2 Make cable terminations by using factory-made kits.

3.5.3 At cable terminations use thermoplastic sleeving over bare conductors.

3.5.4 Where cables are embedded in cast concrete or masonry, provide a sleeve for the entry or exit of cables.

3.5.5 Do not splice the cables.

END OF SECTION

1 **GENERAL**

1.1 REFERENCES AND RELATED SECTIONS

1.1.1 Comply with the requirements of Section 26 05 00 Common Work Results – Electrical.

1.1.2 Section 26 05 19 – Low-Voltage Electrical Power Conductors and Cables.

1.1.3 Section 26 05 24 – Wiring Methods.

1.1.4 Section 26 05 33.16 – Boxes for Electrical Systems.

1.1.5 CSA C22.2No.65-1956 (R1965) Wire Connectors.

1.1.6 EEMAC 1Y-2, 1961 Bushing Stud Connectors and Aluminum Adapters (1200 Ampere Maximum Rating).

2 **PRODUCTS**

2.1 MATERIALS - GENERAL

2.1.1 Provide pressure type wire connectors with current carrying parts of copper sized to fit copper conductors as required.

2.1.2 Provide fixture type splicing connectors with current carrying parts of copper sized to fit copper conductors #10 AWG or less.

2.1.3 Provide bushing stud connectors in accordance with EEMAC 1Y-2-1961 to consist of:

2.1.3.1 A connector body and a stud clamp for stranded copper conductors.

2.1.3.2 A clamp for stranded copper conductors

2.1.3.3 Stud clamp bolts as required.

2.1.3.4 Bolts for the copper conductors.

2.1.3.5 Sized for the conductors as indicated.

2.1.4 Pressure type wire connectors are to be manufactured to CSA C2.22 No. 65. Clamps and connectors are to be manufactured to CSA C22.2 No. 18.

2.1.5 Building wire connectors shall be:

2.1.5.1 For wire sizes up to #6 AWG – Ideal “Wing Nut”.

2.1.5.2 For wire sizes #4 and larger:

2.1.5.2.1 End to end splices – Burndy US

2.1.5.2.2 Parallel splices – Burndy UC

2.1.6 At studs and bus bars – Burndy QQA (CU/AL)

2.1.7 Two or three conductors in parallel – Burndy Q2A or Q3Q (CU/AL).

2.1.8 Cable connectors shall be:

2.1.8.1 For armoured TECK cables, watertight type, with open compounded head – T & B series “Spin-on 2” with corrosion resistant boot.

2.1.8.2 For armoured cables and steel type with nylon insulated throat – T & B “Tite-Bite”.

2.1.8.3 Clamps or connectors for armoured cable, mineral insulated cable, flexible conduit, non-metallic sheathed cable shall be as required.

2.2 <u>STANDARD FIXED SPRING TYPE CONNECTORS</u>

2.2.1 Body constructed of polypropylene rated to 105°C. Body shall be wing type. Body shall be threaded to guide wiring to springs. Barrel end shall be long enough to cover bare end of conductors. Body shall be colour coded to indicate size.

2.2.2 Inner spring shall be rated for copper conductors up to 600V. Inner spring shall be designed to reduce corrosion. The spring shall expand to compress the connection.

2.2.3 Manufacturer:

2.2.4 Thomas and Betts Marrette Type II Winged;

2.2.5 Ideal Industries.

2.3 <u>VABRATION RESISTANT AND HIGH TEMPERATURE SLEEVE & SCREW TYPE CONNECTORS</u>

2.3.1 Insulator body constructed of rugged phynolic material rated to 150°C. Insulator cap to mechanically lock securely in place to safeguard against loosening from vibrations.

2.3.2 Insert sleeve and set screw shall be corrosion resistant brass; rated for copper conductors up 600V. Insert sleeve and set screw shall provide a positive pressure type connection resistant to vibrations and heating cycles.

2.3.3 Manufacturer:

2.3.3.1 Thomas and Betts Marrette Set Screw Vibration Proof/Visible Connection;

2.3.3.2 Ideal Industries.

2.4 WEATHERPROOF FIXED SPRING TYPE CONNECTORS

2.4.1 Body constructed of polypropylene rated to 105°C. Body shall be wing type. Body shall be threaded to guide wiring to springs. Barrel end shall be long enough to cover bare end of conductors. Body shall be colour coded to indicate size.

2.4.2 Inner spring shall be rated for copper conductors up to 600V. Inner spring shall be designed to reduce corrosion. The spring shall expand to compress the connection.

2.4.3 Pre-filled with silicone-based sealant to prevent corrosion. Suitable interior and exterior wet and damp location installations.

2.4.4 Manufacturer:

2.4.4.1 Ideal Industries Weatherproof Wire Connector

2.5 MECHANICAL WIRE CONNECTORS

2.5.1 Tin-plated, cast copper body made from corrosion resistant high strength copper alloy. Serrated barrel for high pull out strength. Barrel to have inspection window to ensure good connection.

2.5.2 Part number and conductor range to be stamped on the connector.

2.5.3 Plated steel hex socket set screw to provide durable electrical contact.

2.5.4 Two hole lugs only where a tong is required.

2.5.5 Rated for copper conductors up to 600V and 90°C.

2.5.6 Manufacturer:

2.5.6.1 Panduit – Pan-Lug Cast Copper Connectors;

2.5.6.2 Blackburn.

2.6 COMPRESSION WIRE CONNECTORS

2.6.1 Long barrel made from seamless, high conductivity copper tubing, electro tin-plated and burnished to inhibit corrosion. Barrel to have inspection window to ensure good connection.

2.6.2 Colour coded with and stamped to indicate proper crimping die size.

2.6.3 Two hole lugs only where a tong is required.

2.6.4 Rated for copper conductors up to 35KV and 90°C.

2.6.5 Manufacturer:

2.6.5.1 Panduit – Pan-Lug Compression Connectors;

2.6.5.2 Blackburn.

2.7 MECHANICAL LUGS

2.7.1 Solid, high strength, extruded aluminum alloy body, electro tin-plated for corrosion resistance. Inspection window for visible assurance.

2.7.2 Plated steel hex set screw for durable electrical connection.

2.7.3 Part number and conductor range to be stamped on the connector.

2.7.4 Two hole mounting only where a tong is required and mounting pace permits.

2.7.5 Dual rated for copper and aluminum conductors up to 600V and 90°C.

2.7.6 Compatible with equipment to be used with.

2.7.7 Manufacturer:

2.7.7.1 Panduit – Pan-Lug Aluminum Mechanical Connectors

2.7.7.2 Blackburn

2.8 INSULATED BUTT (HYPRESS) SPLICE

2.8.1 Tinned copper barrel with brazed seam. Barrel to have wire stop to ensure proper insertion length.

2.8.2 Vinyl insulation with expanded wire entry. Colour coded and printed with conductor range.

2.8.3 Rated for up to 600V and 105°C.

2.8.4 Manufacturer:

2.8.4.1 Panduit – Pan-Term Butt Splice.

2.8.4.2 Blackburn

3 **EXECUTION**

3.1 USAGE

3.1.1 Standard Fixed Spring Type Connectors:

3.1.1.1 General purpose wire connections in junction boxes or electrical equipment

3.1.1.2 Indoor dry Locations only.

3.1.1.3 Where vibration is not a concern.

3.1.1.4 Wire sized: #14 - #12 AWG

3.1.2 Vibration Resistant And High Temperature Sleeve & Screw Type Connectors:

3.1.2.1 General purpose wire connections, motor connections, small transformers, vibrating equipment, in junction boxes or electrical equipment

3.1.2.2 Indoor dry locations only.

3.1.2.3 For connection of vibrating equipment, motors, small transformers, etc.

3.1.2.4 Wire sized: #14 - #10 AWG

3.1.3 Weatherproof Fixed Spring Type Connectors:

3.1.3.1 General purpose wire connections in junction boxes or electrical equipment.

3.1.3.2 Indoor and outdoor damp and wet locations.

3.1.3.3 For all outdoor connections, site lighting, building lighting, parking gates, etc.

3.1.3.4 Wire sized: #14 - #10 AWG

3.1.4 Mechanical Wire Connectors:

3.1.4.1 General purpose wire connections in junction boxes or electrical equipment for large electrical loads.

3.1.4.2 Provide appropriate insulator and / or waterproof jacket as required.

3.1.4.3 Provide copper bus bars, insulators, and mounting hardware as required to arrange connections in electrical junction boxes.

3.1.4.4 Wire sizes: #8 - #1 AWG

3.1.5 Compression Wire Connectors:

3.1.5.1 General purpose wire connections in junction boxes or electrical equipment for large electrical loads.

3.1.5.2 Provide appropriate insulator and / or waterproof jacket as required.

3.1.5.3 Provide copper bus bars, insulators, and mounting hardware as required to arrange connections in electrical junction boxes.

3.1.5.4 Wire sizes: #6 AWG - #750 MCM.

3.1.6 Mechanical Lugs:

3.1.6.1 Wire connections to distribution equipment.

3.1.6.2 Select product to suit distribution equipment, conductor sizes, and clearances.

3.1.6.3 Apply a coat of zinc joint compound on the aluminum conductors prior to the installation of the connectors.

3.1.6.4 Provide all accessories for mounting in distribution equipment.

3.1.6.5 Wire sizes: #6 AWG - #750 MCM.

3.2 INSTALLATION

3.2.1 Remove insulation carefully from ends of conductors and:

3.2.1.1 Install mechanical pressure type connectors and tighten screws with appropriate compression tool recommended by manufacturer. Installation shall meet secureness tests in accordance with CSA C22.2 No.65.

3.2.1.2 Install fixture type connectors and tighten. Replace insulating cap.

3.2.1.3 Install bushing stud connectors in accordance with EEMAC 1Y-2.

END OF SECTION

1 **GENERAL**

1.1 RELATED SECTIONS

1.1.1 Section 26 05 00 – Common Work Results – Electrical.

1.1.2 Conform to relevant sections of specification for this and other Divisions.

1.2 INSPECTION

1.2.1 Obtain inspection certificate of compliance covering high voltage stress coning from the Inspection Authority Engineer and include it with as-built drawings and maintenance manuals.

2 **PRODUCTS**

2.1 CONNECTORS AND TERMINATIONS

2.1.1 Copper compression connectors as required sized for conductors.

2.1.2 Contact aid for aluminum cables where applicable.

3 **EXECUTION**

3.1 INSTALLATION

3.1.1 Install stress cones, terminations, and splices in accordance with manufacturer's instructions.

3.1.2 Bond and ground, as required.

END OF SECTION

1 **GENERAL**

1.1 REFERENCES AND RELATED SECTIONS

1.1.1 Section 26 05 00 – Common Work Results - Electrical.

1.1.2 Section 26 05 19 – Low-Voltage Electrical Power Conductors and Cables.

1.1.3 Section 26 05 20 - Wire & Box Connectors (0 – 1000 VOLTS).

1.1.4 Section 26 05 32 - Outlet Boxes, Conduit Boxes & Fittings.

1.1.5 Section 26 05 33.16 – Boxes for Electrical Systems

1.1.6 Section 26 05 34 - Conduits, Conduit Fastenings & Conduit Fittings.

1.1.7 Conform to relevant sections of specification for this and other Divisions.

2 **PRODUCTS**

2.1 NIL

3 **EXECUTION**

3.1 GENERAL

3.1.1 The wiring method, final connection, and mounting shall be proposed by the Contractor and submitted in writing for each installation type. Unless noted otherwise or to suit particular site conditions, the methods noted in this specifications section shall be considered the minimum standard.

3.1.2 General: All wiring shall be recessed when located in finished areas. Surface mounted wiring may be used in mechanical rooms, service spaces. Provide protection to conduits which may be subject to mechanical damage.

3.2 120/208V DISTRIBUTION & 120/208V LIGHTING

3.2.1 Wire in conduit for all feeders and feeds to mechanical equipment.

3.2.2 Wire in conduit for power branch circuits.

3.2.3 Wire in conduit shall be provided for all services for this project.

3.2.4 Wire in conduit for lighting circuits. Final drops to luminaires may be made with Type AC90 cable or wire in conduit. No runs of type AC90 cable shall exceed 3 meters in length. AC90 where used shall be provided with an integral insulated ground wire.

3.2.5 Final connection to motors and transformer susceptible to vibration shall be made in flexible conduit.

3.2.6 Wire in conduit for dimming systems.

3.2.7 Provide spare boxes for emergency lighting fixtures that maybe required by Building Inspector.

3.2.8 Provide all power wiring to Millwork.

3.2.9 Provide separate minimum No. 12 AWG insulated green ground wire in all conduit runs.

3.2.10 Provide a separate No. 10 AWG neutral wire for all circuits.

3.3 <u>347/600V DISTRIBUTION</u>

3.3.1 Wire in conduit for all feeders and feeds to mechanical equipment.

3.3.2 Wire in conduit for power branch circuits.

3.3.3 Provide separate minimum No. 12 AWG green insulated ground wire in all conduit and runs.

3.3.4 Final connection to motors and transformer susceptible to vibration shall be made in flexible conduit.

3.4 <u>FEEDERS 600V & 120/208V</u>

3.4.1 Wire in conduit for all feeders.

3.4.2 Where specifically noted in the electrical documents, use of armoured cables of the type noted will be acceptable.

3.4.3 Each feeder shall be complete with a ground wire, sized as per Code.

3.5 <u>VERTICAL RISER CABLE INSTALLATIONS</u>

3.5.1 Provide supports for riser cables installed in vertical manner in accordance with OESC Article 12-120. Provide cable pullbox and strain-relief for cable support at intervals as required by the article.

Where the riser cables are installed in inaccessible shaft or within concrete structure, provide access panels at all pullbox and strain-relief locations. Where provision of such accessible installation cannot be accommodated, the Contractor shall use self-supporting vertical riser cables specifically designed for such installations without intermediate supports.

3.6 Fire alarm system wiring

3.6.1.1 Wire in conduit with the approved fire rating as per authorities having jurisdiction.

3.6.1.2 Wiring for fire alarm system shall conform to the requirements of CAN/ULC-S524.

3.6.1.3 Provide flexible connections to supervised valves, pressure switches, flow switches, smoke dampers, and mechanical equipment. Use of flexible armoured conduits or flexible liquid-tight conduits will be acceptable.

3.7 TELEPHONE & DATA COMMUNICATIONS SYSTEMS

3.7.1 Provide blank coverplates on existing outlets as noted on drawings and provide conduit and boxes for all new outlets.

3.7.2 Provide pull cord in conduit system.

3.8 SECURITY SYSTEM

3.8.1 Provide blank coverplates on existing outlets as noted on drawings and provide conduit and boxes for all new outlets.

3.8.2 Provide pull cord in conduit system.

3.9 EMERGENCY POWER FEEDER & FEEDS

3.9.1 All emergency feeders and branch circuits and fire alarm system wiring shall have the required fire rating as per the O.B.C.

3.9.2 Emergency circuits and fire alarm system wiring run in ceiling spaces or wall will have to achieve the required fire rating as per the O.B.C. by means of drywall enclosures or use of MICC cables.

3.9.3 Wire in conduit with approved fire rating per authorities having jurisdiction or MICC cables.

3.10 BX CABLING (AC90)

3.10.1 BX shall only be used for final drops to light fixtures only and the drop shall not exceed 3 meters.

3.10.2 BX is not to be permitted for any other use on this project.

3.11 Vibrating Equipment:

3.11.1 Vibrating equipment includes: motors, transformers, pumps, solenoid valves, telecommunications racks or cabinets, UPS, generator, or any equipment that is prone to vibration.

3.11.2 Provide flexible connection by means of minimum 300mm of armoured flexible conduit or liquid tight conduit.

END OF SECTION

1 GENERAL

1.1 RELATED SECTIONS

1.1.1 Section 26 05 00 – Common Work Results – Electrical.

1.1.2 Section 26 22 13 – Dry Type Transformers Up To 600 V Primary.

1.1.3 Conform to relevant sections of specification for this and other Divisions.

1.2 REFERENCES

1.2.1 ANSI/IEEE 837-1988, Qualifying Permanent Connections Used in Substation Grounding.

1.2.2 CSA Z32.1-M1986, Safety in Anaesthetizing Locations.

1.3 DESCRIPTION OF WORK

1.3.1 Work includes providing all materials, equipment, accessories, services, and tests necessary to complete and make ready for operation. All system grounding, equipment grounding, grounding of outlets, special grounding for telecommunication, grounding of raceways and conduits, grounding of electrical distribution equipment, grounding rod and plates, and accessories work shall be in accordance with drawings and specifications and as required for a complete system.

2 PRODUCTS

2.1 EQUIPMENT

2.1.1 Clamps for grounding of conductor: size as required to electrically conductive underground water pipe.

2.1.2 Copper conductor: minimum 3 m (10') long for each concrete encased electrode, bare, stranded, tinned, soft annealed, size 4/0 AWG or as indicated.

2.1.3 Rod electrodes: copper clad steel 19 mm (¾") dia by 3 m (10') long.

2.1.4 Plate electrodes: Copper surface area 0.2 m^2, 1.6 mm thick.

2.1.5 Grounding conductors: bare stranded copper, tinned, soft annealed, size 4/0 AWG or as indicated.

2.1.6 Insulated grounding conductors: green, type RW90.

2.1.7 Ground bus: copper, size as indicated, complete with insulated supports, fastenings, connectors.

2.1.8 Non-corroding accessories necessary for grounding system, type, size, material as indicated, including but not necessarily limited to:

2.1.8.1 Grounding and bonding bushings.

2.1.8.2 Protective type clamps.

2.1.8.3 Bolted type conductor connectors.

2.1.8.4 Thermite welded type conductor connectors.

2.1.8.5 Bonding jumpers, straps.

2.1.8.6 Pressure wire connectors.

3 EXECUTION

3.1 INSTALLATION GENERAL

3.1.1 Install complete permanent, continuous grounding system including, electrodes, conductors, connectors, accessories. Where EMT is used, run ground wire in conduit.

3.1.2 Install connectors in accordance with manufacturer's instructions.

3.1.3 Protect exposed grounding conductors from mechanical injury.

3.1.4 Make buried connections, and connections to conductive water main, electrodes, using copper welding by thermite process or inspectable wrought copper compression connectors to ANSI/IEEE 837.

3.1.5 Use mechanical connectors for grounding connections to equipment provided with lugs.

3.1.6 Soldered joints not permitted.

3.1.7 Install bonding wire for flexible conduit, connected at both ends to grounding bushing, solderless lug, clamp or cup washer and screw. Neatly cleat bonding wire to exterior of flexible conduit.

3.1.8 Install flexible ground straps for bus duct enclosure joints, where such bonding is not inherently provided with equipment.

3.1.9 Install separate ground conductor to outdoor lighting standards.

3.1.10 Install grounding resistance bank, where specified.

3.1.11 Connect building structural steel and metal siding to ground.

3.1.12 Make grounding connections in radial configuration only, with connections terminating at single grounding point. Avoid loop connections.

3.1.13 Bond single conductor, metallic armored cables to cabinet at supply end, and provide non-metallic entry plate at load end.

3.1.14 Ground secondary service pedestals.

3.2 ELECTRODES

3.2.1 Make ground connections to continuously conductive underground water pipe on street side of water meter.

3.2.2 Install water meter shunt.

3.2.3 Install concrete encased electrodes in building foundation footings, with terminal connected to grounding network.

3.2.4 Install rod electrodes and make grounding connections.

3.2.5 Bond separate, multiple electrodes together.

3.2.6 Use size 4/0 AWG copper conductors for connections to electrodes.

3.2.7 Make special provision for installing electrodes that will give 5 ohm resistance to ground value where rock or sand terrain prevails. Ground as indicated.

3.3 SYSTEM AND CIRCUIT GROUNDING

3.3.1 Install system and circuit grounding connections to neutral of primary 600 V system, secondary 120V system.

3.4 EQUIPMENT BONDING

3.4.1 Install bonding connections from exposed non-current carrying metal part of equipment including, but not necessarily limited to, the following:

3.4.1.1 Frames of motors;

3.4.1.2 Motor control centres;

3.4.1.3 Starters;

3.4.1.4 Control panels;

3.4.1.5 Panelboards and Distribution Panels;

3.4.1.6 Isolations Switch(es);

3.4.1.7 Communication Rooms and equipment;

3.4.1.8 Transformers;

3.4.1.9 Transfer Switch(es);

3.4.1.10 Raceway systems.

3.5 GROUNDING BUS

3.5.1 Install copper grounding bus mounted on insulated supports on wall of electrical room.

3.5.2 Ground items of electrical equipment in electrical room to ground bus with individual bare stranded copper connections size 2/0 AWG.

3.6 COMMUNICATION SYSTEMS

3.6.1 Install grounding connections for telephone, sound, fire alarm, intercommunication systems as follows:

3.6.1.1 Telephones: make telephone grounding system in accordance with telephone company's requirements.

3.6.1.2 Sound, fire alarm, intercommunication systems as indicated.

3.7 FIELD QUALITY CONTROL

3.7.1 Perform ground continuity and resistance tests using method appropriate to site conditions and to approval of Engineer and local authority having jurisdiction over installation.

3.7.2 Perform tests before energizing electrical system.

3.7.3 Disconnect ground fault indicator during tests.

3.7.4 Weld grounding conductors to underground grounding electrodes.

3.7.5 Connect together system neutral, service equipment enclosures, exposed non-current carrying metal parts of electrical equipment, metal raceway systems, earthing conductor in raceways and cables, receptacle ground connectors, and plumbing system.

3.8 INSPECTIONS AND TEST PROCEDURES

3.8.1 The tests to be carried out shall include but not be necessarily limited to:

3.8.1.1 Visual and mechanical inspection:

3.8.1.1.1 Inspect physical and mechanical conditions.

3.8.1.1.2 Inspect anchorage.

3.8.1.2 Electrical Tests:

3.8.1.2.1 Perform fall of potential or alternative test in accordance with IEEE Standard 81 on the main earthing electrode or system.

3.8.1.2.2 Perform point-to-point tests to determine the resistance between the main earthing system and all major electrical equipment frames, system neutral, and/or derived neutral points.

3.8.2 Test Values:

3.8.2.1 The resistance between the main earthing electrode and ground should be no greater than two ohms for commercial or industrial systems and one ohm or less for generating or transmission station grounds unless otherwise specified by the employer. (Reference ANSI/IEEE Standard 142).

END OF SECTION

1 **GENERAL**

1.1 RELATED SECTIONS

1.1.1 Section 26 05 00 – Common Work Results – Electrical.

1.1.2 Section 26 22 13 – Dry Type Transformers up to 600V Primary.

1.1.3 Section 26 24 16 – Panelboards Breaker Type.

1.1.4 Conform to relevant sections of specification for this and other Divisions.

2 **PRODUCTS**

2.1 SUPPORT CHANNELS

2.1.1 U shaped, steel channel, accurately cold rolled formed from 12 gauge, low carbon steel with finished dimensions of 1 5/8" x 1 5/8" (3.1 mm x 3.1 mm), inturned clamping ridges and a continuous slot along one (1) side for the insertion of slotted nuts. Hot dip galvanize the channel after fabrication with a zinc weight of 1.5 oz/ft sq.

2.1.2 Nuts with 2 serrated grooves to engage the clamping ridges of the channel, a spring to hold the nut in place during installation and threaded with Unified and American course threads. Case harden and electrogalvanize after fabrication.

2.1.3 Electrogalvanized bolts, threaded rod, flat and lockwashers as required.

2.1.4 Angle, U, Z and special fittings, brackets, bases, clamps, hangers, couplings and other fittings as required and galvanized unless otherwise indicated.

2.1.5 Provide channel and fittings of one (1) manufacturer. Acceptable manufacturers are:

2.1.6 Unistrut of Canada Ltd;

2.1.7 Burndy Canada Ltd.;

2.1.8 Electrovert Ltd.;

2.1.9 Pilgrim Technical Products Limited.

2.2 CONCRETE ANCHORS

2.2.1 Drilled expansion anchors for anchors set in concrete block or poured concrete after the concrete has set. Size the insert and number of anchors so that the maximum load per anchor does not exceed 25% of the manufacturer's published maximum loading.

2.2.2 Provide concrete anchors of one (1) manufacturer. Acceptable manufacturers are:

2.2.2.1 Hilti Canada Ltd.

2.2.3 U channel concrete inserts shall be 12 gauge steel 1 5/8 in. square with insert anchors 1 3/8 in. long and 4 in. on centre. Acceptable manufacturers are:

2.2.3.1 Pilgrim Technical Products Limited;

2.2.3.2 Electrovert Limited;

2.2.3.3 Unistrut.

3 **EXECUTION**

3.1 INSTALLATION

3.1.1 Secure equipment to solid masonry, tile and plaster surfaces with lead anchors.

3.1.2 Secure equipment to poured concrete with expandable inserts.

3.1.3 Secure equipment to hollow masonry walls or suspended ceilings with toggle bolts.

3.1.4 Secure surface mounted equipment with twist clip fasteners to inverted T-bar ceilings. Ensure that T-bars are adequately supported to carry weight of equipment specified before installation.

3.1.5 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.

3.1.6 Fasten exposed conduit or cables to building construction or support system using straps.

3.1.6.1 One-hole steel straps to secure surface conduits and cables 50 mm (2”) and smaller.

3.1.6.2 Two-hole steel straps for conduits and cables larger than 50 mm (2”).

3.1.6.3 Beam clamps to secure conduit to exposed steel work.

3.1.7 Suspended support systems.

3.1.8 Support individual cable or conduit runs with 6 mm (¼”) diameter threaded rods and spring clips:

3.1.8.1 Support two or more cables or conduits on channels supported by 6 mm (¼”) diameter threaded rod hangers where direct fastening to building construction is impractical.

3.1.9 For surface mounting of two or more conduits use channels at 5 m oc spacing.

3.1.10 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.

3.1.11 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.

3.1.12 Do not use wire lashing or perforated strap to support or secure raceways or cables.

3.1.13 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of Engineer.

3.1.14 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.

3.1.15 Where conduit and equipment is located on walls or slabs which will not permit the support of equipment, provide suitable supports to the building structure. Supports shall be constructed out of steel members or of steel pipe and fittings designed to safely support the equipment.

END OF SECTION

1 **GENERAL**

1.1 RELATED SECTIONS

1.1.1 Section 26 05 00 – Common Work Results – Electrical.

1.1.1 Section 26 05 33.16 – Boxes for Electrical Systems.

1.1.2 Section 26 05 34 – Conduits, Conduit Fastenings & Conduit Fittings.

1.1.3 Conform to relevant sections of specification for this and other Divisions.

1.2 SHOP DRAWINGS & PRODUCT DATA

1.2.1 Submit shop drawings and product data in accordance with Section 26 05 01.

1.2.2 Provide samples of all floor boxes for Consultant's review.

1.3 STANDARDS

1.3.1 Outlet Boxes, Conduit Boxes and Fittings to C.S.A. C22.2 No.18-92.

1.3.2 Rigid PVC Boxes and Fittings to C.S.A. C22.2 No.85-M89.

2 **PRODUCTS**

2.1 general

2.1.1 All device model number listed are intended to represent base specification for design intent. Provide equal product from the acceptable manufacturers.

2.2 OUTLET AND CONDUIT BOXES GENERAL

2.2.1 Size boxes in accordance with CSA C22.1 and electrical code

2.2.2 All sheet steel boxes shall have pre-punched 19 mm knockouts.

2.2.3 Do not use boxes with cable clamps.

2.2.4 Boxes shall be minimum size 75 mm x 50 mm x 50 mm deep. Provide 100 mm square or larger outlet boxes as required for special devices. Add extension and plaster rings as required.

2.2.5 Provide 100 mm square or octagonal outlet boxes for luminaire outlets.

2.2.6 Provide interior baffle divider to separate power and switching devices from low voltage or tel/data wiring.

2.2.7 Provide blank cover plates for boxes without wiring devices as described in Section 26 27 26.

2.2.8 Provide 347 V outlet boxes for 347 V switching devices.

2.2.9 For outlet boxes or devices boxes being installed in rooms designated as pressure controlled space (positive and/or negative pressurized spaces such as lab space), provide putty mat or similar sealing material to complete seal the outside of the outlet boxes. Similarly, ensure associated conduit raceways are sealed to maintain the pressure rating.

2.2.10 For outlet boxes or devices boxes being installed in spaces with noise control or sound transmission requirement, such as theatres or recording studio), provide putty mat or similar sealing material to completely seal the outside of the outlet box and limit the sound transmission.

2.3 SHEET STEEL OUTLET BOXES

2.3.1 Electro-galvanized steel single and multi-gang flush device boxes for flush installation, minimum size 76 x 50 x 38 mm (3" x 2" x 1½") or as required for special devices or as indicated. 102 mm (4") square outlet boxes when more than one conduit enters one side with extension and plaster rings as required.

2.3.2 Boxes for door switch and pushbuttons shall be sized as required.

2.3.3 102 mm (4") square or octagonal outlet boxes for lighting fixture outlets.

2.3.4 102 mm (4") square outlet boxes with extension and plaster rings for flush mounting devices in finished plaster or tile walls.

2.4 MASONRY BOXES

2.4.1 Electro-galvanized steel masonry single and multi-gang MBD boxes for devices flush mounted in exposed block walls.

2.5 CONCRETE BOXES

2.5.1 Electro-galvanized sheet steel concrete type boxes for flush mount in concrete with matching extension and plaster rings as required.

2.6 FLOOR BOXES

2.6.1 Concrete tight electro-galvanized sheet steel floor boxes with adjustable finishing rings to suit floor finish with brass faceplate. Device mounting plate to accommodate short or long ear duplex receptacles. Minimum depth: 28 mm (1 1/8") for receptacles; 73 mm (3") for communication equipment.

2.6.2 Adjustable, watertight, concrete tight, cast floor boxes with openings drilled and tapped for 12 mm and 19 mm (½" and ¾") conduit. Minimum size: 3 mm (3") deep.

2.7 CONDUIT BOXES

2.7.1 Cast FS or FD feraloy boxes with factory-threaded hubs and mounting feet for surface wiring of switches and receptacle in all public areas and 1110 utility boxes in all service rooms.

2.8 OUTLET BOXES FOR NON-METALLIC SHEATHED CABLE

2.8.1 Electro-galvanized, sectional, screw ganging steel boxes, minimum size 76 x 50 x 63 mm (3" x 2" x 2½") with two double clamps to take non-metallic sheathed cables.

2.9 PVC BOXES

2.9.1 All PVC boxes to have approved ground straps and shall be compatible with PVC conduit used.

2.10 FITTINGS – GENERAL

2.10.1 Bushing and connectors with nylon insulated throats.

2.10.2 Knock-out fillers to prevent entry of debris.

2.10.3 Conduit outlet bodies for conduit up to 32 mm (1¼") and pull boxes for larger conduits.

2.10.4 Double locknuts and insulated bushings on sheet metal boxes.

2.11 WEATHERPROOF COVERS

2.11.1 Light switches:

2.11.1.1 Clear bubble plate with silicone rubber for use with all AC toggle switches. Hubbell Cat No. HBL1795

2.11.1.2 For locations with 2-ganged switches and/or 2-gang boxes with single switch and blank, provide custom Hubbell cover to suit requirements.

3 EXECUTION

3.1 INSTALLATION

3.1.1 Support boxes independently of connecting conduits. All boxes to be hung independently of ducts, pipes, etc.

3.1.2 Fill boxes with sponges or foam or similar approved material to prevent entry of debris during construction. Remove upon completion of work.

3.1.3 For flush installations mount outlets flush with finished wall using plaster rings to permit wall finish to come within 6 mm (¼") of opening.

3.1.4 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Reducing washers are not allowed.

3.1.5 Size boxes in accordance with electrical code.

3.1.6 Gang boxes together where wiring devices are grouped.

3.1.7 Provide matching blank cover plates for boxes without wiring devices.

3.1.8 When using PVC conduit, use approved boxes.

3.1.9 Prior to pouring concrete secure flush floor boxes to reinforcing steel, adjust level and to correct height, install cement cover securely. After pour make final adjustments.

END OF SECTION

1 **GENERAL**

1.1 RELATED SECTIONS

1.1.1 Section 26 05 00 – Common Work Results – Electrical.

1.1.2 Section 26 05 24 – Wiring Methods.

1.1.3 Section 26 27 26 – Wiring Devices.

1.1.4 Conform to relevant sections of specification for this and other Divisions.

1.2 REFERENCES

1.2.1 Canadian Standards Association (CSA).

1.2.2 CAN/CSA C22.2 No.18-92, Outlet Boxes, Conduit Boxes, and Fittings.

1.2.3 CSA C22.2 No.45-M1981 (R1992), Rigid Metal Conduit.

1.2.4 CSA C22.2 No.56-1977 (R1977), Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.

1.2.5 CSA C22.2 No.83-M1985 (R1992), Electrical Metallic Tubing.

1.2.6 CSA C22.2 No.211.2-M1984 (R1992), Rigid PVC (Un-plasticized) Conduit.

1.2.7 CAN/CSA C22.2 No.227.3-M91, Flexible Nonmetallic Tubing.

1.3 LOCATION OF CONDUIT

1.3.1 The drawings do not show all conduits. Those shown are in diagrammatic form only. Conduits are to be provided to create complete raceway systems.

1.3.2 No conduits shall be installed within concrete columns.

1.4 NUMBER & SIZES OF CONDUITS

1.4.1 Conduits to be provided shall be as indicated on documents and/or as required to suit requirements of systems installed.

2 **PRODUCTS**

2.1 CONDUITS

2.1.1 Rigid metal conduit: to CSA C22.2 No.45, galvanized steel threaded.

2.1.2 Epoxy coated conduit: to CSA C22.2 No.45, with zinc coating and corrosion resistant epoxy finish inside and outside.

2.1.3 Electrical metallic tubing (EMT): to CSA C22.2 No.83, with couplings.

2.1.4 Rigid Schedule 40 PVC conduit of the sizes indicated and required to CSA C22.2 No.211.2-M1984(R1992).

2.1.5 Flexible metal conduit: liquid-tight flexible metal conduit of the sizes indicated and required to CSA C22.2 No.56-1977(R1992).

2.1.6 Electrical non-metallic tubing, flexible and flexible liquid-tite included, of the sizes indicated and required to C.S.A. C22.2 No.227.1-1988, No.227.2-M1987 and No.227.3-M91.

2.1.7 Do not use conduits smaller than 3/4" unless specifically detailed in these documents.

2.2 CONDUIT FASTENINGS

2.2.1 One hole malleable iron, hot dipped galvanized straps to secure surface mounted conduits. Thomas & Betts series 1275 for rigid, threaded conduit and Thomas & Betts Series 4176 for EMT complete with properly sized pan head screw.

2.2.2 Beam clamps to secure conduits to exposed steel work.

2.2.3 Provide 12 gauge galvanized steel “U” channel type supports for two or more conduits on minimum 1500 mm centres. Use suitable conduit clamps in channel.

2.2.4 Threaded rods, 6 mm (¼”) dia., to support suspended channels.

2.3 CONDUIT FITTINGS

2.3.1 Fittings: manufactured for use with the conduit specified with the same coating as conduit.

2.3.2 Provide insulated bushings on all rigid, threaded conduits.

2.3.3 Provide insulated steel set screw connectors and couplings for

EMT conduits 2" and smaller, Thomas & Betts series.

2.3.4 Provide raintight connectors for conduits in all sprinklered areas.

2.3.5 Provide nylon insulated concrete tight steel set screw connectors and couplings for EMT conduits 2" and smaller installed in cast-in-place concrete. Thomas & Betts 5031 and 5030 Series.

2.3.6 Provide nylon insulated steel set screw couplings and connectors for all EMT conduits 2-1/2" and larger, Thomas & Betts.

2.3.7 Provide double locknuts and a nylon insulated bushing for Schedule 40 conduit connections to sheet steel boxes and enclosures.

2.3.8 Cast Fitting shall not be used on this project.

2.3.9 Provide raintight connectors on conduits into panelboards and MCC's.

2.4 EXPANSION FITTINGS FOR RIGID CONDUIT

2.4.1 Weatherproof expansion fittings with an integral bonding assembly suitable for a 100 (4") mm linear expansion.

2.4.2 Watertight expansion fittings with an integral bonding jumper suitable for linear expansion and a 20 mm deflection in all directions.

2.4.3 Weatherproof expansion fittings for linear expansion at entry to panel.

2.5 FISH CORD

2.5.1 Provide fish cords to be minimum 3 mm polypropylene in all feeder and branch conduit runs.

2.5.2 Provide fish cords to be minimum 3 mm polypropylene in all systems conduit runs.

3 EXECUTION

3.1 INSTALLATION

3.1.1 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.

3.1.2 Use rigid PVC DB-2 type 2 (thick walled) or flexible non-metallic tubing (ENT) in cast concrete indoor slab, in accordance with Section 26 05 24 (Wiring Methods).

3.1.3 Conceal conduits except in mechanical and electrical service rooms and in unfinished areas.

3.1.4 Do not surface mount conduits on building exterior surfaces unless otherwise indicated.

3.1.5 Use rigid PVC DB-2 type 2 (thick walled) in duct banks. Thin walled PVC conduit will not be accepted.

3.1.6 Bend conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter.

3.1.7 Mechanically bend steel conduit over 19 mm (¾") dia.

3.1.8 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.

3.1.9 Install fish cord in empty conduits.

3.1.10 Run 2-1" spare conduits up to ceiling space from each flush panel. Terminate these conduits in 6" x 6" x 4" (152 mm x 152 mm x 102 mm) junction boxes at top of wall above panel. Box to be selected to suit finish required.

3.1.11 Where conduits become blocked, remove and replace blocked section.

3.1.12 Dry conduits out before installing wire.

3.1.13 Use rigid, threaded Schedule 40, galvanized steel threaded conduit where specified.

3.1.14 Use rigid PVC conduit underground for duct bank or otherwise shown within the confines of all applicable codes.

3.1.15 Use electrical metallic tubing (EMT) in general areas, except in cast concrete, or as indicated otherwise on Construction Documents.

3.1.16 Use flexible metal conduit for connection to motors and transformers, connection to recessed incandescent fixtures without a prewired outlet box, connection to surface or recessed fluorescent fixtures and work in movable metal partitions.

3.1.17 Use liquid tight flexible metal conduit for connection to motors, transformers etc.

3.1.18 Use flexible conduit (seal tight) connects on line and load side of all transformers.

3.1.19 Any nonmetallic raceways installed in concealed space used as a plenum shall meet flame and smoke density rating conforming to FT6 rating when tested in conformance with CAN/ULC-S102.4.

3.1.20 Box offsets must be provided where conduits terminate at a junction box or piece of electrical equipment or distribution.

3.1.21 The conduits for the following circuits and systems shall be run separately, except as noted and directed for some low energy systems such as CCTV and intercoms.

3.1.22 Normal power to luminaires

3.1.23 Emergency power to luminaires

3.1.24 Normal power to receptacle outlets

3.1.25 Exit lighting system

3.1.26 Life safety system

3.1.27 Security system

3.1.28 Tele/data system

3.1.29 A/V system

3.1.30 P.A. system wiring

3.1.31 CCTV system

3.1.32 Cable TV – AM/FM

3.1.33 Intercom system

3.1.34 Other auxiliary systems

3.2 <u>PVC CONDUITS</u>

3.2.1 PVC conduits may be bent in the field using approved electrical heating devices or by using the appropriate bends. Damaged or improper bends shall be replaced. All joints shall be made using an

approved coupling with solvent welds. Clean all joints with solvent cleaner prior to applying the solvent. Liberally apply the solvent to the conduit fitting, force the conduit into the fitting and rotate the conduit 45 degrees within the flange to form a tight bond. Allow proper curing time.

3.2.2 All scorched PVC conduit shall be removed.

3.3 SURFACE CONDUITS

3.3.1 Run parallel or perpendicular to building lines.

3.3.2 Locate conduits behind infrared or gas fired heaters with 1.5 m (5') clearance.

3.3.3 Run conduits in flanged portion of structural steel.

3.3.4 Group conduits wherever possible on suspended or surface channels.

3.3.5 Do not pass conduits through structural members except as indicated, or approved in writing by the Structural Consultant.

3.3.6 Do not locate conduits less than 75 mm (1 1/8") parallel to steam or hot water lines with minimum of 25 mm (1") at crossovers.

3.4 CONCEALED CONDUITS

3.4.1 Run parallel or perpendicular to building lines.

3.4.2 Do not install horizontal runs in masonry walls and partition.

3.4.3 Do not install conduits in terrazzo or concrete toppings.

3.5 CONDUITS IN CAST-IN-PLACE CONCRETE

3.5.1 Locate to suit reinforcing steel. Install in centre one third of slab.

3.5.2 Protect conduits from damage where they stub out of concrete.

3.5.3 Install sleeves where conduits pass through slab or wall.

3.5.4 Provide oversized sleeve for conduits passing through waterproof membrane, before membrane is installed. Use cold mastic between sleeve and conduit.

3.5.5 Do not place conduits in slabs in which slab thickness is less than

4 times conduit diameter.

3.5.6 Encase conduits completely in concrete with minimum 3” (75mm) concrete cover.

3.5.7 Organize conduits in slab to minimize crossovers.

3.6 CONDUITS IN CAST-IN-PLACE SLABS ON GRADE

3.6.1 Run conduits 25 mm (1”) and larger below slab and encased in 75 mm (3”) concrete envelope. Provide 50 mm (2”) of sand over concrete envelope below floor slab.

3.7 CONDUITS UNDERGROUND

3.7.1 Slope conduits to provide drainage.

3.7.2 Waterproof joints (except PVC) with heavy coat of bituminous paint.

3.8 EXTERIOR

3.8.1 Run conduit to exterior equipment as detailed.

END OF SECTION

1 **GENERAL**

1.1 RELATED SECTIONS

1.1.1 Section 26 05 00 – Common Work Results – Electrical.

1.1.2 Conform to relevant sections and specification for this and other Divisions.

2 **PRODUCTS**

3 **EXECUTION**

3.1 CABLE INSTALLATION IN DUCTS

3.1.1 Install cables as indicated in ducts.

3.1.2 Do not pull spliced cables inside ducts.

3.1.3 Install multiple cables in duct simultaneously.

3.1.4 Use CSA approved lubricants of type compatible with cable jacket to reduce pulling tension.

3.1.5 To facilitate matching of colour coded multi-conductor control cables reel off in same direction during installation.

3.1.6 Before pulling cable into ducts and until cables are properly terminated, seal ends of lead covered cables with wiping solder; seal ends of non-leaded cables with moisture seal tape.

3.1.7 After installation of cables, seal duct ends with duct sealing compound.

3.2 FIELD QUALITY CONTROL

3.2.1 Perform tests in accordance with Section 26 05 01 – Common Work Results – Electrical.

3.2.2 Perform tests using qualified personnel. Provide necessary instruments and equipment.

3.2.3 Check phase rotation and identify each phase conductor of each feeder.

3.2.4 Check each feeder for continuity, short circuits and grounds. Ensure resistance to ground of circuits is not less than 50 mega-

ohms.

3.2.5 Pre-acceptance Tests.

3.2.5.1 After installing cable but before splicing and terminating, perform insulation resistance test with 1000 V megger on each phase conductor.

3.2.5.2 Check insulation resistance after each splice and/or termination to ensure that cable system is ready for acceptance testing.

3.2.6 Acceptance Tests:

3.2.6.1 Ensure that terminations and accessory equipment are disconnected.

3.2.6.2 Ground shields, ground wires, metallic armor and conductors not under test.

3.2.6.3 High Potential (Hipot) Testing:

3.2.6.3.1 Conduct hipot testing in accordance with manufacturer's recommendations.

3.2.6.4 Leakage Current Testing:

3.2.6.4.1 Raise voltage in steps from zero to maximum values as specified by manufacturer for type of cable being tested.

3.2.6.4.2 Record leakage current at each step.

3.2.7 Provide Consultant with list of test results showing.

3.2.8 Remove and replace entire length of cable if cable fails to meet any of test criteria.

END OF SECTION

1 GENERAL

1.1 REFERENCES AND RELATED SECTIONS

1.1.1 Comply with the requirements of Section 26 05 00 – Common Work Results – Electrical.

1.1.2 Conform to relevant sections of specification for this and other Divisions.

2 PRODUCTS

2.1 NAMEPLATES

2.1.1 Construct all nameplates from laminated plastic having a white core with a black top lamination such that engraving through the top lamination will reveal white lettering on a black background.

2.1.2 Construct all warning and emergency power nameplates from laminated plastic having a white core with a red top lamination such that engraving through the top lamination will reveal white lettering on a black background.

2.2 SIZES

2.2.1 Provide nameplates of the sizes indicated. Where a size is not given, provide a standard size nameplate of sufficient size to contain the text indicated.

2.2.2 Where a numerical size is indicated, provide a nameplate of a size as indicated in the table below. Provide lettering of the height indicated below unless another size is indicated.

Size	Width (mm)	Height (mm)	First Line lettering height (mm)	Following Lines lettering height (mm)
1	50	25	13	-
1A	50	25	7.5	7.5
2	75	50	13	10
3	75	50	10	7.5
4	100	50	25	10
5	125	75	25	10
6	200	100	25	10

2.2.3 Provide lettering of the height indicated. Where no height is indicated, provide lettering 10 mm high for the first line and 7.5 mm high for all following lines.

2.3 SPECIFIC NAMEPLATES

2.3.1 For each power and distribution transformer, provide a Size 5 nameplate to indicate the following information. The number in brackets indicates the lettering height in millimeters:

2.3.1.1 Line 1: Equipment tag number (25)

2.3.1.2 Line 2: KVA, Rated voltage (10)

2.3.1.3 Line 3: Power source (10)

Example: **TX-2A01**
150KVA 600V-208/120V
FED FROM DP-6A0B

2.3.2 For each panelboard, disconnect switch, loose starter, etc. provide a Size 5 nameplate to indicate the following information. The number in brackets indicates the lettering height in millimeters:

2.3.2.1 Line 1: Equipment tag number (25)

2.3.2.2 Line 2: Rated bus, Rated voltage, phase, and wires (10)

2.3.2.3 Line 3: Power Source (10)

Example: **PP-2A01**
225A, 208/120V, 3-PH, 4-W
FED FROM DP-2A01

2.4 WARNING NAME PLATES

2.4.1 Type "A", width = 100 mm , height = 100 mm
(Text height in millimetres in brackets)

Text: **DANGER**..... (25)
MORE THAN ONE POWER SOURCE..... (10)
CONTAINED WITHIN,..... (10)
DISCONNECT ALL POWER.....(10)
SOURCES BEFORE SERVICING.....(10)
THIS EQUIPMENT.....(10)

3 EXECUTION

3.1 INSTALLATION

3.1.1 Coordinate final nameplate design, colour and nomenclature with the Engineer prior to ordering of nameplates.

3.1.2 Install nameplates on the front of the equipment on a prominent flat surface. Attach the nameplates with non-rusting screws.

3.1.3 Provide red mimic bus on Medium Voltage equipment and as specified.

3.1.4 Provide an Excel spreadsheet with all Nameplates for review by the Owner and the Consultant prior to manufacturing. Submit as a shop drawing.

END OF SECTION

1 GENERAL

1.1 RELATED WORK

1.1.1 Comply with relevant Sections of this and other Divisions of this Specification.

1.2 RELATED SECTIONS

1.2.1 Section 26 05 00 – Common Work Results – Electrical

1.2.2 Section 26 24 13 – Switchboards

1.2.3 Section 26 24 16 – Panelboards

1.2.4 Section 26 25 00 – Enclosed Bus Assemblies

1.2.5 Section 26 28 13 – Fuses – Low Voltage.

1.2.6 Section 26 28 16.13 – Enclosed Circuit Breakers

1.2.7 Section 26 28 16.16 – Enclosed Switches

1.2.8 Conform to relevant sections of specification for this and other Divisions.

1.3 SUMMARY

1.3.1 The short circuit analysis evaluates the adequacy of the electrical equipment to withstand or to interrupt the calculated maximum available short circuit current at its location.

1.3.2 The overcurrent device time-current coordination analysis determines the suggested settings and, where appropriate, the ampere ratings and types for the electrical power system protective devices to achieve the desired system protection and electrical service continuity goals.

1.3.3 The harmonic analysis is performed to provide a baseline model predicting the system's level of harmonic distortion. This information is then to be used to evaluate conformance to IEEE 519.

1.3.4 The arc flash analysis calculates arc flash incident energy, flash protection boundary distances and personal protective equipment (PPE) to be used within the flash protection boundary. This analysis is required to meet CSA Z462 and NFPA 70E requirements.

1.3.5 For an existing electrical system, it may be required to perform a field survey to accurately model the analysis. The field survey shall include, but not limited to verification of transformers, meters, fuses, circuit breakers, relays, cable length, impedance and size of conductor, Busway type, etc., as required to perform an accurate analysis.

1.3.6 Complete engineering as-built one line diagrams shall be provided using engineering software.

1.3.7 The furnishing and the installation of Arc Flash warning labels shall be provided.

1.3.8 The company performing the studies shall have at least ten (10) years of experience performing such studies and shall be a registered professional engineer.

1.3.9 Studies shall be performed using the latest edition of one of the following software, unless otherwise noted:

1.3.9.1 SKM System Analysis Power

1.3.9.2 ETAP – Electrical Power Systems Analysis

1.4 ACCEPTABLE SERVICE PROVIDERS

1.4.1 Acceptable companies to provide coordination study:

1.4.1.1 Brosz and Associates

1.4.1.2 Eastenghouse

1.4.1.3 Enkompass

1.4.1.4 G.T. Wood

1.4.1.5 Pelikan

1.4.1.6 Schneider Electric

1.4.1.7 Eaton Electric

2 **STUDIES**

2.1 ELECTRICAL POWER SYSTEM STUDIES

2.1.1 An electrical system Coordination and Short Circuit Analysis:

2.1.1.1 Shall compare the calculated maximum fault current with interrupting ratings of overcurrent protective devices such as fuses and circuit breakers.

2.1.1.2 Shall investigate applicable short circuit series ratings and the protection of electrical equipment by current limiting devices.

2.1.1.3 Shall verify the adequacy of other equipment (such as transformers, switches, equipment bussing) to withstand the effects of the calculated maximum fault current levels.

2.1.1.4 Shall assist in the selection and/or determination of settings for relays, fuses and circuit breakers in order to provide best coordination and minimum Arc Flash.

2.1.1.5 Calculate the maximum available rms symmetrical three-phase short-circuit current at each significant location in the electrical system shall be made using a digital computer.

2.1.1.6 Shall simulate a bolted three phase fault at each point of consideration in the system, and calculate the maximum available short circuit current at that point without any reduction due to current limiting overcurrent devices which may be present.

2.1.1.7 Shall include appropriate motor generators and transformer short-circuit contributions (contribution and transformer data) at the appropriate locations in the system so that the computer calculated values represent the highest short-circuit current the equipment will be subjected to under fault conditions.

2.1.1.8 Shall include a tabular computer printout (three phase fault report and fault study summary) which lists the calculated short-circuit currents, X/R ratios, equipment short-circuit interrupting or withstand current ratings.

2.1.1.9 Shall include a computer printout of input circuit data (feeder data) including conductor lengths, number of conductors per phase, conductor impedance values, insulation types, transformer impedances and X/R ratios, motor contributions, and other circuit information as related to the short-circuit calculations.

2.1.1.10 Shall include a computer printout identifying the maximum available short-circuit current (short circuit comparison tables) in rms symmetrical amperes and the X/R ratio of the fault current for each bus/branch calculation.

2.1.1.11 Shall include a system one-line diagram which is a simplified version of the engineer's drawings showing only those parts of the electrical system under consideration.

2.1.2 An Overcurrent Device Time-Current Coordination Analysis is an organized effort to determine the settings and, where appropriate, the ampere ratings and types for the overcurrent protective devices in an electrical system. The objective of the coordination analysis is to effect a time current coordination among the devices which achieves the desired system protection and electrical service continuity goals.

2.1.2.1 The time-current coordination analysis shall be performed with the aid of a digital computer and shall include the determination of settings, ratings, or types for the overcurrent protective devices supplied.

2.1.2.2 Where necessary, an appropriate compromise shall be made between system protection and service continuity with system protection and service continuity considered to be of equal importance.

2.1.2.3 A sufficient number of computer generated log-log plots (time current curves) shall be provided to indicate the degree of system protection and coordination by displaying the time-current characteristics of series connected overcurrent devices and other pertinent system parameters.

2.1.2.4 Computer printouts shall accompany the log-log plots and shall contain descriptions for each of the devices shown, settings of the adjustable devices, short-circuit current availability at the device location when known, and device identification numbers to aid in locating the devices on the log-log plots and the system one-line diagram.

2.1.2.5 The study shall include a separate, tabular computer printout containing the suggested device settings of all adjustable overcurrent protective devices.

2.1.2.6 Significant deficiencies in protection and/or coordination shall be called to the attention of the owner or designated representative and recommendations made for improvements as soon as they are identified.

2.1.3 Arc-Flash Hazard Analysis

2.1.3.1 The Analysis shall be performed with the aid of computer software intended for this purpose in order to calculate Arc-Flash Incident Energy (AFIE) levels and flash protection boundary distances.

2.1.3.2 The Analysis shall be performed in conjunction with a short-circuit analysis and a time-current coordination analysis.

2.1.3.3 Results of the Analysis shall be submitted in tabular form, and shall include device or bus name, bolted fault and arcing fault current levels, flash protection boundary distances, personal-protective equipment classes and AFIE levels.

2.1.3.4 The Analysis shall be performed for minimum and maximum utility short circuit values.

2.1.3.5 Analysis shall be performed upon all electrical equipment connected to transformers sized at 125kVA and above. This procedure is in accordance with IEEE Standard 1584-2018.

2.1.3.6 The Arc-Flash Hazard Analysis shall be performed in compliance with IEEE Standard 1584-2018, the IEEE Guide for Performing Arc-Flash Calculations and NFPA 70E.

2.1.3.7 The Arc-Flash Hazard Analysis shall include recommendations for reducing AFIE levels and enhancing worker safety. One or more additional reiterations of the analysis shall be performed in attempt to lower incident energy levels to desired level in consultation with the Owner and the consultant, but not more than category 2. If the categories cannot be achieved without the change out of existing equipment, recommendations shall be provided for such new equipment to reduce AIFE levels, which may be exercised at the Owner's discretion. The recommendations shall be discussed with the Owner consultant.

2.1.3.8 The proposed vendor shall demonstrate experience with Arc-Flash Hazard Analysis.

2.1.3.9 The proposed vendor shall demonstrate capabilities in providing equipment, services, and training to reduce Arc-Flash exposure and train workers in accordance with NFPA 70E and other applicable standards.

2.1.3.10 The proposed vendor shall demonstrate experience in providing equipment labels in compliance with ANSI Z535.4 to identify AFIE and appropriate Personal Protective Equipment classes and must also include the following information

2.1.3.10.1 Equipment Name

2.1.3.10.2 AFIE flash hazard boundary

2.1.3.10.3 AFIE value (cal/cm2)

2.1.3.10.4 Hazard Risk Category

2.1.3.10.5 System Voltage

2.1.3.10.6 Limited Approach Boundary

2.1.3.10.7 Restricted Approach Boundary

2.1.3.10.8 Prohibited Approach Boundary

END OF SECTION

1 **GENERAL**

1.1 RELATED SECTIONS

1.1.1 Section 26 05 00 – Common Work Results – Electrical.

1.1.2 Section 26 27 26 – Wiring Devices.

1.1.3 Conform to relevant sections of specification for this and other Divisions.

1.2 SHOP DRAWINGS AND PRODUCT DATA

1.2.1 Submit shop drawings and product data in accordance with Section

1.2.2 26 05 00 – Common Work Results – Electrical.

1.2.3 Samples: Samples of specified devices upon request.

2 **PRODUCTS**

2.1 POWER PANELS

2.1.1 Mechanical:

2.1.1.1 Listed to UL 508 as industrial control equipment. CSA certified, or NOM approved as applicable.

2.1.2 Delivered and installed as a CSA listed factory assembled panel.

2.1.3 Field wiring accessible from front of panel without need to remove dimmer assemblies or other components.

2.1.4 Ship panels with each dimmer in mechanical bypass position by means of jumper bar inserted between input and load terminals. Jumpers to carry full rated load current and be reusable at any time. Mechanical bypass device to allow for switching operation of connected load with dimmer removed by means of circuit breaker.

2.1.5 Electrical

2.1.5.1 Panels contain branch circuit protection for each input circuit unless the panel is a dedicated feed-through type panel or otherwise indicated on the drawings.

2.1.5.2 Branch circuit breakers; meet following performance requirements:

2.1.5.2.1 Listed to UL 489 as molded case circuit breaker for use on lighting circuits.

2.1.5.2.2 Contain visual trip indicator; rated at 10,000 AIC, 120 V Dimming.

2.1.5.2.3 Thermal-magnetic construction for overload, short-circuit, and over-temperature protection. Use of breakers without thermal protection requires dimmers/relays to have integral thermal protection to prevent failures when overloaded or ambient temperature is above rating of panel.

2.1.5.2.4 Accept tag-out/lock-out devices to secure circuit breakers in off position when servicing loads.

2.1.5.2.5 Replaceable without moving or replacing dimmer/relay assemblies or other components in panel.UL listed as switch duty (SWD) so that loads can be switched on and off by breakers.

2.1.5.3 Minimum UL listed Short Circuit Current Rating (SCCR) of 25,000A.

2.1.6 LCD Panel Processor:

2.1.6.1 Separate password protection for installer and end user system settings.

2.1.6.2 Language selection: English.

2.1.6.3 Integral contact closure inputs.

2.1.6.4 Programming and system operation:

2.1.6.4.1 Time clock

- Integral astronomical time clock
- Selectable geographic location (city or latitude/longitude).
- Selectable time zone.
- Selectable date and time format.
- Adjustable starting and ending of daylight savings time.
- Schedule adjustable to add, copy, modify, view, and delete events.

- Assign functionality to time clock events:

2.1.6.4.2 Select global scene

2.1.6.4.3 Select customized scene

2.1.6.4.4 Enable/Disable all control stations (keypads)

2.1.6.4.5 Initiate delay to off

2.1.6.4.6 Enable/disable after hours mode

2.1.6.5 Shut off sequence can be delayed by button press or occupancy sensor override for 30 minutes.

2.1.6.5.1 Repeat shut off sequence after the delay period.

2.1.6.5.2 Global Scene: Set and recall scene programming for multiple wall station locations.

2.1.7 Overrides:

2.1.7.1 Enable/disable time clock

2.1.7.2 Enable/disable all control stations

2.1.7.3 Enable/disable after-hours

2.1.8 Diagnostics and Service:

2.1.8.1 Replacing dimmer/relay does not require re-programming of system or processor.

2.1.8.2 Dimmers/relays: Include diagnostic LED’s to verify proper operation and assist in system troubleshooting.

2.1.8.3 Dimming/relay panels: Include tiered control scheme for dealing with component failure that minimizes loss of control for occupant.

2.1.8.4 If lighting control system fails, lights to remain at current level. Panel processor provides local control of lights until system is repaired.

2.1.8.5 If panel processor fails, lights to remain at current level. Circuit breakers can be used to turn lights off or to full light output, allowing non-dim control of lights until panel processor is repaired.

2.1.8.6 If dimmer fails, factory-installed mechanical bypass jumpers to allow each dimmer to be mechanically bypassed. Mechanical bypass device to allow for switching operation of connected load with dimmer removed by means of circuit breaker.

2.2 GENERAL – 0-10V DIMMERS

2.2.1 These products shall be coordinated with switching devices in Section 26 27 26 which must be in the same line up and have similar appearances.

2.2.2 Provide linear slide dimmer controls: specifically for the required loads (i.e. incandescent, fluorescent, magnetic low voltage, electronic low voltage). All devices shall be CSA listed.

2.2.3 The dimmers shall provide a smooth and continuous Square-Law Dimming curve, calibrated linear slide control, Air Gap off switch, voltage compensation circuitry and utilize a filter network to minimize interference from partially installed radio, audio, and video equipment.

2.2.4 Dimmer numbers are based on Lutron.

2.2.5 LED Dimmer (0-10V)

2.2.5.1 Dimmer shall have direct control of LED dimming driver up to the driver manufacturer's specified rating.

2.2.5.2 Dimmers shall not void warranty of fixture manufacturer.

2.2.5.3 Dimmer shall be rated for minimum load of 300W.

2.2.5.4 Lutron DIVA DVTV or equivalent.

2.2.6 Acceptable Manufacturers:

2.2.6.1 Lutron

2.3 GENERAL – OCCUPANCY SENSORS

2.3.1 Sensor Type: 360º Dual Technology Occupancy Sensors

2.3.1.1 The dual technology sensor shall be capable of detecting presence in the control area by detecting Doppler shifts in transmitted ultrasound and passive infrared heat changes.

2.3.1.2 Sensors shall use patent pending ultrasonic diffusion technology

that spreads coverage to a wider area.

2.3.1.3 Sensors shall utilize dual sensing verification principle for coordination between ultrasonic and PIR technologies. Detection verification of both technologies must occur in order to activated lighting systems. Upon verification, detection by either shall hold lighting on.

2.3.1.4 Sensor shall have a retrigger feature in which detection by either technology shall retrigger the lighting system on within 5 seconds of being switched off.

2.3.1.5 Sensors shall be mounted to the ceiling with a flat, unobtrusive appearance and provide 360º of coverage.

2.3.1.6 Ultrasonic sensing shall be volumetric in coverage with a frequency of 40 KHz. It shall utilize Advanced Signal Processing which automatically adjusts the detection threshold dynamically to compensate for constantly changing levels of activity and air flow throughout controlled space.

2.3.1.7 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.

2.3.1.8 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.

2.3.1.9 Sensors shall operate at 24VDC/VAC and halfwave rectified and utilize a Watt Stopper power pack.

2.3.1.10 Sensors shall have a fixed time delay of 5 to 30 minutes, set by DIP switch.

2.3.1.11 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.

2.3.1.12 The DT-300 sensors shall have a built-in light level sensor that works from 30 to 300 footcandles.

2.3.1.13 The DT-300 and DT-305 sensors shall have a manual on function that is facilitated by installing a momentary switch.

2.3.1.14 Sensors shall have eight occupancy logic options that give the ability to customize control to meet application needs.

2.3.1.15 The sensors shall feature terminal style wiring, which makes installation easier.

2.3.1.16 DT-300 sensor 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.

2.3.1.17 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.

2.3.1.18 To ensure quality and reliability, sensor shall be manufactured by an ISP 9002 certified manufacturing facility and shall have a defect rate of less than 1/3 of 1%.

2.3.1.19 Sensors shall have standard 5 year warranty and shall be UL and CUL listed.

2.3.1.20 Provide low voltage power pack as required for sensor operation.

2.3.2 Automatic Wall Switch Sensor:

2.3.2.1 The passive infrared sensor shall be a completely self-contained control system that replaces a standard toggle switch. Switching mechanism shall be a latching air gap relay, compatible with electronic ballasts, compact fluorescent and inductive loads. Triac and other harmonic generating devices shall not be allowed. Sensor shall have ground wire and grounded strap for safety.

2.3.2.2 Sensor shall be capable of detecting presence in the control area by detecting changes in infrared energy. Small movements shall be detected, such as when a person is writing while seated at a desk.

2.3.2.3 Detection Signature Processing (DSP) shall be used to avoid false offs and false activations and to provide immunity to RFI and EMI.

2.3.2.4 Continuously adjusting Zero Cross relay control shall be used to guarantee reliable operation with non-linear loads (electronic, PL lamp ballasts) even with temperature changes and product aging.

2.3.2.5 Sensor shall have a fixed time delay of 5, 10, 15, 20 or 30 minutes, walk-through mode, or test mode, set by DIP switch, In walk-through mode, lights shall turn off 3 minutes after the area is initially occupied if no motion is detected after the first 30 seconds.

2.3.2.6 Sensor shall have the choice of light flash alert and/or audible alert of impending light shut off, selectable with DIP switch.

2.3.2.7 Sensor shall have sensitivity adjustment that is set with DIP switch.

2.3.2.8 Sensor shall have a built-in light level feature selectable with DIP switch.

2.3.2.9 Sensor shall have automatic-ON or manual-ON operation adjustable with DIP switch.

2.3.2.10 Sensor shall have no minimum load requirement.

2.3.2.11 Sensor shall utilize a temperature compensated, dual element sensor, and a multi-element Fresnel lens.

2.3.2.12 For vandal resistance, Fresnel lens shall be made of hard, 1.0mm Poly IR 2 material that offers protection against direct impact. Lens shall have grooves facing in to avoid dust and residue build up which affects IR reception

2.3.2.13 Sensitivity to motion and detection performance. Lens shall have grooves facing in to avoid dust and residue build up which affects IR reception.

2.3.2.14 Sensor shall cover up to 300 sq ft for walking motion, with a field of view of 180 degrees.

2.3.2.15 Adjustments and mounting hardware shall be concealed under a removable, tamper resistant cover to prevent tampering of adjustments and hardware.

2.3.2.16 Sensor shall have a 100% off switch with no leakage current to the load.

2.3.2.17 Sensor shall not protrude more than 3/8” from the wall and shall blend in aesthetically.

2.3.3 Acceptable Manufacturers:

2.3.3.1 All sensors shall be of one manufacturer. Provide lighting control devices from one of the following approved manufacturers:

2.3.3.1.1 Watt Stopper

2.3.3.1.2 Sensor Switch

2.3.3.2 Lutron

3 EXECUTION

3.1 INSTALLATION

3.1.1 It shall be the Contractor's responsibility to locate and aim sensory in the correct location required for complete and proper volumetric coverage within the range of coverage(s) of controlled areas per the manufacturer's recommendations. Rooms shall have ninety (90) to one hundred (100) percent coverage to completely cover the controlled area to accommodate all occupancy habits of single or multiple occupants at any location within the room(s). The locations and quantities of sensors shown on the drawings are diagrammatic and indicate only the rooms which are to be provided with sensors. The Contractor shall provide additional sensors if required to properly and completely cover the respective room.

3.1.2 It is the Contractor's responsibility to arrange a pre-installation meeting with the manufacturer's factory authorized representative, at the Owner's facility, to verify placement of sensors and installation criteria.

3.1.3 Proper judgement must be exercised in executing the installation so as to ensure the best possible installation in the available space and to overcome local difficulties due to space limitations or interference of structural components. The Contractor shall also provide, at the Owner's facility, training to the owner’s personnel in the operation, use, adjustment, and problem solving diagnosis of the occupancy sensing devices and systems.

END OF SECTION

1 **GENERAL**

1.1 RELATED SECTIONS

1.1.1 Section 26 05 00 – Common Work Results – Electrical.

1.1.2 Section 26 05 24 – Wiring Methods.

1.1.3 Section 26 05 28 – Grounding – Secondary.

1.1.4 Section 26 05 29 – Hangers & Supports.

1.1.5 Section 26 05 53 – Identification For Electrical Systems

1.1.6 Section 26 05 73 – Short Circuit, System Coordination, Arc Flash Study.

1.1.7 Conform to relevant sections of specification for this and other Divisions.

1.2 STANDARDS

1.2.1 Design, manufacture and test the dry type transformers in accordance with good industry practice and in accordance with the following Standards:

1.2.1.1 CSA C22.2 No.47 and CSA C9 – Dry Type Transformers.

1.2.1.2 CSA 802.2-12 Standard. – Minimum efficiency values for dry type transformer.

1.2.1.3 NEMA- ST-20

1.2.1.4 ANSI 57.12.01 General requirements of dry type distribution & power transformers.

1.3 PRODUCT DATA & SHOP DRAWINGS

1.3.1 Submit product data in accordance with Section 26 05 00 – Common Work Results – Electrical. This shall include dimensions, weight, electrical performance %Z, X/R, Inrush current, no load loss, load loss.

1.4 SOURCE QUALITY CONTROL

1.4.1 Submit full production test data per CSA- C9 Standard for each KVA rating to engineer for review. Units shall not be shipped until this process is complete.

1.4.2 Owner reserves the right to verify test data at site by third party.

2 **PRODUCTS**

2.1 TRANSFORMERS

2.1.1 Transformers with primary windings shall have the following characteristics:

2.1.1.1 Voltage and kVA ratings as indicated.

2.1.1.2 Single or three phase as indicated.

2.1.1.3 Delta connected for three phase transformers as indicated.

2.1.1.4 1.2 kV insulation class with standard B.I.L.

2.1.1.5 Four 2 1/2% taps, 2 FCAN and 2 FCBN.

2.1.2 Transformers with secondary windings shall have the following characteristics:

2.1.2.1 Voltage rating as indicated.

2.1.2.2 Wye connected for three phase transformers as indicated on the drawing.

2.1.3 Provide full width electrostatic shield resulting in a maximum effective coupling capacitance between the primary and secondary of 33 picofarads. The shield shall be located in the windings to increase the electrical noise attenuation. Terminate the shields at an isolated terminal in the terminal connection area.

2.1.4 Transformers shall have the following characteristics:

2.1.4.1 Unless specifically noted otherwise, provide K-4 rated transformer as minimum.

2.1.4.3 The transformers shall be K-13 rated transformers, where indicated.

2.1.4.4 Transformer windings shall be copper.

2.1.4.5 Transformers shall be specifically designed to supply 100% of the 60hz fundamental rated current, 33% of the fundamental current as third harmonic, 20% of the fundamental current as fifth harmonic, 14% of the fundamental current as seventh harmonic, 11% of the fundamental current as ninth harmonic, and lower proportional percentages of the fundamental current through the 25th harmonic.

2.1.4.6 Transformers shall be marked with a label stating ‘Suitable for Non-Sinusoidal Current Load with K factor not to exceed 13.

2.1.4.7 Type ANN

2.1.4.8 Class 220 C insulation. Neither the primary nor the secondary temperature shall exceed the 220 C at any point in the coils while carrying their full load.

2.1.4.9 115 degree C temperature rise.

2.1.4.10 Vacuum impregnated polyester resin construction.

2.1.4.11 Transformer to be suitable for loads with crest factor up to 4.5 and capable to deliver full nameplate kVA for loads of up to K-factor of 13, without exceeding 115 C˚ temperature rise.

2.1.4.12 Standard hipot level.

2.1.4.13 A core constructed of laminations of high permeability silicon steel M6 or better grade and visibly grounded to the enclosure by means of a flexible grounding conductor, sized in accordance with applicable standards. It shall be designed with low hysteresis and eddy current losses.

2.1.4.14 No load excitation currents shall be less than 5% up to 75 kVA. & less than 4% above 75 kVA. No load losses can exceed 0.36% to 0.4% of nameplate rating.

2.1.4.15 Transformer Sound Level:

2.1.4.15.1 Up to 9 kVA: 40 dB average

2.1.4.15.2 10 kVA – 50 kVA: 45 dB average

2.1.4.15.3 51 kVA – 150 kVA: 50dB average

2.1.4.15.4 151 kVA – 300 kVA: 55 dB average

2.1.4.15.5 Above 301 kVA: 60db average.

2.1.4.16 Transformer to withstand available short circuit level.

2.1.4.17 Impedance:

2.1.4.17.1 3% min., 4.5% max. up to & including 112.5 kVA

2.1.4.17.2 4% min, 5% max 150 to 225 kVA

2.1.4.17.3 5% min, 6% max 300 & 500 kVA

2.1.4.18 Neutral Connections:

2.1.4.18.1 Neutral connection to be rated at twice the ampacity of the secondary phase current.

2.1.4.18.2 The 200% neutral ampacity to be established at the star point of the transfer coils and extended through to the neutral connection to the Contractor's field wiring.

2.1.4.19 Transformer Enclosures:

2.1.4.19.1 CSA enclosure 1, sprinklerproof with removable front cover.

2.1.4.19.2 Acid etch the enclosure, prime with zinc chromate primer and apply 2 finish coats of enamel. Transformers with manufacturer's standard grey.

2.1.4.19.3 Manufacturer to provide quart of touch-up paint or several pressurized spray cans to touch-up small marred during installation.

2.1.4.19.4 A front accessible terminal compartment at the bottom of the enclosure suitable for 90 degrees C rated conductors (ampacity corresponding to 75 degree).

2.1.4.19.5 Vibration dampers between the frame and the core and coils assembly.

2.1.4.19.6 Bolted type off load tap changer.

2.1.4.20 A nameplate shall be affixed to the enclosure indicating, but not

restricted to the following:

2.1.4.20.1 Voltage ratings

2.1.4.20.2 kVA rating

2.1.4.20.3 Impedance

2.1.4.20.4 Type

2.1.4.20.5 Insulation class

2.1.4.20.6 Temperature rise

2.1.4.20.7 Connection diagram

2.1.4.20.8 Serial number.

2.1.4.21 Transformer to comply with following energy efficiency requirements:

2.1.4.21.1 A minimum efficiency per CSA-802.2-12.

2.1.4.21.2 Energy efficiencies in compliance with NRCan 2019 requirements.

2.2 ACCEPTABLE MANUFACTURERS

2.2.1 Transformers shall be of one manufacturer. Acceptable manufacturers are:

2.2.1.1 Hammond Power Solutions

2.2.1.2 Schneider Electric

2.2.1.3 Delta

2.2.1.4 Rex Power Magnetics

2.2.1.5 STI

3 EXECUTION

3.1 MOUNTING

3.1.1 Verify test reports, serial number and tag identification prior to installation.

3.1.2 The maximum size transformer that is permitted to be suspend

mounted is 75 KVA.

3.1.3 Floor mount all dry type transformers over 75 KVA.

3.1.4 Ensure adequate clearance around the transformers for ventilation.

3.1.5 Install the transformers in a level and upright position.

3.1.6 Remove shipping supports only after the transformers have been installed and just before placing them into service.

3.1.7 Loosen the isolation pad bolts until no compression is visible.

3.1.8 Provide vibration mounting pads for all transformers regardless of mounting method.

3.1.9 The vibration isolation for transformers shall not be short-circuited by the installation of any rigid connections, such as taught flexible conduit.

3.1.10 Provide concrete house keeping pad for all floor mounted transformers. Do not place directly on floor.

3.2 CONNECTIONS

3.2.1 Make the primary and secondary wiring connections as shown.

3.2.2 Energize the transformers as soon as practicable after installation.

3.2.3 Adjust transformer taps as required to achieve suitable secondary voltage at loads.

3.3 EQUIPMENT IDENTIFICATION

3.3.1 Provide equipment identification nameplate in accordance with Section 26 05 53 - Identification for Electrical Systems.

3.4 SHOP DRAWINGS

3.4.1 Shop drawing for this section will not be reviewed prior to the short circuit, coordination and arc flash hazard studies being submitted and reviewed by the Consultant.

END OF SECTION

1 **GENERAL**

1.1 RELATED SECTIONS

1.1.1 Section 26 05 00 – Common Work Results – Electrical

1.1.2 Section 26 – Commissioning for Electrical Systems

1.1.3 Section 26 – Identifications for Electrical Systems

1.1.4 Section 26 – Air Circuit Breakers

1.1.5 Section 26 – Moulded Case Circuit Breakers

1.1.6 Section 26 – Grounding – Secondary

1.1.7 Section 26 – Power Systems Studies

1.1.8 Section 26 – Surge Protective Devices

1.1.9 Conform to relevant sections of specification for this and other Divisions.

1.2 DESCRIPTION OF WORK

1.2.1 Supply, install and connect all switchboards as described hereinafter and in accordance with the requirements of the Contract Documents.

1.2.2 For service entrance switchboards make the utility service connections all as described.

1.2.3 The main switchboards shall comprise of main breakers, indicating instruments and outgoing breakers to provide a complete service and distribution system for the whole project.

1.3 SHOP DRAWINGS AND PRODUCT DATA

1.3.1 Submit shop drawings and product data in accordance with Division 1 and Section 26 05 01.

1.3.2 Indicate on shop drawings.

1.3.2.1 Dimensioned cable entry and exit locations.

1.3.2.2 Dimensioned position and size of bus.

1.3.2.3 Overall length, height and depth.

1.3.2.4 Dimensioned layout of internal and front panel mounted components.

1.3.2.5 Include time-current characteristic curves for circuit breakers and fuses.

1.4 MAINTENANCE DATA

1.4.1 Provide maintenance data for service entrance board for incorporation into manual specified in Division 1 and Section 26 05 01.

1.5 SOURCE QUALITY CONTROL

1.5.1 Consultant to witness final factory tests.

1.5.2 Notify Consultant in writing 5 days in advance that service entrance board is ready for testing.

1.5.3 Submit two copies of certified test results.

2 **PRODUCTS**

2.1 SERVICE ENTRANCE BOARD

2.1.1 Rating: Refer to electrical distribution single line diagram.

2.1.2 Short circuit current withstand rating: 50 kA (rms symmetrical).

2.1.3 Cubicles: free standing, dead front, size as indicated.

2.1.4 Barrier metering section from adjoining sections.

2.1.5 Provision for installation of power supply authority metering in barrier section.

2.1.6 Owners metering.

2.1.7 Distribution section – Residential and Tenants.

2.1.8 Distribution section – Building Services.

2.1.9 Hinged access panels with captive knurled thumb screws.

2.1.10 Bus bars and main connections: 99.3% copper aluminum.

2.1.11 Bus from load terminals of main breaker main lugs of distribution section.

2.1.12 Identify phases with colour coding.

2.2 MOULDED CASE CIRCUIT BREAKERS

2.2.1 Refer to Section 26 28 16.01 Moulded Circuit Breakers.

2.2.2 Blanked off spaces and provisions for future units, including but not limited to cradle, wiring and line side connections.

2.3 GROUNDING

2.3.1 Copper ground bus extending full width of cubicles and located at bottom.

2.3.2 Lugs at each end for size 4/0 grounding cable.

2.4 GROUND FAULT UNIT

2.4.1 Copper ground bus extending full width of cubicles and located at bottom.

2.4.2 Lugs at each end for size 4/0 grounding cable.

2.5 GROUND FAULT EQUIPMENT PROTECTION

2.5.1 Refer to Section 26 28 18 Ground Fault Equipment Protection.

2.6 POWER SUPPLY AUTHORITY METERING

2.6.1 Separate compartment and metal raceway for exclusive use of power supply authority metering.

2.6.2 Mounting accessories and wiring for metering supplied by power supply authority:

2.6.2.1 600V:120V potential transformers.

2.6.2.2 Current transformers: sized to suit service rating. Provide as per the requirements of the local utility.

2.6.2.3 Watthour meter.

2.6.2.4 Demand meter with kWh register.

2.7 FINISHES

2.7.1 Apply finishes in accordance with Section 26 05 00 – Common Work Results - Electrical.

2.7.1.1 Finish shall be manufacturer's standard gray.

2.8 MANUFACTURER

2.8.1 For list of acceptable manufacturers, refer to Section 26 90 00 – List of Acceptable Manufacturers.

3 **EXECUTION**

3.1 INSTALLATION

3.1.1 Locate service entrance board.

3.1.2 Connect main secondary service to line terminals of main breaker.

3.1.3 Connect load terminals of distribution breaker's to feeders.

3.1.4 Check factory made connections for mechanical security and electrical continuity.

3.1.5 Run one grounding conductor 4/0 AWG bare copper in 1" conduit from ground bus to building ground.

3.1.6 Check trip unit settings against co-ordination study to ensure proper working and protection of components.

END OF SECTION

1 **GENERAL**

1.1 RELATED SECTIONS

1.1.1 Section 26 05 00 – Common Work Results - Electrical.

1.1.2 Section 26 05 03 – Nameplates.

1.1.3 Section 26 05 29 – Hangers & Supports.

1.1.4 Section 26 28 15.01 – Moulded Case Circuit Breakers.

1.1.5 Conform to relevant sections of specification for this and other Divisions.

1.2 SHOP DRAWINGS

1.2.1 Submit shop drawings in accordance with Section 26 05 00 – Common Work Results - Electrical.

1.2.2 Drawings to include electrical detail of panel, branch breaker type, quantity, ampacity and enclosure dimension.

2 **PRODUCTS**

2.1 PANELBOARDS

2.1.1 Panelboards: product of one manufacturer.

2.1.1.1 Install circuit breakers in panelboards before shipment.

2.1.2 For 208V receptacle and lighting panelboards, the bus, the main breaker and the branch breakers must be rated for a minimum of 14,000 A (symmetrical) interrupting capacity except as otherwise indicated.

2.1.3 For 208V distribution panelboards, the bus, the main breaker and the branch breakers must be rated to a minimum of 25,000 A (symmetrical) interrupting capacity except as otherwise indicated.

2.1.4 For 600 V panelboards, the bus, the main breaker and the branch breakers must be rated for a minimum of 35,000 A (symmetrical) interrupting capacity except as otherwise indicated

2.1.5 Provide a full size neutral.

2.1.6 Provide neutral with 200% the rating of mains, where indicated.

2.1.7 Sequence phase bussing with odd numbered breakers on left and even on right, with each breaker identified by permanent number identification as to circuit number and phase.

2.1.8 Panelboards: mains, number of circuits, and number and size of branch circuit breakers as indicated.

2.1.9 Two keys for each panelboard and key panelboards alike.

2.1.10 Copper bus with neutral of same ampere rating as mains, unless indicated otherwise.

2.1.11 Aluminum bus will not be accepted.

2.1.12 Mains: suitable for bolt-on breakers.

2.1.13 Trim with concealed front bolts and hinges.

2.1.14 Trim and door finish specified in Section 26 05 00 – Common Work Results - Electrical.

2.1.15 Enclosure shall be sprinkler-proof for indoor applications

2.1.16 Hot-dip galvanize the panelboard tubs after fabrication or acid etch, prime and apply two (2) finish coats.

2.1.17 Panelboards shall be finished with two coats of air dried ASA 61 or ASA 49 grey enamel to the panelboard tubs. Finish shall be over sprayed.

2.1.18 Provide doors with concealed hinges, locks and hardware for all panelboards

2.2 CUSTOM BUILT PANELBOARD ASSEMBLIES

2.2.1 Provide custom fabricated replacement trims and doors for existing panels, as indicated on drawings.

2.2.2 Replacement trim and door assembly shall be NEMA-4X type, and shall be coordinated with the architectural division to suit any modifications to the wall construction and/or finishes.

2.3 BREAKERS

2.3.1 Breakers: to Section 26 28 21 - Moulded Case Circuit Breakers.

2.3.2 Provide breakers as specified.

2.3.3 Main breaker: separately mounted on top or bottom of panel to suit cable entry. When mounted vertically, down position should open breaker.

2.3.4 Lock-on devices for fire alarm, emergency, door supervisory, intercom, snow melting pipe tracing, stairway, exit and night light circuits.

2.4 EQUIPMENT IDENTIFICATION

2.4.1 Provide equipment identification in accordance with Section 26 05 00 – Common Work Results - Electrical.

2.4.2 Nameplate for each panelboard.

2.4.3 Complete circuit directory with typewritten legend showing location and load of each circuit.

2.5 MANUFACTURER

2.5.1 Panelboards shall be of one manufacturer. Acceptable manufacturers are as follows:

2.5.1.1 Schneider Electric

2.5.1.2 Eaton – Cutler Hammer

2.5.1.3 Siemens

3 EXECUTION

3.1 INSTALLATION

3.1.1 Locate panelboards as indicated and mount securely, plumb, true and square, to adjoining surfaces.

3.1.2 Install surface mounted panelboards on block walls or plywood backboards. Where practical, group panelboards on common backboard.

3.1.3 Mount panelboards to height specified in Section 26 05 00 – Common Work Results - Electrical or as indicated.

3.1.4 Field-measure all existing panels and fabricate customized components to suit. Any and/or all work may take place during evenings and/or weekends and shall suit the Owner's schedule. No additional charges shall be incurred by the Owner for work required

to take place during shutdowns after-hours.

3.1.5 Connect loads to circuits.

3.1.6 Connect neutral conductors to common neutral bus, with respective neutral identified.

END OF SECTION

1 **GENERAL**

1.1 RELATED SECTIONS

1.1.1 Section 26 05 00 – Common Work Results – Electrical.

1.1.2 Conform to relevant sections of specification for this and other Divisions.

1.2 SHOP DRAWINGS AND PRODUCT DATA

1.2.1 Submit shop drawings and product data in accordance with Section

1.2.2 26 05 00 – Common Work Results – Electrical.

1.2.3 Product data: Catalog cuts of specified devices upon request as well as field samples

1.2.4 Samples of specified devices upon request.

2 **PRODUCTS**

2.1 QUALITY ASSURANCE

2.1.1 Equipment and materials of type for which there are Underwriters Laboratories standard requirements, CSA Certified, listing and labels, shall be listed and labeled by Underwriters Laboratories.

2.1.2 Where equipment and materials have industry certification, labeling or standards (i.e., NEMA – National Electrical Manufacturers Association), this equipment shall be labeled as certified, or comply with standards.

2.1.3 Material and equipment shall be new and conform to grade, quality and standards specified. Equipment or materials of the same type shall be the product of same manufacturer throughout.

2.1.4 The Manufacturer’s catalog numbers specified represented the minimum standards required.

2.2 WIRING DEVICES

2.2.1 General:

2.2.1.1 Commercial grade wiring devices shall be installed in all areas.

2.2.2 GFCI Receptacle:

2.2.2.1 GFCI receptacles shall be cUL Listed and CSA Certified. Meet cUL943 performance requirements.

2.2.2.2 GFCI receptacles shall have recessed test and reset buttons to avoid accidental tripping from oversized molded plugs.

2.2.2.3 Contacts shall be reinforced to assure maximum plug retention.

2.2.2.4 Large, combination back and side wire terminals to accept up to #10 Wires.

2.2.2.5 GFCI receptacles shall have LED Indicator Light which will flash red to indicate when device no longer has GFCI protection.

2.2.2.6 GFCI shall be of Class A.

2.2.2.7 Receptacles shall be Hubbell 15A (GF15LA), 20A (GF20LA)

2.2.3 Receptacles Decorative Series Spec Grade:

2.2.3.1 Receptacles shall represent high quality performance.

2.2.3.2 Receptacles shall be rated for 15 or 20 amperes as indicated on drawings.

2.2.3.3 Receptacles shall be back and side wired. Decorator style, provide green base ground screw terminal, automatic ground clip, fully enclosed in a nylon face, and have wrap around steel bridge for installation strength, and high heat base.

2.2.3.4 In general, all receptacles shall be of ampere, voltage and type as indicated on drawings or herein specified. The following listings and catalog numbers are for type and quality guideline:

2.2.3.4.1 Receptacle shall be Hubbell 15A HBL2152, 20A HBL2162 series.

2.2.4 Switches Decorative Spec Grade:

2.2.4.1 Switches shall be 15A or 20A rated and must have “framed” outline body to fit stylized plate.

2.2.4.2 Switches shall have heat resistant thermo set base and 100% copper contact arm and nylon face.

2.2.4.3 15A Hubbell Type Single Pole HBL2101, 3 WAY HBL2103, 4 WAY

HBL2104.

2.2.4.4 20A Hubbell Type Single Pole HBL2121, 3 WAY HBL2123, 4 WAY HBL2124.

2.2.5 Twist – Lock Receptacles:

2.2.5.1 The approved manufacturer is Hubbell, Inc. or approved equal if they meet the design parameters set forth:

2.2.5.1.1 NEMA Twist – Lock Receptacles.

2.2.5.1.2 Face (top) shall be nylon with boss diameter of 1.56" on both 20 and 30 amp receptacles.

2.2.5.1.3 Face shall also have identifying colour coding feature (colour coding in accordance to IEC 309 standard) by voltage rating to assure proper mating of devices.

2.2.5.1.4 Terminal screws shall be #10 silicone bronze and accommodate back or side wiring. 20 amp receptacle terminal shall be capable of accepting #8 AWG wire and provide wire restraint non-loosening design.

2.2.5.1.5 Base shall be constructed of dimensionally stable, heat resistant material.

2.2.5.1.6 Contact arm shall be one – piece (no riveted assembly) and shall also provide oxide cutting feature for termination integrity.

Twist – Lock 30 Ampere Devices			**CATALOG NUMBERS**		
Rating Body	**Voltage**	**NEMA**	**Rec.**	**Male Plug**	**Conn.**
2 Pole 3 wire	125 250	L5-30 L6-30	HBL2610 HBL2620	HBL2611 HBL2621	HBL2613 HBL2623
3 Pole 3 wire	125/250V AC 3Ø250V AC 3Ø480V AC 3Ø600V	L14-30 L15-30 L16-30 L17-30	HBL2710 HBL2720 HBL2730 HBL2740	HBL2711 HBL2721 HBL2731 HBL2741	HBL2713 HBL2723 HBL2733 HBL2743
3 Pole 4 wire	3ØY120 / 208V AV	L21-30	HBL2810	HBL2811	HBL2813

Twist – Lock 20 Ampere Devices		**CATALOG NUMBERS**			
Rating Body	**Voltage**	**NEMA**	**Rec.**	**Male Plug**	**Conn.**
2 Pole 3 wire	125 250 277V AC	L5-20 L8-20 L7-20	HBL2310 HBL2320 HBL2330	HBL2311 HBL2321 HBL2331	HBL2313 HBL2323 HBL2333
3 Pole 4 wire	125/250V AC 3Ø250V AC 3Ø480V AC	L14-20 L15-20 L16-20	HBL2410 HBL2420 HBL2430	HBL2411 HBL2421 HBL2431	HBL2413 HBL2423 HBL2433
4 Pole 5 wire	3ØY120	L21-20	HBL2510	HBL2511	HBL2513

2.2.6 USB Charging Convenience Receptacles:

2.2.6.1 Receptacles shall be compatible with USB 1.1/2.0/3.0 devices, including Apple Products.

2.2.6.2 Receptacles shall be rated for 15 or 20 amperes as indicated on drawings.

2.2.6.3 Receptacles shall be back and side wired.

2.2.6.4 Duplex Receptacles shall be complete with 2 USB charging ports.

2.2.6.5 In general, all receptacles shall be of ampere, voltage and type as indicated on drawings or herein specified. The following listings and catalog numbers are for type and quality guideline:

2.2.6.5.1 Receptacle shall be Hubbell USB15X series.

2.2.7 Wall Plates:

2.2.7.1 Device plates, dimmer switches plates, telecommunication outlet plates, and blank plates for junction boxes, etc. shall be as follow:

2.2.7.1.1 Vertically brushed stainless steel, cover plates 0.04" (1 mm) thick for wiring devices mounted in flush-mounted outlet boxes.

2.2.7.1.2 Galvanized sheet steel utility box covers for wiring devices installed in surface-mounted utility boxes.

2.2.7.1.3 Sheet metal cover plates for wiring devices mounted in surface-mounted FS or FD type conduit boxes.

2.2.7.1.4 Ceiling mounted devices cover plates shall match device colour.

2.3 FINISHES

2.3.1 Wiring Devices:

2.3.1.1 General: Devices shall have manufacturer's standard white finish.

2.3.1.2 The 20A duplex outlet adjacent to the main entry door into a laboratory, the outlet is to be **Grey in color** and provided with a "Caretaking Outlet" label.

2.3.2 Cover Plates:

2.3.2.1 General: Provide Plastic/nylon cover plate of the same finish as the wiring devices.

2.4 MANUFACTURERS

2.4.1 Provide wiring devices and cover plates of one (1) manufacturer.

2.4.2 Hubbell Canada LP. Catalogue numbers are shown and indicate the quality of the wiring devices and cover plates required. Equivalent wiring devices and cover plates of other manufacturers may be used.

2.4.3 Acceptable manufacturers are as follows:

2.4.3.1 Hubbell Canada

2.4.3.2 Pass & Seymour

2.4.3.3 Leviton (Specification Grade only)

3 **EXECUTION**

3.1 INSTALLATION

3.1.1 Switches:

3.1.1.1 Install single throw switches with handle in "UP" position when switch closed.

3.1.1.2 Install switches in gang type outlet box when more than one switch is required in one location.

3.1.1.3 Mount toggle switches at height specified in Section 26 05 00, Common Work Results – Electrical, or as indicated.

3.1.2 Receptacles:

3.1.2.1 Install receptacles in gang type outlet box when more than one receptacle is required in one location.

3.1.2.2 Mount receptacles at height specified in Section 26 05 00 – Common Work Results - Electrical or as indicated.

3.1.2.3 Where split receptacle has one portion switched, mount vertically and switch upper portion.

3.1.3 Cover plates:

3.1.3.1 Protect cover plate finish with paper or plastic film until painting and other work is finished.

3.1.3.2 Install suitable common cover plates where wiring devices and/or dimmer switches are grouped.

3.1.3.3 Do not use cover plates meant for flush outlet boxes on surface – mounted boxes.

END OF SECTION

1 **GENERAL**

1.1 RELATED SECTIONS

1.1.1 Section 26 05 00 – Common Work Results - Electrical.

1.1.2 Section 26 28 23 – Disconnect Switches Fused & Non-Fused.

1.1.3 Conform to relevant sections of specification of this and other Divisions.

1.2 SHOP DRAWINGS AND PRODUCT DATA

1.2.1 Submit shop drawings and product data in accordance with Section 26 05 00 – Common Work Results – Electrical.

1.2.2 Submit fuse performance data characteristics for each fuse type and size above 60A. Performance data to include: average melting time-current characteristics, (for fuse coordination), and peak let-through current.

1.3 MAINTENANCE MANUALS

1.3.1 Three spare fuses of each type and size installed above 600 A.

1.3.2 Six spare fuses of each type and size installed up to and including 600 A.

1.4 DELIVERY AND STORAGE

1.4.1 Ship fuses in original containers.

1.4.2 Store fuses in original containers in storage cabinet and moisture free location.

2 **PRODUCTS**

2.1 FUSES GENERAL

2.1.1 Fuse type references L1, L2, J1, R1 etc. have been adopted for use in this specification.

2.1.2 Fuses: product of one manufacturer.

2.2 FUSE TYPES

2.2.1 HRC-L fuses (formerly Class L).

2.2.1.1 Type L1, time delay, capable of carrying 500% of its rated current for 10 s minimum.

2.2.1.2 Type L2, fast acting.

2.2.2 HRCI-J fuses (formerly Class J).

2.2.2.1 Type J1, time delay, capable of carrying 500% of its rated current for 10 s minimum.

2.2.2.2 Type J2, fast acting.

2.2.3 HRCI-R fuses (formerly Class R). For UL Class RK1 fuses, peak let-through current and values not to exceed limits of UL 198E-1982, table 10.2.

2.2.3.1 Type R1, (UL Class RK1), time delay, capable of carrying 500% of its rated current for 10 s minimum, to meet UL Class RK1 maximum let-through limits.

2.2.3.2 Type R2, time delay, capable of carrying 500% of its rated current for 10 s minimum.

2.2.3.3 Type R3, (UL Class RK1), fast acting Class R, to meet UL Class RK1 maximum let-through limits.

2.2.3.4 HRCII-C fuses (formerly Class C).

3 EXECUTION

3.1 INSTALLATION

3.1.1 Install fuses in mounting devices immediately before energizing circuit.

3.1.2 Ensure correct fuses fitted to physically match mounting devices.

3.1.2.1 Install Class R rejection clips for HRCI-R fuses.

3.1.3 Ensure correct fuses fitted to assigned electrical circuit.

3.1.4 Where UL Class RK1 fuses are specified, install warning label "Use only UL Class RK1 fuses for replacement" on equipment.

3.1.5 Fuses protecting motor loads and transformers to be type J1 for up to and including 600 A and L1 for ratings above 600 A.

3.1.6 Fuses protecting feeder circuits to be type J2 for up to and including 600 A, and type L2 for ratings above 600 A.

3.1.7 Fuses protecting other services or equipment shall be of the type required for that purpose.

END OF SECTION

1 **GENERAL**

1.1 RELATED SECTIONS

1.1.1 Section 26 05 00 – Common Work Results - Electrical.

1.1.2 Section 26 05 53 – Identification for Electrical Systems.

1.1.3 Section 26 24 13 - Switchboards

1.1.4 Section 26 24 16 – Panelboard.

1.1.5 Conform to relevant sections of specification for this and other Divisions.

1.2 STANDARDS

1.2.1 CAN/CSA-C22.2 No. 144-M91 (R2001): Ground Fault Circuit Interrupters.

1.2.2 CSA C22.2 No. 5-02: Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures.

1.2.3 CSA C22.1-02-Canadian Electrical Code.

1.2.4 UL 489 (2002) Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures.

1.2.5 ANSI C37.17 (latest) American National Standard for trip devices for AC and general purpose DC low voltage power circuit breakers.

1.2.6 NEMA-AB1-1993 Molded case circuit breakers and molded case switches.

1.2.7 ANSI C37.50 American National Standard for Switchgear – test procedures for low voltage AC power circuit breakers used in enclosures.

1.2.8 IEEE Standard 1015, specifically acceptance practice.

1.2.9 NETA –ATS Section 7.

1.2.10 Ontario Electrical Safety Code.

1.2.11 Section 26 05 10 – Short Circuit, System Coordination & Arc Flash Study.

1.3 PRODUCT DOCUMENTATION

1.3.1 Submit shop drawings in accordance with Section 26 05 01. There will be details such as dimensions, clearances required, cable entries, tabulation of all devices including tags, wiring diagrams (power ,signals, control wiring). The notes will identify field wiring and factory installed wiring).

1.3.2 Include time-current characteristic curves for breakers with ampacity of 150A and over. In some cases due to critical nature of the equipment smaller size breaker may have to be verified for Time Current coordination as well.

2 **PRODUCTS**

2.1 BREAKERS GENERAL

2.1.1 Provide bolt-on molded case circuit breaker, quick-make, quick-break type, for manual and automatic operation with temperature compensation for 40 degrees C ambient as indicated.

2.1.2 Circuit breakers that are 400 amps and higher that are part of the emergency distribution system shall be 100% rated.

2.1.3 Provide multi-pole breakers with a common-trip device and a single handle.

2.1.4 Provide 100% rated breaker where indicated.

2.1.5 All breakers 400 amps and higher shall be LSI solid state trip type.

2.1.6 Provide magnetic instantaneous trip elements in circuit breakers, to operate only when the value of the current reaches the setting, as indicated. For breakers with adjustable trips, provide a trip range of 3 to 10 times the rated current or as indicated.

2.1.7 Provide circuit breakers with interchangeable trips as indicated.

2.1.8 Provide pad locking devices on all breakers to lock the handle of a breaker in the "on" or "off" position with the trip units to remain free to function and protect the circuit from both overload and short circuit conditions.

2.2 THERMAL MAGNETIC BREAKERS (TMB)

2.2.1 Provide molded case circuit breakers to operate automatically by means of thermal and magnetic tripping devices to provide inverse

time current tripping characteristic.

2.3 MAGNETIC BREAKERS

2.3.1 Moulded case circuit breaker to operate automatically by means of magnetic tripping devices to provide instantaneous tripping for short circuit protection.

2.4 SOLID STATE TRIP BREAKERS

2.4.1 Provide moulded case circuit breakers to operate by means of a solid-state trip unit with associated current monitors and self-powered shunt trip devices to provide an inverse time vs current trip characteristic under overload conditions, and long-time short time instantaneous tripping for phase ground fault short circuit protection.

2.5 OPTIONAL FEATURES

2.5.1 Provide NEMA and UL rated enclosures for individual breakers as required.

2.6 MANUFACTURER

2.6.1 Provide breakers of one manufacturer. Breakers shall be of same manufacturer as the panelboards:

2.6.2 Acceptable manufacturers are as follows:

2.6.2.1 Schneider Electric

2.6.2.2 Eaton – Cutler-Hammer

2.6.2.3 Siemens

3 **EXECUTION**

3.1 EXAMINATION

3.1.1 Examine the circuit breakers for compliance with installation tolerances and other conditions affecting performance. Proceed with installation only after satisfactory compliance.

3.2 INSTALLATION

3.2.1 Circuit breakers in panelboards shall be factory installed.

3.2.2 Install other individual breakers where indicated.

3.3 IDENTIFICATION

3.3.1 Identify all field installed conductors, wiring and components; provide warning signs as required by manufacturer and also CEC and Ontario Electrical Safety Code. Install engraved nameplates and lamacoid nameplates on enclosures.

3.4 CONNECTION

3.4.1 Install grounding connections, power wiring and indication devices. Verify the torque recommended by manufacturer.

3.5 TESTS

3.5.1 Test for continuity of phase and ground connections and insulation resistance (Megger) for each phase to phase and phase to ground.

3.5.2 Verify all acceptance tests as per NETA test procedure.

3.5.3 Any malfunctioning of the units shall be corrected and retested to demonstrate compliance.

3.6 SUBMITTALS

3.6.1 Field test reports: Include the test procedures and instruments used. Record test results for formal submission to consultant and owner for information.

3.6.2 Final maintenance manual shall include all the routine maintenance requirements and complete information about each circuit breaker settings.

END OF SECTION

1 **GENERAL**

1.1 RELATED SECTIONS

1.1.1 Section 26 05 00 – Common Work Results - Electrical.

1.1.2 Section 26 05 53 – Identification for Electrical Systems.

1.1.3 Conform to relevant sections of specification for this and other Divisions.

1.2 PRODUCT DATA

1.2.1 Submit product data in accordance with Section 26 05 00 – Common Work Results - Electrical.

1.2.2 Standards: Design, manufacture and test all disconnect switches in accordance with good industry practice and in accordance with the following Standards and Codes:

1.2.3 CSA Standard C22.2 No. 4 Enclosed switches;

1.2.4 CSA Standard C22.2 No. 39 Fuseholder assemblies.

2 **PRODUCTS**

2.1 DISCONNECT SWITCHES

2.1.1 Provide fusible and non-fusible disconnect switches in CSA Enclosure to suit the environment where the switch is located.

2.1.2 Provide the provision for padlocking the switch in the ON and OFF switch position by using one lock via a multi-lock hasp.

2.1.3 Mechanically interlocked door to prevent opening when handle in ON position.

2.1.4 Fuses: size as indicated, to Section 26 28 14 - Fuses - Low Voltage.

2.1.5 Fuseholders: suitable without adaptors, for type and size of fuse indicated.

2.1.6 Provide a type A quick-make, quick-break switching action with arc chutes or arc snuffers.

2.1.7 Provide a vertically moving handle with an ON-OFF switch position

indication on the switch enclosure cover with the ON position being the upper handle position.

2.1.8 Provide solderless neutral terminals where indicated.

2.1.9 Disconnect switches integrated rating must be rated to handle the design interrupting capacity for this project.

2.1.10 Ensure system coordination per Section 26 05 10 prior to ordering of the equipment.

2.2 EQUIPMENT IDENTIFICATION

2.2.1 Provide equipment identification in accordance with Section 26 05 00 – Common Work Results - Electrical.

2.2.2 Indicate name of load controlled on nameplate.

2.3 ACCEPTABLE MANUFACTURERS

2.3.1 Provide all disconnect switches of one manufacturer. Acceptable manufacturers are as follows:

2.3.1.1 Schneider Electric

2.3.1.2 Eaton – Cutler-Hammer

2.3.1.3 Siemens

2.4 ENCLOSURE

2.4.1 Individually mounted disconnect switch shall be installed in Sprinkler proof enclosure c/w drip shield.

3 EXECUTION

3.1 INSTALLATION

3.1.1 Install disconnect switches complete with fuses if applicable.

END OF SECTION

1 **GENERAL**

1.1 SCOPE

1.1.1 This section describes the materials and installation requirements for surge protective devices (SPD) for the protection of all AC electrical circuits.

1.2 RELATED SECTIONS

1.2.1 Section 26 05 00 Common Work Results - Electrical.

1.2.2 Conform to relevant sections of specification for this and other Divisions.

1.3 STANDARDS

1.3.1 The specified system shall be designed, manufactured, tested and installed in compliance with the following codes and standards:

1.3.1.1 Institute of Electrical and Electronic Engineers (ANSI/IEEE C62.11, C62.41, C62.45).

1.3.1.2 American National Standards Institute.

1.3.1.3 Federal Information Processing Standards Publication 94 (FIPS PUB 94).

1.3.1.4 National Electrical Manufacturer Association (NEMA LS-1 1992 All Tests).

1.3.1.5 MIL Standard 220A Method of Insertion Loss Measurement.

1.3.1.6 Underwriters Laboratories UL 1283 and UL 1449 (most recent edition).

1.3.1.7 Canadian Standards (CUL).

1.3.1.8 Canadian Standards Association (CSA) CSAC22.2-Latest Edition.

1.3.1.9 Ontario Hydro Electrical Safety Code Latest Edition.

1.4 PRODUCT SHOP DRAWING DATA

1.4.1 Product data shall be submitted in accordance with Section 26 05 01, Electrical General Provisions. This shall include schematic diagram and all options including indicating lights and dry contacts.

1.4.2 Evidence of compliance to the certifications as per CSA and UL 1449 must be submitted. Manufacturer shall submit the NEMA LS-11992 test results. This will show actual test data as certified by UL and ANSI standard. Documentation must include copy of UL Listing Report. Manufacturer shall certify stating that tested product (UL tests) and delivered product both had same suppliers for raw materials and same processes to manufacture.

1.5 SUBMITTALS

1.5.1 Product Data: Provide catalogue sheets showing voltage, physical size, Measured Limited Voltage for each waveform listed, UL1449 latest revision, latest edition, suppressed voltage ratings, dimensions showing construction, lifting and support points, enclosure details, per mode and per phase peak surge current, modes of discrete suppression circuitry, warranty period and replacement terms, conductor size, conductor type and lead length.

1.5.1.1 Short Circuit Current Rating (SCCR)

1.5.1.2 Voltage Protection Ratings (VPRs) for all modes

1.5.1.3 Maximum Continuous Operating Voltage rating (MCOV)

1.5.1.4 I-nominal rating (I-n)

1.5.1.5 SPD shall be UL listed and labeled as Type 2 or Type 4 intended for Type 2 applications

1.5.2 Submit product data for all components and accessories.

1.5.3 Manufacturer’s Installation Instructions: use stipulated by product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product. Indicate maximum size of circuit breaker or fuse to be connected for each unit.

1.5.4 List and detail all protection systems such as fuses, disconnecting means and protective features.

1.5.5 Provide verification that the SPD device complies with the required UL1449 latest edition, latest revision, and CSA approvals.

1.5.6 Provide actual let through voltage test data in the form of oscillograph results for the ANSI/IEEE C62.41 Category C3 & C1 (combination wave) and A1 (ringwave) tested in accordance with

ANSI/IEEE C62.45.

1.5.7 Provide spectrum analysis of each unit based on MIL-STD-220A test procedures between 10 khz and 100 khz verifying the devices noise attenuation equals or exceeds 50 db at 100 khz.

1.5.8 Provide test report in compliance with NEMA LS1 from a recognized independent testing laboratory verifying the suppressor components can survive published surge current rating on both per mode and per phase basis using the IEEE C 62.41, 8x20 microsecond current wave. Test data must be on a complete SPD with internal fusing in place. Test data on an individual module is not acceptable.

1.6 QUALITY ASSURANCE

1.6.1 Manufacturer Qualifications: Engage a firm with at least 5 years experience in manufacturing transient voltage surge suppressors.

1.6.2 Manufacturer shall be ISO 9001 or 9002 certified.

1.6.3 The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of ten (10) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

1.6.4 The SPD shall be compliant with the Restriction of Hazardous Substances (RoHS) Directive 2002/95/EC.

1.7 DELIVERY, STORAGE, AND HANDLING

1.7.1 Handle and store equipment in accordance with manufacturer's Installation and Maintenance Manuals. One (1) copy of this document to be provided with the equipment at time of shipment.

2 **PRODUCTS**

2.1 MANUFACTURERS

2.1.1 Provide an internally mounted Surge Protective Devices (SPD) formally called Transient Voltage Suppressor (TVSS) by:

2.1.1.1 Eaton.

2.1.1.2 Schneider

2.1.1.3 Siemens

2.2 ELECTRICAL DISTRIBUTION EQUIPMENT

2.2.1 Switchboards:

2.2.1.1 SPD shall be UL 1449 labeled as Type 4 intended for Type 2 applications, verifiable at UL.com, without need for external or supplemental overcurrent controls. Every suppression component of every mode, including N-G, shall be protected by internal over-current and thermal over-temperature controls. SPDs relying upon external or supplementary installed safety disconnectors do not meet the intent of this specification.

2.2.1.2 SPD shall be factory installed integral to electrical distribution equipment.

2.2.1.3 Type 4 SPD shall be UL labeled with 20kA I-nominal (I-n)

2.2.1.4 SPD shall be UL labeled with 200kA Short Circuit Current Rating (SCCR).

2.2.1.5 Standard 7 Mode Protection paths: SPD shall provide surge current paths for all modes of protection: L-N, L-G, L-L, and N-G for Wye systems; L-L, L-G in Delta and impedance grounded Wye systems.

2.2.1.6 SPD shall be connected to the buss of the distribution equipment with an appropriately sized 200kA SCCR rated disconnect.

2.2.1.7 SPD shall meet or exceed the following criteria:

2.2.1.7.1 Maximum 7-Mode surge current capability shall be 200kA or higher per phase.

2.2.1.7.2 UL 1449 - Third Edition Revision; effective September 29, 2009, where applicable either Type 2 or Type 4 Voltage Protection Ratings shall not exceed the following:

Voltage	L-N	L-G	N-G	L-L	MCOV
208/120V	800V	800V	800V	1200V	150V
480/277V	1200V	1200V	1200V	2000V	320V
600/347V	1500V	1500V	1500V	2500V	420V

2.2.1.8 UL 1449 Listed Maximum Continuous OPerating Voltage (MCOV)

System Voltage	Allowable System Voltage Fluctuation (%)	MCOV
208/120V	25%	150V
600/347V	20%	420V

2.2.1.9 SPD shall incorporate a UL 1283 listed EMI/RFI filter with minimum attenuation of - 50dB at 100 kHz.

2.2.1.10 Suppression components shall be heavy duty 'large block' MOVs, each exceeding 30mm diameter.

2.2.1.11 SPD shall include a serviceable, replaceable module.

2.2.1.12 SPD shall be equipped with the following diagnostics:

2.2.1.12.1 Visual LED diagnostics including a minimum of one green LED indicator per phase, and one red service LED.

2.2.1.12.2 Audible alarm with on/off silence function and diagnostic test function.

2.2.1.12.3 Form C dry contacts

2.2.1.12.4 Optional – Surge Counter

2.2.1.12.5 No other test equipment shall be required for SPD monitoring or testing before or after installation.

2.2.1.13 SPD shall have a response time no greater than 1/2 nanosecond.

2.2.1.14 SPD shall have a 10 year warranty.

2.2.2 Distribution Panels:

2.2.2.1 SPD shall be UL 1449 labeled as Type 4 intended for Type 2 applications, verifiable at UL.com, without need for external or supplemental overcurrent controls. Every suppression component of every mode, including N-G, shall be protected by internal overcurrent and thermal over temperature controls. SPDs relying

upon external or supplementary installed safety disconnectors do not meet the intent of this specification.

2.2.2.2 SPD shall be factory installed integral to electrical distribution equipment.

2.2.2.3 Type 4 SPD shall be UL labeled with 20kA I-nominal (I-n)

2.2.2.4 SPD shall be UL labeled with 200kA Short Circuit Current Rating (SCCR).

2.2.2.5 Standard 7 Mode Protection paths: SPD shall provide surge current paths for all modes of protection: L-N, L-G, L-L, and N-G for Wye systems; L-L, L-G in Delta and impedance grounded Wye systems.

2.2.2.6 SPD shall be connected to the buss of the distribution equipment with an appropriately sized 200kA SCCR rated disconnect.

2.2.2.7 SPD shall meet or exceed the following criteria:

2.2.2.7.1 Maximum 7-Mode surge current capability shall be 150kA or higher per phase

2.2.2.7.2 UL 1449 - Third Edition Revision; effective September 29, 2009, where applicable either Type 2 or Type 4 Voltage Protection Ratings shall not exceed the following:

Voltage	L-N	L-G	N-G	L-L	MCOV
208/120V	800V	800V	800V	1200V	150V
480/277V	1200V	1200V	1200V	2000V	320V
600/347V	1500V	1500V	1500V	2500V	420V

2.2.2.8 UL 1449 Listed Maximum Continuous Operating Voltage (MCOV)

System Voltage	Allowable System Voltage Fluctuation (%)	MCOV
208/120V	25%	150V
600/347V	20%	420V

2.2.2.9 SPD shall incorporate a UL 1283 listed EMI/RFI filter with minimum attenuation of - 50dB at 100 kHz.

2.2.2.10 Suppression components shall be heavy duty 'large block' MOVs, each exceeding 30mm diameter.

2.2.2.11 SPD shall include a serviceable, replaceable module.

2.2.2.11.1 SPD shall be equipped with the following diagnostics:

2.2.2.11.2 Visual LED diagnostics including a minimum of one green LED indicator per phase, and one red service LED.

2.2.2.12 Audible alarm with on/off silence function and diagnostic test function (excluding branch).

2.2.2.12.1 Form C dry contacts

2.2.2.12.2 Optional – Surge Counter

2.2.2.12.3 No other test equipment shall be required for SPD monitoring or testing before or after installation.

2.2.2.12.4 SPD shall have a response time no greater than 1/2 nanosecond.

2.2.2.12.5 SPD shall have a 10 year warranty.

2.2.2.13 Branch Panels:

2.2.2.14 The panelboard shall be CSA C22.2 No.29 certified and the SPD shall be UL 1449 labeled as Type 4 intended for Type 2 applications.

2.2.3 The unit shall be top or bottom feed according to requirements. A circuit directory shall be located inside the door.

2.2.3.1 SPD shall meet or exceed the following criteria:

2.2.3.2 Maximum 7-Mode surge current capability shall be 100kA or higher per phase.

2.2.3.3 UL 1449 - Third Edition Revision; effective September 29, 2009, where applicable either Type 2 for Canada (or Type 1 for US) or Type 4 Voltage Protection Ratings shall not exceed the following:

Voltage	L-N	L-G	N-G	L-L	MCOV

208/120V	800V	800V	800V	1200V	150V
480/277V	1200V	1200V	1200V	2000V	320V
600/347V	1500V	1500V	1500V	2500V	420V

2.2.3.4 UL 1449 Listed Maximum Continuous Operating Voltage (MCOV) (verifiable at UL.com):

System Voltage	Allowable System Voltage Fluctuation (%)	MCOV
208/120V	25%	150V
600/347V	20%	420V

2.2.3.5 SPD shall incorporate a UL 1283 listed EMI/RFI filter with minimum attenuation of - 50dB at 100 kHz.

2.2.3.6 Suppression components shall be heavy duty ‘large block’ MOVs, each exceeding 30mm diameter.

2.2.3.7 SPD shall include a serviceable, replaceable module.

2.2.3.8 SPD shall be equipped with the following diagnostics:

2.2.3.8.1 Visual LED diagnostics including a minimum of one green LED indicator per phase, and one red service LED.

2.2.3.8.2 Audible alarm with on/off silence function and diagnostic test function.

2.2.3.8.3 Form C dry contacts

2.2.3.8.4 Optional – Surge Counter

2.2.3.8.5 No other test equipment shall be required for SPD monitoring or testing before or after installation.

2.2.3.9 SPD shall have a response time no greater than 1/2 nanosecond.

2.2.3.10 SPD shall have a 10 year warranty.

2.2.3.11 The unit shall have removable interior.

2.2.3.12 The main bus shall be copper or aluminum and rated for the load

current required.

2.2.3.13 The unit shall include a 200% rated neutral assembly with copper neutral bus.

2.2.3.14 The unit shall be provided with a safety ground bus.

2.2.3.15 The field connections to the panelboard shall be main lug or main breaker.

2.2.3.16 The unit shall be constructed with flush or surface mounted trim and shall be in a Sprinkler proof enclosure.

3 EXECUTION

3.1 INSTALLATION

3.1.1 Install per manufacturer's recommendations and contract documents.

3.2 ADJUSTMENTS AND CLEANING

3.2.1 Remove debris from installation site and wipe dust and dirt from all components.

3.2.2 Repaint marred and scratched surfaces with touch up paint to match original finish.

3.3 TESTING

3.3.1 Check tightness of all accessible mechanical and electrical connections to assure they are torqued to the minimum acceptable manufacture's recommendations.

3.3.2 Check all installed panels for proper grounding, fastening and alignment.

3.4 WARRANTY

3.4.1 Equipment manufacturer warrants that all goods supplied are free of non-conformities in workmanship and materials for one year from date of initial operation, but not more than eighteen months from date of shipment.

END OF SECTION

1 **GENERAL**

1.1 RELATED SECTIONS

1.1.1 Section 26 05 00 – Common Work Results - Electrical.

1.1.2 Conform to relevant sections of specification for this and other Divisions.

1.2 REFERENCES

1.2.1 CGSB 31-GP-103Ma, Heavy Phosphate Conversion Coatings for Iron and Steel (for Corrosion Resistance).

1.2.2 CGSB 31-GP-105Ma, Zinc Phosphate Conversion Coatings for Paint Base.

1.2.3 CGSB 31-GP-106M, Coating, Conversion, Iron Phosphate, for Paint Base.

1.3 SHOP DRAWINGS AND PRODUCT DATA

1.3.1 Submit shop drawings in accordance with Section 01 33 00 - Submittals.

1.3.2 Submit complete photometric data prepared by independent testing laboratory for luminaires where specified, for approval and review by Engineer.

1.3.3 Photometric reports shall include lamp-type used, reflection values used, mounting height of all fixtures, and all associated light loss factors for each fixture type, along with the name and contact information of designer who prepared calculations.

1.3.4 Photometric data to include recommended spacing criterion.

2 **PRODUCTS**

2.1.1 LED Systems

2.1.1.1 Luminaire photometric report published by manufacturer will be based on LM- 79-08 (IESNA).

2.1.1.2 Data pertaining to the temperature (such as solder joint temperature) for the LEDs when operated inside the luminaire in the intended application; and information about how the measured

temperature relates to expected life of the system will be provided.

2.1.1.3 Any test data available about longer term performance of the LED luminaire, such as DOE CALiPER testing, manufacturer in-house testing, or field tests conducted by DOE, utilities, or other parties will be provided.

2.1.1.4 Life Rating will be based on LM-80-08 (IESNA) . It will be defined as number of hours of operation where at least 70% of initial lumens for LEDs is maintained.

2.1.1.5 CRI should be greater than 80 (chromaticity as per ANSI C78.377-2008).

2.1.1.6 Mock up, if requested by architect, should be done before execution of the project.

2.1.1.7 Power supplies and control interfaces should be suitable/compatible with the LED modules/luminaires.

2.1.1.8 Input voltage for power supply will be 120v.

2.1.1.9 Ambient temperature -20 deg C to +50 deg C.

2.1.1.10 FCC 47CFR Part 15 compliant.

2.1.1.11 LED systems to be RoHS compliant.

2.1.1.12 Wiring to be as per the manufacturer's data sheet and to comply with local codes/standards.

2.2 FINISHES

2.2.1 Baked enamel finish:

2.2.1.1 Conditioning of metal before painting:

2.2.1.1.1 For corrosion resistance conversion coating to CGSB 31-GP-103Ma.

2.2.1.1.2 For paint base, conversion coating to CGSB 31-GP-105Ma, CGSB 31-GP-106M.

2.2.1.2 Metal surfaces of luminaire housing and reflectors finished with high gloss baked enamel or polyester powder coat to give smooth, uniform appearance, free from pin holes or defects.

2.2.1.3 Reflector and other inside surfaces finished as follows:

2.2.1.3.1 White, minimum reflection factor 85%.

2.2.1.3.2 Colour fastness: yellowness factor not above 0.02 and after 250 h exposure in Atlas fade-ometer not to exceed 0.05.

2.2.1.3.3 Film thickness, not less than 0.03 mm average and in no areas less than 0.025mm.

2.2.1.3.4 Gloss not less than 80 units as measured with Gardner 60 gloss meter.

2.2.1.3.5 Flexibility: withstand bending over (12 mm) ½" mandrel without showing signs of cracking or flaking under ten (10) times magnification.

2.2.1.3.6 Adhesion: (24 mm) 1" square lattice made of (3 mm) 1/8"-square cut through film to metal with sharp razor blade. Adhesive cellulose tape applied over lattice and pulled. Adhesion satisfactory if no coating removed.

2.2.2 Alzak finish:

2.2.2.1 Aluminum sheet fabricated from special aluminum alloys and chemically brightened, subsequently anodically treated to specifications established by Alcoa, to produce:

2.2.2.1.1 Finish for mild commercial service, minimum density of coating 7.8 g/m, minimum reflectivity 83% for specular, 80.5% for semi-specular and 75% for diffuse.

2.2.2.1.2 Finish for regular industrial service, minimum density of coating 14.8 g/m, minimum reflectivity 82% for specular and 73% for diffuse.

2.2.2.1.3 Finish for heavy duty service, minimum density of coating 21.8 g/m, minimum reflectivity 85% for specular, 65% for diffuse.

2.3 LIGHT OPTICAL CONTROL DEVICES

2.3.1 Plastic for clear lenses and diffusers shall be manufactured from injection-molded clear virgin acrylic, unless otherwise noted.

2.3.2 Glass used for lenses, refractors, and diffusers shall be tempered for high impact and heat resistance. For exterior fixtures use tempered Borosilicate glass.

2.3.3 Generally, lenses shall be 0.125” (3.18mm) thick overall with 0.084” (2.13mm) maximum penetration in a K-12 pattern unless otherwise noted.

2.3.4 Provide ultraviolet inhibited lenses and shields over lamps as indicated.

2.4 LUMINAIRE CONSTRUCTION

2.4.1 Unless otherwise indicated, luminaire bodies shall be of minimum 20-gauge (0.0359” thick), cold rolled prime steel of rigid construction with knockouts as required.

2.4.2 Fixture rigidity shall permit any suspension method without sag. Fluorescent luminaires shall be suitable for either individual or continuous mounting.

2.4.3 Fixtures shall be finished in baked white enamel unless otherwise noted, with exposed surfaces matching the exposed tee bars specified in other sections and shall resist chipping, corrosion, and discolouration

2.4.4 Fixture lenses and diffusers shall be rigid enough to be self-supporting without sag, easily removable but not loose. Provide additional thickness of lens to prevent sag at no extra cost to the owner.

2.4.5 Where the architect is to select colours and finish of luminaires after award of contract, it shall be the responsibility of the contractor for Division 26 to obtain this information well in advance of installation schedule.

2.4.6 Where fixtures are specified to have two separate power sources within, provide all necessary barriers, etc., to isolate the two power sources as per the requirements of the authorities having jurisdiction.

2.4.7 Where fixtures are located in sound-critical spaces including but not limited to theater, multi-purpose room, as described in noise section shall be mounted with rubber cushion or assemblies provide necessary isolation barrier.

2.4.8 Where fixtures are specified to be IP65 rated, rating shall be tested to IEC 60598 by a recognized independent testing authority.

2.5 MANUFACTURERS

2.5.1 The listing of a manufacturer as "acceptable" does not imply automatic approval. It is the responsibility of the contractor to ensure that any price quotations received and submittals made are for devices that meet or exceed the specifications included herein, including all custom options selected.

2.5.2 Refer to Luminaire Schedule for the acceptable manufacturers for the specific luminaire types.

2.5.3 Luminaires:

2.5.3.1 The catalog number, if provided, is for reference only and may not include all options and features required by the description. Manufacturer/supplier to ensure the submitted luminaire meet all requirements identified in each luminaire schedule.

2.5.3.2 Include cost for aiming and adjustment(s) of luminaires, programming, dimming setting, LV lighting control adjustment(s), etc. as part of this contract.

2.5.3.3 Where several manufacturers are shown, the first one named, accompanied by a model or catalog number, is the one on which the design is based.

2.5.3.4 The presence of a manufacturer's name as an acceptable alternate indicates acceptance of that manufacturer's level of quality, but does not imply that a comparable luminaire by that manufacturer necessarily exists and/or equivalent.

2.5.3.5 The products of the other named manufacturers may be used, provided that the product offered meets the specification, is visually similar to, and has photometric performance comparable to, the first-named product. The manufacturer/supplier shall be responsible to review the base luminaire and make the final determination as to whether the product of an alternative manufacturer meets the above criteria. In the event that such product is deemed not to meet those criteria, the manufacturer/supplier shall provide the product on which the design was based at no additional cost to the contract.

2.5.3.6 All luminaries will be specification grade. Do not provide luminaries that are not similar in shape and/or not equivalent. It is the responsibility of the manufacturer/ supplier to ensure compliance.

2.6 <u>OWNER'S SPARE STOCK</u>

2.6.1 Provide 2% of all luminaires, lamps, ballasts, and drivers as installed on this project for Owner's attic stock. The spare stock products shall be handed over to the Owner in their original packaging prior to the substantial completion of the project.

3 **EXECUTION**

3.1 INSTALLATION

3.1.1 Replace all light fixtures with new, if there is any rapid deterioration of lamps/LED which the Consultant views as excessive in terms of the project warranty, at no cost to the Owner.

3.1.2 Replace all light fixtures with a colour shift which does not correlate to manufacturers published data.

3.1.3 Locate and install luminaires as indicated.

3.2 WIRING

3.2.1 Connect luminaires to lighting circuits:

3.2.1.1 Through flexible conduit or modular wiring system.

3.3 LUMINAIRE SUPPORTS

3.3.1 For suspended ceiling installations, support luminaires independently of ceiling, duct work, or piping.

3.4 LUMINAIRE ALIGNMENT

3.4.1 Align luminaires mounted in continuous rows to form straight uninterrupted line.

3.4.2 Align luminaires mounted individually parallel or perpendicular to building grid lines.

3.4.3 Install pendant lighting fixtures plumb and at a height from the floor as specified on drawings/specifications. In cases where conditions make this impractical, refer to the Architect for decision. Use ball aligners and canopies on pendant fixtures unless noted otherwise.

3.5 CLEANUP

3.5.1 All lighting fixtures shall be thoroughly cleaned with materials and methods recommended by the manufacturers. All broken parts shall have been replaced and all lamps shall be operative.

END OF SECTION

1 **GENERAL**

1.1 RELATED SECTIONS

1.1.1 Section 26 05 00 Common Work Results - Electrical.

1.1.2 Conform to relevant sections of specification for this and other Divisions.

1.2 PRODUCT DATA

1.2.1 Submit product data in accordance with Section 01 33 00 – Submittals.

1.2.2 Data to indicate system components, mounting method, source of power and special attachments.

2 **PRODUCTS**

2.1 EQUIPMENT

2.1.1 Supply voltage: 120 V, ac.

2.1.2 Output voltage: 24V dc.

2.1.3 Operating time: 60 min, under full load.

2.1.4 Battery: sealed, maintenance free.

2.1.5 Charger: solid state, multi-rate, voltage/current regulated, inverse temperature compensated, short circuit protected with regulated output of plus or minus 0.01 V for plus or minus 10% input variations.

2.1.6 Solid state transfer circuit.

2.1.7 Low voltage disconnect: solid state, modular, operates at 80% battery output voltage.

2.1.8 Signal lights: solid state, for AC Power ON, and High Charge.

2.1.9 Lamp heads: integral on unit and remote as indicated on the floor plans, 345 horizontal and 180 vertical adjustment. Lamp type: LED 12W.

2.1.10 Cabinet: suitable for direct or shelf mounting to wall and c/w knockouts for conduit. Removable or hinged front panel for easy

access to batteries.

2.1.11 Finish: To be selected by the Architect from standard options.

2.1.12 Auxiliary equipment:

2.1.12.1 Ammeter.

2.1.12.2 Voltmeter.

2.1.12.3 Test switch.

2.1.12.4 Time delay relay.

2.1.12.5 Battery disconnect device.

2.1.12.6 Ac input and dc output terminal blocks inside cabinet.

2.1.12.7 Cord and duplex receptacle plug connection for ac.

2.1.12.8 RFI suppressors.

2.2 WIRING OF REMOTE HEADS

2.2.1 Conduit: To Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.

2.2.2 Conductors: To Section 26 05 21 - Wires and Cables0 - 1000 V, sized in accordance with manufacturer's recommendations.

2.3 MANUFACTURER

2.3.1 Acceptable manufacturers are:

2.3.1.1 Lumacell

2.3.1.2 Emergi-lite

3 **EXECUTION**

3.1 INSTALLATION

3.1.1 Install unit equipment and remote mounted fixtures.

3.1.2 Direct heads.

3.1.3 Connect exit lights to unit equipment.

3.1.4 Minimum #10AWG wiring to each remote head. Increase wire gauge to limit voltage drop as per manufacturer's recommendations.

END OF SECTION

1 **GENERAL**

1.1 REFERENCE

1.1.1 Read and be governed by Section 26 05 00.

1.2 RELATED WORK

1.2.1 Comply with relevant Sections of this and other Divisions of this Specification.

1.3 PRODUCT DATA

1.3.1 Submit product data in accordance with Section 26 05 00.

1.3.2 Exit Signs based on CSA C22.2 No141

1.3.3 NRCAN/CSA C860 Certified.

2 **PRODUCTS**

2.1 PUBLIC AREAS TYPE

2.1.1 Edge lit type, either single face recessed wall mount, or recessed single or double faced ceiling mount.

2.1.2 Housing to have steel bevelled trim plate, with white finish.

2.1.3 Faceplate to have green pictogram on clear, white or mirrored background, complying to NBC 2010, with or without directional indicators as required.

2.1.4 Lamps to be high output LED, not exceeding 2W power draw, vertically aligned, and parallel proprietary lateral, acrylic lens, such that they are fully contained and not be visible or protruding.

2.1.5 Self-powered unit for 120V input with dust-tight relay transfer and maintenance free nickel cadmium battery. Include low voltage disconnect, short circuit, reverse polarity test switch, high charge, and brownout protection features.

2.1.6 Edgelit sign to be Beghelli GUIDA RM series or approved equal.

2.2 BACK OF THE HOUSE AND SERVICE AREAS TYPE

2.2.1 Thin line type with a maximum depth of 51 mm (2"), surface, single or double face, end or ceiling mounted.

2.2.2 Housing to be fully extruded aluminum, with matt white finish.

2.2.3 Faceplate to be green pictorial sign complying to NBC 20 12 stand and with or without directional indicators as required.

2.2.4 Lamps to be high output LED not exceeding 2W power draw, vertically aligned, and parallel proprietary lateral, acrylic lens, such that they are fully contained and not be visible or protruding.

2.2.5 Edgelit exit sign shall be AimLite – RPEL Series. Note: This is the UTM standard fire exit signs, other manufacturers will not be accepted.

2.3 GENERAL

2.3.1 All exit lights shall have :

2.3.1.1 Have no light leakage from joints and fittings.

2.3.1.2 Have canopy and/or stem hangers to match housing.

2.3.1.3 Meet the requirements of standard CSA C860.

2.3.1.4 Must be 2010 NBC compliant

3 EXECUTION

3.1 INSTALLATION

3.1.1 Install exit lights where shown.

3.1.2 Connect exit lights to circuits as indicated.

3.1.3 Ensure that exit light circuit breaker is locked in ON position.

3.1.4 Ensure that nowhere, are exit lights mounted less than 2m (6'-6") between underside of unit and finished floor.

3.1.5 For ceiling mounting in areas with unfinished ceiling, mount unit alongside junction box, with or without canopy, and supply unit laterally with conduit (or with buried conduit, where allowed or specified, or by using the exit light canopy as a junction box where approved).

3.1.6 Include in the Bid, for the installation of 5 (five) additional exit lights of each type X1 where directed on site.

END OF SECTION

Project Name: *UNIVERSITY OF TORONTO MISSISSAUGA - PRE-ENGINEERED BUILDING*
Project No.: *2023-0059*
Section Name: ***List of Acceptable Manufacturers***
Section No.: ***26 90 00***
Date: *November 15, 2024*

List of Acceptable Manufacturers

SPECIFICATION SECTION	EQUIPMENT	ACCEPTABLE MANUFACTURERS
26 05 19 **Low-voltage Electrical Power Conductors and Cables**	Building Wires	• General Cable • SouthWire • Nexans • Canada Wire and Cable
	Type TECK90 Cable	• General Cable • SouthWire • Nexans • United Wire and Cable
	Armoured Cables	• General Cable • SouthWire • Nexans
	Mineral-Insulated Cables	• nVent - Pyrotenax
	Fire-Rated Power Cables	• nVent – Pyrotenax •
	Control Cables	• General Cable • SouthWire • Nexans • United Wire and Cable • Belden • Delco
	Drive RX Cables for Variable Frequency Drives Application	• General Cable • SouthWire • Nexans
26 05 20 **Wiring and Box Connectors 0-1000V**	Standard Fixed Spring Type Connectors	• Thomas & Betts: Marrett Type II Winged • Ideal Industries
	Vibration Resistant and High Temperature	• Thomas and Betts: Marrett Set Screw

	Sleeve & Screw Type Connectors	Vibration Proof/Visible Connector • Indeal Industries
	Weatherproof Fixed Spring Type Connectors	• Ideal Industries: Weatherproof Wire Connector
	Mechanical Wire Connectors	• Panduit: Pan-Lug Cast Copper Connectors • Blackburn
	Compression Wire Connectors	• Panduit: Pan-Lug Compression Connectors • Blackburn
	Mechanical Lugs	• Panduit: Pan-Lug Aluminum Mechanical Connectors • Blackburn
	Insulated Butt (Hypress) Splice	• Panduit: Pan-Term Butt splice • 3M • Blackburn
26 05 29 **Hangers and Supports for Electrical Systems**	Support Channels	• Unistrut of Canada Ltd. • Burndy Canada Ltd. • Electrovert Ltd. • Pilgrim Technical Products Limited
	Concrete Anchors	• Hilti Canada Ltd • Pilgrim Technical Products Limited • Electrovert Ltd. • Unistrut
26 05 33.23 **Surface Raceways for Electrical Systems**	Surface Floor Raceway System	• Legrand: 4000 Series Multi-Channel Metal Raceway

26 05 36 **Cable Trays for Electrical Systems**	Cable Trays	• Thomas & Betts Canada • Cablofil • Canadian Electrical Raceways • Eaton B-Line
26 05 73 **Short Circuit System Coordination & Arc Flash Study**	Short Circuit System Coordination and Arc Flash Study	• Brosz and Associates • Eastenghouse • Enkompass • GT Wood • Pelikan • Schneider • Eaton
26 09 13 **Power Monitoring**	Power Monitoring	• Intellimeter Canada • Quadlogic Controls Corp • Carma Industries • Shneider Electric • Eaton Electric
26 09 23 **Lighting Control Devices**	General 0-10V Dimmers	• Lutron: DIVA or equivalent • Acuity: nLight • Leviton (Specification Grade)
	General Occupancy Sensors	• Lutron • Acuity: Sensor Switch • Watt Stopper • Leviton (Specification Grade)
26 22 13 **Dry Type Transformers up to 600V Primary**	Dry Type Transformers	• Hammond Power Solutions • Schneider Electric – Square D • Rex Power Magnetics • Delta • STI

26 24 13 **Switchboard**	Switchboards	• Schneider Electric – Square D • Eaton – Cutler Hammer • Siemens
26 24 16 **Panelboards**	Panelboards	• Schneider Electric – Square D • Eaton – Cutler Hammer • Siemens
26 27 26 **Wiring Devices**	Wiring Devices	• Hubbell Canada • Pass & Seymour • Leviton (Specification Grade)
26 28 16.01 **Moulded Case Circuit Breakers**	Moulded Case Circuit Breakers	• Schneider Electric – Square D • Eaton – Cutler Hammer • Siemens
26 28 23 **Disconnect Switches Fused & Non-fused**	Disconnect Switches	• Schneider Electric – Square D • Eaton – Cutler Hammer • Siemens
26 43 13 **Surge Protective Devices**	Surge Protective Devices	• Schneider • Eaton • Siemens
26 52 01 **Unit Equipment for Emergency Lighting**	Unit Equipment for Emergency Lighting	• Beghelli • Emergi-Lite • Lumacell

APPENDIX A

PANEL SCHEDULES

HIDI

PROJECT NAME: **UTM 3359 MISSISSAUGA RD**
PROJECT NUMBER: **2023-0059**
DATE: November 15, 2024
ENGINEER/DESIGNER Dwayne DeSouza

PANEL: PP-2B1
PAGE: 1 of 2
LOCATION: MULTI-PUROSE SPACE

Panel Mains:	100 A	**SC Rating:**	25 KAIC	**Voltage:**	120 / 208	**Ph/Wire:**	3ϕ /4W	**Fed from:**	DP-2A1

BRKR	*	DESCRIPTION	C [W]	cct	PHASE A B C	cct	C [W]	DESCRIPTION	*	BRKR
15A-1P	S	MULTI-PURPOSE SPACE WEST RECEPTACLES	**750**	1		2	**200**	DRONE RESEARCH LAB OVERHEAD DOOR	S	**15A-2P**
15A-1P	S	MULTI-PURPOSE SPACE NORTH RECEPTACLES	**750**	3		4	**200**			
15A-1P	S	MULTI-PURPOSE SPACE EAST RECEPTACLES	**500**	5		6	**250**	MULTI-PURPOSE SPACE FLOOR MOUNTED RECEPTACLE #5	S	**15A-1P**
15A-1P	S	MULTI-PURPOSE SPACE FLOOR MOUNTED RECEPTACLE #1	**250**	7		8	**250**	MULTI-PURPOSE SPACE FLOOR MOUNTED RECEPTACLE #6	S	**15A-1P**
15A-1P	S	MULTI-PURPOSE SPACE FLOOR MOUNTED RECEPTACLE #2	**250**	9		10	**800**	BATTERY CHARGING CABINETS	S	**15A-1P**
15A-1P	S	MULTI-PURPOSE SPACE FLOOR MOUNTED RECEPTACLE #3	**250**	11		12	**250**	RCPT-LAPTOPS	S	**15A-1P**
15A-1P	S	MULTI-PURPOSE SPACE FLOOR MOUNTED RECEPTACLE #4	**250**	13		14	**250**	RCPT-LAPTOPS	S	**15A-1P**
				15		16	**250**	RCPT-LAPTOPS	S	**15A-1P**
15A-1P	S	MULTI-PURPOSE SPACE AV RACKS	**300**	17		18	**250**	RCPT-LAPTOPS	S	**15A-1P**
15A-1P	S	CONV RECEPTACLE	**250**	19		20	**250**	RCPT-LAPTOPS	S	**15A-1P**
15A-1P	S	FLOATING OFFICE RECEPTACLES	**500**	21		22	**250**	RCPT-DRONE LAB-20A	S	**20A-1P**
				23		24	**250**	RCPT-DRONE LAB-20A	S	**20A-1P**
				25		26	**250**	RCPT-DRONE LAB-15A	S	**15A-1P**
				27		28	**250**	RCPT-DRONE LAB-15A	S	**15A-1P**
15A-1P	S	WORKSTATION RECEPTACLE #1	**250**	29		30	**250**	RCPT-DRONE LAB-15A	S	**15A-1P**
20A-1P		QUAD RECEPTACLE FOR AV RACK	**250**	31		32	**250**	RCPT-DRONE LAB-15A	S	**15A-1P**
15A-1P	S	WORKSTATION RECEPTACLE #2	**250**	33		34	**250**	RCPT-DRONE LAB-15A	S	**15A-1P**
20A-1P		QUAD RECEPTACLE FOR AV RACK	**250**	35		36	**250**	RCPT-DRONE LAB-15A	S	**15A-1P**
15A-1P	S	WORKSTATION RECEPTACLE #3	**250**	37		38		SPARE	S	**15A-1P**
				39		40		SPARE	S	**15A-1P**
15A-1P	S	DRONE RESEARCH LAB ADO	**1200**	41		42		SPARE	S	**15A-1P**

LEGEND:
S : Standard Breaker
G : Ground Fault Circuit Interrupt
3G : 30mA Ground Fault Circuit Interrupt
A : Arc Fault Circuit Interrupt
(L) : Lock-on Device

OPTIONS:
☑ Main Breaker **100 A**
☐ Feed-through/Double Lugs
☐ Isolated Ground Bus
☐ Integral SPD

CSA Enclosure Rating: Type 3R
Tub Type: Single
Mounting: Flush
Total Circuits: 60

Demand "A"	**5103 W**
Demand "B"	**5313 W**
Demand "C"	**5663 W**

TOTAL DEMAND AMPS	**49.6 A**
TOTAL CONNECTED LOAD	**23.0 kW**
TOTAL DEMAND LOAD	**16.1 kW**

NOTES: PANEL TO BE SPRINKLER PROOF & C/W LOCKABLE DOOR.

PROJECT NAME: **UTM 3359 MISSISSAUGA RD**
PROJECT NUMBER: **2023-0059**
DATE: November 15, 2024
ENGINEER/DESIGNER Dwayne DeSouza

PANEL: PP-2B1
PAGE: 2 of 2
LOCATION: MULTI-PUROSE SPACE

Panel Mains:	100 A	**SC Rating:**	25 KAIC	**Voltage:**	120 / 208	**Ph/Wire:**	3ϕ /4W	**Fed from:**	DP-2A1

BRKR	*	DESCRIPTION	C [W]	cct	PHASE A B C	cct	C [W]	DESCRIPTION	*	BRKR
20A-1P	S	UPS-1 RECEPTACLE	**1920**	43		44				**15A-1P**
20A-1P	S	UPS-2 RECEPTACLE	**1920**	45		46				**15A-1P**
20A-1P	S	UPS-3 RECEPTACLE	**1920**	47		48				**15A-1P**
20A-1P	S	UPS-4 RECEPTACLE	**1920**	49		50				**15A-1P**
20A-1P	S	UPS-5 RECEPTACLE	**1920**	51		52				**15A-1P**
20A-1P	S	UPS-6 RECEPTACLE	**1920**	53		54				**15A-1P**
15A-1P				55		56				**15A-1P**
15A-1P				57		58				**15A-1P**
15A-1P				59		60				**15A-1P**

LEGEND:

S	: Standard Breaker
G	: Ground Fault Circuit Interrupt
3G	: 30mA Ground Fault Circuit Interrupt
A	: Arc Fault Circuit Interrupt
(L)	: Lock-on Device

OPTIONS:

- ☑ Main Breaker: **hidi**
- ☐ Feed-through/Double Lugs
- ☐ Isolated Ground Bus
- ☐ Integral SPD

CSA Enclosure Rating: Type 3R
Tub Type: Single
Mounting: Flush
Total Circuits: 60

Demand "A"	5103	W
Demand "B"	5313	W
Demand "C"	5663	W

TOTAL DEMAND AMPS	**49.6**	**A**
TOTAL CONNECTED LOAD	**23.0**	**kW**
TOTAL DEMAND LOAD	**16.1**	**kW**

NOTES: PANEL TO BE SPRINKLER PROOF & C/W LOCKABLE DOOR.

PROJECT NAME: **UTM 3359 MISSISSAUGA RD**
PROJECT NUMBER: **2023-0059**
DATE: November 15, 2024
ENGINEER/DESIGNER Dwayne DeSouza

PANEL: PP-2C1
PAGE: 1 of 1
LOCATION: M&E ROOM 201

Panel Mains:	100 A	**SC Rating:**	25 KAIC	**Voltage:**	120 / 208	**Ph/Wire:**	3ϕ /4W	**Fed from:**	DP-2A1

BRKR	*	DESCRIPTION	C [W]	cct	PHASE A B C	cct	C [W]	DESCRIPTION	*	BRKR
15A-1P	S	LOUNGE + CORRIDOR 102B RECEPTACLES	**750**	1		2	**800**	UNI W/C HAND DRYER	S	**20A-1P**
20A-1P	S	MICROWAVE #1	**1000**	3		4	**1000**	OFFICE RECEPTACLES	S	**15A-1P**
20A-1P	S	MICROWAVE #2	**1000**	5		6	**500**	OFFICE QUAD RECEPTACLE	S	**15A-1P**
20A-1P	S	FRIDGE	**300**	7		8	**150**	ILLUMINATED SIGNAGE	S	**15A-1P**
15A-1P	S	KITCHEN GFI RECEPTACLE	**250**	9		10	**1000**	M&E ROOM RECEPTACLES	S	**15A-1P**
15A-1P	S	CORRIDOR GFI - WATER STATION	**250**	11		12	**750**	M&E ROOM RECEPTACLES	S	**15A-1P**
15A-1P	S	CORRIDOR 102A RECEPTACLES	**750**	13		14	**150**	FIRE ALARM PANEL	S(L)	**15A-1P**
15A-1P	S	AUTO FAUCETS #1	**10**	15		16	**50**	ROOF RECEPTACLE #1	S	**20A-1P**
15A-1P	S	AUTO FAUCETS #2	**10**	17		18	**50**	ROOF RECEPTACLE #2	S	**20A-1P**
20A-1P	S	HAND DRYER #1	**800**	19		20	**100**	EPO CONTACTORS	S	**15A-1P**
20A-1P	S	HAND DRYER #2	**800**	21		22	**500**	LAN ROOM CONV. RECEPTACLE	S	**20A-1P**
15A-1P	S	AUTO FLUSH #1	**10**	23		24				
15A-1P	S	AUTO FLUSH #2	**10**	25		26	**250**	L6-30R LAN ROOM RECEPTACLE	S(L)	**30A-2P**
15A-1P	S	ELECTRONIC SEAL PRIMER	**10**	27		28				
15A-1P	S	CUSTODIAL GFI RECEPTACLES	**500**	29		30	**250**	L6-30R LAN ROOM RECEPTACLE	S(L)	**30A-2P**
15A-1P	S	VESTIBULE ADO #1	**800**	31		32				
15A-1P	S	VESTIBULE ADO #2	**800**	33		34				
15A-1P	S	UNI W/C ADO	**800**	35		36				
15A-1P	S	CEILING LIFT		37		38		SPARE	S	**15A-1P**
15A-2P	S	CHANGE TABLE	**250**	39		40		SPARE	S	**15A-1P**
				41		42		SPARE	S	**15A-1P**

LEGEND:
S : Standard Breaker
G : Ground Fault Circuit Interrupt
3G : 30mA Ground Fault Circuit Interrupt
A : Arc Fault Circuit Interrupt
(L) : Lock-on Device

OPTIONS:
☐ Main Breaker **N/A**
☐ Feed-through/Double Lugs
☐ Isolated Ground Bus
☐ Integral SPD

CSA Enclosure Rating: Type 3R
Tub Type: Single
Mounting: Surface
Total Circuits: 42

Demand "A"	**3402 W**
Demand "B"	**3969 W**
Demand "C"	**2884 W**

TOTAL DEMAND AMPS	**31.7 A**
TOTAL CONNECTED LOAD	**14.7 kW**
TOTAL DEMAND LOAD	**10.3 kW**

NOTES: 1) PANEL TO BE SPRINKLER PROOF C/W LOCKABLE DOOR. 2) PAINT BREAKER FOR FIRE ALARM PANEL IN RED. PROVIDE LOCK ON DEVICE.

HIDI

PROJECT NAME: **UTM 3359 MISSISSAUGA RD**
PROJECT NUMBER: **2023-0059**
DATE: November 15, 2024
ENGINEER/DESIGNER Dwayne DeSouza

PANEL: PP-2D1
PAGE: 1 of 1
LOCATION: FORENSIC GARAGE

Panel Mains:	100 A	**SC Rating:**	25 KAIC	**Voltage:**	120 / 208	**Ph/Wire:**	3ϕ /4W	**Fed from:**	DP-2A1

BRKR	*	DESCRIPTION	C [W]	cct	PHASE A B C	cct	C [W]	DESCRIPTION	*	BRKR
15A-1P	S	LAB RECEPTACLES	**500**	1		2	**800**	ADO	S	**15A-1P**
15A-1P	S	LAB GFI RECEPTACLE	**250**	3		4	**250**	QUAD RECEPTACLE FOR AV RACK	S	**20A-1P**
15A-1P	S	TEACHING LAB DUPLEX RECEPTACLES	**750**	5		6	**250**	QUAD RECEPTACLE FOR AV RACK	S	**20A-1P**
15A-1P	S	TEACHING LAB DUPLEX RECEPTACLES	**750**	7		8	**250**		S	**15A-1P**
15A-1P	S	TEACHING LAB QUAD RECEPTACLES	**750**	9		10	**100**	MOTORIZED BLINDS	S	**15A-1P**
15A-1P	S	TEACHING LAB QUAD RECEPTACLES (EAST)	**750**	11		12				
				13		14				
				15		16				
15A-2P	S	FORENSIC GARAGE OVERHEAD DOOR	**200**	17		18				
			200	19		20				
15A-1P	S	FORENSIC GARAGE OVERHEAD CAMERA	**50**	21		22				
15A-1P	S	FORENSIC GARAGE DISPLAY	**400**	23		24				
15A-1P	S	CAMERA CHARGERS (X3)	**450**	25		26				
15A-1P	S	FORENSIC GARAGE GFI RECEPTACLES	**500**	27		28				
15A-1P	S	FORENSIC TEACHING CLASSROOM MOTORIZED BLINDS	**200**	29		30				
				31		32				
				33		34				
				35		36				
				37		38		SPARE	S	**15A-1P**
15A-1P	S	FORENSIC TEACHING CLASSROOM QUAD RECEPTACLE	**250**	39		40		SPARE	S	**15A-1P**
				41		42		SPARE	S	**15A-1P**

LEGEND:

S	: Standard Breaker
G	: Ground Fault Circuit Interrupt
3G	: 30mA Ground Fault Circuit Interrupt
A	: Arc Fault Circuit Interrupt
(L)	: Lock-on Device

OPTIONS:

☑ Main Breaker	**100 A**	CSA Enclosure Rating:	Type 1
☐ Feed-through/Double Lugs		Tub Type:	Single
☐ Isolated Ground Bus		Mounting:	Flush
☐ Integral SPD		Total Circuits:	42

Demand "A"	**2065 W**
Demand "B"	**1505 W**
Demand "C"	**1785 W**

TOTAL DEMAND AMPS	**16.5 A**
TOTAL CONNECTED LOAD	**7.7 kW**
TOTAL DEMAND LOAD	**5.4 kW**

NOTES: PANEL TO BE SPRINKLER PROOF C/W LOCKABLE DOORS.

HIDI

PROJECT NAME: **UTM 3359 MISSISSAUGA RD**
PROJECT NUMBER: **2023-0059**
DATE: November 15, 2024
ENGINEER/DESIGNER Dwayne DeSouza

PANEL: **PP-2F1**
PAGE: 1 of 1
LOCATION: FLEX GARAGE

Panel Mains:	100 A	**SC Rating:**	25 KAIC	**Voltage:**	120 / 208	**Ph/Wire:**	3ϕ /4W	**Fed from:**	DP-2A1

BRKR	*	DESCRIPTION	C [W]	cct	PHASE A B C	cct	C [W]	DESCRIPTION	*	BRKR
15A-1P	S	FLEX OFFICE TV RECEPTACLE	**250**	1		2				
15A-1P	S	FLEX OFFICE STATION RECEPTACLE #1	**250**	3		4				
15A-1P	S	FLEX OFFICE STATION RECEPTACLE #2	**250**	5		6				
15A-1P	S	FLEX OFFICE STATION RECEPTACLE #3	**250**	7		8				
15A-1P	S	FLEX OFFICE STATION RECEPTACLE #4	**250**	9		10				
15A-1P	S	FLEX OFFICE STATION RECEPTACLE #5	**250**	11		12				
15A-1P	S	FLEX OFFICE STATION RECEPTACLE #6	**250**	13		14				
15A-1P	S	FLEX OFFICE STATION RECEPTACLE #7	**250**	15		16				
15A-1P	S	FLEX OFFICE STATION RECEPTACLE #8	**250**	17		18				
15A-1P	S	FLEX OFFICE FLOOR MOUNTED RECEPTACLE	**250**	19		20				
15A-1P	S	FLEX GARAGE GFI RECEPTACLES	**500**	21		22				
15A-1P	S	FLEX GARAGE GFI RECEPTACLES	**750**	23		24				
15A-2P	S	FLEX GARAGE OVERHEAD DOOR	**500**	25		26				
			500	27		28				
				29		30				
				31		32				
				33		34				
				35		36				
				37		38		SPARE	S	**15A-1P**
				39		40		SPARE	S	**15A-1P**
				41		42		SPARE	S	**15A-1P**

LEGEND:
S : Standard Breaker
G : Ground Fault Circuit Interrupt
3G : 30mA Ground Fault Circuit Interrupt
A : Arc Fault Circuit Interrupt
(L) : Lock-on Device

OPTIONS:
☑ Main Breaker **100 A**
☐ Feed-through/Double Lugs
☐ Isolated Ground Bus
☐ Integral SPD

CSA Enclosure Rating: Type 3R
Tub Type: Single
Mounting: Flush
Total Circuits: 42

Demand "A"	**1050 W**
Demand "B"	**1225 W**
Demand "C"	**1050 W**

TOTAL DEMAND AMPS	**10.3 A**
TOTAL CONNECTED LOAD	**4.8 kW**
TOTAL DEMAND LOAD	**3.3 kW**

NOTES: PROVIDE SPRINKLER PROOF PANEL C/W LOCKABLE DOOR.

HIDI

PROJECT NAME: **UTM 3359 MISSISSAUGA RD**
PROJECT NUMBER: **2023-0059**
DATE: November 15, 2024
ENGINEER/DESIGNER Dwayne DeSouza

PANEL: **PP-2G1**
PAGE: 1 of 1
LOCATION: AV GARAGE

Panel Mains:	100 A	**SC Rating:**	25 KAIC	**Voltage:**	120 / 208	**Ph/Wire:**	3ϕ /4W	**Fed from:**	DP-2A1

BRKR	*	DESCRIPTION	C [W]	cct	PHASE A B C	cct	C [W]	DESCRIPTION	*	BRKR
15A-1P	S	AV GRAD OFFICE TV RECEPTACLE	**250**	1		2				
15A-1P	S	AV GRAD OFFICE WORKSTATION RECEPTACLE #1	**250**	3		4				
15A-1P	S	AV GRAD OFFICE WORKSTATION RECEPTACLE #2	**250**	5		6				
15A-1P	S	AV GRAD OFFICE WORKSTATION RECEPTACLE #3	**250**	7		8				
15A-1P	S	AV GRAD OFFICE WORKSTATION RECEPTACLE #4	**250**	9		10				
15A-1P	S	AV GRAD OFFICE WORKSTATION RECEPTACLE #5	**250**	11		12				
15A-1P	S	AV GRAD OFFICE WORKSTATION RECEPTACLE #6	**250**	13		14				
15A-1P	S	AV GRAD OFFICE WORKSTATION RECEPTACLE #7	**250**	15		16				
15A-1P	S	AV GRAD OFFICE WORKSTATION RECEPTACLE #8	**250**	17		18				
15A-1P	S	AV GRAD OFFICE FLOOR MOUNTED RECEPTACLE	**250**	19		20				
15A-1P	S	AV GARAGE GFI RECEPTACLES	**500**	21		22				
15A-1P	S	AV GARAGE GFI RECEPTACLES	**750**	23		24				
15A-2P	S	AV GARAGE OVERHEAD DOOR	**500**	25		26				
			500	27		28				
				29		30				
				31		32				
				33		34				
				35		36				
				37		38		SPARE	S	**15A-1P**
				39		40		SPARE	S	**15A-1P**
				41		42		SPARE	S	**15A-1P**

LEGEND:
S : Standard Breaker
G : Ground Fault Circuit Interrupt
3G : 30mA Ground Fault Circuit Interrupt
A : Arc Fault Circuit Interrupt
(L) : Lock-on Device

OPTIONS:
☑ Main Breaker **100 A**
☐ Feed-through/Double Lugs
☐ Isolated Ground Bus
☐ Integral SPD

CSA Enclosure Rating: Type 1
Tub Type: Single
Mounting: Flush
Total Circuits: 42

Demand "A"	**1050 W**
Demand "B"	**1225 W**
Demand "C"	**1050 W**

TOTAL DEMAND AMPS	**10.3 A**
TOTAL CONNECTED LOAD	**4.8 kW**
TOTAL DEMAND LOAD	**3.3 kW**

NOTES:

HIDI

PROJECT NAME: **UTM 3359 MISSISSAUGA RD**
PROJECT NUMBER: **2023-0059**
DATE: November 15, 2024
ENGINEER/DESIGNER Dwayne DeSouza

PANEL: PP-2L2
PAGE: 1 of 1
LOCATION: M&E ROOM 201

Panel Mains:	100 A	**SC Rating:**	As per Spec	**Voltage:**	120 / 208	**Ph/Wire:**	3ϕ /4W	**Fed from:**	DP-2A1

BRKR	*	DESCRIPTION	C [W]	cct	PHASE A B C	cct	C [W]	DESCRIPTION	*	BRKR
15A-1P	S	LW1	**25**	1		2	**330**	CORRIDOR 102A LIGHTING	S	**15A-1P**
15A-1P	S	LP1 AND LP2	**200**	3		4	**320**	CORRIDOR 102B LIGHTING	S	**15A-1P**
15A-1P	S	LQ1	**40**	5		6	**190**	WASHROOMS LIGHTING	S	**15A-1P**
15A-1P	S(L)	GROUND FLOOR EXIT SIGNS	**50**	7		8	**145**	CUSTODIAL AND LAN ROOM	S	**15A-1P**
15A-1P	S	LR1	**15**	9		10	**800**	M&E ROOM LIGHTING AND BU-1,2 AND 3	S	**15A-1P**
				11		12	**70**	VESTIBULE 101 AND OFFICE 109 LIGHTING	S	**15A-1P**
				13		14	**400**	LAB 107 AND TEACHING LAB 108 LIGHTING	S	**15A-1P**
				15		16	**550**	FORENSIC GARAGE LIGHTING	S	**15A-1P**
				17		18	**950**	FORENSIC TEACHING CLASSROOM LIGHTING	S	**15A-1P**
				19		20	**200**	AV GRAD OFFICE LIGHTING	S	**15A-1P**
				21		22	**200**	FLEX OFFICE LIGHTING	S	**15A-1P**
				23		24	**600**	AV GARAGE LIGHTING	S	**15A-1P**
				25		26	**600**	FLEX GARAGE LIGHTING	S	**15A-1P**
				27		28	**950**	MULTIPURPOSE SPACE LIGHTING	S	**15A-1P**
				29		30	**320**	FLOATING OFFICE LIGHTING	S	**15A-1P**
				31		32	**720**	DRONE RESEARCH LAB LIGHTING	S	**15A-1P**
				33		34	**450**	LOUNGE LIGHTING	S	**15A-1P**
				35		36				
15A-1P	S	SPARE		37		38				
15A-1P	S	SPARE		39		40				
15A-1P	S	SPARE		41		42				

LEGEND:
S : Standard Breaker
G : Ground Fault Circuit Interrupt
3G : 30mA Ground Fault Circuit Interrupt
A : Arc Fault Circuit Interrupt
(L) : Lock-on Device

OPTIONS:
☐ Main Breaker **N/A**
☐ Feed-through/Double Lugs
☐ Isolated Ground Bus
☐ Integral SPD

CSA Enclosure Rating: Type 3R
Tub Type: Single
Mounting: Flush
Total Circuits: 42

Demand "A"	**2470 W**
Demand "B"	**3485 W**
Demand "C"	**2170 W**

TOTAL DEMAND AMPS	**25.1 A**
TOTAL CONNECTED LOAD	**8.1 kW**
TOTAL DEMAND LOAD	**8.1 kW**

NOTES: PANEL SHALL BE SPRINKLER PROOF, AND COMPLETE WITH LOCKABLE DOOR.

PROJECT NAME: **UTM 3359 MISSISSAUGA RD**
PROJECT NUMBER: **2023-0059**
DATE: November 15, 2024
ENGINEER/DESIGNER Dwayne DeSouza

PANEL: **PP-2M2**
PAGE: 1 of 2
LOCATION: M&E ROOM 201

Panel Mains:	100 A	**SC Rating:**	25 KAIC	**Voltage:**	120 / 208	**Ph/Wire:**	3ϕ /4W	**Fed from:**	DP-2A1

BRKR	*	DESCRIPTION	C [W]	cct	PHASE A B C	cct	C [W]	DESCRIPTION	*	BRKR
15A-2P	S	BBH-1 (LAB 107)	**624**	1		2	**624**	BBH-1 (FORENSIC TEACHING CLASSROOM)	S	**15A-2P**
			624	3		4	**624**			
15A-2P	S	BBH-1 (TEACHING LAB 108)	**624**	5		6	**624**	BBH-1 (FORENSIC TEACHING CLASSROOM)	S	**15A-2P**
			624	7		8	**624**			
15A-2P	S	BBH-1 (MULTI-PURPOSE SPACE)	**624**	9		10	**624**	BBH-1 (FORENSIC TEACHING CLASSROOM)	S	**15A-2P**
			624	11		12	**624**			
15A-2P	S	BBH-1 (MULTI-PURPOSE SPACE)	**624**	13		14	**624**	BBH-1 (LOUNGE)	S	**15A-2P**
			624	15		16	**624**			
15A-2P	S	BBH-1 (MULTI-PURPOSE SPACE)	**624**	17		18	**624**	BBH-1 (LOUNGE)	S	**15A-2P**
			624	19		20	**624**			
15A-2P	S	BBH-1 (MULTI-PURPOSE SPACE)	**624**	21		22	**624**	BBH-1 (CORRIDOR)	S	**15A-2P**
			624	23		24	**624**			
15A-2P	S	BBH-1 (MULTI-PURPOSE SPACE)	**624**	25		26	**624**	BBH-1 (CORRIDOR)	S	**15A-2P**
			624	27		28	**624**			
15A-2P	S	BBH-1 (DRONE RESEARCH LAB)	**624**	29		30	**624**	BBH-1 (OFFICE)	S	**15A-2P**
			624	31		32	**624**			
				33		34	**624**	BBH-1 (DRONE RESEARCH LAB)	S	**15A-2P**
				35		36	**624**			
				37		38	**624**	BBH-1 (DRONE RESEARCH LAB)	S	**15A-2P**
15A-2P	S	BBH-1 (FORENSIC TEACHING CLASSROOM)	**624**	39		40	**624**			
			624	41		42				

LEGEND:
- S : Standard Breaker
- G : Ground Fault Circuit Interrupt
- 3G : 30mA Ground Fault Circuit Interrupt
- A : Arc Fault Circuit Interrupt
- (L) : Lock-on Device

OPTIONS:
- ☑ Main Breaker **SIZE?**
- ☐ Feed-through/Double Lugs
- ☐ Isolated Ground Bus
- ☐ Integral SPD

CSA Enclosure Rating: Type 1
Tub Type: Single
Mounting: Flush
Total Circuits: 84

Demand "A"	**4368 W**
Demand "B"	**4368 W**
Demand "C"	**3744 W**

TOTAL DEMAND AMPS	**38.5 A**
TOTAL CONNECTED LOAD	**25.0 kW**
TOTAL DEMAND LOAD	**12.5 kW**

NOTES:

PROJECT NAME: **UTM 3359 MISSISSAUGA RD**
PROJECT NUMBER: **2023-0059**
DATE: November 15, 2024
ENGINEER/DESIGNER Dwayne DeSouza

PANEL: PP-2M2
PAGE: 2 of 2
LOCATION: M&E ROOM 201

Panel Mains:	100 A	**SC Rating:**	25 KAIC	**Voltage:**	120 / 208	**Ph/Wire:**	3ϕ /4W	**Fed from:**	DP-2A1

BRKR	*	DESCRIPTION	C [W]	cct	PHASE A B C	cct	C [W]	DESCRIPTION	*	BRKR
				43		44	**624**	BBH-1 (FLOATING OFFICE)	S	**15A-2P**
				45		46	**624**			
				47		48				
				49		50				
				51		52				
				53		54				
				55		56				
				57		58				
				59		60				
				61		62				
				63		64				
				65		66				
				67		68				
				69		70				
				71		72				
				73		74				
				75		76				
				77		78				
				79		80		SPARE	S	**15A-1P**
				81		82		SPARE	S	**15A-1P**
				83		84		SPARE	S	**15A-1P**

LEGEND:

S	: Standard Breaker
G	: Ground Fault Circuit Interrupt
3G	: 30mA Ground Fault Circuit Interrupt
A	: Arc Fault Circuit Interrupt
(L)	: Lock-on Device

OPTIONS:

- ☑ Main Breaker: **hidi**
- ☐ Feed-through/Double Lugs
- ☐ Isolated Ground Bus
- ☐ Integral SPD

CSA Enclosure Rating: Type 1
Tub Type: Single
Mounting: Flush
Total Circuits: 84

Demand "A"	4368	W
Demand "B"	4368	W
Demand "C"	3744	W

TOTAL DEMAND AMPS	**38.5**	**A**
TOTAL CONNECTED LOAD	**25.0**	**kW**
TOTAL DEMAND LOAD	**12.5**	**kW**

NOTES:

HIDI

PROJECT NAME: **UTM 3359 MISSISSAUGA RD**
PROJECT NUMBER: **2023-0059**
DATE: November 15, 2024
ENGINEER/DESIGNER Dwayne DeSouza

PANEL: PP-2N2
PAGE: 1 of 2
LOCATION: M&E ROOM 201

Panel Mains:	225 A	**SC Rating:**	25 KAIC	**Voltage:**	120 / 208	**Ph/Wire:**	3ϕ /4W	**Fed from:**	DP-2A1

BRKR	*	DESCRIPTION	C [W]	cct	PHASE A B C	cct	C [W]	DESCRIPTION	*	BRKR
15A-2P	S	FC-10	**150**	1		2		AC-1	S	**15A-2P**
			150	3		4				
15A-2P	S	FC-9	**150**	5		6	**624**	UH-2	S	**15A-2P**
			150	7		8	**624**			
15A-2P	S	AC-2		9		10	**800**	BAS	S	**15A-1P**
				11		12				
15A-2P	S	FC-5	**150**	13		14				
			150	15		16				
15A-1P	S	SF-1	**600**	17		18				
15A-2P	S	FC-4	**100**	19		20				
			100	21		22	**85**	FC-7	S	**15A-2P**
80A-2P	S	EDH-1	**6000**	23		24	**85**			
			6000	25		26	**85**	FC-11	S	**15A-2P**
15A-2P	S	UH-1	**600**	27		28	**85**			
			600	29		30	**210**	UH-1 (AV GARAGE)	S	**15A-2P**
15A-2P	S	FC-2	**150**	31		32	**210**			
			150	33		34	**85**	FC-8	S	**15A-2P**
15A-2P	S	FC-3	**150**	35		36	**85**			
			150	37		38	**85**	FC-12	S	**15A-2P**
15A-2P	S	FC-1	**150**	39		40	**85**			
			150	41		42	**400**	EF-6	S	**15A-1P**

LEGEND:
S : Standard Breaker
G : Ground Fault Circuit Interrupt
3G : 30mA Ground Fault Circuit Interrupt
A : Arc Fault Circuit Interrupt
(L) : Lock-on Device

OPTIONS:
☐ Main Breaker **N/A**
☐ Feed-through/Double Lugs
☐ Isolated Ground Bus
☐ Integral SPD

CSA Enclosure Rating: Type 3R
Tub Type: Single
Mounting: Surface
Total Circuits: 84

Demand "A"	**12822**	**W**
Demand "B"	**10418**	**W**
Demand "C"	**13774**	**W**

TOTAL DEMAND AMPS	**114.2**	**A**
TOTAL CONNECTED LOAD	**74.0**	**kW**
TOTAL DEMAND LOAD	**37.0**	**kW**

NOTES: PANEL TO BE SPRINKLER PROOF AND C/W LOCKABLE DOOR.

PROJECT NAME: **UTM 3359 MISSISSAUGA RD**
PROJECT NUMBER: **2023-0059**
DATE: November 15, 2024
ENGINEER/DESIGNER Dwayne DeSouza

PANEL: PP-2N2
PAGE: 2 of 2
LOCATION: M&E ROOM 201

Panel Mains:	225 A	**SC Rating:**	25 KAIC	**Voltage:**	120 / 208	**Ph/Wire:**	3ϕ /4W	**Fed from:**	DP-2A1

BRKR	*	DESCRIPTION	C [W]	cct	PHASE A B C	cct	C [W]	DESCRIPTION	*	BRKR
15A-2P	S	FC-6	**190**	43		44	**210**	UH-1 (FLEX GARAGE)	S	**15A-2P**
			190	45		46	**210**			
15A-2P	S	BS-1	**70**	47		48	**624**	FFH-1	S	**15A-2P**
			70	49		50	**624**			
15A-2P	S	BS-2	**70**	51		52	**530**	EF-3	S	**15A-1P**
			70	53		54	**4100**	DHWH-2	S	**45A-3P**
45A-3P	S	DHWH-1	**4100**	55		56	**4100**			
			4100	57		58	**4100**			
			4100	59		60	**530**	EF-5	S	**15A-1P**
				61		62	**696**	EF-1	S	**15A-1P**
15A-1P	S	P-1	**700**	63		64	**696**	EF-2	S	**15A-1P**
				65		66	**1200**	CU-3	S	**15A-2P**
				67		68	**1200**			
				69		70	**1200**	CU-4	S	**15A-2P**
				71		72	**1200**			
				73		74	**3300**	CU-1	S	**35A-3P**
				75		76	**3300**			
				77		78	**3300**			
15A-1P	S	SPARE		79		80	**3300**	CU-2	S	**35A-3P**
15A-1P	S	SPARE		81		82	**3300**			
15A-1P	S	SPARE		83		84	**3300**			

LEGEND:
- S : Standard Breaker
- G : Ground Fault Circuit Interrupt
- 3G : 30mA Ground Fault Circuit Interrupt
- A : Arc Fault Circuit Interrupt
- (L) : Lock-on Device

OPTIONS:
- ☐ Main Breaker: **hidi**
- ☐ Feed-through/Double Lugs
- ☐ Isolated Ground Bus
- ☐ Integral SPD

CSA Enclosure Rating: Type 3R
Tub Type: Single
Mounting: Surface
Total Circuits: 84

Demand "A"	12822	W
Demand "B"	10418	W
Demand "C"	13774	W

TOTAL DEMAND AMPS	**114.2**	**A**
TOTAL CONNECTED LOAD	**74.0**	**kW**
TOTAL DEMAND LOAD	**37.0**	**kW**

NOTES: PANEL TO BE SPRINKLER PROOF AND C/W LOCKABLE DOOR.

DIVISION 27 – COMMUNICATIONS

SPECIFICATIONS

FOR THE

UNIVERSITY OF TORONTO MISSISSAUGA - PRE-ENGINEERED BUILDING

3359 MISSISSAUGA RD, MISSISSAUGA, ON

Prepared by:

The HIDI Group
155 Gordon Baker Road
Suite 200
Toronto, ON M2H 3N5

Telephone: 416-364-2100

DISCIPLINES
MECHANICAL
ELECTRICAL
FIRE PROTECTION
LIGHTING DESIGN
COMMUNICATIONS & AV
SECURITY & RISK
COMMISSIONING
ENERGY SERVICES

Our Project No. 2023-0059

SEAL:

LICENSED PROFESSIONAL ENGINEER
A. TAN
100087772
15-Nov-2024
PROVINCE OF ONTARIO

November 15, 2024
Issued for Tender

SECTION 27 05 00 COMMON WORK RESULTS FOR COMMUNICATIONS

1 GENERAL

1.1 SYSTEM DESCRIPTION

1.1.1 Provide a complete telephone and data raceway system consisting of outlet boxes, cover plates, cabling, cabinets, conduits, cabletroughs, pull boxes, sleeves and caps, backboards, fish wires, service poles, and service fittings, required to make a complete and operative system.

1.1.2 The system shall be provided to the requirements of the local telephone company, interconnect company and all other authorities having jurisdiction.

1.1.3 Install the empty raceway system, including pullstrings, terminal cabinets, outlet boxes, pull boxes, conduit, sleeves and caps, cabletroughs, miscellaneous and positioning material to constitute a complete system. Coordinate with other services.

1.1.4 Supply all labour, materials, tools and equipment required to complete the installation in accordance with the full intent of the drawings and specifications.

1.1.5 Provide all work in accordance with codes and manufacturers recommendations

1.1.6 All pathways including conduits, innerduct and cable tray should be installed parallel or perpendicular to building lines.

1.2 REFERENCES

1.2.1 UTM Communication Cabling Standards Revision 3.1 https://anacond.ca/wp-content/uploads/2024/09/Appendix-5-Communication-Cabling-Standards-Revision-R3.1.pdf

2 PRODUCTS

2.1 MATERIAL

2.1.1 Conduits: In accordance with Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.

2.1.2 Junction boxes and cabinets: In accordance with Section 26 05 33.16 – Boxes for Electrical Systems..

2.1.3 Outlet boxes, conduit boxes and fittings: In accordance with

Section 26 05 32 – Outlet Boxes, Conduit Boxes & Fittings.

2.1.4 Cover Plates: In accordance with Section 26 27 26 – Wiring Devices

2.1.5 Fish wire: polypropylene type, minimum 3/8" (9 mm) dia.

3 EXECUTION

3.1 INSTALLATION

3.1.1 Install empty raceway system, including overhead distribution system, fish-wire, terminal cabinets, outlet boxes, floor boxes, pull boxes, cover plates, conduit, sleeves and caps, cable troughs, service poles, miscellaneous and positioning material to constitute complete system.

3.1.2 Conduit system shall comply with UTM Communication Cabling Standards, Rev 3.1. In case of descripencies between the drawings, specifications and the UTM communication Cabling Standards, the UTM standards shall govern.

3.1.3 Any questions related to communications conduit path way, they shall be directed UTM I&ITS (and nobody else) for direction. Any assumptions made will be corrected and paid for by that given trade to adhere to 20201112 - UTM Communication Cabling Standards - R3.1.

END OF SECTION

UTM Communication Cabling Standards

UTM Information and Instructional Technology Services (I&ITS)

Revision 3.1
November 2020

UTM Standards: Renovations & New Construction

Facilities Management & Planning
Maanjiwe nendamowinan, 2nd Floor, Room #2220,
3359 Mississauga Rd, Mississauga, ON L5L 1C6 Canada.
Tel: +1 905-828-5301 * Fax +1 905-828-5300

Disclaimer:

Revisions History

Revision Number	Revision Date	Affected Sections																	
		2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
		27 05 13	27 05 26	27 05 29	27 05 33	27 05 36	27 05 53	27 05 55	27 11 16	27 11 19	27 11 23	27 11 26	27 13 13	27 13 13 13	27 13 23	27 13 23 13	27 15 01 16	27 15 01 19	27 15 43	27 16 19
R 1.0	April 2015	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
R 1.1	December 2015	✓			✓										✓					
R1.2	February 2017	✓			✓															
R1.4	March 2017	✓			✓															✓
R 2.0	August 16, 2018	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
R 2.1	September 20, 2018								✓											
R 2.2	October 30, 2019							✓							✓					
R 3.0	July 09, 2020	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
R 3.1	November 12, 2020								✓									✓		

1 PART 1- GENERAL

1.1 WORK INCLUDED

1.1.1 Comply with the General requirements and documents referred to within.

1.1.2 To be read in conjunction with associated electrical and communication specification sections.

1.1.3 The contractor should seek clarification from the UTM I&ITS Designate on site conditions and on any technical, work and/or premises-related questions without delay.

1.2 RELATED DOCUMENTS

1.2.1 Drawings and general provisions of the contract, including general and supplementary conditions apply to this section. Refer to the following for additional information.

1.2.2 27 05 26 Grounding and Bonding for Communications Systems

1.2.3 27 05 29 Hangers and Supports for Communication Systems

1.2.4 27 05 33 Conduits and Back Boxes for Communication Systems

1.2.5 27 05 36 Cable Trays for Communication Systems

1.2.6 27 05 53 Identification for Communication Systems

1.2.7 27 15 55 Testing for Communication Services

1.2.8 27 11 16 Communication Cabinets, Racks, Frames and Enclosures

1.2.9 27 11 19 Communication Termination Blocks and Patch Panels

1.2.10 27 11 23 Communications Cable Management and Ladder Rack

1.2.11 27 11 26 Communications Rack Mounted Power and Power Strips

1.2.12 27 13 13 Communications Copper Backbone Cabling

1.2.13 27 13 13 13 Communications Copper Cable Splicing and Terminations

1.2.14 27 13 23 Communications Optical Fibre Backbone Cabling

1.2.15 27 13 23 13 Communications Optical Fibre Splicing and Terminations

1.2.16 27 15 01 16 Voice Communications Horizontal Cabling

1.2.17 27 15 01 19 Data Communications Horizontal Cabling

1.2.18 27 15 43 Communication Faceplates and Connectors

1.2.19 27 16 19 Communication Patch Cords and Cross Connect Wire

1.3 QUALITY ASSURANCE

1.3.1 The contractor shall be certified, along with all technicians who should be properly trained by the manufacturer of a proposed cabling solution, with proof of certification readily available upon request.

1.3.2 Only new products listed in this document may be used unless otherwise submitted for approval.

1.3.3 The bidder shall demonstrate proven expertise in the implementation of network cabling. Expertise can be illustrated through the inclusion of details of at least two projects involving the design and installation of balanced unshielded twisted pair copper cable and OS2 single-mode fibre backbone cabling systems within the past two years. Names and contact information for each of the two projects shall be included in their bid response.

1.4 SCOPE

1.4.1 The contractor shall be responsible for the complete supply and installation of the following where required:

1.4.2 Communication basket cabling trays, supporting and installation hardware.

1.4.3 Horizontal Cabling: **always consult with the UTM I&ITS Designate before procuring materials. Cabling in existing installations may follow legacy standards.** New installations will follow Cat 6A standards, including faceplates, Keystone jacks, patch cords, patch panels, etc.

1.4.4 Cabinets and data racks along with associated hardware.

1.4.5 Grounding of cable trays and data racks/cabinets.

1.4.6 Copper and fibre backbone cabling including all components for a complete end to end system.

1.4.7 Testing of all horizontal voice, data, and backbone fibre cabling.

1.4.8 Contractor to make all necessary preparations, allowances and precautions to comply with the labour requirements for the job site to ensure that there will not be any disruption of work arising from the successful bidders work or workers.

1.5 GENERAL STIPULATIONS

1.5.1 The contractor shall furnish all labour, materials, tools and other equipment necessary to provide a complete horizontal and backbone (copper and fibre) cabling system.

1.5.2 The contractor shall be responsible for the completion of all work included in the contract and shall employ certified, skilled technicians as necessary to satisfy all work and trades.

1.5.3 The contractor shall carefully review all drawings (architectural, mechanical, electrical and communications) associated with the project and carry out the work so as not to delay or interfere with other trades.

1.5.4 The contractor must comply with all requirements of the Occupational Health & Safety Act.

1.5.5 The contractor shall provide all necessary permits to carry out their work.

1.5.6 Local codes shall take precedence over the drawings and specifications, except where the contract documents are more stringent, then the contract documents shall apply.

1.5.7 When the installation of the cabling system is completed and ready for acceptance the UTM I&ITS Designate shall be present for testing of the complete system.

1.5.8 All testing and retesting shall be done at the contractor's expense.

1.5.9 Contractor to provide cable test results 10 (ten) business days prior to the cutover to the UTM I&ITS Designate for review.

1.5.10 A DRAFT network drawing, detailing physical port locations, quantities and identifications must be provided ahead of time for I&ITS Network Engineering to configure network equipment. This length of time is variable and is represented as a function of the number of data drops. Each drop requires approximately 7 minutes of configuration time, hence a network map for a building with 500 data drops must be provided at least 8 business days prior to commissioning network equipment: 500 drops x 7 minutes per drop = 3,500 minutes = 58.33 hours; 58.33 / 7.25 working hours per day =~ 8.04 days.

1.5.11 Contractor to provide a finalized network drawing reflecting the cable tray routing and all data drop labels. A network drawing is similar to, but less complex than, an as-built drawing. Its sole purpose is to depict the physical locations of each network wall jack and its associated label on a floor plan.

1.5.12 All network drawings and printing of drawings for the UTM I&ITS Designate shall be done at the contractor's expense.

1.5.13 The Project Manager and lead technician that start the project must remain on the project until its completion.

1.6 FIRE STOPPING

1.6.1 The contractor shall seal all openings, new and/or old, they have utilized in floors, ceilings and partitions after all cabling has been completed. The fire stopping system and materials used shall comply with all applicable codes and conform to the acceptable testing methods and current standards in Canada, including, but not limited to, ULC-S115 and CAN/ULC-S101. The acceptability by ULC and by local authorities having jurisdiction, should be confirmed by the contractor to ensure that the test procedures were performed to ULC-S115 and CAN/ULC-S101.

1.6.2 The non-permanent intumescent and systems used for sealing the openings shall have a fire rating equal to or greater than the fire rating of the floor/wall/partition assemblies

being penetrated. The contractor shall be responsible for confirming the fire rating of the different assemblies to be penetrated with the UTM designate and for ensuring the use of the proper fire proofing methods accordingly.

1.6.3 Provide a non-permanent intumescent or hybrid fire stop system to cap all empty conduit ends, ducts, sleeves and slots, meeting or exceeding the requirements of 1.6.1.

1.6.4 Provide a non-permanent intumescent or hybrid fire stop system around all cabling to seal the conduit, cable tray, ducts, sleeves and slot openings, re-sealable with minimal risk of damage to cables, meeting or exceeding the requirements of 1.6.1

1.6.5 A non-permanent intumescent of hybrid fire stop system will be used, as per 1.6.3-1.6.4 even when conduits, ducts, sleeves or slots are filled to maximum capacity.

1.6.6 Firestopping materials/systems used to fill voids in floors having openings greater than 100 mm in diameter, and which are accessible to the public, shall support floor design loading

1.6.7 The contractor shall furnish all labour, materials, tools and other equipment necessary to provide a complete fire stopping system

1.6.8 The contractor shall provide data sheets and applicable documentation for the fire stopping systems to be used and to demonstrate that the systems meets or exceeds the requirements of 1.6.1 & 1.6.2 prior to supply, installation and/or construction.

1.7 SCHEDULE OF WORK

1.7.1 The contractor shall submit a schedule of work to be approved by the UTM I&ITS Designate. The schedule shall clearly indicate the proposed order in which the various activities will be undertaken and the estimated time required for the completion of the various activities.

1.7.2 The schedule of work may be revised periodically during the course of the project and must be approved by the UTM I&ITS Designate.

1.8 CLEAN-UP

1.8.1 The working space, telecommunications rooms and office spaces must be swept and free of unused cables, cable clippings, cardboard boxes or any other debris produced by the contractor, on a daily basis, by the end of each day, or as needed during the course of the day. The contractor is responsible for removing all trash to outside garbage containers at least once a day. The contractor shall provide a complete clean-up of the rooms at the end of the project or MAC work activity.

1.8.2 Workstation outlet location areas shall be cleaned on an on-going basis each time the contractor completes any MAC work activity in the area.

1.8.3 Costs associated for keeping the areas clean are the responsibility of the contractor.

1.8.4 Cleanliness of the site to be governed by the General Contractor/Construction Manager who may, after proper notice, back charge the contractor for site clean-up.

1.9 DELIVERY AND STORAGE

1.9.1 Delivery and receipt of project materials shall be the sole responsibility of the contractor to receive, move, secure and store all equipment and material. All delivery costs are to be included in the contractor's proposal.

1.9.2 All cable to be used in the project shall be stored according to manufacturer's recommendations. In addition, all cable must be stored in a protected area. If cable is stored outside, it must be covered with opaque plastic or canvas for protection from the elements, with adequate ventilation to prevent condensation. If air temperature at the cable storage location will be below 4.4 °C (40 °F), the cable shall be moved to a heated location [minimum 10 °C (50 °F)]. If necessary, cable shall be stored off-site at the contractor's expense.

1.9.3 The contractor is allowed one (1) standard size job box on the site during construction. All tools, material and the job box are the sole responsibility of the contractor. The contractor is responsible for the complete storage, handling, moving, delivery and installation of all materials used in the performance of the work.

1.10 PROJECT/SITE CONDITION

1.10.1 All bidders to arrange to obtain all necessary or referenced drawings and documents.

1.10.2 The contractor is responsible for seeking clarification with the UTM I&ITS Designate on how to address site and technical issues that may arise due to unforeseen difficulties. The contractor is not to operate under assumptions and make design changes without prior approval of the UTM I&ITS Designate. Whenever necessary, clarification must be sought every time unpredictable difficulties arise, from start to completion of a project.

1.10.3 No claim for additional payment to be made for extra material or work made necessary by circumstances encountered due to conditions which were made visible upon, or reasonably inferable from thorough examination and review of all associated project documents, drawings and systems, prior to the submission of the response.

1.10.4 No claim for additional payment to be made for extra material or work made necessary by circumstances encountered due to conditions which were made visible upon visit to premises. The contractor must be abundantly experienced to infer material and workmanship required to carry out work performed both within visible and obstructed, hidden and underground locations. Such assessment is to be performed prior to the submission of the response

1.10.5 During the implementation phase of a project, the contractor is not to deviate, willingly or due to misunderstanding of documentation, from the specifications, diagrams and project documents provided by the UTM I&ITS Designate. Doing so will require immediate corrective action by the contractor and additional costs incurred in order to

match the implementation with the design and specifications of the project will be done without hesitation at the contractor's expenses.

1.10.6 The cable routing diagrams only depict the cable routing and cable connectivity requirements. They are not installation drawings. Make all necessary allowances in the bid price to achieve the intent of the drawings.

1.11 CUTTING AND PATCHING

1.11.1 Complete all cutting and patching required for the installation of the infrastructure.

1.11.2 In existing work and work already finished, cutting, patching and painting will be required by the contractor.

1.11.3 Be aware of fire rated partitions and return all services to the condition encountered before start of the work.

1.12 SITE RESPONSIBILITIES

1.12.1 All pull strings present at the beginning of the installation must be returned or replaced to the initial state at the end of the communications cabling installation.

1.12.2 Do all cutting and patching required for the installation of the infrastructure.

1.12.3 The client is not responsible or liable for any missing material and/or tools belonging to the contractor.

1.12.4 The contractor is responsible for the removal and re-installation of all ceiling/floor tiles in the areas affected by its work. This is to be completed on a daily basis for the areas affected.

1.12.5 Any damage to ceiling tiles during the completion of any work outlined in this document is the responsibility of the contractor. Damage includes breaking, chipping or smudging. The decision with respect to any damage will be made by the General Contractor, Project Manager and the client.

1.12.6 The contractor is responsible for the storage and protection of the floor/ceiling tiles that are removed for cable installation.

1.12.7 Cabling that is not terminated on both ends, must not, under any circumstances, be abandoned in place. At the completion of work, the contractor is responsible for end-to-end removal of dead and unterminated cables from existing conduits, raceways, fittings, cable trays, wiring troughs and any other apparatus used to protect and route cables, i.e. from 8P8C receptacles (a.k.a. RJ45 jacks) to the cable's termination point (usually a patch panel or network switch). Great care should be taken during the removal process so as to protect the existing live cables from damage.

1.13 TERMS AND CONDITIONS

1.13.1 All terms and conditions of the specifications, bid documents and accompanying drawings to be strictly adhered to by the contractor, unless otherwise noted.

1.13.2 Any inability to comply with these requirements must be stated in writing, in detail with the response submission. Otherwise, it will be understood that the contractor is bound to the compliance with the stated terms and conditions.

1.13.3 Contractor to comply with the G.C. construction and installation schedule.

1.13.4 Do not assign or sub-contract any work without prior written consent from the IT department and or communication consultant.

1.13.5 Perform the complete installation in accordance with the latest editions of the Ontario and National Building Codes along with any other governing authorities of competent jurisdiction.

1.14 COORDINATION

1.14.1 Coordinate telecommunications work with that of the other trades.

1.14.2 Contractor to review any interference between general construction, telecommunications, architectural, mechanical, electrical, structural, and other specialty trades involved and bring it to the attention of the G.C.

1.15 EQUIPMENT IDENTIFICATION

1.15.1 All telecommunication equipment such as cabinets, racks and similar items shall be identified with labels which, ideally, should not exceed 8cm in length and 4cm in height.

1.15.2 Coordinate telecommunications work with that of the other trades.

1.16 WARRANTY

1.16.1 Contractor shall warrant the materials and workmanship used in the installation of this project. Components must be covered by a manufacturer’s warranty against defects in material and workmanship for a period of at least 25 years from the date test results are submitted to the manufacturer and approved by UTM.

1.16.2 All cabling system will meet or exceed the UTP channel transmission requirements specified by ANSI/TIA 568-D.

1.16.3 Contractor shall provide all material and labour to make any deficiencies due to faulty materials or workmanship which become apparent within a one-year period.

1.16.4 All terminated horizontal cabling runs shall be 100% tested for defects in installation. Cabling system performance under installed conditions should comply to the requirements found in the TIA/EIA-568-C series of standards. All pairs in each installed cable shall be verified prior to system acceptance. Any defect in the cabling system

installation, including (but not limited to) cables, connectors, and cordage shall be repaired or replaced in order to ensure 100% usability of all installed cable runs.

1.16.5 The communications contractor shall submit the test results for the project to the UTM I&ITS Designate 10 (ten) business days prior to the cutover, as indicated in 1.5.9.

1.16.6 Upon completion of the testing by the contractor for any MAC work, the contractor shall submit to the UTM I&ITS Designate the network drawing, including cable ID numbers related to the cabling completed for the project, 10 (ten) business days prior to the cutover, as indicated in 1.5.10.

1.16.7 Failure to provide test results upon request will require the contractor to retest all horizontal and or backbone cabling related to the project and any MAC work with no cost to the client.

1.17 SUBMISSIONS

1.17.1 The contractor shall provide product data and shop drawings for all materials proposed for installation under this contract. The product data and shop drawings shall be submitted to the UTM I&ITS Designate for approval before such equipment is purchased and or delivered to the site.

1.17.2 Review all aspects of the specifications and drawings and identify any and all issues for inclusion in the contract documents examination report.

1.17.3 This section contains the definitions, acronyms and abbreviations that have special technical meaning or are unique to the technical content of this document.

1.18 STANDARDS

1.18.1 The design considerations, and installation guidelines provided in this document are in part derived from recommendations found in recognized telecommunications industry standards. The following are used as guidelines.

Spaces and Pathways

TIA-569-B– Commercial Building Standard for Telecommunications Pathways and Spaces.

Grounding

ANSI-J-STD-607-B – Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications.

Cabling Systems

ANSI/TIA 568-C.0 Generic Telecommunications Cabling for Customer Premises.

ANSI/TIA 568-C.1 Commercial Building Telecommunications Cabling Standard.

ANSI/TIA 568-C.2 Balanced Twisted-Pair Telecommunications Cabling and Components Standards.

ANSI/TIA 568-C.3 Optical Fibre Cabling Components Standard.

Cabling Administration

TIA/EIA-606-B – Administration Standard for Commercial Telecommunications Infrastructure

Networking

IEEE Standard 802.3an (2006) – 10GBASE-T

Design

BICSI Telecommunications Distribution Methods Manual (TDMM) – 13th edition.

Installation

BICSI Information Transport Systems Installation Manual (ITSIMM) – 6th edition.

1.19 DEFINITIONS

1.19.1 This section contains the definitions, acronyms and abbreviations that have special technical meaning or are unique to the technical content of this document.

1.19.2 **Above Finished Floor (AFF)** - Standard mounting height (e.g.12-inch AFF) for a device using the centre line of the device as the measuring point.

1.19.3 **Backbone** - A facility (e.g. pathway, cable or conductors) between the telecommunications room and the main telephone room.

1.19.4 **Bonding** - The permanent joining of metallic parts to form an electrically conductive patch that will assure electrically continuity and the capacity to conduct safely any current likely to be imposed on it.

1.19.5 **Cable** - An assembly of one or more conductors or optical fibres within a sheath, constructed so as to permit use of conductors singly or in groups.

1.19.6 **Entrance Room** - A space in which the joining of inter or intra-building telecommunications backbone facilities takes place. An entrance room may also serve as the equipment room

1.19.7 Horizontal Cabling - Portion of the cabling system that extends from the work area outlet, through the cabling in the wall/ceiling/floor and then to the patch panel in the telecommunications room. The system also includes the patch cords at the work area outlet, and patch cords in the telecommunications room.

1.19.8 **Intra-building Backbone** - A backbone network providing communications within the building.

1.19.9 **Inter-building Backbone** - A backbone network providing communications for more than one building.

1.19.10 **Patch Panel** - A cross connect system of connectors that can be mated together to facilitates administration of a cabling system.

1.19.11 **Pathway** - A facility for the placement of telecommunication cabling.

1.19.12 **Patch Cord** - A length of copper or fibre cable with connectors on each end to be used to join telecommunications circuits/links at the cross-connects. Copper cables will usually, but not always, be of Cat 6A grade. **The UTM I&ITS Designate must be consulted before materials are procured.**

1.19.13 **Telecommunications Room (TR)** - An ample space in which the end of horizontal cabling is terminated in data racks. It connects to another TR or to the MTR for intra-building data and voice communication. The facility must be clean, dust-free and include proper air handling to regulate temperature and moisture in order to prevent the lifespan reduction of the equipment.

1.19.14 **Main Telecommunications Room (MTR)** - An ample space in which the end of horizontal and backbone cabling are terminated in data racks. It is also a TR and is usually the node assigned for inter-building data and voice communication. The facility must be clean, dust-free and include proper air handling to regulate temperature and moisture in order to prevent the lifespan reduction of the equipment.

1.19.15 **Telecommunications Grounding Busbar (TGB)** - A common point of connection for the telecommunications system and bonding to ground. It is located in the telecommunications room.

1.19.16 **Telecommunications Main Grounding Busbar (TMGB)** - A common point of connection for the telecommunications system and bonding to ground. It is located in the main telecommunications room.

1.19.17 **Wireless Access Point (WAP)** - The central or control point in a wireless cell that acts as a link for data traffic to and from the wireless devices in the cell.

1.20 ACRONYMS AND ABBREVIATIONS

ACR	Attenuation-to Crosstalk Ratio
ANSI	American National Standards Institute
AWG	American Wire Gauge
BC	Building Conductor
BICSI	Building Industry Consulting Service International
BTU	British Thermal Unit
CATV	Community Antenna Television (cable television)
CCTV	Closed Circuit Television
CSA	Canadian Standards Association
CT	Cable Tray
dB	Decibel

DSL	Digital Subscriber Line
DSU	Digital Service Unit
EMT	Electrical Metallic Tubing
EP	Entrance Point
FOTP	Fibre Optic Test Procedure
Ga	Gauge
Gb	Gigabit
HC	Horizontal Cross-connect
HVAC	Heating, ventilating and air conditioning
Hz	Hertz
IC	Intermediate cross-connect
LAN	Local Area Network
MTR	Main Telecommunications Room
NIC	Network Interface Card
OSP	Outside Plant
OTDR	Optical Time Domain Reflectometer
PB	Pull Box
PE	Polyethylene
RF	Radio Frequency
RFI	Radio Frequency Interference
RMC	Rigid Metal Conduit
SM	Single-mode
TBB	Telecommunications Bonding Backbone
TBBIBC	Telecommunications Bonding Backbone Interconnecting Bonding Connector
UPS	Uninterruptible Power Supply
WAP	Wireless Access Point

2. PART 2 - PRODUCTS

2.1. NOT USED

3. PART 3 - EXECUTION

3.1. NOT USED

END OF SECTION

1 PART 1- GENERAL

1.1 WORK INCLUDED

1.1.1 Comply with the General requirements and documents referred to within.

1.1.2 Provide labour, materials, products, equipment and services to complete the grounding and bonding for communications systems work specified within.

1.1.3 To be read in conjunction with associated electrical and communication specification sections.

1.1.4 The contractor should seek clarification from the UTM I&ITS Designate on site conditions and on any technical, work and/or premises-related questions without delay.

1.2 RELATED DOCUMENTS

1.2.1 Drawings and general provisions of the contract, including general and supplementary conditions apply to this section. Refer to the following for additional information.

1.2.2 27 05 13 Communication Services

1.2.3 27 05 29 Hangers and Supports for Communications Systems

1.2.4 27 05 33 Conduits and Back Boxes for Communication Systems

1.2.5 27 05 36 Cable Trays for Communication Systems

1.2.6 27 11 16 Communication Cabinets, Racks, Frames and Enclosures

1.2.7 27 11 19 Communication Termination Blocks and Patch Panels

1.2.8 27 11 23 Communications Cable Management and Ladder Rack

1.2.9 27 11 26 Communications Rack Mounted Power and Power Strips

1.2.10 27 13 13 Communications Copper Backbone Cabling

1.2.11 27 13 13 13 Communications Copper Cable Splicing and Terminations

1.2.12 27 13 23 Communications Optical Fibre Backbone Cabling

1.2.13 27 13 23 13 Communications Optical Fibre Splicing and Terminations

1.2.14 27 15 01 16 Voice Communications Horizontal Cabling

1.2.15 27 15 01 19 Data Communications Horizontal Cabling

1.2.16 27 15 43 Communication Faceplates and Connectors

1.2.17 27 16 19 Communication Patch Cords and Cross Connect Wire

1.3 REFERENCES

1.3.1 Comply with the latest addition of the following applicable specifications and standards except as otherwise shown or specified.

1.3.2 Underwriters Laboratories, Inc (UL).

1.3.3 ANSI/TIA 607 requirements (current version including all addenda): Commercial Building Grounding and Bonding Requirements for Telecommunications.

1.4 QUALITY ASSURANCE

1.4.1 All materials, equipment and parts comprising the unit's specified within this document shall be new and unused and of a current manufacture.

1.4.2 Only new products and applications listed in this section may be used unless otherwise submitted for approval.

1.5 SYSTEM DESCRIPTION

1.5.1 The main entrance facility/equipment room shall be equipped with a TMGB. The TMGB shall be connected to the building electrical entrance grounding facility. In all other telecommunications rooms there is to be a TGB; these are to be connected back to the TMGB through appropriately sized copper conductors that form the TBB.

1.5.2 An electrical engineer is to provide the correct sizing of the ground wire for 1.5.1. Conductors shall be sized according to distance and must be stranded copper with green insulation.

1.5.3 In each telecommunications room provide #6 AWG stranded copper with green insulation from the TGB to all metallic components (cable trays, racks and all other enclosures). No serial connections are acceptable.

1.5.4 The TMGB must meet ANSI/TIA 607 requirements for network system grounding applications. Must be made of high conductivity copper and tin-plated to inhibit corrosion. Minimum bar size must be 4"W x ¼"H x 12"L with insulators and standoffs. Must be pre-drilled, complete with 12 x ¼" stud holes with ⅝" hole spacing and 6 x ⅜" stud holes with 1" hole spacing.

1.5.5 The TGB must meet ANSI/TIA 607 requirements for network system grounding applications. Must be made of high conductivity copper and tin-plated to inhibit corrosion. Minimum bar size must be 2"W x ¼"H x 12"L with insulators and standoffs. Must be pre-drilled, complete with 6 x ¼" stud holes with ⅝" hole spacing and 3 x ⅜" stud holes with 1" hole spacing.

1.5.6 The contractor must visually inspect the Grounding and Bonding System for loose connections. A potential difference test must be made between the TMGB and electrical ground, and between the TMGB and each TGB. All test measurements must comply with the ANSI/TIA 607 requirements.

1.6 SUBMITTALS

1.6.1 Shop drawing to reflect the type and size of the TMGB and the TGB for review.

1.6.2 Provide a ground test report in compliance with the ANSI/TIA 607 requirements.

2 PART 2- PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

2.1.1 Thomas and Betts, Chatsworth Products Inc., Burndy, Panduit or approved equal.

3 PART 3- EXECUTION

3.1 INSTALLATION

3.1.1 Bond all telecommunication cable trays, data cabinets, data racks and all other metallic communication infrastructure components to the nearest TMGB or TGB using a minimum of a #6 AWG stranded, green insulated conductor and appropriate 2-hole, long barrel, window lug.

3.1.2 Contractor to ensure that the data rack and/or cabinet grounding does not block and/or interfere with any rack mount units in the racks and/or cabinets.

3.1.3 Racks and/or cabinets are to be grounded at their top the TMGB or TGB.

3.1.4 Bonding connectors shall be continuous and routed in the shortest straight path. Any bends placed in the connector shall be sweeping bends.

3.1.5 A yellow ground tag to be supplied and installed by the contractor at the TMGB and TGB that states the following **"IF THIS CONNECTOR OR CABLE IS LOOSE OR MUST BE REMOVED, PLEASE CONTACT PHONE NUMBER _____".** Verify with the UTM I&ITS Designate the correct phone number.

3.1.6 Provide a record of the ground resistance measurements from the ground bus to earth.

3.1.7 Furnish all test results to be reviewed by an electrical engineer.

3.1.8 All installations must be performed by licensed unionized (IBEW) electricians/telecommunication technicians. The tradesperson must follow the latest safety requirements from the Ministry of Labour.

3.1.9 The contractor shall provide installers trained in the applicable codes, regulations and installation standards. Quality workmanship of the highest standard is expected to be delivered by the tradespersons. Acceptance of the work is subject to the approval of the university's designate and IT contact.

END OF SECTION

1 PART 1- GENERAL

1.1 WORK INCLUDED

1.1.1 Comply with the general requirements and documents referred to within.

1.1.2 Provide labour, materials, products, equipment and services to complete the hangers and supports for communications systems work specified within.

1.1.3 To be read in conjunction with associated electrical and communication specification sections.

1.1.4 The contractor should seek clarification from the UTM I&ITS Designate on site conditions and on any technical, work and/or premises-related questions without delay.

1.2 RELATED DOCUMENTS

1.2.1 Drawings and general provisions of the contract, including general and supplementary conditions apply to this section. Refer to the following for additional information.

1.2.2 27 05 13 Communication Services

1.2.3 27 05 26 Grounding and Bonding for Communications Systems

1.2.4 27 05 33 Conduits and Back Boxes for Communication Systems

1.2.5 27 05 36 Cable Trays for Communication Systems

1.2.6 27 05 53 Identification for Communication Services

1.2.7 27 05 55 Testing for Communication Services

1.2.8 27 11 16 Communication Cabinets, Racks, Frames and Enclosures

1.2.9 27 11 19 Communication Termination Blocks and Patch Panels

1.2.10 27 11 23 Communications Cable Management and Ladder Rack

1.2.11 27 11 26 Communications Rack Mounted Power and Power Strips

1.2.12 27 13 13 Communications Copper Backbone Cabling

1.2.13 27 13 13 13 Communications Copper Cable Splicing and Terminations

1.2.14 27 13 23 Communications Optical Fibre Backbone Cabling

1.2.15 27 13 23 13 Communications Optical Fibre Splicing and Terminations

1.2.16 27 15 01 16 Voice Communications Horizontal Cabling

1.2.17 27 15 01 19 Data Communications Horizontal Cabling

1.2.18 27 15 43 Communication Faceplates and Connectors

1.2.19 27 16 19 Communication Patch Cords and Cross Connect Wire

1.3 QUALITY ASSURANCE

1.3.1 Only new products and applications listed in this section may be used unless otherwise submitted for approval.

1.4 SYSTEM DESCRIPTION

1.4.1 Hangers and supports are to be supplied and installed as per this document and drawings to support the various cabling from the workstation to the overhead cable tray or to the MTR and/or TR locations.

1.5 SUBMITTALS

1.5.1 Shop drawings for each type of product indicated in the following document, including construction details, material descriptions, dimensions of individual components and profiles and finishes for the products listed. Include rated capacities, operating characteristics along with furnished specialties and accessories.

2 PART 2- PRODUCTS

2.1 ADJUSTABLE CABLE SUPPORTS

2.1.1 Shall be similar to the one pictured below

2.1.2 Suitable for use in air handling spaces.

2.1.3 Allow for attachment to ceilings, beams, walls, threaded rods and underfloor supports.

2.1.4 Support a minimum cable capacity of 210 Cat 6A.

2.1.5 Support a minimum static load of 46kg (100lbs).

3 PART 3- EXECUTION

3.1 INSTALLATION

3.1.1 The horizontal cabling pathway shall be a self-supporting system.

3.1.2 Cable supports shall not be attached to ceiling grid support rods, conduits, water pipes HVAC ducts or lighting fixture wires.

3.1.3 The cable supports shall be installed no more that 1.5 meters (48”) apart.

3.1.4 All cable supports shall be rated for a minimum of Cat 6A for the structured cabling infrastructure.

3.1.5 In a ceiling distribution design the cable supports shall be installed at a minimum of 36” clearance between the ceiling tile and the structured cabling pathway.

3.1.6 All hangers, rods and supports must be suspended from or attached to the structural steel, concrete slab and or walls with proper hardware designed to support their load bearing rating.

3.1.7 Only touch-fasteners (a.k.a. velcro fasteners) shall be used where required. Under no circumstances plastic zip ties and similar products shall be utilized.

3.1.8 Where support for horizontal cable is required, the contractor shall install appropriate sized cable supports to support the horizontal cabling listed in this document.

3.1.9 To minimize any possibility of disruption, maintain the following minimum clearances from electrical and heat sources when installing cable supports for the horizontal cabling pathway:

CLEARANCES TABLE	
Item	Minimum Clearance
Motor	1.2 m (4’-0”)
Transformers	1.2 m (4’-0”)
Conduit and cables used for electrical distribution less than 1kV	0.3 m (1’-0”)

Conduit and cables used for electrical distribution greater than 1kV	1.0 m (3'-0")
Fluorescent Luminaires	12 cm (5")
Pipes (gas, oil, water, etc)	0.3 m (1'-0")
HVAC (equipment, ducts, etc	15 cm (6 ")

END OF SECTION

1 PART 1- GENERAL

1.1 WORK INCLUDED

1.1.1 Comply with the General requirements and documents referred to within.

1.1.2 Provide labour, materials, products, equipment and services to complete the conduits and back boxes for communications systems work specified within.

1.1.3 To be read in conjunction with associated electrical and communication specification sections.

1.1.4 The contractor should seek clarification from the UTM I&ITS Designate on site conditions and on any technical, work and/or premises-related questions without delay.

1.2 RELATED DOCUMENTS

1.2.1 Drawings and general provisions of the contract, including general and supplementary conditions apply to this section. Refer to the following for additional information.

1.2.2 27 05 13 Communication Services

1.2.3 27 05 26 Grounding and Bonding for Communications Systems

1.2.4 27 05 29 Hangers and Supports for Communication Systems

1.2.5 27 05 36 Cable Trays for Communication Systems

1.2.6 27 05 53 Identification for Communication Services

1.2.7 27 05 55 Testing for Communication Services

1.2.8 27 11 16 Communication Cabinets, Racks, Frames and Enclosures

1.2.9 27 11 19 Communication Termination Blocks and Patch Panels

1.2.10 27 11 23 Communications Cable Management and Ladder Rack

1.2.11 27 11 26 Communications Rack Mounted Power and Power Strips

1.2.12 27 13 13 Communications Copper Backbone Cabling

1.2.13 27 13 13 13 Communications Copper Cable Splicing and Terminations

1.2.14 27 13 23 Communications Optical Fibre Backbone Cabling

1.2.15 27 13 23 13 Communications Optical Fibre Splicing and Terminations

1.2.16 27 15 01 16 Voice Communications Horizontal Cabling

1.2.17 27 15 01 19 Data Communications Horizontal Cabling

1.2.18 27 15 43 Communication Faceplates and Connectors

1.2.19 27 16 19 Communication Patch Cords and Cross Connect Wire

1.3 QUALITY ASSURANCE

1.3.1 Only new products and applications listed in this section may be used unless otherwise submitted for approval.

1.4 SYSTEM DESCRIPTION

1.4.1 The conduits and telecommunication boxes are to be supplied and installed as per this document and drawings to support the various cabling from the workstation to the overhead cable tray or to the MTR and/or TR locations.

1.5 SUBMITTALS

1.5.1 Shop drawings for each type of product indicated in the following document, including construction details, material descriptions, dimensions of individual components and profiles and finishes for the products listed. Include rated capacities, operating characteristics along with furnished specialties and accessories.

2 PART 2- PRODUCTS

2.1 CONDUIT

2.1.1 All indoor conduits shall be thin wall EMT reamed and bushed at both ends.

2.1.2 The external surface of all visible indoor conduits shall be painted as to match colours already existing on the surrounding structure so as not to create an unpleasant view.

2.1.3 Conduits exposed to the weather, in wet locations, subject to mechanical injury, or in any hazardous locations or where required by code, shall be rigid threaded, galvanized steel conduit.

2.1.4 Joints in conduits installed underground, in concrete slab on grade or in a concrete duct bank shall be made completely watertight.

2.2 IN SLAB FLOOR BOXES

2.2.1 All in slab floor boxes shall be constructed of galvanized steel and includes a lid assembly.

2.2.2 Box equipped with conduit knockouts at each end and on each side for conduit feeds for data cabling and power.

2.2.3 The lid to be available either recessed for carpet or tile or a flat flush lid.

2.2.4 The lid shall have an open for the easy access for data patch cords and power cords.

2.2.5 The floor box shall be a minimum of 12” x 12” x 5” deep.

2.2.6 Joints in conduits installed underground, in concrete slab on grade or in a concrete duct bank shall be made completely watertight.

2.2.7 Minimum concrete thickness over or around a conduit in a concrete slab shall be 75mm (3").

2.3 METAL RACEWAY

2.3.1 The single raceway shall be steel.

2.3.2 ScuffCoat scratch-resistant finish.

2.3.3 Resists oxidation, corrosion and fading.

2.3.4 Can be installed as recessed or surface.

2.3.5 Various types of fittings for horizontal and vertical pathways.

2.3.6 Use surface mount box for voice and data cabling.

3 PART 3- EXECUTION

3.1 INSTALLATION

3.1.1 The inside radius of a bend in a conduit shall be at least 10 times the internal diameter of the conduit.

3.1.2 All zone conduits shall be identified and labelled at both ends. Tags shall identify the start and finish of conduit runs. Pull boxes shall be labelled on the exposed exterior.

3.1.3 All conduits dedicated for the communication structured cabling system shall not be shared with other services.

3.1.4 The telecommunication system shall be labelled green from end to end on conduits and at pull boxes.

3.1.5 All conduits shall originate and be physically connected to the MTR, TR, backboards, cable tray and pull boxes.

3.1.6 All fittings, connectors and couplings are to be steel.

3.1.7 All conduits entering or exiting through the ceilings or walls of the MTR and or TR shall be installed to the basket cable tray in the room and stop 6” above the cable tray.

3.1.8 All conduit runs shall follow the building grid lines and shall be concealed where possible.

3.1.9 Unless otherwise specified, all conduit runs shall be a maximum of 30 meters (100 feet) in length with a maximum of two ninety-degree bends between pull boxes.

3.1.10 A pull box shall be placed in conduit runs where the sum of the bends exceeds 180 degrees, where the overall length of the conduit run is more than 30m, or if there is a reverse bend in the run.

3.1.11 In all instances pull boxes shall be placed in straight sections of a conduit run and shall not be used in lieu of a bend. Corresponding ends of the conduit are to be aligned with each other.

3.1.12 Conduit fittings or pull elbows fittings shall not be used in place of pull boxes or bends.

3.1.13 Pull boxes shall be installed at a reasonable height, in an exposed location and such that access for the installation of cables is not prohibited.

3.1.14 Pull boxes shall not be placed in a fixed false ceiling space, unless immediately above a suitably marked and hinged access panel.

3.1.15 Provide and install 25mm (1”) diameter green dot decals on the ceiling T-bar rail showing location of pull box.

3.1.16 Pull boxes shall be constructed and sized in accordance with the Canadian Electrical Code and ANSI/TIA standards of gauge steel and shall have a rust resistant finish.

3.1.17 Place pull boxes in readily accessible locations only.

3.1.18 Locations and sizes of all pull boxes shall be indicated on the design submission.

3.1.19 Pull boxes shall be placed in straight sections of a conduit run and shall not be used in lieu of a bend. Corresponding ends of the conduit are to be aligned with each other. Conduit fittings or pull elbow fittings shall not be used in place of pull boxes or bends.

3.1.20 All conduits shall be installed in accordance with the Canadian Electrical Code, Part 1 Section 12, applicable building codes and in accordance with TIA/EIA 569-B.

3.1.21 The use of C, LB, LL, LR and T type fittings or elbows fittings is not permitted.

3.1.22 Conduits ending in the vicinity of a cable tray shall be terminated at a height of no less than 100mm (4”) and no more than 150mm (6”) from the top of the cable tray. Conduit runs shall not be punched through the side of the cable tray.

3.1.23 The minimum size (inside diameter) for EMT conduit running between the MTR and the telecommunications outlet location is twenty-five millimeters (25mm) (1”).

3.1.24 The formulas below should be used to calculate the maximum number of UTP cables per conduit size, at a maximum 40% fill ratio. The ensuing chart provides an example for UTP cables (.288OD) in various conduit sizes.

Conduit outside diameter = C*od*
Conduit wall thickness = C*wt*
UTP cable outside diameter = U *od*

(a) $((Cod - Cwt * 2)^2) * \Pi * 0.1$

(b) $(\Pi * (U\,od)^2)/4$

(c) TRUNC (a/b)

National Pipe Size (NPS)	Outside Diameter	Wall Thickness (Sch 40 / Std)	Maximum Number of UTP Cables
¾"	1.050	0.113	3
1"	1.315	0.133	5
1 ¼"	1.660	0.140	9
1 ½"	1.900	0.145	12
2"	2.375	0.154	20
2 ½"	2.875	0.203	29
3"	3.500	0.216	45
3 ½"	4.000	0.226	60
4	4.500	0.237	78

3.1.25 Cable fill capacities of conduit, cable tray and raceways shall not be greater than 40%.

3.1.26 A pull cord or fish tape shall be installed in all conduits.

3.1.27 Conduit must enter the outlet boxes from the top or bottom.

3.1.28 The contractor is responsible for cleaning all conduits prior to pulling any cable.

3.1.29 The outlet boxes shall be installed in the locations identified on the drawing. The outlet box shall be installed at 300mm (12") AFF or at the same height and within 300mm (12") of the adjacent electrical duplex receptacles, unless otherwise noted on the drawings. Wherever possible, the face of the plastic ring should be installed flush with the finished wall.

3.1.30 Back to back outlet boxes shall not be used.

3.1.31 Outlet boxes must be equipped with a plaster ring to accommodate the installation of the multimedia faceplate.

3.1.32 Plaster rings will be specified as a single or double gang to accommodate cabling requirements.

3.1.33 Plaster rings or raised adapter plates shall not reduce the size of the outlet such that two additional outlets could not be added in the future.

3.1.34 In slab floor boxes are to be sized to reflect the total quantity of data cabling along with power requirements.

3.1.35 If AV cabling is to be combined with data cabling, the in slab floor box needs to be enlarged and reviewed by the IT department for approval.

3.1.36 See conduit fill chart in item 3.1.24 related to the size of conduits that are required for the number of data drops for floor boxes.

3.1.37 Quality and workmanship shall be at the highest of professional tradesman levels to be accepted for completion.

3.1.38 To minimize any possibility of disruption, maintain the following minimum clearances from electrical and heat sources when installing the horizontal conduits for the horizontal cabling pathway:

CLEARANCES TABLE	
Item	Minimum Clearance
Motor	1.2 m (4’-0”)
Transformers	1.2 m (4’-0”)
Conduit and cables used for electrical distribution less than 1kV	0.3 m (1’-0”)
Conduit and cables used for electrical distribution greater than 1kV	1.0 m (3’-0”)
Fluorescent Luminaires	12 cm (5”)
Pipes (gas, oil, water, etc)	0.3 m (1’-0”)
HVAC (equipment, ducts, etc)	15 cm (6 “)

3.1.39 For concrete wall locations the single channel shall be used and properly secured to the block wall.

3.1.40 If more than two data cables are to be installed at a single location the metal raceway is to be sized to accommodate the total number of data cables using the 40% fill ratio.

3.1.41 At the faceplate location a surface wiremold box is to be connected using proper mounting hardware to install voice and data cabling in a communication faceplate.

END OF SECTION

1 PART 1- GENERAL

1.1 WORK INCLUDED

1.1.1 Comply with the General requirements and documents referred to within.

1.1.2 Provide labour, materials, products, equipment and services to complete the cable tray for communications systems work specified within.

1.1.3 To be read in conjunction with associated electrical and communication specification sections.

1.1.4 The contractor should seek clarification from the UTM I&ITS Designate on site conditions and on any technical, work and/or premises-related questions without delay.

1.2 RELATED DOCUMENTS

1.2.1 Drawings and general provisions of the contract, including general and supplementary conditions apply to this section. Refer to the following for additional information.

1.2.2 27 05 13 Communication Services

1.2.3 27 05 26 Grounding and Bonding for Communications Systems

1.2.4 27 05 29 Hangers and Supports for Communication Systems

1.2.5 27 05 33 Conduits and Back Boxes for Communication Systems

1.2.6 27 05 53 Identification for Communication Systems

1.2.7 27 05 55 Testing for Communication Services

1.2.8 27 11 16 Communication Cabinets, Racks, Frames and Enclosures

1.2.9 27 11 19 Communication Termination Blocks and Patch Panels

1.2.10 27 11 23 Communications Cable Management and Ladder Rack

1.2.11 27 11 26 Communications Rack Mounted Power and Power Strips

1.2.12 27 13 13 Communications Copper Backbone Cabling

1.2.13 27 13 13 13 Communications Copper Cable Splicing and Terminations

1.2.14 27 13 23 Communications Optical Fibre Backbone Cabling

1.2.15 27 13 23 13 Communications Optical Fibre Splicing and Terminations

1.2.16 27 15 01 16 Voice Communications Horizontal Cabling

1.2.17 27 15 01 19 Data Communications Horizontal Cabling

1.2.18 27 15 43 Communication Faceplates and Connectors

1.2.19 27 16 19 Communication Patch Cords and Cross Connect Wire

1.3 QUALITY ASSURANCE

1.3.1 Comply with EIA/TIA 569-B Commercial Building Standard for Telecommunication Pathways and Spaces.

1.3.2 Only products and applications listed in this section may be used unless otherwise submitted for approval.

1.4 SYSTEM DESCRIPTION

1.4.1 Provide an appropriate cable tray solution within the ceiling space of an area as indicated on the drawings.

1.4.2 Cable tray supports shall be installed at intervals of no more than 6 feet. At each interval, appropriate support (trapeze hangers, central hangers, cantilever arms) will be selected from the products listed in this document (Section 2) based on the following criteria:

1.4.2.1 If the cable tray is to be installed on or against a wall, cantilevered arms shall be used to support the tray (see 2.3 of this document).

1.4.2.2 If the ceiling area does not have enough clearance to accommodate two support rods per support point, a cable tray system based on the T-shape tray will be installed.

1.4.2.3 In all other cases, a trapeze cable tray mounting method will be used. This is the least desirable solution and should be avoided.

1.4.3 Coordinate layout and installation of cable trays and their suspension system with other construction that penetrates ceilings or is supported by them, including all light fixtures, HVAC equipment, fire suppression system and partitions.

1.4.4 Cable tray systems should be designed and installed with adequate room around the cable tray to allow for the setup of cable pulling equipment. Also, space around the cable tray provides easy access for installation of additional cables or the removal of surplus cables. See subsection 3.1.12 for details.

1.4.5 Provide all fittings and miscellaneous hardware necessary to provide complete cable tray solution. Miscellaneous hardware includes, but is not limited to: coupling nuts, hex nuts, clamps, washers, bolts, hinges, splices, expansion joints and couplers.

1.5 SUBMITTALS

1.5.1 Shop drawing to reflect the type, size and material finish of the cable tray for review.

1.5.2 Provide fabrication and installation details of the cable trays along with all components and attachments including clamps, brackets, hanger rods, splice plate connectors, expansion joint assemblies, straight lengths and all fittings.

2 PART 2- PRODUCTS

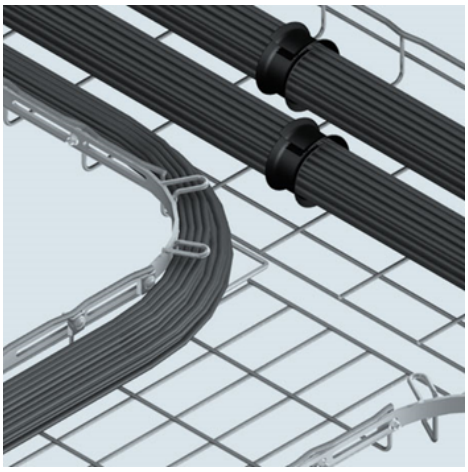
2.1 CABLE TRAYS

2.1.1 Cable tray material must be steel mesh or Aluminum Association Alloy 6063, similar to this picture:

Overhead Basket Cable Tray

2.1.2 Straight sections shall be supplied in standard 10 foot (3.05m) lengths

2.1.3 All bends in cable tray, including 90º, 45º bends, and tee intersections shall be “radius bends” with a minimum internal bend radius of 5”. See below picture as example:



2.1.4 Minimum height of cable tray for horizontal cabling is 2 inches.

2.1.5 Width of cable tray will be selected based on available clearance in selected cable tray pathway. Largest cable tray width available which still fits in selected pathway with appropriate clearance will be provided. For example, if the pathway is 25” wide, and minimum horizontal clearance is 10” on each side, then the maximum available width for cable tray is 5”. If cable tray is available in widths of 4”, 6”, and 8”, then 4” wide cable tray must be supplied and installed.

2.1.6 Minimum width of cable tray is 4 inches. If available space in a given pathway does not allow for a cable tray width of at least 4 inches, contractor shall report to the UTM I&ITS Designate for further instructions.

2.1.7 Must conform to NEMA VE1 standards for load capacity.

2.1.8 Must be certified E-30 to E-90 for fire and heat resistance.

2.2 DROP OUTS

2.2.1 Must be used anywhere cabling enters or exits the cable tray at an angle greater than 30°.

2.2.2 Must be compatible with existing or new cable tray (compatible fasteners & supports).

2.2.3 Examples are provided on the pictures below:

2.3 CABLE TRAY SUPPORTS – CANTILEVER ARMS

2.3.1 Must be compatible with cable tray and allow for cable tray to be securely fastened to a wall.

2.3.2 Must be able to support between 68kg and 136kg (150 ~ 300 lbs) loads per span, based on width of cable tray:

2.3.2.1 For cable width of 4”, each support must support up to 68kg (150lbs).

2.3.2.2 For cable width of 6”, each support must support up to 82kg (180lbs).

2.3.2.3 For cable width of 8”, each support must support up to 104kg (230lbs).

2.3.2.4 For cable width of 12”, each support must support up to 136kg (300lbs).

2.4 CABLE TRAY SUPPORTS – CENTRAL HANGERS

2.4.1 Must be compatible with cable tray and allow for cable tray to be securely fastened to a wall.

2.4.2 Must be able to mount on ⅜" threaded rod.

2.4.3 Must include protective sleeve around threaded rod to protect cables from friction damage.

2.4.4 Must be able to support between 68kg and 136kg (150 ~ 300 lbs) loads per span, based on width of cable tray:

2.4.4.1 For cable width of 4", each support must support up to 68kg (150lbs).

2.4.4.2 For cable width of 6", each support must support up to 82kg (180lbs).

2.4.4.3 For cable width of 8", each support must support up to 104kg (230lbs).

2.4.4.4 For cable width of 12", each support must support up to 136kg (300lbs).

2.5 CABLE TRAY SUPPORTS – TRAPEZE SUPPORTS

2.5.1 Must be compatible with cable tray and allow for cable tray to be securely fastened to a wall

2.5.2 Must be able to mount on ⅜" threaded rod.

2.5.3 Must be able to support between 68kg and 136kg (150 ~ 300 lbs) loads per span, based on width of cable tray:

2.5.3.1 For cable width of 4", each support must support up to 68kg (150lbs).

2.5.3.2 For cable width of 6", each support must support up to 82kg (180lbs).

2.5.3.3 For cable width of 8", each support must support up to 104kg (230lbs).

2.5.3.4 For cable width of 12", each support must support up to 136kg (300lbs).

3 PART 3- EXECUTION

3.1 INSTALLATION

3.1.1 Contractor shall be responsible for the complete supply and installation of the overhead basket type cable tray along with the installation of all supports, dropouts (waterfalls) fittings, connectors threaded rods, bolts, brackets, clips, and miscellaneous hardware for a complete basket cable tray and support system.

3.1.2 Install overhead basket type cable tray as shown on the drawings, sketches and be securely attached under the installation guidelines of the cable tray manufacturer.

3.1.3 The basket cable tray supports can be installed on either side of the tray or supported in the centre of the cable tray.

3.1.4 There shall be no sharp edges on any cable trays, exposed rods, bolts, nuts etc.

3.1.5 Cut back all exposed hanging rods to a maximum of 2” to prevent accidental injury.

3.1.6 Cable tray is to be properly supported at the end of the tray at the wall locations in the TR locations.

3.1.7 Contractor to supply and install properly sized and the correct quantity of dropouts (waterfalls) at the cabinet and or data rack locations for the total number of data cables plus 50% growth.

3.1.8 The basket tray is to be cut to accept the waterfalls within the cable tray. No cabling shall run over the side of or under the cable tray.

3.1.9 Ground cable trays as per Section 27 05 26.

3.1.10 Quality and workmanship shall be the highest of professional tradesman levels to be accepted for completion.

3.1.11 The contractor shall provide installers trained in the installation of the cable tray, regulations and installation standards.

3.1.12 Clearances:

3.1.12.1 Minimum of 6” vertical clearance from the top of the cable trays installed in tiers except where cables of 2” in diameter or greater are installed, then the clearance shall be 12”.

3.1.12.2 Minimum of 12” vertical clearance from the top of the cable trays installed to all ceilings, heating ducts, heating equipment and 6” for short length obstructions.

3.1.12.3 Minimum of 10” horizontal clearance from the side of the cable tray mounted adjacent to each other or to walls or obstructions.

3.1.12.4 Clearances for cable trays shall be in accordance with the Canadian Electrical Code C22.1-09.

3.1.12.5 To minimize any possibility of disruption, maintain the following minimum clearances from electrical and heat sources when installing basket tray:

CLEARANCES TABLE	
Item	**Minimum Clearance**
Motor	1.2 m (4'-0")
Transformers	1.2 m (4'-0")
Conduit and cables used for electrical distribution less than 1kV	0.3 m (1'-0")
Conduit and cables used for electrical distribution greater than 1kV	1.0 m (3'-0")
Fluorescent Light Fixtures	12 cm (5")
Pipes (gas, oil, water, etc)	0.3 m (1'-0")
HVAC (equipment, ducts, etc)	15 cm (6 ")

END OF SECTION

1 PART 1- GENERAL

1.1 WORK INCLUDED

1.1.1 Comply with the General requirements and documents referred to within.

1.1.2 Provide labour, materials, products, equipment and services to complete the identification for communications systems work specified within.

1.1.3 To be read in conjunction with associated electrical and communication specification sections.

1.1.4 The contractor should seek clarification from the UTM I&ITS Designate on site conditions and on any technical, work and/or premises-related questions without delay.

1.2 RELATED DOCUMENTS

1.2.1 Drawings and general provisions of the contract, including general and supplementary conditions apply to this section. Refer to the following for additional information.

1.2.2 27 05 13 Communication Services

1.2.3 27 05 26 Grounding and Bonding for Communications Systems

1.2.4 27 05 29 Hangers and Supports for Communication Systems

1.2.5 27 05 33 Conduits and Back Boxes for Communication Systems

1.2.6 27 05 36 Cable Trays for Communication Systems

1.2.7 27 05 55 Testing for Communication Services

1.2.8 27 11 16 Communication Cabinets, Racks, Frames and Enclosures

1.2.9 27 11 19 Communication Termination Blocks and Patch Panels

1.2.10 27 11 23 Communications Cable Management and Ladder Rack

1.2.11 27 11 26 Communications Rack Mounted Power and Power Strips

1.2.12 27 13 13 Communications Copper Backbone Cabling

1.2.13 27 13 13 13 Communications Copper Cable Splicing and Terminations

1.2.14 27 13 23 Communications Optical Fibre Backbone Cabling

1.2.15 27 13 23 13 Communications Optical Fibre Splicing and Terminations

1.2.16 27 15 01 16 Voice Communications Horizontal Cabling

1.2.17 27 15 01 19 Data Communications Horizontal Cabling

1.2.18 27 15 43 Communication Faceplates and Connectors

1.2.19 27 16 19 Communication Patch Cords and Cross Connect Wire

1.3 QUALITY ASSURANCE

1.3.1 Only new products and applications listed in this section may be used unless otherwise submitted for approval.

1.4 SYSTEM DESCRIPTION

1.4.1 The contractor shall furnish all labour, materials, tools and other equipment necessary to provide a complete labelling system for the horizontal and backbone (copper and fibre) cabling system.

1.4.2 The contractor shall be responsible for completion of all work included in the contract and shall employ certified, skilled technicians as necessary to satisfy all work and trades.

2 PART 2 - PRODUCTS

2.1 All adhesive cable labels shall meet the legibility, defacement, and adhesion requirements specified in UL 969 (Ref. D-16). In addition, the labels shall meet the general exposure requirements in UL 969 for indoor use.

2.2 Cable wrap labels shall be self-laminating vinyl construction with a white printing area and a clear tail that self-laminates the printed area when wrapped around a cable. The clear area should be of sufficient length to wrap around the cable at least one and one-half times.

2.3 Use label sheets designed for laser/inkjet printers size 7.6mm x 15.5mm (0.3in x 0.61in). E.g. Panduit part number C061X030FJJ

2.4 Labels must use font 'Liberation Sans Narrow'. This is a family of open source fonts, free for use, that can be downloaded at: https://pagure.io/liberation-fonts/

PART 3- EXECUTION

3.1 INSTALLATION

3.1.1 All labelling should be unique across the entire intra-building and/or inter-building wiring infrastructure.

3.1.2 Labels are to be mechanically printed using a laser/inkjet printer.

Font size 8 is the preferred size. However, font sizes 7 or 6 should be used if the entire information cannot fit adequately on the first or second lines of the label, as detailed further in this section. The following is an example mockup of a patch panel labelling.

3.1.3 Handwritten labels are not permitted.

3.1.4 Labels obscured from view will not be acceptable and will be replaced by the contractor at no cost to the client.

3.1.5 One label should be attached to the front of the workstation faceplate, one to the front of the patch panel, and one within 10cm (approximately 4 inches) of each end of the horizontal Cat 6A UTP cable. The labelling scheme for the horizontal cabling is as follows:

All labelling and patching schedules to come from UTM. The UTM I&ITS Designate will produce the schedules (an example follows below) in a spreadsheet for the data communications cabling contractor to use to print complete labels.

Room	Cabling Number	Patch Panel	Patch Panel Port	Patch Panel Position	TR Room	Label	Chassis	Switch Number	Switch Port
1074c	001	4	7	151	1091	D-1091-151 / D-1074C-001	1	1	16

From the example above, "D-1091-151 / D-1074C-001" represents a TWO-LINE label. The / (slash) represents a new line. This label will be seen as such when on the rack itself:
D-1091-151
D-1074C-001

These labels are to be A SINGLE PIECE affixed above the port they are labelling and cannot be cut in half and affixed above and below the port. The following is the information breakdown:

D = Data

1091 = Data communication closet room number

151 = The physical position in the patch panel of the cable in question. This number ranges from 001-048 on the first (TOP) patch panel, followed by 049-096 on the second patch panel (NEXT DOWN FROM THE TOP), followed by 097-144 on the third patch panel, and so on.

/ = New line

D = Data

1074C = The room where the other end of the cable terminates, typically an office or classroom.

001 = The cable number for this cable in the area where the far side terminates. These numbers MUST be unique and can never be reused inside the same area.

3.1.6 If adding voice and/or data cabling to an existing telecommunication room, a hybrid labelling scheme between the existing format in the area and the format described in 3.1.6 must be used. Since UTM has a large number of legacy labelling formats across campus, contractors MUST seek clarification about the hybrid scheme with the appropriate UTM I&ITS Designate, on a per case basis.

3.1.7 Each fibre port on the fibre strip in all fibre patch panels shall be labelled.

3.1.8 Example F-01, F-02, F-03 etc.

3.1.9 Each fibre patch panel shall indicate the destination along with fibre count in large font for ease of reading.

3.1.10 Example: **12-STRAND SM DV2045A to IB073.**

3.1.11 Cabling contractor to supply and leave in the TR 25% spare labels for future use.

END OF SECTION

1 PART 1- GENERAL

1.1 WORK INCLUDED

1.1.1 Comply with the General requirements and documents referred to within.

1.1.2 Provide labour, materials, products, equipment and services to complete the testing for communications systems work specified within.

1.1.3 To be read in conjunction with associated electrical and communication specification sections.

1.1.4 The contractor should seek clarification from the UTM I&ITS Designate on site conditions and on any technical, work and/or premises-related questions without delay.

1.2 RELATED DOCUMENTS

1.2.1 Drawings and general provisions of the contract, including general and supplementary conditions apply to this section. Refer to the following for additional information.

1.2.2 27 05 13 Communication Services

1.2.3 27 05 26 Grounding and Bonding for Communications Systems

1.2.4 27 05 29 Hangers and Supports for Communication Systems

1.2.5 27 05 33 Conduits and Back Boxes for Communication Systems

1.2.6 27 05 36 Cable Trays for Communication Systems

1.2.7 27 05 53 Identification for Communication Systems

1.2.8 27 11 16 Communication Cabinets, Racks, Frames and Enclosures

1.2.9 27 11 19 Communication Termination Blocks and Patch Panels

1.2.10 27 11 23 Communications Cable Management and Ladder Rack

1.2.11 27 11 26 Communications Rack Mounted Power and Power Strips

1.2.12 27 13 13 Communications Copper Backbone Cabling

1.2.13 27 13 13 13 Communications Copper Cable Splicing and Terminations

1.2.14 27 13 23 Communications Optical Fibre Backbone Cabling

1.2.15 27 13 23 13 Communications Optical Fibre Splicing and Terminations

1.2.16 27 15 01 16 Voice Communications Horizontal Cabling

1.2.17 27 15 01 19 Data Communications Horizontal Cabling

1.2.18 27 15 43 Communication Faceplates and Connectors

1.2.19 27 16 19 Communication Patch Cords and Cross Connect Wire

1.3 SYSTEM DESCRIPTION

1.3.1 The contractor shall furnish all labour, materials, tools and other equipment necessary to provide manufacturer-certified test results, and minimum 25-year warranty for the voice, data, and backbone (copper and fibre) cabling system.

1.3.2 The contractor shall be responsible for the completion of all work included in the contract and shall employ certified, skilled and trained technicians as necessary to satisfy all work and trades.

2 PART 2- PRODUCTS

2.1 NOT USED

3 PART 3- EXECUTION

3.1 VOICE AND DATA TESTING

3.1.1 Cabling test results for every UTP cable, voice and data, must be provided at least 5 business days before commissioning of any data drop. Such results must be provided as both PDF and native tester files (e.g. FLW file). Full bandwidth, graphical results of all tests must be provided for all cables.

3.1.2 All tests will be full certification tests to current industry standards. All test results to be submitted to the manufacturer to produce a full certification report and warranty certificate covering the installed infrastructure for a minimum of 25 years.

3.1.3 All terminated horizontal voice and data cable runs shall be tested for defects in installation and to verify cabling system performance under installed conditions according to the requirements found in the ANSI/TIA-568-C series of standards. All pairs in each installed cable shall be verified prior to system acceptance. Any defect in the cabling system installation, including (but not limited to) cables, connectors, and cordage shall be repaired or replaced in order to ensure total usability of all installed runs.

3.1.4 The contractor shall field test all four pairs of communications data UTP cable runs using the Permanent Link testing method. Cable test results for newly installed cables must **surpass** the accepted ANSI/TIA-1152 Level III and ANSI/TIA-568-C.2 standards parameters, in that cables with Marginal Passes are deemed unsatisfactory and must be repaired prior to system acceptance. Work done on existing cables, due to moves or

changes, whose results are Marginal Passes must be brought up to the UTM I&ITS Designate's attention prior to system acceptance.

3.1.5 Acceptable testers are as follows:

3.1.5.1 Fluke DSX 5000 or equivalent.

3.1.5.2 Fluke DSX 8000 or equivalent.

3.1.6 Upon completion of the testing by the contractor, the contractor will submit the test results for the various work activities to the UTM I&ITS Designate.

3.1.7 Failure to provide UTP test results will require the contractor to retest all horizontal voice and data cabling related to the project with no cost to the client.

3.1.8 All horizontal permanent link tests are to be performed using one of the approved testers (3.1.5), equipped with the most recent version of its firmware, calibrated within one year of testing date, and in accordance to ANSI/TIA-1152 standard.

3.1.9 Ensure all launch testing cables and connectors are within the parameters set by the manufacturer for the number of insertions for copper.

3.1.10 The technicians must be able to provide successful completion documents for one of the approved testers (3.1.5) training courses upon request.

3.2 FIBRE TESTING

3.2.1 Cabling test results for every fibre strand end point must be provided at least 5 business days before commissioning of any fibre pair. Such results must be provided as both PDF and native tester files (e.g. FLW file).

3.2.2 All tests will be full certification tests to current industry standards. All test results to be submitted to the manufacturer to produce a full certification report and warranty certificate covering the installed infrastructure for a minimum of 25 years.

3.2.3 All fibre backbone cable runs shall be 100% tested for defects in installation and its performance verified under installed conditions according to the requirements found in the TIA/EIA-568-C series of standards. All strands in each installed cable shall be verified prior to system acceptance. Any defect in the cabling system installation, including (but not limited to) cables, connectors, and cordage shall be repaired or replaced in order to ensure 100% usability of all installed runs.

3.2.4 All testing to be done with the fibre in its final installed position and configuration. NO testing to be done with strands that are not connected to the appropriate final patch panel assemblies.

3.2.5 Acceptable testers are as follows:

3.2.5.1 Fluke DSX 5000 or equivalent.

3.2.5.2 Fluke DSX 8000 or equivalent.

3.2.6 All fibre tests are to be performed using one of the approved testers equipped with the most recent version of its firmware and in accordance to ANSI/EIA/TIA-568-C series of standards.

3.2.7 Tester to be calibrated within one year of testing date.

3.2.8 Contractor must have up to date training for one of the approved testers being used to test any type of optical fibre, including all necessary launch cables and connectors.

3.2.9 Testing method shall be Tier 1 and test for the following parameters, at the very least:

- Link Insertion Loss (attenuation).
- Continuity.
- Connector Polarity.
- Length.

3.2.10 Testing of all fibre strands MUST be completed using the 1-jumper method as stated in the EIA/TIA 568-C standard (1-jumper) so that all strands are tested in pairs and not singularly.

3.2.11 Measurement of end-to-end attenuation at 850nm and 1300nm wavelengths for all connectorized fibres in accordance with the loss test procedure defined by EIA/TIA-526-14, Method B: Optical Power Loss measurements of installed fibre cable plant. Attenuation to be measured from both ends of each strand at both wavelengths (bi-directional testing of all strands).

3.2.12 The maximum overall attenuation loss from end to end shall be less than 3dB.

3.2.13 The contractor shall have access to an OTDR for troubleshooting issues during the project.

3.2.14 All installed fibres and connectors must meet or exceed the minimum specifications of the manufacturer. Any fibres or connectors failing to meet these specifications to be promptly replaced or repaired by contractor at no additional cost to the client.

3.2.15 All installed fibres and connectors shall maintain a maximum total optical attenuation of <0.5 dB through any installed strand pair. Any fibres or connectors failing to meet these specifications to be promptly replaced or repaired by contractor at no additional cost to the client.

3.2.16 All repairing must be completed at least 10 business days prior to the area move-in date or system cut-over date.

3.2.17 Failure to provide fibre test results will require the contractor to retest all optical fibre strands related to the project with no cost to the client.

3.2.18 Provide adequate personnel for immediate on-site problem determination and correction during the move-in date(s) and occupancy by the owner and for a reasonable period of time thereafter.

3.2.19 All defects and deficiencies which originate or become evident during the warranty period to be repaired or replaced without additional expense to the client within 5 business days. All such work must be performed at a time which is acceptable to the client, which may be outside regular working hours.

3.2.20 Contractor to provide a letter of certification within 2 weeks of substantial completion. This letter shall include: notification of the installation, verification of performance of the installed system, manufacturers certification number, identification of installation by location and project number and a copy of the warranty certification request form.

3.3 COPPER BACKBONE TESTING

3.3.1 Cabling test results for every backbone UTP cable must be provided at least 5 business days before commissioning of any data drop. Such results must be provided as both PDF and native tester files (e.g. FLW file). Full bandwidth, graphical results of all tests must be provided for all cables.

3.3.2 All tests will be full certification tests to current industry standards. All test results to be submitted to the manufacturer to produce a full certification report and warranty certificate covering the installed infrastructure for a minimum of 25 years.

3.3.3 All copper backbone cable runs shall be tested for defects in installation and to verify cabling system performance under installed conditions according to the requirements found in the ANSI/TIA-568-C series of standards. All pairs in each installed cable shall be verified prior to system acceptance. Any defect in the cabling system installation, including (but not limited to) cables, connectors, and cordage shall be repaired or replaced in order to ensure total usability of all installed runs.

3.3.4 The contractor shall field test all four pairs of communications data UTP cable runs using the Permanent Link testing method. Cable test results for newly installed cables must **surpass** the accepted ANSI/TIA-1152 Level III and ANSI/TIA-568-C.2 standards parameters, in that cables with Marginal Passes are deemed unsatisfactory and must be repaired prior to system acceptance. Work done on existing cables, due to moves or changes, whose results are Marginal Passes must be brought up to the UTM I&ITS Designate's attention prior to system acceptance.

3.3.5 Acceptable testers are:

3.3.5.1 Fluke DSX 5000 or equivalent.

3.3.5.2 Fluke DSX 8000 or equivalent.

3.3.6 Upon completion of the testing by the contractor, the contractor will submit the test results for the various work activities to the UTM I&ITS Designate.

3.3.7 Failure to provide UTP test results will require the contractor to retest all horizontal voice and data cabling related to the project with no cost to the client.

3.3.8 All horizontal permanent link tests are to be performed using one of the approved testers (3.3.5), equipped with the most recent version of its firmware, calibrated within one year of testing date, and in accordance to ANSI/TIA-1152 standard.

3.3.9 All installed backbone copper and connectors must meet or exceed the minimum specifications of the manufacturer. Any pairs or connectors failing to meet these specifications to be promptly replaced or repaired by contractor at no additional cost.

3.3.10 All testing and repairing must be completed at least two weeks prior to the area move-in date or system cut-over date.

3.3.11 All copper backbone test results/reports to be submitted to the UTM I&ITS Designate for review and comment at least two weeks prior to any move in date.

3.3.12 Failure to provide test results upon request will require the Communication Cabling Contractor to retest all copper cabling with no cost to the client.

3.3.13 Provide adequate personnel for immediate on-site problem determination and correction during the move in weekend and occupancy by the owner and for a reasonable period of time thereafter.

3.3.14 All defects and deficiencies which originate or become evident during the warranty period to be repaired or replaced without additional expense to the client within 24 hours (1 day). All such work must be performed at a time which is acceptable to the client which may be outside regular working hours.

3.3.15 Contractor to provide a letter of certification within 2 weeks of substantial completion. This letter shall include: notification of the installation, verification of performance of the installed system, manufacturers certification number, identification of installation by location and project number and a copy of the warranty certification request form.

END OF SECTION

1 PART 1- GENERAL

1.1 WORK INCLUDED

1.1.1 Comply with the General requirements and documents referred to within.

1.1.2 Provide labour, materials, products, equipment and services to complete the telecommunication rooms (TRs), cabinets, racks, frames and enclosures for communications systems work specified within.

1.1.3 To be read in conjunction with associated electrical and communication specification sections.

1.1.4 The contractor should seek clarification from the UTM I&ITS Designate on site conditions and on any technical, work and/or premises-related questions without delay.

1.2 RELATED DOCUMENTS

1.2.1 Drawings and general provisions of the contract, including general and supplementary conditions apply to this section. Refer to the following for additional information.

1.2.2 27 05 13 Communication Services

1.2.3 27 05 26 Grounding and Bonding for Communications Systems

1.2.4 27 05 29 Hangers and Supports for Communication Systems

1.2.5 27 05 33 Conduits and Back Boxes for Communication Systems

1.2.6 27 05 36 Cable Trays for Communication Systems

1.2.7 27 05 53 Identification for Communication Systems

1.2.8 27 15 55 Testing for Communication Services

1.2.9 27 11 19 Communication Termination Blocks and Patch Panels

1.2.10 27 11 23 Communications Cable Management and Ladder Rack

1.2.11 27 11 26 Communications Rack Mounted Power and Power Strips

1.2.12 27 13 13 Communications Copper Backbone Cabling

1.2.13 27 13 13 13 Communications Copper Cable Splicing and Terminations

1.2.14 27 13 23 Communications Optical Fibre Backbone Cabling

1.2.15 27 13 23 13 Communications Optical Fibre Splicing and Terminations

1.2.16 27 15 01 16 Voice Communications Horizontal Cabling

1.2.17 27 15 01 19 Data Communications Horizontal Cabling

1.2.18 27 15 43 Communication Faceplates and Connectors

1.2.19 27 16 19 Communication Patch Cords and Cross Connect Wire

1.3 QUALITY ASSURANCE

1.3.1 Only new products listed in this section may be used unless otherwise submitted for approval.

1.4 SYSTEM DESCRIPTION

1.4.1 TRs are secure facilities whose primary purpose is to house network equipment for data communication. Analogue telephone lines (PSTN) cabling may be terminated in them with prior approval of the UTM I&ITS Designate.

1.4.2 TR access is restricted to I&ITS personnel.

1.4.3 Equipment unrelated to a TR's primary purpose cannot enter, pass through, or be installed in them. This includes but it is not limited to: Building Automation System devices, Audio-Visual devices and supporting equipment (e.g. switches), and servers/workstations of any kind.

1.4.4 Materials unrelated to a TR's primary purpose cannot be stored in them, including but not limited to: cleaning supplies, furniture, and office supplies.

1.4.5 TRs in new buildings should be stacked in a straight vertical line to facilitate a clear vertical riser to be used for isolated communication system components, such as fibre optics, and isolated performance-based grounding. They should be situated as close to the centre of the section / floor / building to be cabled to maximise the area the facility will support and minimise the length of cable runs.

1.4.6 The data racks and or cabinets to be supplied and installed as per this document and drawings are to house the various cabling and network hardware associated with this project.

1.5 SUBMITTALS

1.5.1 Shop drawings for each type of product indicated in the following document, including construction details, material descriptions, dimensions of individual components and profiles and finishes for the data racks and cabinets. Include rated capacities, operating characteristics along with furnished specialties and accessories.

2 PART 2- PRODUCTS

2.1 FLOORING SYSTEM

2.1.1 The floor finishing in TRs should be of Electrostatic Dissipative (ESD) type. Acceptable products are ESD Vinyl Flooring or ESD epoxy resin system complete with electrode earthing points.

The ESD system must withstand heavy foot and rolling load traffic, increase safety and prevent damage to electronic equipment by providing a continuous static dissipative surface throughout the space to earth ground as per ANSI/TIA-607 specifications (current version including all addenda), have low maintenance and be easy to clean.

2.2 DATA RACK

2.2.1 Always consult with the UTM I&ITS Designate before procuring materials. Racks added to an existing installation must match model and maker of existing racks. New installations: two-post Distribution Rack System. Frame constructed of rugged 11 GA (0.120") steel, robotically welded and rigid.

2.2.2 Standard with 19" EIA 10-32 tapped mounting holes with permanently marked U-spacing identification.

2.2.3 5/16" sturdy steel base with anchor holes for mounting to floor.

2.2.4 Rack is standard with 1 copper 10-32 x 0.5" L double ground stud.

2.2.5 All racks come standard tapped double-sided.

2.3 DATA CABINET

2.3.1 Frame constructed of rugged 11 GA (0.120") steel, robotically welded and rigid.

2.3.2 Frames are to be constructed of rugged heavy gauge steel.

2.3.3 All welded construction.

2.3.4 30"W x 36"D x 83" high foot print.

2.3.5 Lockable perforated split front doors.

2.3.6 Lockable perforated split rear doors.

2.3.7 Solid side panels.

2.3.8 Two sets of mounting angles (front and back) punched to EIA/TIA universal spacing cage nuts.

2.3.9 Minimum one two post ground lug.

2.3.10 The top lid of the cabinet is to have a minimum of six 4" holes (2 for fans and 4 for cabling). Include plates for holes not used.

2.3.11 One set of two fans with minimum of 6-foot power cords to connect to power bar at the rear of cabinet.

2.3.12 Cabinet colour is **BLACK.**

2.3.13 Two vertical wire managers (3-1/2" w x 9"d).

2.3.14 Frame constructed of rugged 11 GA (0.120") steel, robotically welded and rigid.

3 PART 3- EXECUTION

3.1 INSTALLATION

3.1.1 Installation of the ESD flooring system must follow the manufacturer's instructions and recommendations.

3.1.2 Install data racks along with vertical wire managers in the MTR or TR location as identified within this document and associated drawings.

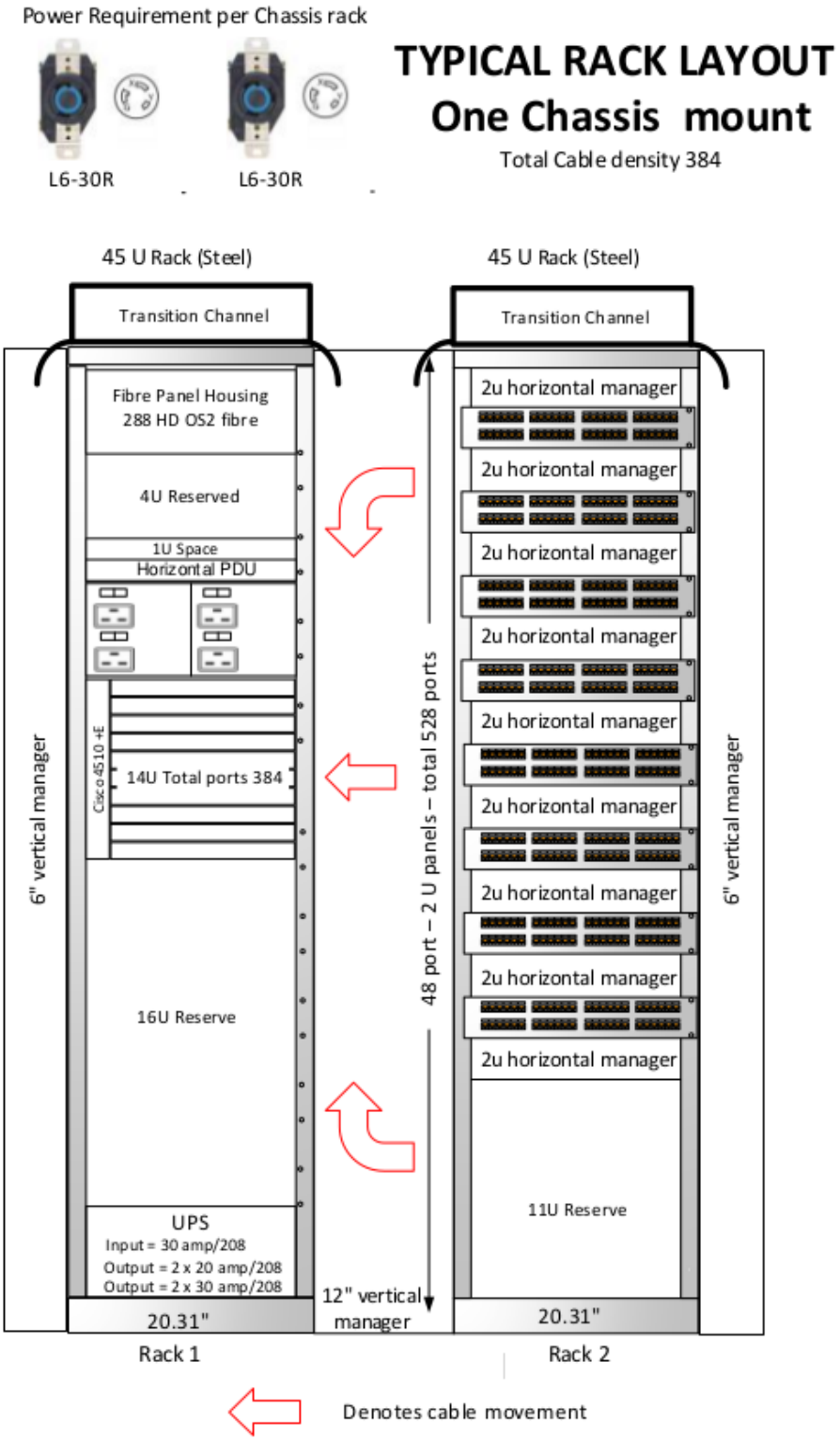
3.1.3 Utilize proper fasteners for the vertical wire managers, power bars and all accessories as per manufacture's recommendations and in the various documents.

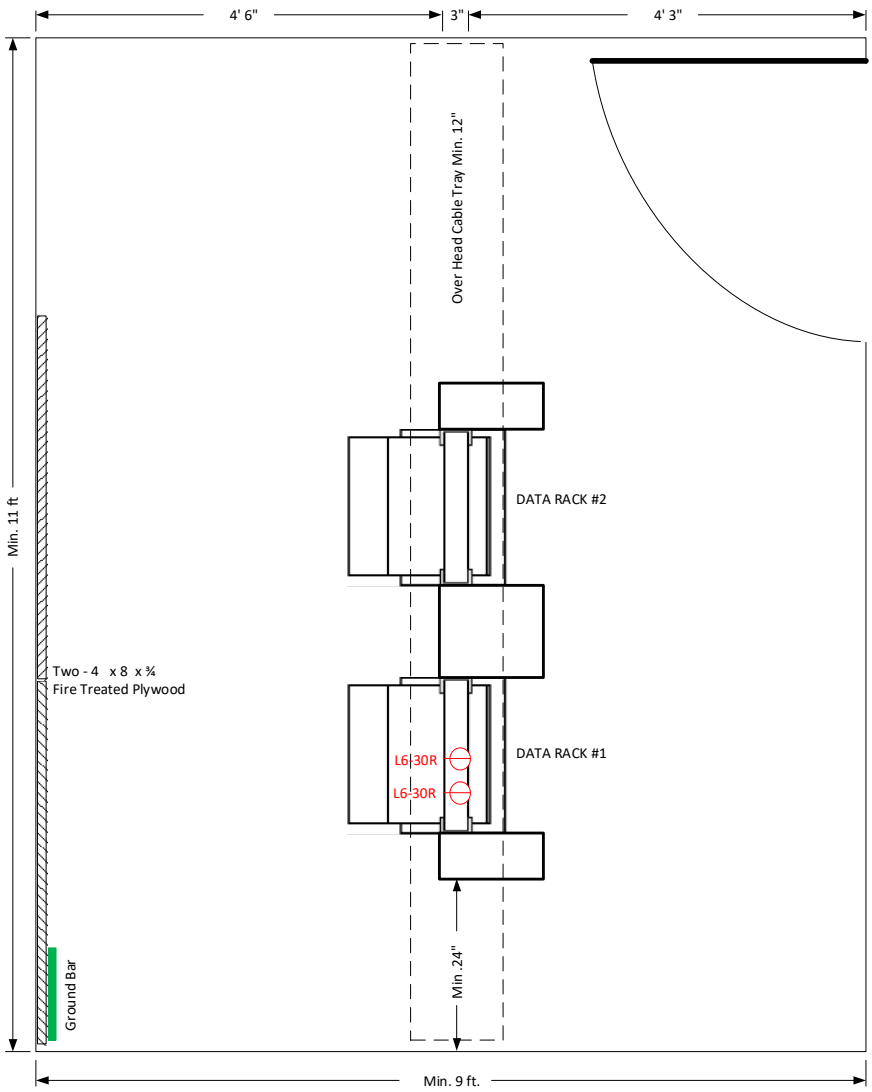
3.1.4 Bolt the racks to the floor using the appropriate size bolts to ensure the stability of the racks.

3.1.5 Gang racks with appropriate size bolts to ensure stability of the racks.

3.1.6 Refer to the Grounding and Bonding Section for more information for grounding of data racks and cabinets.

3.1.7 Install data cabinets along with vertical wire managers in the computer room location as identified within this document and associated drawings.

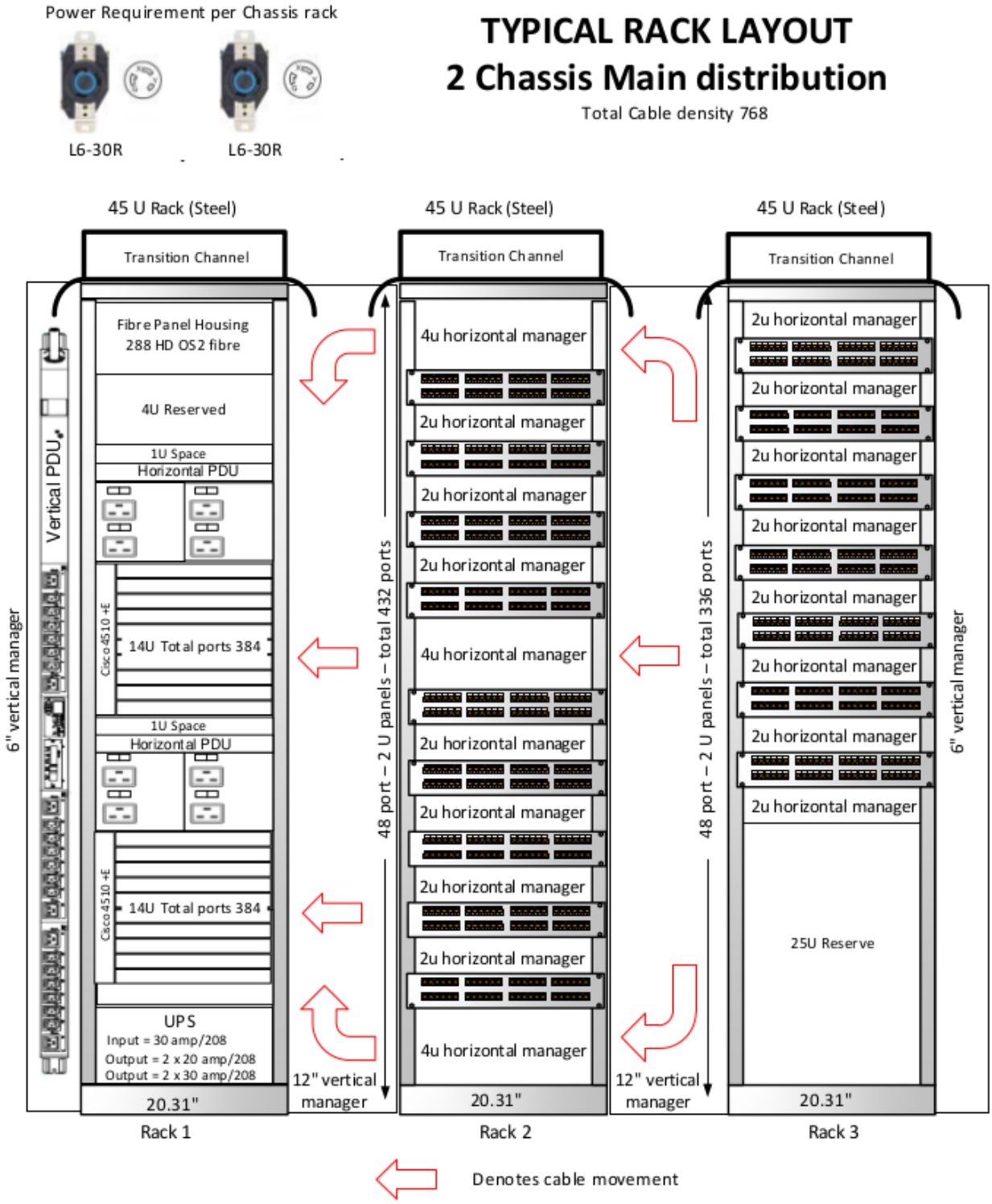

Power Requirement per Chassis rack
L6-30R
L6-30R
TYPICAL RACK LAYOUT
One Chassis mount
Total Cable density 384
45 U Rack (Steel)
45 U Rack (Steel)
Transition Channel
Transition Channel
Fibre Panel Housing
288 HD OS2 fibre
4U Reserved
1U Space
Horizontal PDU
Cisco 4510 +E
14U Total ports 384
16U Reserve
UPS
Input = 30 amp/208
Output = 2 x 20 amp/208
Output = 2 x 30 amp/208
6" vertical manager
48 port – 2 U panels – total 528 ports
12" vertical manager
6" vertical manager
2u horizontal manager
2u horizontal manager
2u horizontal manager
2u horizontal manager
2u horizontal manager
2u horizontal manager
2u horizontal manager
2u horizontal manager
2u horizontal manager
11U Reserve
20.31"
20.31"
Rack 1
Rack 2
Denotes cable movement

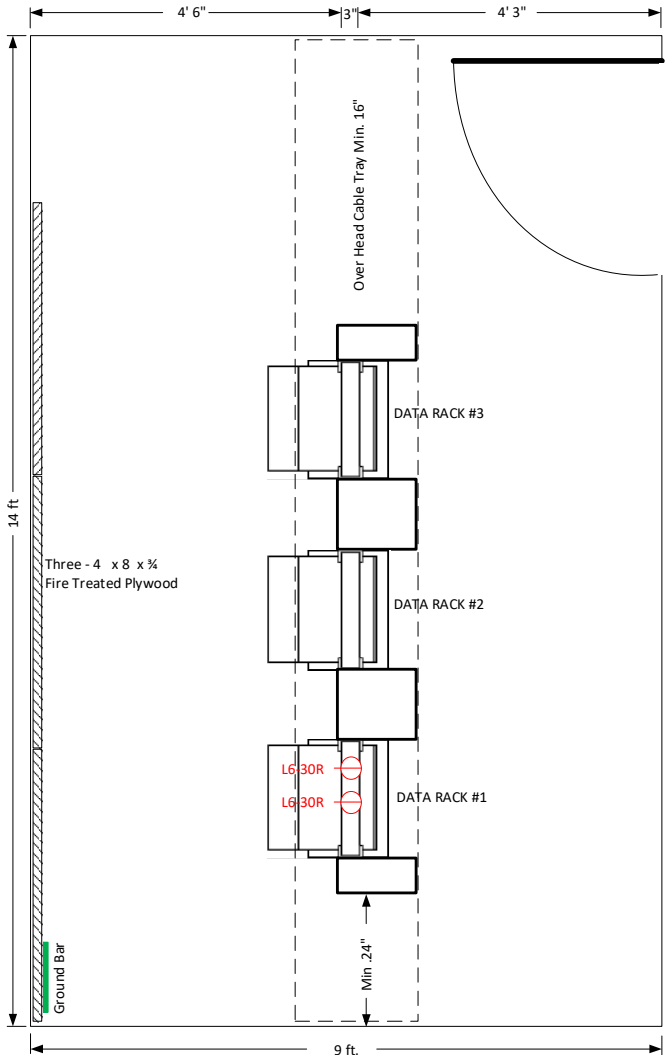


NOTES:

1. Minimum of 36" of clearance is required in front of the data racks to the drywall or any other devices located on the wall in front of racks (electrical and security panels).
2. Minimum of 54" of clearance is required behind the data racks.
3. Minimum of 24" of clearance is required from the side of the vertical wire managers to wall.
4. Overhead cable tray to be a minimum of 12" wide x 4" high and be secured at each end and from above to prevent swaying.
5. Bottom of overhead cable tray to be minimum 12" above data racks.
6. Exact location of overhead tray may change due to site conditions.

Not to Scale


Power Requirement per Chassis rack
L6-30R
L6-30R
TYPICAL RACK LAYOUT
2 Chassis Main distribution
Total Cable density 768
45 U Rack (Steel)
45 U Rack (Steel)
45 U Rack (Steel)
Transition Channel
Transition Channel
Transition Channel
Fibre Panel Housing
288 HD OS2 fibre
4U Reserved
1U Space
Horizontal PDU
Vertical PDU
Cisco 4510 +E
14U Total ports 384
1U Space
Horizontal PDU
Cisco 4510 +E
14U Total ports 384
UPS
Input = 30 amp/208
Output = 2 x 20 amp/208
Output = 2 x 30 amp/208
6" vertical manager
48 port – 2 U panels – total 432 ports
12" vertical manager
20.31"
Rack 1
4u horizontal manager
2u horizontal manager
2u horizontal manager
2u horizontal manager
2u horizontal manager
2u horizontal manager
4u horizontal manager
2u horizontal manager
2u horizontal manager
2u horizontal manager
2u horizontal manager
2u horizontal manager
4u horizontal manager
20.31"
Rack 2
2u horizontal manager
2u horizontal manager
2u horizontal manager
2u horizontal manager
2u horizontal manager
2u horizontal manager
2u horizontal manager
2u horizontal manager
2u horizontal manager
2u horizontal manager
25U Reserve
48 port – 2 U panels – total 336 ports
12" vertical manager
20.31"
Rack 3
6" vertical manager
Denotes cable movement



NOTES:

1. Minimum of 36" of clearance is required from the data racks to the drywall or any other devices located on the wall in front of racks (electrical and security panels).
2. Minimum of 54" of clearance is required behind the data racks.
3. Minimum of 24" of clearance is required from the side of the vertical wire managers to wall.
4. Overhead cable tray to be a minimum of 16" wide x 4" high and be secured at each end and from above to prevent swaying.
5. Bottom of overhead cable tray to be minimum 12" above data racks.
6. Exact location of overhead tray may change due to site conditions.

Not to Scale

END OF SECTION

1 PART 1- GENERAL

1.1 WORK INCLUDED

1.1.1 Comply with the General requirements and documents referred to within.

1.1.2 Provide labour, materials, products, equipment and services to complete the communication termination blocks and patch panels for communications systems work specified within.

1.1.3 To be read in conjunction with associated electrical and communication specification sections.

1.1.4 The contractor should seek clarification from the UTM I&ITS Designate on site conditions and on any technical, work and/or premises-related questions without delay.

1.2 RELATED DOCUMENTS

1.2.1 Drawings and general provisions of the contract, including general and supplementary conditions apply to this section. Refer to the following for additional information.

1.2.2 27 05 13 Communication Services

1.2.3 27 05 26 Grounding and Bonding for Communications Systems

1.2.4 27 05 29 Hangers and Supports for Communication Systems

1.2.5 27 05 33 Conduits and Back Boxes for Communication Systems

1.2.6 27 05 36 Cable Trays for Communication Systems

1.2.7 27 05 53 Identification for Communication Systems

1.2.8 27 15 55 Testing for Communication Services

1.2.9 27 11 16 Communication Cabinets, Racks, Frames and Enclosures

1.2.10 27 11 23 Communications Cable Management and Ladder Rack

1.2.11 27 11 26 Communications Rack Mounted Power and Power Strips

1.2.12 27 13 13 Communications Copper Backbone Cabling

1.2.13 27 13 13 13 Communications Copper Cable Splicing and Terminations

1.2.14 27 13 23 Communications Optical Fibre Backbone Cabling

1.2.15 27 13 23 13 Communications Optical Fibre Splicing and Terminations

1.2.16 27 15 01 16 Voice Communications Horizontal Cabling

1.2.17 27 15 01 19 Data Communications Horizontal Cabling

1.2.18 27 15 43 Communication Faceplates and Connectors

1.2.19 27 16 19 Communication Patch Cords and Cross Connect Wire

1.3 QUALITY ASSURANCE

1.3.1 Only new products listed in this section may be used unless otherwise submitted for approval.

1.4 SYSTEM DESCRIPTION

1.4.1 The connecting hardware provides the means of transporting signals between the telecommunication outlet/connector and the horizontal cross connect location in the MTR or TR locations.

1.5 SUBMITTALS

1.5.1 Shop drawings for each type of product indicated in the following document, including construction details, material descriptions, dimensions of individual components and profiles and finishes for the termination blocks and patch panels. Include rated capacities, operating characteristics along with furnished specialties and accessories.

2 PART 2- PRODUCTS

2.1 MODULAR PATCH PANELS

2.1.1 Always consult with the UTM I&ITS Designate before procuring materials. Patch panels added to an existing installation must match model and maker of existing panels. New installations: rack-mountable, modular, flat, 48 ports (2U), Keystone style.

2.1.2 All patch panels mount in 19” EIA standard mountings.

2.1.3 Pinout termination sequence is 568A.

2.1.4 Patch panels will be black.

2.2 GIGABIX MOUNTS

2.2.1 To be used only on a per-case basis. Must be approved by the UTM I&ITS Designate prior to any work is performed, or equipment is ordered by the contractor.

3 PART 3- EXECUTION

3.1 INSTALLATION

3.1.1 The patch panels will be installed beginning at the top of the passive data rack with a 2U horizontal wire manager installed in between each data patch panel as per section 27 11 23.

3.1.2 If existing patch panels are full, the contractor is to install new, black, 48-port patch panels (match existing) that is to be properly secured to the existing 19” data rack.

END OF SECTION

1 PART 1- GENERAL

1.1 WORK INCLUDED

1.1.1 Comply with the General requirements and documents referred to within.

1.1.2 Provide labour, materials, products, equipment and services to complete the communication cable management and ladder rack for communications systems work specified within.

1.1.3 To be read in conjunction with associated electrical and communication specification sections.

1.1.4 The contractor should seek clarification from the UTM I&ITS Designate on site conditions and on any technical, work and/or premises-related questions without delay.

1.2 RELATED DOCUMENTS

1.2.1 Drawings and general provisions of the contract, including general and supplementary conditions apply to this section. Refer to the following for additional information.

1.2.2 27 05 13 Communication Services

1.2.3 27 05 26 Grounding and Bonding for Communications Systems

1.2.4 27 05 29 Hangers and Supports for Communication Systems

1.2.5 27 05 33 Conduits and Back Boxes for Communication Systems

1.2.6 27 05 36 Cable Trays for Communication Systems

1.2.7 27 05 53 Identification for Communication Systems

1.2.8 27 15 55 Testing for Communication Services

1.2.9 27 11 16 Communication Cabinets, Racks, Frames and Enclosures

1.2.10 27 11 19 Communications Termination Blocks and Patch panels

1.2.11 27 11 26 Communications Rack Mounted Power and Power Strips

1.2.12 27 13 13 Communications Copper Backbone Cabling

1.2.13 27 13 13 13 Communications Copper Cable Splicing and Terminations

1.2.14 27 13 23 Communications Optical Fibre Backbone Cabling

1.2.15 27 13 23 13 Communications Optical Fibre Splicing and Terminations

1.2.16 27 15 01 16 Voice Communications Horizontal Cabling

1.2.17 27 15 01 19 Data Communications Horizontal Cabling

1.2.18 27 15 43 Communication Faceplates and Connectors

1.2.19 27 16 19 Communication Patch Cords and Cross Connect Wire

1.3 QUALITY ASSURANCE

1.3.1 Only new products listed in this section may be used unless otherwise submitted for approval.

1.4 SYSTEM DESCRIPTION

1.4.1 The cable management to be supplied and installed as per this document and drawings for proper routing of fibre and UTP patch cords from the network hardware associated with this project.

1.5 SUBMITTALS

1.5.1 Shop drawings for each type of product indicated in the following document, including construction details, material descriptions, dimensions of individual components and profiles and finishes for the cable management. Include rated capacities, operating characteristics along with furnished specialties and accessories.

2 PART 2- PRODUCTS

2.1 VERTICAL WIRE MANAGERS

2.1.1 Frame shall be black with a smooth paint finish, single sided vertical manager with door and back-cover.

2.1.2 Fabricated of 16 GA (0.060”) steel.

2.1.3 Channel style supports heavy cable load, while maintaining clean concealed appearance.

2.1.4 The vertical cable manager shall have a hinged door with a positive locking mechanism (non-magnetic).

2.1.5 The vertical wire manager shall have stiffeners welded inside for additional strength.

2.1.6 The openings for cable routing shall have finger type openings to ensure smooth transition of the patch cords without removing the patch cord from the patch panel or switch.

2.1.7 The vertical wire managers shall have the ability to fasten cable ties externally to the rear of the cable manager.

2.1.8 Each vertical wire manager shall have at least three (3) easily removable metal or plastic patch cord spools for ease of patch cord management.

2.1.9 The horizontal patch cord spools are to be at least expandable to 10”.

2.1.10 The vertical wire managers shall be a minimum of 12” wide x 9” deep.

2.1.11 The end vertical wire managers shall be a minimum of 6” wide x 9” deep.

2.2 HORIZONTAL WIRE MANAGERS

2.2.1 To be used only in existing TR locations.

2.2.2 Fabricated of 16 GA (0.060”) steel.

2.2.3 All managers mount in 19” EIA standard mountings

2.2.4 Designed to hide and organize cabling.

2.2.5 Shall have a hinged door with a positive mechanism (non-magnetic).

2.2.6 Shall have at least a 7” deep profile to maintain proper bend radius of the patch cables.

2.2.7 Shall have openings for cable routing. Shall have finger type openings to ensure smooth transition of the patch cords without removing the patch cord from the patch panel or switch.

2.2.8 Shall be a minimum of 3-1/2” high x 7” deep (2U).

3 PART 3- EXECUTION

3.1 INSTALLATION

3.1.1 Install vertical wire managers to the data racks in the MTR or TR location as identified within this document and associated drawings.

3.1.2 Utilize proper and all fasteners for the vertical wire managers.

3.1.3 The 2U horizontal wire manager shall be installed before and after every 48-port patch panel.

END OF SECTION

1 PART 1- GENERAL

1.1 WORK INCLUDED

1.1.1 Comply with the General requirements and documents referred to within.

1.1.2 Provide labour, materials, products, equipment and services to complete the communication rack mounted power distribution units for communications systems work specified within.

1.1.3 Contractor to provide, install, and commission PDUs, power cables, UPSes, as per UTM specification, in TR. Proper grounding/bonding following industry best-practices (ANSI/TIA-607) must be ensured.

1.1.4 To be read in conjunction with associated electrical and communication specification sections.

1.1.5 The contractor should seek clarification from the UTM I&ITS Designate on site conditions and on any technical, work and/or premises-related questions without delay.

1.2 RELATED DOCUMENTS

1.2.1 Drawings and general provisions of the contract, including general and supplementary conditions apply to this section. Refer to the following for additional information.

1.2.2 27 05 13 Communication Services

1.2.3 27 05 26 Grounding and Bonding for Communications Systems

1.2.4 27 05 29 Hangers and Supports for Communication Systems

1.2.5 27 05 33 Conduits and Back Boxes for Communication Systems

1.2.6 27 05 36 Cable Trays for Communication Systems

1.2.7 27 05 53 Identification for Communication Systems

1.2.8 27 15 55 Testing for Communication Services

1.2.9 27 11 16 Communication Cabinets, Racks, Frames and Enclosures

1.2.10 27 11 19 Communications Termination Blocks and Patch panels

1.2.11 27 11 23 Communications Cable management and Ladder Rack

1.2.12 27 13 13 Communications Copper Backbone Cabling

1.2.13 27 13 13 13 Communications Copper Cable Splicing and Terminations

1.2.14 27 13 23 Communications Optical Fibre Backbone Cabling

1.2.15 27 13 23 13 Communications Optical Fibre Splicing and Terminations

1.2.16 27 15 01 16 Voice Communications Horizontal Cabling

1.2.17 27 15 01 19 Data Communications Horizontal Cabling

1.2.18 27 15 43 Communication Faceplates and Connectors

1.2.19 27 16 19 Communication Patch Cords and Cross Connect Wire

1.3 QUALITY ASSURANCE

1.3.1 Only new products listed in this section may be used unless otherwise submitted for approval.

1.4 SYSTEM DESCRIPTION

1.4.1 The vertical power bars to be supplied and installed as per this document and drawings for network hardware associated with this project.

1.5 SUBMITTALS

1.5.1 Shop drawings for each type of product indicated in the following document, including construction details, material descriptions, dimensions of individual components and profiles and finishes for the vertical power bars and the standoff brackets. Include rated capacities, operating characteristics along with furnished specialties and accessories.

2 PART 2- PRODUCTS

2.1 VERTICAL POWER DISTRIBUTION UNITS

2.1.1 Fabricated from 18 GA (0.048”) steel.

2.1.2 Power bars mount into 19” EIA cabinet frames or network racks.

2.1.3 Must support a zero U installation method.

2.1.4 Must support dual Ethernet for daisy-chain connectivity.

2.1.5 Must support Visible Light Communication (VLC) technology for out of band monitoring.

2.1.6 Features breaker protection with reset button, three-stage surge protection, L6-30P input power, illuminated power switch showing power “ON”, and colour-coded power outlets that are ORANGE and GREEN.

2.1.7 Must have a standard 10’ power cord.

2.1.8 Standard Metered single phase 30 amp 208/240V capacity.

2.1.9 Digital meters must report at a minimum current in amps for each load bank.

2.1.10 Must have a minimum of 6 (six) C19 and 18 (eighteen) C13 connectors.

2.2 HORIZONTAL POWER DISTRIBUTION UNITS

2.2.1 Fabricated from 18 GA (0.048") steel.

2.2.2 Power bars mount into 19" EIA cabinet frames or network racks.

2.2.3 Must support dual Ethernet for daisy-chain connectivity.

2.2.4 Must support Visible Light Communication (VLC) technology for out of band monitoring.

2.2.5 Features breaker protection with reset button, three-stage surge protection, L6-30P input power, illuminated power switch showing power "ON", and colour-coded power outlets that are ORANGE and GREEN.

2.2.6 Must have a standard 10' power cord.

2.2.7 Standard Metered single phase 30 amp 208/240V capacity.

2.2.8 Digital meters must report at a minimum current in amps for each load bank.

2.2.9 Must have a minimum of 4 (four) C19 and 4 (four) C13 connectors.

3 PART 3- EXECUTION

3.1 INSTALLATION

3.1.1 Power distribution units, their installation and configuration are to be approved on a case by case basis. The size of the telecommunications facility and the type of equipment to be installed will govern the type and size of power distribution unit to be used.

3.1.2 UTM I&ITS will produce a rack diagram detailing how the approved PDUs are to be installed for a given project.

3.1.3 This information and approval can only come from the UTM I&ITS Designate.

END OF SECTION

1 PART 1- GENERAL

1.1 WORK INCLUDED

1.1.1 Comply with the General requirements and documents referred to within.

1.1.2 Provide labour, materials, products, equipment and services to complete the copper cable splicing and terminations for the communications systems work specified within.

1.1.3 To be read in conjunction with associated electrical and communication specification sections.

1.1.4 The contractor should seek clarification from the UTM I&ITS Designate on site conditions and on any technical, work and/or premises-related questions without delay.

1.2 RELATED DOCUMENTS

1.2.1 Drawings and general provisions of the contract, including general and supplementary conditions apply to this section. Refer to the following for additional information.

1.2.2 27 05 13 Communication Services

1.2.3 27 05 26 Grounding and bonding for Communication Systems

1.2.4 27 05 29 Hangers and Supports for Communications Systems

1.2.5 27 05 33 Conduits and Back Boxes for Communication Systems

1.2.6 27 05 36 Cable Trays for Communication Systems

1.2.7 27 05 53 Identification for Communication Systems

1.2.8 27 05 55 Testing for Communication Services

1.2.9 27 11 16 Communication Cabinets, Racks, Frames and Enclosures

1.2.10 27 11 19 Communication Termination Blocks and Patch Panels

1.2.11 27 11 23 Communications Cable Management and Ladder Rack

1.2.12 27 11 26 Communications Rack Mounted Power and Power Strips

1.2.13 27 13 13 Communications Copper Backbone Cabling

1.2.14 27 13 23 Communications Optical Fibre Backbone Cabling

1.2.15 27 13 23 13 Communications Optical Fibre Splicing and Terminations

1.2.16 27 15 01 16 Voice Communications Horizontal Cabling

1.2.17 27 15 01 19 Data Communications Horizontal Cabling

1.2.18 27 15 43 Communication Faceplates and Connectors

1.2.19 27 16 19 Communication Patch Cords and Cross Connect Wire

1.3 QUALITY ASSURANCE

1.3.1 All materials, equipment and parts comprising the unit's specified within this document shall be new and unused and of a current manufacture.

1.3.2 Only new products and applications listed in this section may be used unless otherwise submitted for approval.

1.4 SYSTEM DESCRIPTION

1.4.1 This copper cabling is designed to be a backbone for analog telephone lines only.

1.4.2 This copper backbone cabling serves to interconnect the main PSTN demarcation point and the distributed analog voice demarcation points throughout the university.

1.4.3 Copper backbone cabling and its connecting hardware provides the means of transporting voice signals between the analog voice telecommunication room and the horizontal cross-connect location in the main PSTN demarcation room.

1.4.4 The copper backbone cabling shall contain no more than two transition points between the telecommunication room and the PSTN demarcation room.

1.4.5 Splices shall not be installed in the backbone cabling.

1.4.6 The backbone design is based on a star topology from each TR location to the designated demarc TR location.

1.5 SUBMITTALS

1.5.1 Shop drawings shall be submitted for each type of product indicated or equivalent in the following document.

2 PART 2- PRODUCTS

2.1 BIX HARDWARE

2.1.1 The 250 and 300 pair mounts can be wall mounted or installed in BIX frames.

2.1.2 These mounts feature an interlocking design to allow them to be stacked for larger cross-connect installations.

2.1.3 Can be assembled with interlocking distribution rings into easily expandable wall mounted installations.

2.1.4 The distribution ring is used for wall mount installations providing a cross-connect channel for jumper wires.

2.1.5 The distribution rings interlocks with all BIX type mounts.

2.1.6 The BIX distribution connector (1A) is a 25pr connector.

2.1.7 Each connector is equipped with 50 double-ended insulation displacement connection (IDC).

2.2 ENTRANCE PROTECTION

2.2.1 Circa Telecom Building Entrance Products (or equivalent).

2.2.2 Corning QTPET Building Entrance Products (or equivalent).

3 PART 3- EXECUTION

3.1 COPPER BACKBONE INSTALLATION

3.1.1 The copper backbone shall be installed in the appropriate conduits, pathways and routes that have been approved for inter-building and intra-building.

3.1.2 One 200pr OSP cable (or equivalent) shall be installed from the campus PSTN demarc to the TR location designated as the demarcation location for that building.

3.1.3 The copper backbone cabling is to be protected at each building location using either one of the two following products:

- Circa Telecom Building Entrance Products (or equivalent).
- Coring QTPET Building Entrance Products (or equivalent).

3.1.4 All copper cable pairs are to be protected 100% using solid state protection modules.

3.1.5 The copper stub cabling from the protectors is to be terminated in a 300-PR GIGABIX type hardware on BIX1A wafers with associated designations strips with proper coloured labels on the fire treated plywood in the PSTN demarc room and the designated TR demarcation room in the building.

3.1.6 The metallic sheath of all backbone cables shall be grounded using the appropriate manufacturer's bond clamp for the specific size of cable with a green #6 ground wire to the TGB.

3.1.7 The voice 25pr copper intra-building backbone shall be installed in conduit in plenum rated areas or in cable tray in non-plenum areas from the TR demarc location to the various TR locations on the floors.

3.1.8 For certain TR locations terminate the copper backbone cable on the designated GigaBIX 25pr connectors mounted in GigaBIX mounts in the TR room and on BIX1A1 connectors mounted in 300-PR GIGABIX mounts at the PSTN demarc location (no substitutes).

3.2 GENERAL INSTALLATION INFORMATION

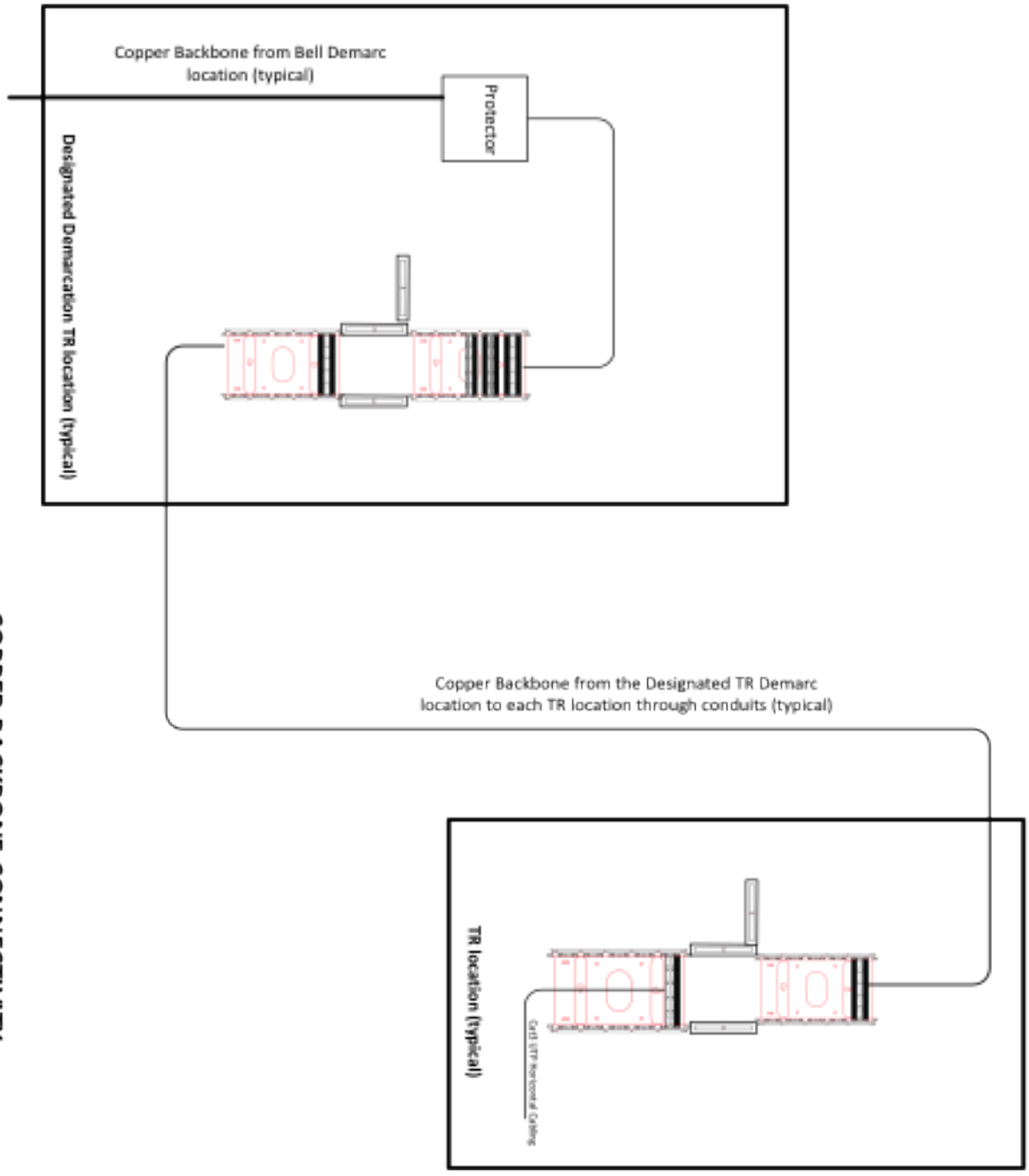
3.2.1 Any cable damaged or exceeding recommended installation parameters during installation shall be replaced by the contractor prior to final acceptance at no cost to the owner of the cabling system.

3.2.2 All backbone cables shall be identified by a self-adhesive label in accordance with the System Documentation section of this document, TIA/EIA-606-B, and section 27 05 53

3.2.3 The copper backbone shall be installed using the appropriate conduits, pathways and routes that have been approved.

3.2.4 Refer to section 27 05 36 for additional information on clearances.

COPPER BACKBONE CONNECTIVITY



END OF SECTION

1 PART 1- GENERAL

1.1 WORK INCLUDED

1.1.1 Comply with the General requirements and documents referred to within.

1.1.2 Provide labour, materials, products, equipment and services to complete the copper backbone for the communications systems work specified within.

1.1.3 To be read in conjunction with associated electrical and communication specification sections.

1.1.4 The contractor should seek clarification from the UTM I&ITS Designate on site conditions and on any technical, work and/or premises-related questions without delay.

1.2 RELATED DOCUMENTS

1.2.1 Drawings and general provisions of the contract, including general and supplementary conditions apply to this section. Refer to the following for additional information.

1.2.2 27 05 13 Communication Services

1.2.3 27 05 26 Grounding and Bonding for Communication Systems

1.2.4 27 05 29 Hangers and Supports for Communications Systems

1.2.5 27 05 33 Conduits and Back Boxes for Communication Systems

1.2.6 27 05 36 Cable Trays for Communication Systems

1.2.7 27 05 53 Identification for Communication Systems

1.2.8 27 05 55 Testing for Communication Services

1.2.9 27 11 16 Communication Cabinets, Racks, Frames and Enclosures

1.2.10 27 11 19 Communication Termination Blocks and Patch Panels

1.2.11 27 11 23 Communications Cable Management and Ladder Rack

1.2.12 27 11 26 Communications Rack Mounted Power and Power Strips

1.2.13 27 13 13 13 Communications Copper Cable Splicing and Terminations

1.2.14 27 13 23 Communications Optical Fibre Backbone Cabling

1.2.15 27 13 23 13 Communications Optical Fibre Splicing and Terminations

1.2.16 27 15 01 16 Voice Communications Horizontal Cabling

1.2.17 27 15 01 19 Data Communications Horizontal Cabling

1.2.18 27 15 43 Communication Faceplates and Connectors

1.2.19 27 16 19 Communication Patch Cords and Cross Connect Wire

1.3 QUALITY ASSURANCE

1.3.1 All materials, equipment and parts comprising the unit's specified within this document shall be new and unused and of a current manufacture.

1.3.2 Only new products and applications listed in this section may be used unless otherwise submitted for approval.

1.4 SYSTEM DESCRIPTION

1.4.1 This copper cabling is designed to be a backbone for analog telephone lines only.

1.4.2 This copper backbone cabling serves to interconnect the main PSTN demarcation point and the distributed analog voice demarcation points throughout the university.

1.4.3 Copper backbone cabling and its connecting hardware provides the means of transporting voice signals between the analog voice telecommunication room and the horizontal cross-connect location in the main PSTN demarcation room

1.4.4 The copper backbone cabling shall contain no more than two transition points between the telecommunication room and the PSTN demarcation room.

1.4.5 Splices shall not be installed in the backbone cabling.

1.4.6 The backbone design is based on a star topology from each TR location to the designated demarc TR location.

1.5 SUBMITTALS

1.5.1 Shop drawings shall be submitted for each type of product indicated or equivalent in the following document.

2 PART 2- PRODUCTS

2.1 COPPER OSP BACKBONE CABLE (INTER-BUILDING)

2.1.1 The OSP-rated cable type is a rugged multi-pair cable series that meets and exceeds ANSI/TIA/EIA-568-A for Category 3 transmission characteristics.

2.1.2 Conductors 24 AWG solid copper.

2.1.3 Cable core-25pr cables all twisted placed in a cable core. 50pr cables and more are formed by binder groups of 25pr.

2.1.4 The copper cable is filled with waterproofing compound and wrapped with a non-hygroscopic core tape.

2.1.5 The copper cable shall have a flooding compound applied over the core and all surfaces of the shielded armour to resist moisture entry and corrosion.

2.1.6 The copper cable shall have a black polyethylene jacket, printed at intervals indicating cable code AWG listings (NRC Code and or CSA), verification, date, time, machine code and length (meters/feet).

2.1.7 The copper cable shall be terminated in protector type housings at each end of the cable and all copper pairs terminated on BIX type 1A connectors in BIX10A mounts at each end on plywood.

2.2 COPPER BACKBONE CABLE (INTRA-BUILDING)

2.2.1 The riser-rated cable type is a rugged multi-pair cable series that meets and exceeds ANSI/TIA/EIA-568-A for Category 3 transmission characteristics.

2.2.2 Conductors 24 AWG solid copper.

2.2.3 Insulation: Inner layer Polyolefin, Outer layer Polyvinyl Chloride.

2.2.4 Cable core-25pr cables all twisted placed in a cable core. 50pr cables and more are formed by binder groups of 25pr.

2.2.5 PVC jacket is gray.

2.2.6 Printed at intervals indicating cable code AWG listings (NRC Code and or CSA), verification, date, time, machine code and length (meters/feet).

3 PART 3- EXECUTION

3.1 NOT APPLICABLE

END OF SECTION

1 PART 1- GENERAL

1.1 WORK INCLUDED

1.1.1 Comply with the General requirements and documents referred to within.

1.1.2 Provide labour, materials, products, equipment and services to complete the optical fiber splicing and terminations for the communications systems work specified within.

1.1.3 To be read in conjunction with associated electrical and communication specification sections.

1.1.4 The contractor should seek clarification from the UTM I&ITS Designate on site conditions and on any technical, work and/or premises-related questions without delay.

1.2 RELATED DOCUMENTS

1.2.1 Drawings and general provisions of the contract, including general and supplementary conditions apply to this section. Refer to the following for additional information.

1.2.2 27 05 13 Communication Services

1.2.3 27 05 26 Grounding and Bonding for Communication Systems

1.2.4 27 05 29 Hangers and Supports for Communications Systems

1.2.5 27 05 33 Conduits and Back Boxes for Communication Systems

1.2.6 27 05 36 Cable Trays for Communication Systems

1.2.7 27 05 53 Identification for Communication Systems

1.2.8 27 05 55 Testing for Communication Services

1.2.9 27 11 16 Communication Cabinets, Racks, Frames and Enclosures

1.2.10 27 11 19 Communication Termination Blocks and Patch Panels

1.2.11 27 11 23 Communications Cable Management and Ladder Rack

1.2.12 27 11 26 Communications Rack Mounted Power and Power Strips

1.2.13 27 13 13 Communications Copper Backbone Cabling

1.2.14 27 13 13 13 Communications Copper Cable Splicing and Terminations

1.2.15 27 13 23 13 Communications Optical Fibre Splicing and Terminations

1.2.16 27 15 01 16 Voice Communications Horizontal Cabling

1.2.17 27 15 01 19 Data Communications Horizontal Cabling

1.2.18 27 15 43 Communication Faceplates and Connectors

1.2.19 27 16 19 Communication Patch Cords and Cross Connect Wire

1.3 QUALITY ASSURANCE

1.3.1 All materials, equipment and parts comprising the unit's specified within this document shall be new and unused and of a current manufacture.

1.3.2 Only new products and applications listed in this section may be used unless otherwise submitted for approval.

1.4 SYSTEM DESCRIPTION

1.4.1 Backbone cabling system connects all campus buildings and TRs together, comprising both inter-building and intra-building cabling. It includes backbone cables, intermediate and main cross-connects, mechanical terminations, patch cords and jumpers used for backbone-to-backbone cross connections.

1.4.2 The fibre backbone cabling shall contain no more than two transition points between TRs.

1.4.3 Splices shall not be installed in the backbone cabling.

1.4.4 The backbone design is based on a star topology from each TR location to the designated demarc TR location.

1.4.5 **Inter-building** backbone cabling shall consist of two paths, as geographically distinct as possible. One of the paths will be used to connect the building's MTR (endpoint A) to an existing TR located elsewhere on campus (endpoint B), henceforth known as fibre path (A↔B). The second path will either connect endpoint A to a third TR located elsewhere on campus (endpoint C), henceforth known as fibre path (A↔C), or to endpoint B over a separate conduit, henceforth known as fibre path (A↔B)**'**. Path option (A↔C) is always preferred over path option (A↔B)**'**. The UTM I&ITS Designate will identify for the contractor the building's MTR and determine which path option should be used, on a per case basis.

1.4.6 The number of OS1 and/or OS2 optical fibre strands for **inter-building** communication will either be 2 x 24 strands (amounting to 48 strands in total, henceforth known as option 1), or 2 x 48 strands (amounting to 96 strands in total, henceforth known as option 2). For option 1: the first bundle of 24 fibre strands will take fibre path (A↔B), and the second bundle of 24 fibre strands will either take fibre path (A↔C), or fibre path (A↔B)**'**. For option 2: the first bundle of 48 fibre strands will take fibre path (A↔B), and the second bundle of 48 fibre strands will either take fibre path (A↔C), or fibre path (A↔B)**'**. The UTM I&ITS Designate will determine which one of the options should be used on a per case basis.

1.4.7 **Intra-building** backbone cabling shall connect all TRs to the MTR in a given building. It consists of two paths (path A and path B) between each TR and the MTR, as geographically distinct as possible in the building. The UTM I&ITS Designate will identify for the contractor the building's TRs and MTR, and determine the path options on a per case basis.

1.4.8 The number of OS1 and/or OS2 optical fibre strands for intra-building communication will be 2 x 12 strands per TR to the MTR. The first bundle of 12 fibre strands will take path A identified in 1.4.7 (above). The second bundle of 12 fibre strands will take path B, also identified in 1.4.7 (above). As an example, consider a building with 3 TRs and 1 MTR. The first TR will have 12 strands of fibre between it and the MTR over path A, and another 12 strands of fibre between it and the MTR over path B. This process should repeat for the second and third TRs, which brings the total count of fibre strands for intra-building network connectivity, for this particular example, to 72 strands. The UTM I&ITS Designate will identify for the contractor the building's TRs and MTR, and determine the path options on a per case basis.

1.5 SUBMITTALS

1.5.1 Shop drawings shall be submitted for each type of product indicated or equivalent in the following document.

1.5.2 Upon completion the contractor must provide the manufacturer 25 Year warranty in name of client within ten (10) business days of project completion.

2 PART 2 - PRODUCTS

2.1 FIBRE BACKBONE CABLE

2.1.1 OS1 and/or OS2 single-mode optical fibre, depending on the case, is to be provided between TRs on campus, both for inter-building and intra-building deployments.

2.1.2 Fibre optic cables must be colour-coded as defined in the ANSI/TIA-598D scheme. The scheme shall apply to buffer tubes, fibre groups, fibre units and fibre strands.

2.1.3 **Inter-building** fibre shall be Belden (or equivalent), OSP-type cabling (Out Side Plant). It must be fully water blocked, loose tube, indoor/outdoor, gel-filled, plenum rated. Sheath consisting of an overall jacket and one or more layers of dielectric material applied over the core. Depending on the installation, armoured fibre may be required; The contractor should seek clarification with the UTM I&ITS Designate**prior** to purchasing the fibre cable.

2.1.4 **Inter-building** fibre requires a tracer/locator wire (2.1.5 below) **and** detectable warning tape (2.1.6 below) to be placed with direct burial cable, pipe and microduct installation (air-assisted cable).

2.1.5 A tracer/locator wire shall have a solid or stranded copper conductor, as per ASTM B-1, B-3, or B-8 (Standard Specification for Soft Drawn Bare Copper Wire). Insulation shall be yellow in colour and must have high molecular weight polyethylene (HMWPE) ASTM D-1248.

2.1.6 A detectable warning tape shall be orange in colour and be installed above the cable as set by the A.P.W.A standard. Sizes and dimensions of the tape are determined by the depth the cable is buried:

Warning Tape Width / Recommended Depth:

2” width for up to 12” depth

3” width for up to 18” depth

6” width for up to 24” depth

2.1.7 **Intra-building** fibre must be indoor/outdoor, tight buffer, plenum rated and installed in conduit.

2.1.8 **Intra-building** fibre installed in a cable tray must be with an interlocking aluminium armoured sheath. Armour must be bonded at both ends to earth ground.

3 PART 3 – EXECUTION

3.1 UNDERGROUND CONDUITS: INSTALLATION

3.1.1 Fibre optic installations must be recorded in a professional manner including, but not limited to, proper route drawings, fibre strand assignments, loss readings and OTDR traces.

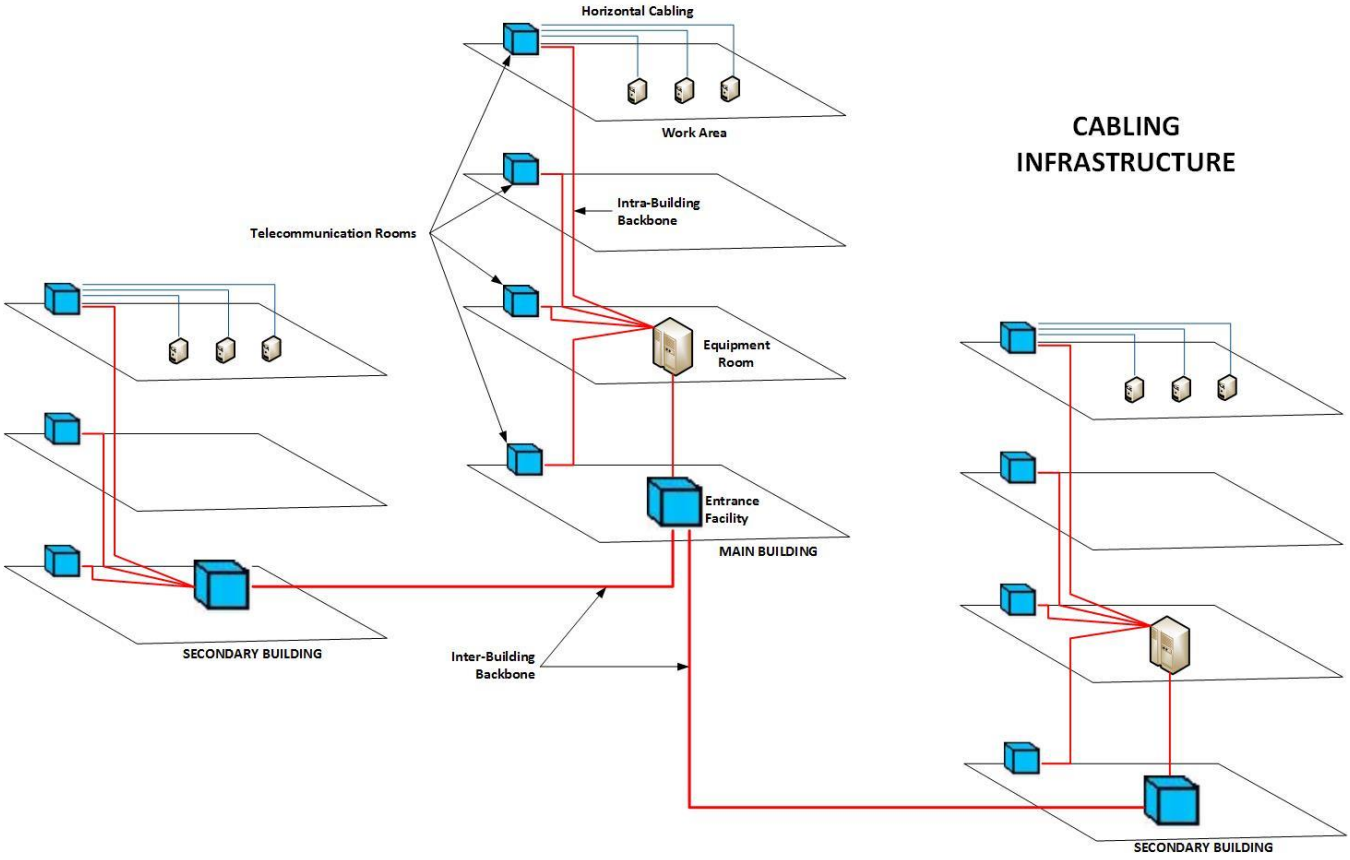
3.1.2 Newly installed conduits should be a minimum size of 4”, complete with a pull cable.

3.1.3 For every 100-metre segment:

- The segment run shall be as straight as possible. If bends are required, the sum of all bend angles may add up to maximum 90 degrees (e.g. 1 x 95° bend, or 2 x 45° bends, 1 x 45° bend + 3 x 15° bends, and so on).

- A junction box must be installed.

- Lubricants compatible with the cable jacket must be used.



END OF SECTION

1 PART 1- GENERAL

1.1 WORK INCLUDED

1.1.1 Comply with the General requirements and documents referred to within.

1.1.2 Provide labour, materials, products, equipment and services to complete the optical fiber splicing and terminations for the communications systems work specified within.

1.1.3 To be read in conjunction with associated electrical and communication specification sections.

1.1.4 The contractor should seek clarification from the UTM I&ITS Designate on site conditions and on any technical, work and/or premises-related questions without delay.

1.2 RELATED DOCUMENTS

1.2.1 Drawings and general provisions of the contract, including general and supplementary conditions apply to this section. Refer to the following for additional information.

1.2.2 27 05 13 Communication Services

1.2.3 27 05 26 Grounding and Bonding for Communication Systems

1.2.4 27 05 29 Hangers and Supports for Communications Systems

1.2.5 27 05 33 Conduits and Back Boxes for Communication Systems

1.2.6 27 05 36 Cable Trays for Communication Systems

1.2.7 27 05 53 Identification for Communication Systems

1.2.8 27 05 55 Testing for Communication Services

1.2.9 27 11 16 Communication Cabinets, Racks, Frames and Enclosures

1.2.10 27 11 19 Communication Termination Blocks and Patch Panels

1.2.11 27 11 23 Communications Cable Management and Ladder Rack

1.2.12 27 11 26 Communications Rack Mounted Power and Power Strips

1.2.13 27 13 13 Communications Copper Backbone Cabling

1.2.14 27 13 13 13 Communications Copper Cable Splicing and Terminations

1.2.15 27 13 23 13 Communications Optical Fibre Splicing and Terminations

1.2.16 27 15 01 16 Voice Communications Horizontal Cabling

1.2.17 27 15 01 19 Data Communications Horizontal Cabling

1.2.18 27 15 43 Communication Faceplates and Connectors

1.2.19 27 16 19 Communication Patch Cords and Cross Connect Wire

1.3 QUALITY ASSURANCE

1.3.1 All materials, equipment and parts comprising the unit's specified within this document shall be new and unused and of a current manufacture.

1.3.2 Only new products and applications listed in this section may be used unless otherwise submitted for approval.

1.4 SYSTEM DESCRIPTION

1.4.1 Backbone cabling system connects all campus buildings and TRs together, comprising both inter-building and intra-building cabling. It includes backbone cables, intermediate and main cross-connects, mechanical terminations, patch cords and jumpers used for backbone-to-backbone cross connections.

1.4.2 The fibre backbone cabling shall contain no more than two transition points between TRs.

1.4.3 Splices shall not be installed in the backbone cabling.

1.4.4 The backbone design is based on a star topology from each TR location to the designated demarc TR location.

1.4.5 Definition for **inter-building** backbone cabling: refer to 27 13 23, section 1.4.

1.4.6 Definition for **intra-building** backbone cabling: refer to 27 13 23, section 1.4.

1.4.7 Fusion splicing must be used for fibre termination.

1.4.8 Fibre cables must be identified by means of rigid PVC tags that clearly denotes building and TR numbers.

1.5 SUBMITTALS

1.5.1 Shop drawings shall be submitted for each type of product indicated or equivalent in the following document.

1.5.2 Upon completion the contractor must provide the manufacturer 25 Year warranty in name of client within ten (10) business days of project completion.

2 PART 2- PRODUCTS

2.1 FIBRE PATCH PANEL SYSTEMS AND ENCLOSURE

2.1.1 An ultra high-density rack-mount fibre connectivity system shall be used for cross-connecting or interconnecting purposes.

2.1.2 The ultra high-density rack-mount fibre connectivity system must allow splice cassettes using LC manufactured pigtails.

2.1.3 The fibre optic patch panel shall be mounted in a 482mm (19") rack or cabinet.

2.1.4 The fibre optic patch panel may vary from 1U to 4U high and will be black in colour.

2.1.5 The unit shall have patch cord routing guides that allow a transition and segregation for fibre optic patch cords to exiting the sides of the fibre patch panel.

2.1.6 The splice cassette shall be complete with HD OS2 blue, 12 port, 24 fibre LC adapter.

2.1.7 Splice cassettes are to be identical in all manner on both sides of a given fibre run.

2.1.8 Standard manufactured OS2 LC pigtails are to be used with each ultra high-density rack-mount fibre connectivity system splice cassette, complete with splice protectors.

2.1.9 The OS2 LC connector shall have a ceramic ferrule and a factory PC polish.

3 PART 3- EXECUTION

3.1 FIBRE BACKBONE INSTALLATION

3.1.1 The backbone fibre installation shall comply with the ANSI/TIA 607 requirements (current version including all addenda).

3.1.2 Installation of inter-building cabling: refer to 27 13 23, section 1.4.

3.1.3 Installation of intra-building cabling: refer to 27 13 23, section 1.4.

3.1.4 When installing the fibre optic cable into the fibre optic patch panel, secure the aramid yarn to the patch panel with the tie down provided.

3.1.5 Terminate the fibre optic cable in the appropriate rack mounted fibre patch panel located at the top of the data rack using the "LC" type connector in the TR, MTR and data centre.

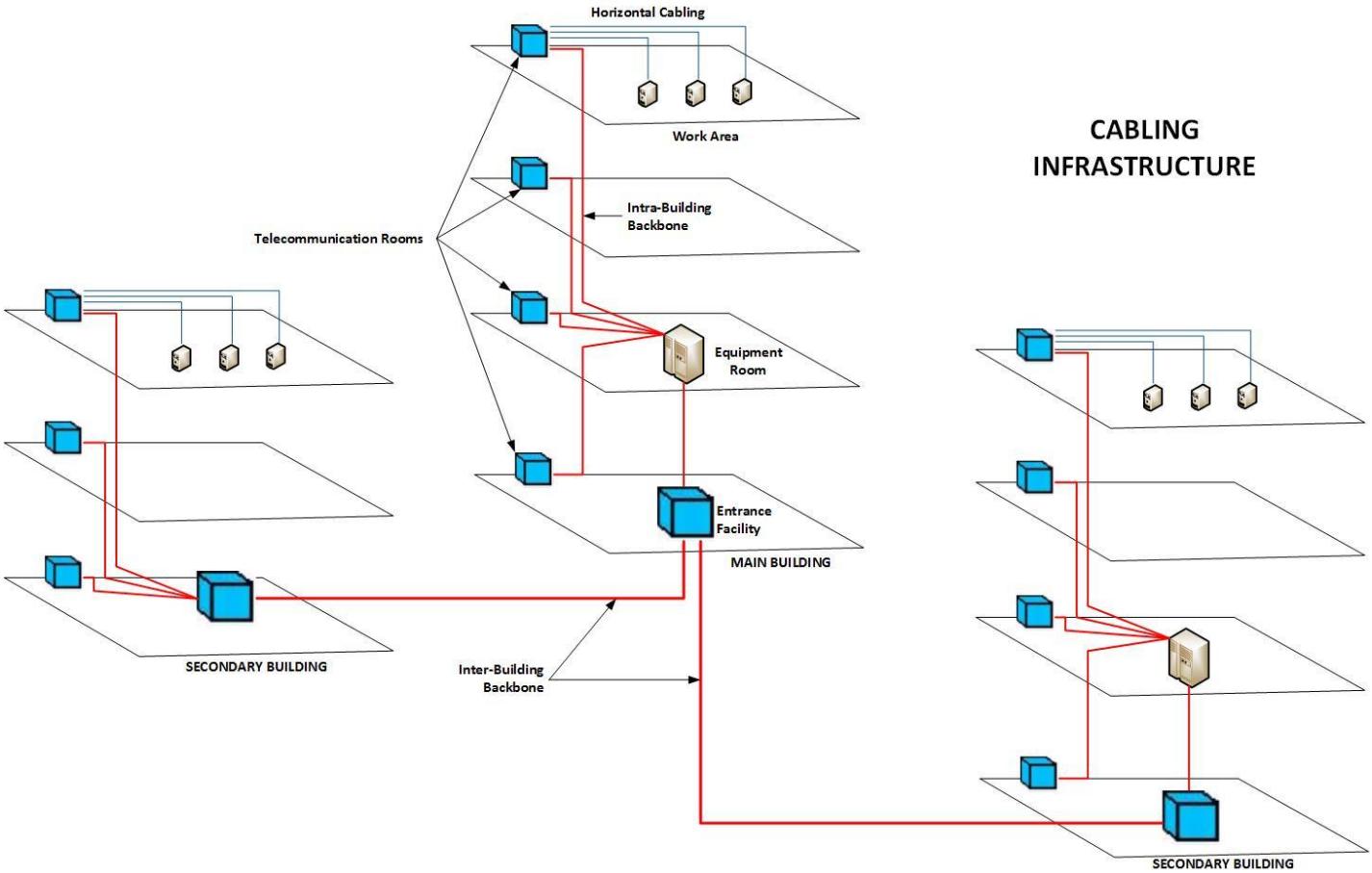
3.1.6 Exposed fibre shall be protected with yellow innerduct.

3.2 GENERAL INSTALLATION INFORMATION

3.2.1 Any cable damaged or exceeding recommended installation parameters during installation shall be replaced by the contractor prior to final acceptance at no cost to the owner of the cabling system.

3.2.2 All backbone cables shall be identified by a self-adhesive label in accordance with the System Documentation section of TIA/EIA-606-B.

3.2.3 The fibre backbone shall be installed and the appropriate conduits, pathways and routes that have been approved.



END OF SECTION

1 PART 1- GENERAL

1.1 WORK INCLUDED

1.1.1 Comply with the General requirements and documents referred to within.

1.1.2 Provide labour, materials, products, equipment and services to complete the horizontal voice cabling for communications systems work specified within.

1.1.3 To be read in conjunction with associated electrical and communication specification sections.

1.1.4 The contractor should seek clarification from the UTM I&ITS Designate on site conditions and on any technical, work and/or premises-related questions without delay.

1.2 RELATED DOCUMENTS

1.2.1 Drawings and general provisions of the contract, including general and supplementary conditions apply to this section. Refer to the following for additional information.

1.2.2 27 05 13 Communication Services

1.2.3 27 05 26 Grounding and Bonding for Communications Systems

1.2.4 27 05 29 Hangers and Supports for Communications Systems

1.2.5 27 05 33 Conduits and Back Boxes for Communication Systems

1.2.6 27 05 36 Cable Trays for Communication Systems

1.2.7 27 05 53 Identification for Communication Systems

1.2.8 27 05 55 Testing for Communication Services

1.2.9 27 11 16 Communication Cabinets, Racks, Frames and Enclosures

1.2.10 27 11 19 Communication Termination Blocks and Patch Panels

1.2.11 27 11 23 Communications Cable Management and Ladder Rack

1.2.12 27 11 26 Communications Rack Mounted Power and Power Strips

1.2.13 27 13 13 Communications Copper Backbone Cabling

1.2.14 27 13 13 13 Communications Copper Cable Splicing and Terminations

1.2.15 27 13 23 Communications Optical Fibre Backbone Cabling

1.2.16 27 13 23 13 Communications Optical Fibre Splicing and Terminations

1.2.17 27 15 01 16 Voice Communications Horizontal Cabling

1.2.18 27 15 43 Communication Faceplates and Connectors

1.2.19 27 16 19 Communication Patch Cords and Cross Connect Wire

1.3 QUALITY ASSURANCE

1.3.1 All materials, equipment and parts comprising the unit's specified within this document shall be new and unused and of a current manufacture.

1.3.2 Only new products and applications listed in this section may be used unless otherwise submitted for approval.

1.3.3 All horizontal voice cabling must be certified to manufacturer's warranty of at least 25 years.

1.4 SYSTEM DESCRIPTION

1.4.1 The horizontal voice cabling and its connecting hardware provides the means of transporting signals between the telecommunication outlet/connector and the horizontal cross connect location in the MTR or TR locations. This cabling and its connecting hardware are called the "Permanent Link" a term that is used in testing protocols.

1.4.2 The horizontal voice cabling shall not contain any transition points or consolidation points between the horizontal cross-connect and the telecommunications outlet/connector. If a transition point or consolidation point is necessary for the functionality of the horizontal voice cabling, a request shall be submitted to the UTM I&ITS Designate for approval.

1.4.3 Bridge taps and splices shall not be installed in the voice horizontal cabling.

1.4.4 The maximum distance for horizontal voice cabling is 90m (295 feet).

1.5 PERFORMANCE REQUIREMENTS

1.5.1 The complete end-to-end horizontal cabling system shall meet or exceed the requirements for Cat 6A cabling as specified by the TIA/EIA-568-C.2 Telecommunication Cabling Standard.

1.5.2 The complete end-to-end horizontal cabling system shall meet or exceed the requirements for Class E cabling as specified by the ISO/IEC 11801 International Standard.

1.6 SUBMITTALS

1.6.1 Shop drawings shall be submitted for each type of product indicated or equivalent in the following document.

2 PART 2- PRODUCTS

2.1 BALANCED TWISTED-PAIR CABLES

2.1.1 Voice cabling shall be 4-pair balanced twisted pair Cat 6A UTP, plenum rated (CMP) cables for all cabling projects

2.1.2 Cat 6A cable jacket colour: to be determined by the UTM I&ITS Designate.

2.1.3 The cable conductors shall be 23 AWG solid copper.

2.1.4 The outside diameter (OD) shall be no greater than 6.73mm (0.265").

2.1.5 The minimum bend radius shall be no greater than four times the OD of the cable.

3 PART 3- EXECUTION

3.1 VOICE CABLE INSTALLATION

3.1.1 The contractor shall clarify with the UTM I&ITS Designate the ANSI/TIA termination standard that must be employed, prior to commencing the work.

3.1.2 No voice cable shall exceed 90 meters. Any cables longer than 90 meters shall be reported immediately to the UTM I&ITS Designate.

3.1.3 Pair untwist at the termination point shall not exceed 13mm (0.5").

3.1.4 Bend radius of the cable along its pathway and at the termination areas shall not be less than four times the OD of the cable.

3.1.5 The pulling tension on any 4-pair balanced UTP cable shall not exceed 110N (25lbf).

3.1.6 All cable ties shall be black, touch-fasteners (a.k.a. velcro fasteners) style.

3.1.7 No plastic cable ties are allowed. If found on site during any phase of the project the plastic cable ties will be removed by the contractor at the contractor’s expense.

3.1.8 All exposed cables in TRs are to be placed in a neat and professional manner and routed in accordance with the specifications and drawings provided.

3.1.9 If installing horizontal voice cabling outlets/connectors through floors/walls and into furniture access locations, all exposed cabling at the workstation between the wall/floor and the furniture access locations is to be wrapped with black split loom tubing, size and length as required to suit.

3.1.10 Cable raceways shall not be filled greater than the TIA/EIA-569-B recommended maximum fill for the particular raceway type, or 40% whichever is less.

3.1.11 Cable support systems shall be provided and installed by contractor everywhere along the cable pathway and shall adhere to the following:

3.1.11.1 Existing cable tray and adjustable cable support as defined in sections 27 05 29 and 27 05 36 shall be used where available. Existing cable supports not specified in those documents (e.g. J-hooks) shall not be used for new cabling, new cable supports shall be installed adjacent to them

3.1.11.2 All cable support systems shall be self-supporting.

3.1.11.3 At no point shall cable(s) rest on acoustic ceiling grids, water pipes, metal conduits, ceiling panels or any other structure not defined as a cable support.

3.1.11.4 Horizontal voice cabling shall be supported by use of cable trays where clearances allow for the installation of cable trays. See section 27 05 36 for details on cable tray systems and minimum required clearances.

3.1.11.5 Where clearances do not allow for the installation of cable trays, contractor shall submit a request to the UTM I&ITS Designate for additional instructions. UTM I&ITS may, at its own discretion, lower the minimum required clearances to allow for the installation of cable tray, or instruct contractor to use alternate cable supports as defined in sections 27 05 29 and 27 05 33.

3.1.12 Horizontal voice cables shall be bundled in groups of no more than 16 cables. Cable bundle quantities in excess of 16 cables may cause deformation of the bottom cables within the bundle, which will degrade the performance of those cables.

3.1.13 The horizontal voice cable shall be installed above fire-sprinkler systems and shall not be attached to such systems or any associated ancillary equipment or hardware. The cabling system and its associated pathways shall be installed so that they do not obscure any valves, fire alarm conduit(s), boxes, or other control devices.

3.1.14 Any voice cable damaged or exceeding recommended installation parameters during installation shall be replaced by the contractor prior to final acceptance at no cost to the owner of the cabling system.

3.1.15 All voice cables shall be identified by a self-adhesive label in accordance with the Identification for Comm. System section of this specification, Section 27 05 53.

3.1.16 Any voice cable located on a penthouse level for other services (BAS, elevator room, mechanical room, electrical room) shall be installed to the closet TR location via conduit.

3.1.17 All voice cables must be terminated on the same floor as the workstation location. The exception to this rule is item 3.1.16.

3.1.18 Termination jacks on both ends of the permanent link shall be Keystone style T568A/B. Colour to be determined by the UTM I&ITS Designate.

3.1.19 To minimize any possibility of disruption, maintain the following minimum clearances from electrical and heat sources when routing cables:

CLEARANCES TABLE	
Item	**Minimum Clearance**
Motor	1.2 m (4’-0”)
Transformers	1.2 m (4’-0”)
Conduit and cables used for electrical distribution less than 1kV	0.3 m (1’-0”)
Conduit and cables used for electrical distribution greater than 1kV	1.0 m (3’-0”)
Fluorescent Light Fixtures	12 cm (5”)
Pipes (gas, oil, water, etc)	0.3 m (1’-0”)
HVAC (equipment, ducts, etc)	15 cm (6 “)

END OF SECTION

1 PART 1- GENERAL

1.1 WORK INCLUDED

1.1.1 Comply with the General requirements and documents referred to within.

1.1.2 Provide labour, materials, products, equipment and services to complete the horizontal data cabling for communications systems work specified within.

1.1.3 To be read in conjunction with associated electrical and communication specification sections.

1.1.4 The contractor should seek clarification from the UTM I&ITS Designate on site conditions and on any technical, work and/or premises-related questions without delay.

1.2 RELATED DOCUMENTS

1.2.1 Drawings and general provisions of the contract, including general and supplementary conditions apply to this section. Refer to the following for additional information.

1.2.2 27 05 13 Communication Services

1.2.3 27 05 26 Grounding and Bonding for Communications Systems

1.2.4 27 05 29 Hangers and Supports for Communications Systems

1.2.5 27 05 33 Conduits and Back Boxes for Communication Systems

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1.2.13 27 13 13 Communications Copper Backbone Cabling

1.2.14 27 13 13 13 Communications Copper Cable Splicing and Terminations

1.2.15 27 13 23 Communications Optical Fibre Backbone Cabling

1.2.16 27 13 23 13 Communications Optical Fibre Splicing and Terminations

1.2.17 27 15 01 16 Voice Communications Horizontal Cabling

1.2.18 27 15 43 Communication Faceplates and Connectors

1.2.19 27 16 19 Communication Patch Cords and Cross Connect Wire

1.3 QUALITY ASSURANCE

1.3.1 All materials, equipment and parts comprising the unit's specified within this document shall be new and unused and of a current manufacture.

1.3.2 Only new products and applications listed in this section may be used unless otherwise submitted for approval.

1.3.3 All horizontal data cabling must be certified to manufacturer's warranty of at least 25 years.

1.4 SYSTEM DESCRIPTION

1.4.1 The horizontal data cabling and its connecting hardware provides the means of transporting signals between the telecommunication outlet/connector and the horizontal cross connect location in the MTR or TR locations. This cabling and its connecting hardware are called the "Permanent Link" a term that is used in testing protocols.

1.4.2 The horizontal data cabling shall not contain any transition points or consolidation points between the horizontal cross-connect and the telecommunications outlet/connector. If a transition point or consolidation point is necessary for the functionality of the horizontal data cabling, a request shall be submitted to the UTM I&ITS Designate for approval.

1.4.3 Bridge taps and splices shall not be installed in the data horizontal cabling.

1.4.4 The maximum distance for horizontal data cabling is 90m (295 feet).

1.5 PERFORMANCE REQUIREMENTS

1.5.1 The complete end-to-end horizontal cabling system shall meet or exceed the requirements for Cat 6A cabling as specified by the TIA/EIA-568-C.2 Telecommunication Cabling Standard.

1.6 SUBMITTALS

1.6.1 Shop drawings shall be submitted for each type of product indicated or equivalent in the following document.

2 PART 2- PRODUCTS

2.1 BALANCED TWISTED-PAIR CABLES

2.1.1 Always consult with the UTM I&ITS Designate before procuring materials. Data cabling added to an existing installation must match the manufacturer of the current infrastructure, i.e. must match maker of existing cables, connectors, patch panels and racks. This is best-practice and allows new cables to be added to an already certified infrastructure.

2.1.2 Data cabling shall be 4-pair balanced twisted pair Cat 6A UTP, plenum rated (CMP) cables for all cabling projects.

2.1.3 The horizontal Cat 6A data cable jackets shall be **blue** in colour, and its hue shall be as close as possible to colour code #0000FF.

2.1.4 The cable conductors shall be 23 AWG solid copper.

2.1.5 The outside diameter (OD) shall be no greater than 6.73mm (0.265").

2.1.6 The minimum bend radius shall be no greater than four times the OD of the cable.

3 PART 3- EXECUTION

3.1 DATA CABLE INSTALLATION

3.1.1 The contractor shall clarify with the UTM I&ITS Designate the ANSI/TIA termination standard that must be employed, prior to commencing the work

3.1.2 No data cable shall exceed 90 meters. Any cables longer than 90 meters shall be reported immediately to the UTM I&ITS Designate.

3.1.3 Pair untwist at the termination point shall not exceed 13mm (0.5").

3.1.4 Bend radius of the cable along its pathway and at the termination areas shall not be less than four times the OD of the cable.

3.1.5 The pulling tension on any 4-pair balanced UTP cable shall not exceed 110N (25lbf).

3.1.6 All cable ties shall be black, touch-fasteners (a.k.a. velcro fasteners) style.

3.1.7 No plastic cable ties are allowed. If found on site during any phase of the project the plastic cable ties will be removed by the contractor at the contractor's expense.

3.1.8 All exposed cables in TRs are to be placed in a neat and professional manner and routed in accordance with the specifications and drawings provided.

3.1.9 If installing horizontal data cabling outlets/connectors through floors/walls and into furniture access locations, all exposed cabling at the workstation between the

wall/floor and the furniture access locations is to be wrapped with black split loom tubing, size and length as required to suit.

3.1.10 Cable raceways shall not be filled greater than the TIA/EIA-569-B recommended maximum fill for the particular raceway type, or 40% whichever is less.

3.1.11 Cable support systems shall be provided and installed by contractor everywhere along the cable pathway and shall adhere to the following:

3.1.11.1 Existing cable tray and adjustable cable support as defined in sections 27 05 29 and 27 05 36 shall be used where available. Existing cable supports not specified in those documents (e.g. J-hooks) shall not be used for new cabling, new cable supports shall be installed adjacent to them

3.1.11.2 All cable support systems shall be self-supporting.

3.1.11.3 At no point shall cable(s) rest on acoustic ceiling grids, water pipes, metal conduits, ceiling panels or any other structure not defined as a cable support.

3.1.11.4 Horizontal data cabling shall be supported by use of cable trays where clearances allow for the installation of cable trays. See section 27 05 36 for details on cable tray systems and minimum required clearances.

3.1.11.5 Where clearances do not allow for the installation of cable trays, contractor shall submit a request to the UTM I&ITS Designate for additional instructions. UTM I&ITS may, at its own discretion, lower the minimum required clearances to allow for the installation of cable tray, or instruct contractor to use alternate cable supports as defined in sections 27 05 29 and 27 05 33.

3.1.12 Horizontal data cables shall be bundled in groups of no more than 16 cables. Cable bundle quantities in excess of 16 cables may cause deformation of the bottom cables within the bundle, which will degrade the performance of those cables.

3.1.13 The horizontal data cable shall be installed above fire-sprinkler systems and shall not be attached to such systems or any associated ancillary equipment or hardware. The cabling system and its associated pathways shall be installed so that they do not obscure any valves, fire alarm conduit(s), boxes, or other control devices.

3.1.14 Any data cable damaged or exceeding recommended installation parameters during installation shall be replaced by the contractor prior to final acceptance at no cost to the owner of the cabling system.

3.1.15 All data cables shall be identified by a self-adhesive label in accordance with the Identification for Comm. System section of this specification, Section 27 05 53.

3.1.16 Any data cable located on a penthouse level for other services (BAS, elevator room, mechanical room, electrical room) shall be installed to the closet TR location via conduit.

3.1.17 All data cables must be terminated on the same floor as the workstation location. The exception to this rule is item 3.1.16.

3.1.18 Coloured jacks will be used to differentiate cable types. The colour scheme for 8P8C modular connector jacks (a.k.a. RJ45) is the following:

Description	Cable Type
Keystone Style T568A/B, Blue	Workstation Data Cabling
Keystone Style T568A/B, Colour to be determined by the UTM I&ITS Designate	Voice Cabling
Keystone Style T568A/B, Yellow	Security Cabling (e.g. security cameras)
Keystone Style T568A/B, Orange	Wireless Access Point Data Cabling
Keystone Style T568A/B, Red	Building Automation Data Cabling

3.1.19 To minimize any possibility of disruption, maintain the following minimum clearances from electrical and heat sources when routing cables:

CLEARANCES TABLE	
Item	**Minimum Clearance**
Motor	1.2 m (4’-0”)
Transformers	1.2 m (4’-0”)
Conduit and cables used for electrical distribution less than 1kV	0.3 m (1’-0”)
Conduit and cables used for electrical distribution greater than 1kV	1.0 m (3’-0”)
Fluorescent Light Fixtures	12 cm (5”)
Pipes (gas, oil, water, etc)	0.3 m (1’-0”)
HVAC (equipment, ducts, etc)	15 cm (6 “)

END OF SECTION

1 PART 1- GENERAL

1.1 WORK INCLUDED

1.1.1 Comply with the General requirements and documents referred to within.

1.1.2 Provide labour, materials, products, equipment and services to complete the faceplates and connectors for the communications systems work specified within.

1.1.3 To be read in conjunction with associated electrical and communication specification sections.

1.1.4 The contractor should seek clarification from the UTM I&ITS Designate on site conditions and on any technical, work and/or premises-related questions without delay.

1.2 RELATED DOCUMENTS

1.2.1 Drawings and general provisions of the contract, including general and supplementary conditions apply to this section. Refer to the following for additional information.

1.2.2 27 05 13 Communication Services

1.2.3 27 05 26 Grounding and Bonding for Communication Systems

1.2.4 27 05 29 Hangers and Supports for Communications Systems

1.2.5 27 05 33 Conduits and Back Boxes for Communication Systems

1.2.6 27 05 36 Cable Trays for Communication Systems

1.2.7 27 05 53 Identification for Communication Systems

1.2.8 27 05 55 Testing for Communication Services

1.2.9 27 11 16 Communication Cabinets, Racks, Frames and Enclosures

1.2.10 27 11 19 Communication Termination Blocks and Patch Panels

1.2.11 27 11 23 Communications Cable Management and Ladder Rack

1.2.12 27 11 26 Communications Rack Mounted Power and Power Strips

1.2.13 27 13 13 Communications Copper Backbone Cabling

1.2.14 27 13 13 13 Communications Copper Cable Splicing and Terminations

1.2.15 27 13 23 Communications Optical Fibre Backbone Cabling

1.2.16 27 13 23 13 Communications Optical Fibre Splicing and Terminations

1.2.17 27 15 01 16 Voice Communications Horizontal Cabling

1.2.18 27 15 01 19 Data Communications Horizontal Cabling

1.2.19 27 16 19 Communication Patch Cords and Cross Connect Wire

1.3 QUALITY ASSURANCE

1.3.1 All materials, equipment and parts comprising the unit's specified within this document shall be new and unused and of a current manufacture.

1.3.2 Only new products and applications listed in this section may be used unless otherwise submitted for approval.

1.4 SYSTEM DESCRIPTION

1.4.1 The horizontal voice and data connectors provide the means of transporting signals between the telecommunication outlet/connector and the horizontal cross connect location in the MTR or TR locations.

1.5 PERFORMANCE REQUIREMENTS

1.5.1 The voice and data connecting hardware shall match the horizontal voice and data cabling specifications for performance.

1.6 SUBMITTALS

1.6.1 Shop drawings shall be submitted for each type of product indicated or equivalent in the following document.

2 PART 2- PRODUCTS

2.1 UTP CONNECTORS

2.1.1 Minimum rates for the 8P8C modular connector jacks (a.k.a. RJ45) are as follows: insertion loss 0.10dB @ 100MHz, return loss 27dB @ 100MHz.

2.1.2 The PSANEXT isolation between modules must be greater than 70dB @ 100 MHz when connectors are mounted side by side, top to bottom in a 48 ports 1U configuration.

2.1.3 Colour details for 8P8C modular connector jacks are found in section 27 15 01 19 – 3.1.18.

2.2 FACEPLATES

2.2.1 Available in 2, 4 and 6 port configurations for greater workstation outer density.

2.2.2 Faceplates shall be available in multiple colours to match any suit décor.

2.2.3 Faceplates are compatible for Cat 6A 8P8C modular connector (Keystone).

2.2.4 Space to facilitate outlet labelling identification and ease of network management.

2.2.5 Blanks supplied to fill all unused ports.

2.2.6 Faceplates to fit over standard NEMA type outlet boxes or wall mounting bracket for flush mounting installations

2.2.7 Faceplates shall be able to fit over an interface adaptor boxes for surface mount installations.

3 PART 3- EXECUTION

3.1 VOICE CONNECTOR TERMINATION

3.1.1 At the workstation faceplate terminate each voice cable on an 8P8C modular connector jack wired TIA/EIA-568A ISDN standard.

3.1.2 For all voice locations there shall be one Cat 6A voice cable terminated at each end as per this document.

3.1.3 The voice 8P8C modular connector jack shall occupy the far right position of the 4-port faceplate (top to bottom).

3.1.4 Use blanks for all unused ports. Blanks to match faceplate colour.

3.1.5 Where communications are ganged with electrical décora type, inserts are to be used and the colour is to match electrical.

3.1.6 Where the voice cabling is terminated at a furniture workstation the 4-port faceplate shall be installed in an interface surface adaptor box and secured to the furniture base using short self-tapping screws. (***Do not install the self-adhesive product that is with the interface surface adapter box***).

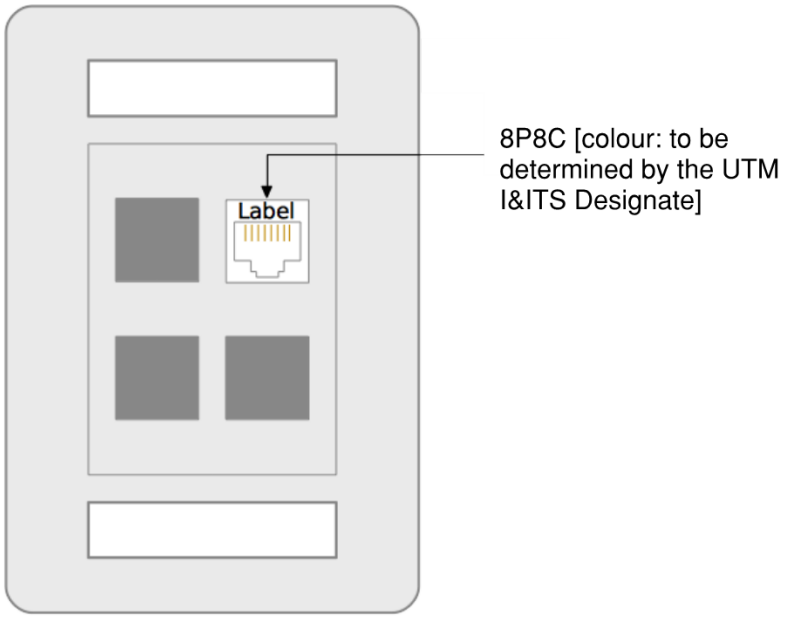
3.1.7 Include all necessary furniture adaptors/spacers/surface boxes/Keystone type jacks and any other hardware required to ensure the faceplate can be properly installed/secured to the furniture while maintaining a proper bend radius.

3.1.8 Include all necessary adaptors/spacers/surface boxes/Keystone type jacks and any other hardware required to ensure the faceplate can be properly installed in the floor box while maintaining a proper bend radius.

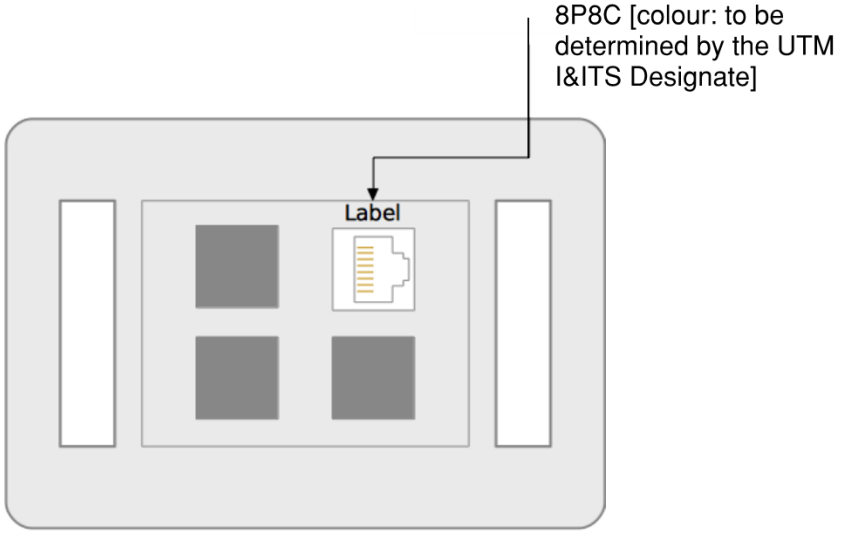
3.1.9 Any voice cable damaged or exceeding recommended installation parameters during termination shall be replaced by the contractor prior to final acceptance at no cost to the owner of the cabling system.

3.1.10 All voice cables shall be identified by a self-adhesive label in accordance with the Identification for Comm. System section of this specification, 27 05 53.

3.1.11 Each voice cable shall be clearly labeled on the cable jacket within 4 inches of the termination behind the connector at the faceplate. Labels obscured from view will not be accepted and will be replaced by the contractor at no cost to the client.



Wall Faceplate



Horizontal Faceplate

3.2 DATA CONNECTOR TERMINATION

3.2.1 At the workstation faceplate terminate each data cable on a blue 8P8C modular connector Keystone jack wired TIA/EIA-568A ISDN standard.

3.2.2 The data 8P8C modular connector jack will be blue in colour and shall occupy the top left position of the 4-port faceplate (top to bottom).

3.2.3 Use blanks for all unused ports. Blanks to match faceplate colour.

3.2.4 Where communications are ganged with electrical décora type inserts are to be used and the colour is to match electrical.

3.2.5 Where the data cabling is terminated at a furniture workstation the 4-port faceplate shall be installed in an interface surface adaptor box and secured to the furniture base using short self-tapping screws. (***Do not install the self-adhesive product that is with the interface surface adapter box***).

3.2.6 Include all necessary furniture adaptors/spacers/surface boxes/Keystone type jacks and any other hardware required to ensure the faceplate can be properly installed/secured to the furniture while maintaining a proper bend radius.

3.2.7 Include all necessary adaptors/spacers/surface boxes/Keystone type jacks and any other hardware required to ensure the faceplate can be properly installed in the floor box while maintaining a proper bend radius.

3.2.8 Any data cable damaged or exceeding recommended installation parameters during termination shall be replaces by the contractor prior to final acceptance at no cost to the owner of the cabling system.

3.2.9 All data cables shall be identified by a self-adhesive label in accordance with the Identification for Comm. System section of this specification, 27 05 53.

3.2.10 Each data cable shall be clearly labeled on the cable jacket within 4 inches of the termination behind the connector at the faceplate. Labels are to be a self-laminating wrap around style. Labels obscured from view will not be accepted and will be replaced by the contractor at no cost to the client.

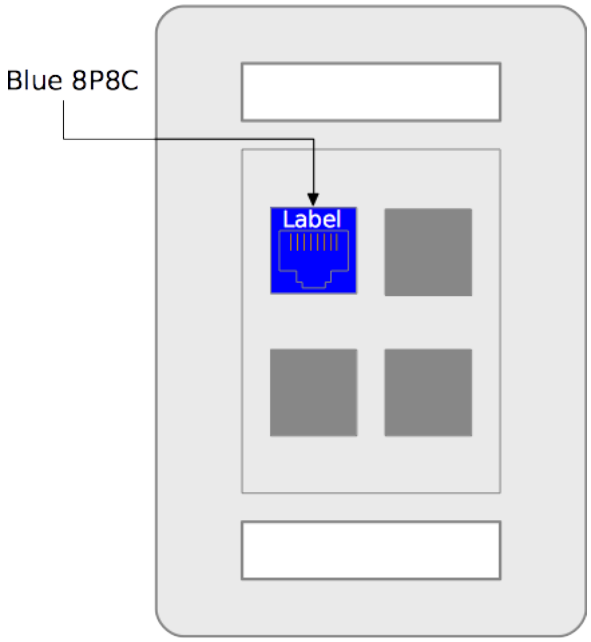
3.2.11 The data cabling will be terminated on either existing patch panels or on new 48-port patch panels. I&ITS designate to confirm per project.

3.2.12 If existing patch panels are full, the contractor is to install new, black 48-port patch panels (match existing) that is to be properly secured to the existing 19" data rack.

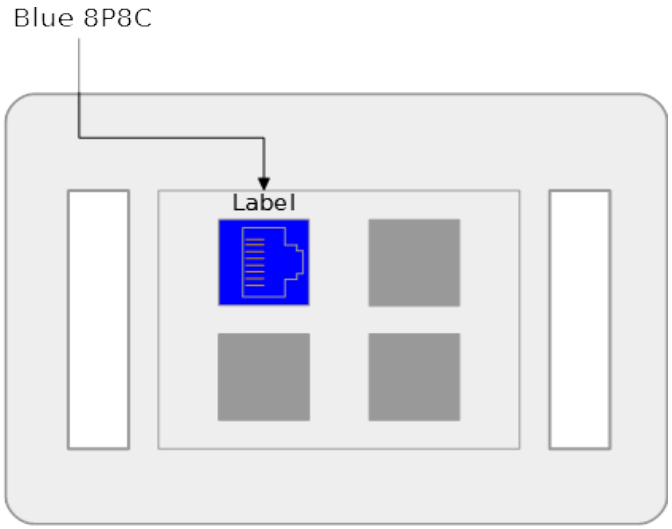
3.2.13 If a new patch panel is installed below an existing full panel, a 2RU horizontal cable manager will be installed above the new panel to preserve the interlacing of patch panels and horizontal cable manger as per section 27 11 23.

3.2.14 Pair untwist at the termination point shall not exceed 13mm (0.5in).

3.2.15 All cable ties shall be black, touch-fasteners (a.k.a. velcro fasteners) style.



Wall Faceplate



Horizontal Faceplate

END OF SECTION

1 PART 1- GENERAL

1.1 WORK INCLUDED

1.1.1 Comply with the General requirements and documents referred to within.

1.1.2 Provide labour, materials, products, equipment and services to complete the patch cords, station cords and cross-connect wire for communications systems work specified within.

1.1.3 To be read in conjunction with associated electrical and communication specification sections.

1.1.4 The contractor should seek clarification from the UTM I&ITS Designate on site conditions and on any technical, work and/or premises-related questions without delay.

1.2 RELATED DOCUMENTS

1.2.1 Drawings and general provisions of the contract, including general and supplementary conditions apply to this section. Refer to the following for additional information.

1.2.2 27 05 13 Communication Services

1.2.3 27 05 26 Grounding and Bonding for Communication Systems

1.2.4 27 05 29 Hangers and Supports for Communications Systems

1.2.5 27 05 33 Conduits and Back Boxes for Communication Systems

1.2.6 27 05 36 Cable Trays for Communication Systems

1.2.7 27 05 53 Identification for Communication Systems

1.2.8 27 05 55 Testing for Communication Services

1.2.9 27 11 16 Communication Cabinets, Racks, Frames and Enclosures

1.2.10 27 11 19 Communication Termination Blocks and Patch Panels

1.2.11 27 11 23 Communications Cable Management and Ladder Rack

1.2.12 27 11 26 Communications Rack Mounted Power and Power Strips

1.2.13 27 13 13 Communications Copper Backbone Cabling

1.2.14 27 13 13 13 Communications Copper Cable Splicing and Terminations

1.2.15 27 13 23 Communications Optical Fibre Backbone Cabling

1.2.16 27 13 23 13 Communications Optical Fibre Splicing and Terminations

1.2.17 27 15 01 16 Voice Communications Horizontal Cabling

1.2.18 27 15 01 19 Data Communications Horizontal Cabling

1.2.19 27 15 43 Communication Faceplates and Connectors

1.3 QUALITY ASSURANCE

1.3.1 Only new products and applications listed in this section may be used unless otherwise submitted for approval.

1.4 SYSTEM DESCRIPTION

1.4.1 The data UTP and fibre patch cords provide the means of transporting signals between the telecommunication outlet/connector and the horizontal cross-connect location in the MTR or TR locations.

1.5 PERFORMANCE REQUIREMENTS

1.5.1 The fibre patch cords shall match the single-mode backbone fibre.

1.6 SUBMITTALS

1.6.1 Shop drawings shall be submitted for each type of product indicated or equivalent in the following document to be approved prior to installation.

2 PART 2 - PRODUCTS

2.1 UTP PATCH CORDS

2.1.1 All data patch cords shall conform to the requirements of the ANSI/TIA 568-D series or the latest edition of the Commercial Building Telecommunication cabling Standard for horizontal cabling section.

2.1.2 The cordage shall use 28 AWG small diameter solid copper conductors.

2.1.3 The nominal cable diameter of the cordage shall be no greater than 4.72 mm (0.186 in). The minimum bend radius shall be no greater than four times the nominal cable diameter of the cordage.

2.1.4 Patch cords are to be available in the following colours and lengths.

LENGTH	COLOUR
1.2m	Blue (colour code #0000ff)
2.1m	Blue (colour code #0000ff)
3.0m	Blue (colour code #0000ff)

2.2 OPTICAL FIBRE PATCH CORDS (OS1/OS2 SINGLE-MODE)

2.2.1 Dual fibre optic patch cords, OS1 and/or OS2 single-mode equipped with LC to LC connectors.

2.2.2 Patch cords are to be factory assembled and not site prepared.

2.2.3 Patch cords shall be the shortest length possible that can be correctly installed. Clarify with the UTM I&ITS Designate if any of the following lengths are acceptable: 1.2m (4'), 2.1m (7') and 3m (10').

3 PART 3 - EXECUTION

3.1 INSTALLATION

3.1.1 Install the Cat 6A UTP patch cords from the network switches to the data patch panel using the horizontal and vertical wire managers as per the supplied patching and labelling schedule received from the UTM I&ITS Designate.

3.1.2 Supply a Cat 6A UTP patch cord for the workstation, and connect it to the data jack on the faceplate. One per data drop installed.

END OF SECTION

Smith + Andersen
1100–100 Sheppard Ave. East, Toronto ON M2N 6N5
416 487 8151 f 416 487 9104 smithandandersen.com

AUDIOVISUAL SPECIFICATION

PROJECT NAME:

ROBOTICS LABORATORY ENVIRONMENT BUILDING
UNIVERSITY OF TORONTO – MISSISSAUGA
MISSISSAUGA, ONTARIO

OUR PROJECT NUMBER:

21352.002.AV.001

DATE:

2023-11-15

ISSUED / REVISION:

FOR AV TENDER

27 00 00.01 Index

END OF SECTION

27 00 00.10 Audiovisual Compliance Statement

Our company has reviewed all specifications identified on the Audiovisual Index 27 00 00.00, all addenda and contract drawings as identified on AV-000 and confirm our bid submission is compliant with the requirements described in these contract documents. We commit to delivering the project in compliance with the contract documents at the price submitted on the tender form.

_____
Signing Officer Signature

_____
Signing Officer Name

_____
Company

END OF SECTION

27 40 05.00 Audiovisual Definitions and Abbreviations

1. General

1.1. DEFINITIONS

1.1.1. Generally, the following definitions are used in this Division:

Addendum	-	Normative document used to provide additional requirements and recommendations to a published document (e.g., standards, contracts). When published, an addendum effectively becomes part of the document that it supports.
AV Contractor	-	The successful bidder to this Specification responsible for the supply and installation of the Audiovisual Systems as detailed in this document & associated drawings.
AV Consultant	-	Smith + Andersen Consulting Engineers
Deficiency Review	-	A meeting between the Owner, AV Contractor and AV Consultant to review the Project to determine whether the work meets the requirements of the Owner as detailed in this document and associated drawings.
Final Acceptance	-	The date which the Owner, AV Contractor and AV Consultant have agreed the Project is complete, functional, free of deficiencies and the AV Contractor has submitted all required documentation for project closeout. Refer to section 27 40 10 “Final Acceptance” for greater detail.
Project	-	Supply and installation of a complete and functional Audiovisual System as described in this document.
Provide	-	Supply, install, terminate, test and commission.
Substantial Completion	-	The period between the deficiency review meeting date and the date of final acceptance. The audiovisual system physical installation, programming and Contractor commissioning is complete and ready for review by Consultant and Owner.

1.2. ABBREVIATIONS

1.2.1. Generally, the following abbreviations are used in this Division:

ADA	-	Americans with Disabilities Act
AES	-	Audio Engineering Society
AFF	-	Above Finished Floor
AGC	-	Automatic Gain Control
AHJ	-	Authority Having Jurisdiction
ALS	-	Assistive Listening System
AV or A/V	-	Audiovisual

AVB	-	Audio Video Bridging
AVC	-	Advanced Video Coding
AWG	-	American Wire Gauge
BACnet	-	Building Automation and Control Networking Protocol
BAS	-	Building Automation System
BICSI®	-	Building Industry Consulting Service International
BOM	-	Bill Of Material
BTU	-	British Thermal Unit
CAD	-	Computer Aided Design
CATV	-	Community Antenna Television (Cable Television)
CCIA	-	Computer Communications Industry Association
CCTV	-	Closed Circuit Television
CSA	-	Canadian Standards Institute
CTS	-	Certified Technology Specialist
CTS-D	-	Certified Technology Specialist Design
CTS-I	-	Certified Technology Specialist Installation
DANTE	-	Digital Audio Network Through Ethernet
dB	-	Decibel
dBa	-	A-weighted Decibels
dBm	-	Decibel milliwatt
dBmV	-	Decibel millivolt
DCI	-	Digital Cinema Initiatives
DHCP	-	Dynamic Host Configuration Protocol
DM	-	DigitalMedia
DNS	-	Domain Name System
DSP	-	Digital Sound Processing
DVI	-	Digital Visual Interface
EBU	-	European Broadcasting Union
EDID	-	Extended Display Identification
EIA	-	Electronics Industry Alliance
EMI	-	Electromagnetic Interference
EMI/RFI	-	Electromagnetic Interference / Radio Frequency Interference
FCC	-	Federal Communications Commission
ft	-	Foot / Feet
ft^2	-	Square Foot / Feet
FTP	-	File Transfer Protocol
Gb/s	-	Gigabit per Second
GC	-	General Contractor
GHz	-	Gigahertz
GUI	-	Graphical User Interface
HDCP	-	High-Bandwidth Digital Content Protection
HDMI	-	High-Definition Multimedia Interface
Hz	-	Hertz
IEC	-	International Electrotechnical Commission
IEEE®	-	Institute of Electrical and Electronics Engineers, Inc. ®
IG	-	Isolated Ground
in	-	Inch
in^2	-	Square Inch
I/O	-	Input / Output (Device)
IPv4	-	Internet Protocol version 4
IR	-	Infrared
ISDN	-	Integrated Services Digital Network
ISO	-	International Organization for Standardization
IT	-	Information Technology
kb	-	Kilobit

kB	-	Kilobyte
kg	-	Kilogram
Km	-	Kilometre
KSVs	-	Key Selection Vectors
kV	-	Kilovolt
kVA	-	Kilovoltampere
kW	-	Kilowatt
kWh	-	Kilowatt hour
LAN	-	Local Area Network
laser	-	Light Amplification by Stimulated Emission of Radiation
lb	-	Pound
LCD	-	Liquid Crystal Display
LED	-	Light Emitting Diode
LSZH	-	Low Smoke Zero Halogen
m	-	Metre
m^2	-	Square Metre
mA	-	Milliampere
Mb	-	Megabit
MB	-	Megabyte
Mb/s	-	Megabit per Second
MB/s	-	Megabyte per Second
MHz	-	Megahertz
MIDI	-	Musical Instrument Digital Interface
mm	-	Millimetre
MM	-	Multimode
MMF	-	Multimode Fibre
ms	-	Millisecond
mW	-	Milliwatt
MW	-	Megawatt
NFPA	-	National Fire Protection Association
NIC	-	Network Interface Card
OD	-	Outside Diameter
OEM	-	Original Equipment Manufacturer
OFE	-	Owner-furnished equipment
OLED	-	Organic Light Emitting Diode
OTDR	-	Optical time domain reflectometry
PBX	-	Private Branch Exchange
PDU	-	Power Distribution Unit
PoE	-	Power-Over-Ethernet
POTS	-	Plain Old Telephone Service
PTZ	-	Pan, Tilt, Zoom
PVC	-	Polyvinyl Chloride
QA	-	Quality Assurance
QC	-	Quality Control
QoS	-	Quality of Service
QXGA	-	Quad Extended Graphics Array
RCA	-	Radio Corporation of America
RCDD®	-	Registered Communications Distribution Designer
RF	-	Radio Frequency
RFI	-	Radio Frequency Interference
rms	-	Root Mean Square
RU	-	Rack Unit (1.75”)
RX	-	Receiver
SDI	-	Serial Digital Interface
SI	-	International System of Units (Le Système International d’Unités)

SIP	-	Session Initiation Protocol
SLA	-	Service level Agreement
SM	-	Singlemode
SNR	-	Signal-to-Noise Ratio
S/PDIF	-	Sony/Phillips Digital Interface
SPL	-	Sound Pressure Level
STP	-	Shielded Twisted Pair
STP-A	-	Shielded Twisted Pair A
TCP	-	Transmission Control Protocol
TDR	-	Time Domain Reflectometer
TFT	-	Thin Film Transistor
TIA	-	Telecommunications Industry Association
TP	-	Twisted Pair
TR	-	Telecommunications Room
TRS	-	Tip, Ring, Sleeve
TS	-	Technical Standard
TV	-	Television
UHD	-	Ultra high definition
ULC	-	Underwriters Laboratories of Canada
UPC	-	Universal Product Code
UPS	-	Uninterruptible Power Supply
USB	-	Universal Serial Bus
UTP	-	Unshielded Twisted Pair
V	-	Volt
VA	-	Volt-Ampere
VESA	-	Video Electronics Standards Association
VGA	-	Video Graphics Array
VLAN	-	Virtual Local Area Network
VoIP	-	Voice over Internet Protocol
VPN	-	Virtual Private Network
W	-	Watt
WAN	-	Wide Area Network
WAP	-	Wireless Application Protocol
WiFi	-	Wireless Fidelity
Wi-Fi	-	Wireless Fidelity
WLAN	-	Wireless Local Area Network
WUXGA	-	Widescreen Ultra Extended Graphics Array
WXGA	-	Wide Extended Graphics Array
XGA	-	Extended Graphics Array
XLR	-	External Line Return

2. Products

2.1. NOT USED

3. Execution

3.1. NOT USED

END OF SECTION

27 40 10.00 General Instructions for Audiovisual System Installation

1. General

1.1. GENERAL

1.1.1. Conform to the requirements of Division 0, Division 1 and Division 25 which applies to and forms part of all sections of the work. If these are not included within Tender package, AV Contractor can request a copy from the Owner's representative.

1.1.2. This Specification is for the supply and installation of AV Systems at the 'facility' for the following project:

University of Toronto

Ground Floor

Mississauga, Ontario

1.2. WORK INCLUDED

1.2.1. Read and comply with all sections of this document.

1.2.2. This Specification is to be read in conjunction with the corresponding Tender Drawings, which together, describe the complete scope of work, associated systems and system requirements necessary to achieve the intended performance, installation and functions of the Audiovisual Systems to be provided. Equipment shown on drawings but not written specifications or vice versa does not preclude the AV Contractor from supplying equipment. Take note of the "Division of Responsibility" table on drawing AV-000.

1.2.3. The Specification is divided into Sections which are not intended to identify contractual limits between Sub-Contractors nor between the AV Contractor and any Sub-Contractors. The requirements of any one Section apply to all Sections. Refer to other Divisions and Sections to ensure a complete and operational system.

1.2.4. Provide AV components and accessories which may not be specifically shown on the Drawings or stipulated in the Specifications, but are required to ensure complete and operational systems.

1.2.5. Provide all labour, materials, tools, and equipment required for the complete installation of work called for in all sections of the Contract Documents.

1.3. ERRORS AND OMISSIONS

1.3.1. Errors and/or omissions in the proposal documents shall be reported to the AV Consultant and Owner immediately during the time of response. Items not reported during this time shall not relieve the AV Contractor of the responsibility for providing properly functioning systems as specified or intended in the Contract Documents.

1.3.2. The AV Contractor shall review all reference drawings and site conditions, and report any discrepancies prior to award of contract, including additional electrical infrastructure requirements, to the AV Consultant as part of the review drawing submission.

1.3.3. While every attempt has been made to ensure all information is correct at the time of publication, verification for the availability of products specified and correct part numbers shall be the responsibility of the AV Contractor. Some products and components may be discontinued at the time of procurement. It shall be the responsibility of the proponent to provide the most current replacement model for all discontinued products that meet the requirements of these specifications at no additional cost to the Owner. Any errors and/or omissions in this Specification shall be included with their bid submissions.

1.4. BID SUBMISSION

1.4.1. Bidder Information

1.4.2. Supply a description of the firm complete with the following information:

.1 Main contact information

.2 Number and type of full-time staff

.3 Corporate history

.4 Office performing the work (if not the main office)

.5 Product Representation

.6 Certifications and Service Authorizations

.7 Test Equipment (eg. Fluke, Sencore, SMAART)

.8 Facilities

.9 Financial Information

.10 Average Gross Receipts (for past 5 years)

.11 Bonding Capacity – state whether Performance Bond ever exercised

.12 Insurance Limits

.13 Bank Credit References

.14 Recent and current litigation experience, both project and non-project related

1.4.3. Project Experience

.1 Provide summary and references for project experience of similar scope and scale.

.2 Qualified bidders should have completed a minimum of two projects of similar scope and scale within the past 24 months. Contact names and telephone numbers are required for these projects.

1.4.4. Statement of Qualifications

.1 The AV Contractor shall provide all required manufacturer certifications to procure, install and support all products and solutions indicated in this specification.

.2 The AV Contractor shall identify service technicians that shall service the project. It is expected that the Service depot for the project is within 100km of the project.

.3 Please see “Warranty” section 1.12 for further submission requirements.

1.4.5. Project Schedule

.1 Provide a project schedule with milestones and completion dates. Milestones should include:

.1 Kick-off meeting (with Owner, general Contractor and AV Consultant)

.2 Approval drawing submission

.3 Coordination meeting with client’s IT department (if required)

.4 Equipment delivery to site

.5 Room-by-room completion dates

.6 Substantial Completion date

.7 Date for submission of Owner manuals and as-built drawings

.8 Training

1.4.6. Project Execution

.1 Provide a description of all techniques used to meet major deliverables including schedules, meeting reports, escalation procedures, approval drawings, testing, on-site installation, equipment and user manuals, training and commissioning.

1.4.7. Post Commissioning

.1 Provide a description of the Bidder's post commissioning service procedures including response times, extended warranty information and extended services.

.2 The AV Contractor shall identify service technicians that shall service the project. It is expected that the Service depot for the project is within 100km of the project.

.3 Please see section 27 40 10 clause 1.12 "Warranty" for further submission requirements.

1.4.8. Compliance Statement

.1 The Bidder is required to review and sign the included compliance statement. The bidder's Compliance Statement must be provided with the bid response.

1.4.9. Project Personnel

.1 Provide Curriculum Vitae or Statement of Qualifications for all project personnel. CVs should include past project experience, educational background and relevant certifications. Contractor must have personnel with AVIXA Certified Technology Specialist (CTS) designation.

.2 Bid response should include CVs for the following personnel:

.1 Account Executive/Client Contact

.2 Project Manager

.3 Project Engineer

.4 Programmers (Control systems and DSP)

.5 Site Lead

.6 All other assigned technical personnel

.3 Approved SubContractors

.1 All subContractors must be declared at the time of bid submission. Owner reserves the right to withdraw its purchase order at any time should the Systems Contractor engage a subContractor that does not meet the approval of the Owner.

1.4.10. Bill of Materials

.1 Responses should include a complete and accurate itemized list of all equipment to be supplied including wire and all hardware. The list should indicate the manufacturer, manufacturer's model number and unit of quantity. The list should be divided according to subsections in section 27 41 00.00. Proposed substitutions should be explicitly stated. If the manufacturer has permanently stopped fabrication of a specific item or has replaced an item with an almost identical item but with new model number, this item should be explicitly noted in this list.

.2 The AV Contractor shall review and submit a final Bill of Materials to the Owner four weeks prior to ordering product from the manufacturer/distributors.

.3 Include in bid all labour, materials, plant, transportation, storage costs, training, equipment, insurance, temporary protection, permits, inspections, taxes and all necessary and related items required to provide complete and operational systems shown and described.

.4 Substitutions

.1 The AV Contractor is encouraged to review the equipment specified herein and suggest alternates that may provide increased functionality and savings to the Owner without degradation to system performance or functional requirements.

.2 The AV Consultant's decision regarding the acceptance or rejection of the proposed substitution shall be final. Substitutions may be accepted if the delivery of the component or item is such that it shall not jeopardise the construction schedule. Otherwise substitution shall not be allowed.

.3 The Owner reserves the right to accept or reject any alternate without question.

.4 Substitutions shall be proposed during the question period of the bid process.

1.4.11. Pricing

.1 Provide each of the following in this section as separate sections of the bid.

.2 Base Price

.1 The respondent shall state a stipulated price to provide all work shown and described in the System Specification that shall include all premium and/or overtime charges involved to finish the stages of work before the milestones stated under Schedule. This price shall exclude all Add/Delete and Option pricing

.3 Detailed Pricing

.1 Responses are to include a complete and accurate list of all AV equipment to be supplied including wire. Include name of manufacturer, model number, unit quantity and itemized pricing. Provide subtotals according to subsections in Audiovisual System Scope of Work.

.4 Add/Delete Option Pricing

.1 An Add/Delete Option specifies work which may be added to/deleted from the Base Price at the discretion of the Owner. It can be carried separately at the discretion of the Owner. The bidder shall state a separate price for each Add/Delete option which shall increase/decrease to the total purchase price of the work, including all premiums/overtime charges.

.5 Alternate Pricing

.1 Indicate increase/decrease to overall purchase price of work as a result of switching from one specified item to another.

.6 Unit Labor Rate

.1 State hourly rates for all audiovisual specific trades on a separate page as part of the submission.

.7 Taxes TO BE ADDED

.1 Include as a separate line item applicable taxes.

1.5. CODES, STANDARDS AND REGULATIONS COMPLIANCES

1.5.1. The AV Contractor must ensure all federal, provincial, and municipal laws, codes, regulations are adhered to.

1.5.2. All products installed must meet or exceed all Local, Provincial and Federal Building, Fire, Health, Safety and Electrical Codes.

1.5.3. The AV Contractor is also responsible for any Sub-Contractors that are providing work or services under the same contract. The AV Contractor, where applicable, shall provide proof that final inspections have been adhered to and are completely satisfactory and clear with regards to the authority having jurisdiction, including any work performed by any and all Sub-Contractors. All costs associated with meeting these requirements shall also be carried within the price of the project.

1.5.4. Comply with the following industry standards:

.1 CSA Standard T527 (ANSI/TIA/EIA-607) - Grounding and Bonding for Telecommunication in Commercial Buildings

.2 ANSI/AVIXA 10:2013– Audiovisual Systems Performance Verification

.3 EIA RS-310-C – Racks and Associated Equipment

.4 AVIXA International - AV Installation Handbook, 2nd Ed. – The Best Practices for Quality Audiovisual Systems

.5 ANSI/AVIXA 2M-2010 – Standard Guide for Audiovisual Systems Design and Coordination Processes

.6 ANSI/AVIXA 1M-2009 – Audio Coverage Uniformity

.7 ANSI/AVIXA 3M-2011 – Projected Image Contrast Ratio

.8 AVIXA F502.01:2018 – Rack Building for Audiovisual Systems

.9 AVIXA F501.01:2015 – Cable Labeling for Audiovisual Systems

.10 ANSI/TIA-568-C.0 – Generic Telecommunications Cabling for Customer Premises

.11 TIA-568.1-D – Commercial Building Telecommunications Cabling Standard

1.6. SUMMARY OF WORK AND AV CONTRACTOR PERFORMANCE

1.6.1. The A/V systems described herein, shall include providing and integrating a fully functional and seamlessly integrated Audiovisual system complete with high quality professional and commercial grade audiovisual and electronic products, which include for the following equipment and systems but not limited to:

.1 Media Control Systems

.2 Flat Panel Displays

.3 Multimedia Projectors

.4 Motorized Projection Screens

.5 AV Control Systems including Touch Panel and other controllers

.6 Audio Conferencing Systems

.7 Loudspeakers

.8 Audio-Video Source Equipment

.9 Audio-Video Reinforcement and Distribution Systems

.10 Audio-Video Switching

.11 Audio-Video Interface Equipment

.12 Audio-Video Cabling and Terminations

.13 Ethernet and Control Support

.14 Architectural Elements and Mounting Hardware

.15 Display or projector lifts

.16 Video cameras (fixed or PTZ)

.17 Audiovisual production and broadcast consoles

1.6.2. Quantities or lengths indicated in any of the Contract Documents are approximate only and shall not be held to gauge or limit the work. All dimensions and conditions must be verified at the job site prior to installation. The AV Contractor to include for any additional components, slack of cabling etc. as required to complete and neatly finish the installation throughout the interior design.

1.6.3. In assessing differences between customer specifications and vendor equipment specifications, the AV Contractor shall ensure customer's maximum specified parameters are met.

1.6.4. Some products and components may be discontinued at the time of procurement. It shall be the responsibility of the proponent to provide the most current replacement model for all discontinued product that meets the requirements of these specifications.

1.6.5. The AV Contractor shall be completely responsible for the acceptable condition and operation of all systems, equipment and components forming part of the installation or directly associated with it. Promptly replace defective material, equipment and part of equipment and repair related damages.

1.6.6. In addition to providing the services and materials as described, the AV Contractor is required to provide for the following services and perform the following on-site work.

.1 Coordinate all AV requirements and system components with the project and construction team of all disciplines as required or specifically stated within the package.

.2 If required, remove any existing AV equipment not required for reuse and dispose of the equipment using environmentally accepted electronic waste disposal methods. Provide a disposal report to the project team of equipment being disposed of, include make, model and serial number for each item. Removal and disposal of all existing cabling from the ceiling space, walls and within conduit including all accessories (jacks, furniture adapters, decora straps, faceplates, surface mount boxes, patch panels, patch cords, punch down blocks, cross-connect wire etc.)

.3 Coordinate and ensure all AV cabling is provided via conduit infrastructure and raceways correctly installed to support the AV systems and related cabling networks. Where conduit infrastructure is not required, supply and install cable slings and J-hooks to supports any free cables. Any discrepancies shall be reported to the AV Consultant immediately.

.4 Coordinate and verify the AV infrastructure required for all equipment including, but not limited to, projectors, loudspeakers and associated mounting hardware prior to installation. The AV Contractor to provide for any infrastructure that has not been coordinated (i.e. backboards).

.5 Any other structural support, blocking or infrastructure to be provided by others and required to support the AV systems shall be coordinated by the AV Contractor. The AV Contractor to provide for any infrastructure that has not been coordinated.

.6 Coordinate and ensure all AV related millwork is correctly implemented and provided to support the AV systems. The AV Contractor shall review all furniture shop drawings and report to the AV Consultant if there are any issues with cutouts, pathways, ventilation, etc.

.7 Pre-build and test all systems possible prior to delivery of equipment to project site.

.8 Supply all items to be built in ample time for rapid progress of the work. Schedule and proceed with work as required to satisfy the construction schedule.

.9 Include for on-going project management, coordination among trades for all AV work and any required site meetings.

.10 Label all equipment to correlate with operation and maintenance manuals. Labelling schemes shall be confirmed with the AV Consultant prior to installation.

1.6.7. Supply all AV outlets, terminating hardware and selected connectivity devices as outlined in this Specification. All outlet shall be metal. Plastic decora plates are not acceptable.

1.6.8. Supply all hoists and scaffolds necessary to install AV equipment.

1.6.9. Visually inspect all equipment for damage or defects prior to installation. Damaged or defective materials shall be reported to the AV Consultant and the Owner.

1.6.10. The AV Contractor is responsible for loss or damage of any and all system equipment until it is permanently fastened to the building or signed over to the Owner.

1.6.11. All materials and equipment obtained for this contract shall be through manufacturer authorized distribution channels and the warranty shall be supported in the jurisdiction of the Owner. Under NO circumstances shall 'Grey Market' or 'Refurbished' items be acceptable

1.7. DRAWINGS, CHANGES AND INSTALLATION

1.7.1. The location, arrangement and connection of equipment and material as shown on the drawings represent a close approximation to the intent and requirements of the contract. The right is reserved by the AV Consultant to make reasonable changes required to accommodate conditions arising during the progress of the work, at no extra cost to the Owner.

1.7.2. The location and size of existing services shown on the drawings are based on the best available information. The AV Contractor shall verify the actual location of existing services in the field before work is commenced.

1.7.3. Changes and modifications necessary to ensure co-ordination and to avoid interference and conflicts with other trades, or to accommodate existing conditions, shall be made at no extra cost to the Owner.

1.7.4. Adequate space and provisions shall be left for removal of components and servicing of equipment, with minimum inconvenience to the operation of systems.

1.7.5. Where equipment is shown to be 'roughed in only' obtain accurate information from the AV Consultant before proceeding with the work.

1.7.6. Location of outlets, luminaires, diffusers, grilles, registers, thermostats, sprinklers and all other equipment shown on drawings (if shown) is diagrammatic. The AV Contractor to coordinate on-site or ask direction from AV Consultant to address any discrepancies on site.

1.7.7. The AV Contractor is responsible to mark-out their work and fully co-ordinate with all other trades. The AV Contractor shall review architectural and interior design drawings for exact locations of equipment. Review with AV Consultant prior to rough in.

1.8. FINAL ACCEPTANCE

1.8.1. Final acceptance is the date which the Owner, AV Contractor and AV Consultant agree the project is complete, functional, free of deficiencies and the AV Contractor has submitted all required documentation for project closeout.

1.8.2. A holdback equating to 10% of the value of the base contract shall be released on the date of Final Acceptance. 10% is equated as the value of testing, training, commissioning, deficiency correction and close-out documentation submittal.

1.8.3. The step-by-step process to reach Final Acceptance is as follows:

.1 AV Contractor declares the project is substantially complete and ready for the deficiency walk-through.

.2 AV Contractor to complete the Compliance Checklist as supplied by the AV Consultant prior to deficiency walk-through.

.3 Deficiency walk-through visit between AV Consultant, AV Contractor and Owner Representative to review all systems to ensure compliance with the design intent.

.4 Following the deficiency walk-through, a final Job Report shall be issued by the AV Consultant outlining any deficiencies or outstanding items to be completed. The AV Contractor shall be responsible for making all corrections as identified in the report. A second visit may be required depending on the extensiveness of deficiencies.

.5 Submittal of as-built drawings, control and DSP program source code and manuals as stated in section 3.

.6 Training sessions supplied as described in this specification. Training sign-off sheets from each training session including a list of participants.

.7 Warranty letter with the start of service period marked as the date of final acceptance.

1.9. LABOUR

1.9.1. The AV Contractor must comply with all job-site requirements for the duration of the project.

1.9.2. The AV Contractor shall not assign or sub-contract any work without the prior written consent of the Project Manager. A list of sub-Contractors shall be submitted with the Tender response.

1.9.3. The AV Contractor agrees to use only tradesmen who are fully trained, qualified and experienced on the installation, termination and testing of the AV System Solution. The AV Contractor must have their AVIXA Certified Technology Specialist designation.

1.9.4. The AV Contractor shall supply unionized workers on construction sites where this is a requirement.

1.10. PROGRESS BILLING EVALUATIONS

1.10.1. Monthly progress billings shall be issued by the AV Contractor and payment certificates shall require approval from AV Consultant. The AV Contractor shall bill according to an estimate of the percentage of the completed AV sub-systems. Progress billings shall not be reviewed unless they are submitted in the format outlined in the following example:

BASE CONTRACT	
Total Contract Amount	$250,000.00
Tender Completed to Date	$125,000.00
Amount Previously Approved	$25,000.00
Amount of this Draw	$100,000.00
Less 10% Holdback	$10,000.00
Amount of this Draw (less 10% holdback)	$90,000.00
CHANGES	
Total Contract Changes:	$5,000.00
Total Changes Completed to Date	$2,500.00
Amount Previously Approved	$0.00
Amount of this Draw	$2,500.00
Less 10% Holdback	$250.00
Amount of this Draw (less 10% holdback)	$2,250.00

1.10.2. The AV Contractor shall not bill for materials that are not on-site and in the process of installation.

1.10.3. The AV Contractor may be asked to revise the amount being billed based on the AV Consultant's assessment of project progress and completed systems.

1.10.4. The AV Contractor shall provide current site progress photos with each draw to support the amounts requested.

1.10.5. The following milestones shall be deemed as acceptable for monthly draw (holdback not included):

.1 Deposit and kick off – 25%

.2 Shops submitted & Reviewed – 35%

.3 Cables pulled/Site prepared – 45%

.4 Equipment delivered – 60%

.5 Equipment installed – 80%

.6 Substantial Completion – 90%

.7 Project Complete & Close out Document Received – 100%

.8 all above do not include holdback

1.11. TRAINING

1.11.1. The AV Contractor shall provide a comprehensive review with the Owner to cover all system operation and maintenance.

1.11.2. Training shall be provided in multiple sessions, within a minimum total of sixteen (16) hours. Each session shall be a minimum of two (2) hours in length.

1.11.3. One (1) training session shall be scheduled immediately following final acceptance by the AV Consultant of the system.

1.11.4. Training materials shall be provided to the users prior to scheduled session.

1.11.5. The Owner shall have the ability to schedule sessions within the warranty period at mutually acceptable dates and times.

1.11.6. Provide a sign-off sheet for each training session. The sign-off sheet shall include:

.1 A list of attendees

.2 Topics covered within session

.3 Date, time and duration of session

.4 Signature by an Owner's representative to confirm session was performed and completed to the satisfaction of the Owner.

1.12. WARRANTY

1.12.1. Provide a written warranty for all work of the AV system for a period no less than one (1) year from the date of substantial completion as certified by the AV Consultant. Warranty certificate shall be submitted as part of the close out documentation as described in Final Acceptance

1.12.2. Warranty shall cover the installation and equipment to be free of all defects resulting from faulty components, workmanship, installation or incorrect calibration. Replacements and repairs shall be made without cost to the Owner.

1.12.3. Provide the name of a contact, phone number and 24 hour emergency number and insert into all manuals and update as required. Ensure that all contact information is kept current.

1.12.4. All service calls should be answered or returned within four hours between 8:00am and 6:00pm (local time). All onsite responses should be within 24 hours.

1.12.5. Perform onsite replacement of failed equipment. All failed equipment must be replaced by identically functional and technically equivalent device. Timelines for equipment replacement have been separated into two types:

.1 Critical Equipment

.1 Replacement must be provided by next business day of the initial service call.

.2 This includes any piece of equipment that renders the system of a room not useable for either conferencing or presentation capabilities.

.3 Temporary/rental equipment of similar functionality is acceptable upon approval from Owner at no additional cost.

.2 Non-critical

.1 Replacement must be provided at best effort within a week of the initial service call.

.2 This includes any piece of equipment that limits the functionality of a room system.

1.12.6. The system warranty shall include parts and labour for the duration of the warranty.

1.12.7. Warranties offered by manufacturers that exceed the AV Contractors installation warranty, shall be reported and noted with the Owner and recorded in the manuals. The AV Contractor shall be responsible for managing these extended warranties. Additional costs regarding removal, shipping and re-installation after the installation warranty period has expired, shall be reported to the Owner prior to commencing work.

1.12.8. All custom programming shall be warranted against faults and deficiencies for the duration of the installation warranty commencing at certificate of substantial completion. Any and all necessary changes under this warranty are to be at no cost to the Owner and the AV Contractor shall notify the AV Consultant of such changes.

1.12.9. When custom programming is used to mimic a manufacturer's graphical user interface to provide a consistent graphical user experience, the AV Contractor shall update the custom programming at no cost during the warranty period in the event that a firmware updated changes the manufacturer's graphical user interface. For example, if a project contains both Cisco and Crestron Touch panels, any changes made by Cisco to their graphical interface shall result in the AV Contractor adjusting the custom programming to reflect that change. Allow for one update to be complete within the last 60-days of the warranty period.

1.12.10. The AV Contractor must follow-up with the Owner ninety days after substantial completion to investigate any potential issues or concerns relating to the completed system. Any concerns raised shall be addressed appropriately and with the AV Consultant for clarification.

1.12.11. The AV Contractor shall provide one (1) preventative maintenance visit for the extent of the warranty period at no additional cost to the Owner. This system maintenance visit shall not be required until after duration of six (6) months after substantial completion. Subsequent services shall be coordinated and agreed to by Owner.

1.13. EXTENDED WARRANTY

1.13.1. Any extended warranty or service plan commencing after the installation warranty, may be offered by the AV Contractor to the Owner. Communications regarding this service must commence at least sixty (60) days prior to warranty expiration, at which time, the AV Contractor is responsible to update any firmware and software available for system components to the latest version and verify that update has not affected the functional requirements and system performance as outlined in within this scope of work.

2. Products

2.1. NOT USED

3. Execution

3.1. WORKMANSHIP AND BEST PRACTICES

3.1.1. The AV Contractor is responsible for the requirements of the practices and testing requirements detailed in this section.

3.1.2. Equipment installed by the AV Contractor shall not present safety hazards to the public, to other trades, or to equipment operators.

3.1.3. All equipment must be sufficiently ventilated when operating under worst-case power and heat dissipation scenarios.

3.1.4. Any equipment or material not directly specified within this document but still required for a fully functioning system shall be of commercial standard and high quality.

3.1.5. Submit proposed equipment and device samples to AV Consultant if requested.

3.1.6. Workmanship is as important a consideration for the overall job as functionality. Fabricate and install all equipment in accordance with the manufacturers' recommendations and the AV Consultant's specifications. Coordinate with other trades and the AV Consultant to provide an installation of the highest quality.

3.1.7. Before the system is deemed complete and ready for final acceptance, all hardware and software issues shall be rectified by AV Contractor and reviewed by AV Consultant.

3.2. APPROVAL DOCUMENTATION

3.2.1. General

.1 Prior to ordering equipment, commencing work on site or expending labor on programming time provide the information detailed in this section.

.2 Maintain a copy all documentation and software files for a minimum of three (3) years and provide accessibility to the Owner at any time within that time frame.

3.2.2. Equipment Cutsheets

.1 Prior to ordering equipment, submit all equipment cutsheets to be included in the project. Identify all colour choices. Ensure cutsheets are submitted through the established construction process. The general Contractor, architect, interior designer and AV Consultant shall review the cutsheets.

.2 Provide a spreadsheet of all items that are available to be ordered.

.3 Organize and name the cutsheets according to product specification types identified in 27 41 00 Audiovisual System Scope of Work Part 2 "Products".

.4 Indicate all colour choices on the spreadsheet.

.5 Submit the spreadsheet for approval by the Owner or their representatives and the project team prior to ordering of any equipment.

.6 Cutsheets for different equipment shall have their own dedicated file. The cutsheet file title shall be formatted as follows: "MANUFACTURER – MODEL NUMBER". Identify the file format naming convention in the spreadsheet.

3.2.3. Approval (Shop) Drawings

.1 The AV Contractor must obtain written approval of shop drawings from the AV Consultant and/or Owner prior to procurement of equipment and commencement of work on site unless directed otherwise by the AV Consultant.

.2 Approval drawings are defined as drawings required to execute the job to the standards and conformance of the specification and contract drawings.

.3 Approval drawings are used to ensure conformance with the project system design. Only compliance with the Contract Documentation shall be reviewed as part of the approval process. Corrections or comments submitted by the AV Consultant do not relieve the AV Contractor of conformance to the specification and contract drawings.

.4 The AV Contractor shall provide to the AV Consultant a complete set of electronic approval drawings in PDF format. Bound hard copies of shop drawings / engineering specifications must be made available on request by the AV Consultant and/or Owner.

.5 Approval drawings should include:

.1 Cable pull schedules which includes wire numbers, source and destination locations, cable type, AV system serviced and conduit the cable is to be run within.

.2 AV system functional diagrams that show the interconnection of all equipment. For each wire indicate wire number (numbering scheme should indicate wire type). At each device connection indicate connector and termination type. For each device or device group identity type, model and location. For each multi-pin connection provide pin/conductor/function detail. For 70 V speakers indicate transformers with loudspeaker tap connections.

.3 Front and rear equipment rack elevations including rack accessories. Provide all specifications for equipment rack and accessories. Provide AC rack power distribution scheme.

.4 Wall plate, bulkhead and floorbox plate layouts. Give each plate a unique identifier. Give each connector a unique identifier.

.5 Sightline studies, equipment installation and any other details that clearly communicates the AV Contractor's installation methodology to the AV Consultant.

.1 For devices or systems in weight over 22kg (50lbs), shop drawings will be reviewed for design intent. After no comments by the AV Consultant, the AV Contractor shall obtain a Structural Engineer stamp with appropriate jurisdiction in the region of that installation on the drawing. The shop drawing with the stamp shall be resubmitted for record. Installation of device or system shall not commence without a stamped drawing.

.6 Software flow diagrams and any preliminary control system programming code.

.6 Include annotations, amendments and or comments as required. These must be corrected where noted and if modifications are needed or if added equipment is needed for the system to function as intended, there shall be no changes to the contract value as the AV Contractor is responsible to provide a proper working system. Corrections shall be made in a timely manner as to not impact Construction schedule or delivery of system.

3.2.4. Graphical User Interfaces

.1 Provide preliminary graphical user interfaces for touch panels, custom software, button interfaces or any other control surfaces. Format the document in a method that clearly indicates menu navigation hierarchies.

.2 Submit user interfaces for review prior to the commencement of system programming. See section 27 41 16.15 Control Systems for further details.

.3 Coordinate an on-site workshop with the Owner's user group to review the proposed interfaces for Owner feedback. This workshop should occur after GUIs are developed, before detailed programming is completed. Allow for one (1) major revision and one (1) minor revision to the interfaces following the workshop.

3.3. AS-BUILT DRAWINGS

3.3.1. As-Built Drawings

.1 As-Built Drawings shall include:

.1 Approval drawings revised to reflect as-built changes.

.2 Device locations showing all floor, wall and ceiling equipment locations

.3 Elevation drawings of all mounted AV equipment.

.4 Riser/cable diagrams indicating system conduit, back boxes, connector, and cable interconnections. Indicate cable quantity and type for each cable run.

.5 Functional line diagram of the completed system per specification

.6 Metalwork fabrication drawings can be excluded.

.7 Include any other drawings indicated in the specification.

.8 Any diagrams that is required for a complete description of the system.

.9 Supply two (2) soft copies of As-Built Drawings in PDF and AutoCad format. One copy shall be for the Owner, the other for the AV Consultant.

3.4. SYSTEM MANUALS

3.4.1. Approval System Manuals

.1 Provide two soft copies of the System Manual, one to the AV Consultant and one to the Owner in PDF format by email/FTP for review and approval.

.2 All operation and maintenance manuals and all testing and commissioning reports shall be provided to Owner and Owner's representative. Any deficiencies found during the testing or commissioning phase of work, shall be reported immediately to the Owner and the Owner's representative.

.3 Manuals shall contain a minimum of the following:

.1 Detailed table of contents

.2 Title page which clearly indicated Project Name and Document Title.

.3 Contacts and credits page.

.4 User operating instructions with detailed views of various systems for the day-to-day user. Include all control panel layouts, screen dumps, DSP control interfaces, and any other GUI.

.5 Manufacturer product manual(s) and literature for all components. Include technical system manuals for all systems described in the specification which should include all service procedures.

.6 Software instruction manuals.

.7 Copies of all approvals, stamps and inspection certificates.

.8 Optimally configured settings for all signal processing equipment, zone selections, gain settings and control systems.

.9 Performance data of completed system test results.

.10 Amplifier connections and corresponding test results at normal operation.

.11 Termination records, for strips, switches, floor plug connections.

.12 Warranty Certificate with statement of completion.

.13 List of manufacturer's warranties by date of expiration.

.14 Room configuration procedures.

.15 Troubleshooting activities

.16 Service support contact numbers divided by Account Manager and 24/7 support staff.

3.4.2. As-Built System Manuals

.1 After AV Consultant sign-off of Approval Manuals, Provide two soft-copy sets in PDF format by cloud storage/FTP/email to the project team, AV Consultant and the Owner. At the request of the Owner or AV Consultant, supply one bound hard copy set of manuals.

.2 The Owner reserves the right to reproduce all documents for internal corporate use.

.3 The AV Contractor shall ensure an electronic copy of the close-out documentation are available to the Owner for a period of three years following the date of substantial completion.

3.4.3. Quick Reference Guide

.1 Provide (qty: 1) laminated quick reference guide for each custom user interface described in the Scope of Work. The quick reference sheet is intended to assist with training end-users on the AV systems in order to minimize unnecessary helpdesk calls. Quick reference sheet shall visually depict user interfaces and describe how the user is to interact with the system.

3.5. EQUIPMENT STORAGE

3.5.1. The AV Contractor shall coordinate with the General Contractor/Construction Manager for any required on-site storage during construction.

3.5.2. The AV Contractor is responsible for loss or damage of any and all system equipment until it is signed over to the Owner on the date of final acceptance.

3.5.3. The AV Contractor shall include all storage costs as required to meet the project timelines at time of bid.

3.6. OFF-SITE SYSTEM STAGING

3.6.1. All items within this section shall be completed offsite, at the AV Contractor facility.

3.6.2. All equipment shall be tested prior to delivery to site to ensure fully functionality.

3.6.3. All equipment shall be configured and shall be ready for use upon installation onsite.

3.6.4. All equipment shall have it's firmware updated prior to testing.

3.6.5. All equipment racks shall be configured and populated with equipment to allow for pre-delivery inter-rack cabling termination and labeling.

3.6.6. All digital signal processors shall have the site file loaded to ensure that only calibration is required to occur on site.

3.6.7. All control processors shall have the compiled files uploaded and tested.

3.6.8. All touch panels shall have the control interface uploaded and fully operational.

3.6.9. All AV network switches shall be configured with port assignments and VLANs.

3.6.10. All systems shall be connected to simulate the onsite installation as close as possible prior to delivery on site to test interconnectivity so that upon arrive and installation, the systems shall be ready for testing and commissioning to minimize schedule impacts.

3.6.11. All systems shall be left functioning as per the above for a minimum of two (2) days to allow for a burn-in cycle to occur and identify any possible defective equipment.

3.7. CONTROL HARDWARE AND USER INTERFACES

3.7.1. All custom graphical user interfaces for touch panels and other control system user interfaces shall be submitted to the AV Consultant and the Owner for review and approval prior to system commissioning.

3.7.2. All hardware used to control and interface with the computer system shall be tested and fully functional prior to installation on site.

3.7.3. Software programs that control operable machinery must require tally from said devices.

3.7.4. Any control hardware located on walls that may be subject to impacts shall include an impact resistant cover to prevent damage.

3.8. DEVICE SECURITY (PASSWORDS)

3.8.1. All device access and configuration passwords for devices shall be changed from default to a custom password.

3.8.2. All passwords shall be created to the maximum security level of the device.

3.8.3. Passwords shall include the below criteria items based on the level of security of the device:

.1 Include a combination of upper and lower case letters

.2 Include a minimum of one number

.3 Include a minimum of one special character

.4 Minimum length of 8 characters

3.8.4. All passwords shall be recorded and included in close out documents.

3.9. SOFTWARE STANDARDS (CONTROL SYSTEM, DSP AND COMPUTER-BASED)

3.9.1. Supply two copies of custom developed software (compiled and uncompiled) and documentation along with System Manuals. The documentation shall describe all GUIs, modes of operation, licenses, presets, and programming so service personnel can competently operate and troubleshoot the system.

3.9.2. Upon request of AV Consultant, supply licensed development environment, compiler software, project-specific source code with source commenting, custom executables and libraries, uncompiled script files and any other code required for program evaluation and debugging.

3.9.3. The AV Contractor can expect that the AV Consultant shall expect the manufacturer to review the AV Contractor's programming. The AV Contractor may be requested to modify program according to manufacturer's recommendations.

3.9.4. All custom software shall be created by programmers with the appropriate manufacturer certification or by manufacturer authorized personnel.

3.9.5. Where security passwords are used, ensure that each security level is properly defined and all users have appropriate access as directed by the AV Consultant. The AV Contractor must submit to the AV Consultant for review all security features prior to commissioning.

3.9.6. When utilizing DSP processing for loudspeaker optimization, consult the manufacturer of the loudspeaker system to obtain recommended settings and/or macros. Include any custom loudspeaker setting within the system documentation.

3.9.7. Prior to commissioning, submit all software programming files to AV Consultant for review. All software submissions must be accompanied by documentation indicating the intent of the program, table of presets, flow diagrams, revision date and any omissions to overall functionality.

3.10. COMPUTER SYSTEMS

3.10.1. Computer system shall not be installed on site during construction with the presence of dust and debris.

3.10.2. All computer system components should be of premium quality and sourced from reputable vendors.

3.10.3. All computer-based systems should meet the Owner's specifications.

3.10.4. All computer systems should be 19" rack-mountable.

3.10.5. Backup all hard drives and ensure a duplicate image of the hard disk exists at time of Owner acceptance.

3.10.6. Integrate any security features with Windows Security standard suite where possible.

3.11. WIRING AND CABLE TERMINATION

3.11.1. The AV Contractor should take all measures to prevent electromagnetic and electrostatic interference.

3.11.2. All precautions should be taken to avoid inadvertent grounding of shield. All terminations of shielded twisted pair cables shall have the shield drain wire covered with a Teflon sleeve and a heat shrink or neoprene sleeve covering the point where the cable jacket and shield end. At the termination point, the unshielded leads should be less than 50 mm in length.

3.11.3. All wiring entering equipment racks should have a 2-meter service loop neatly dressed and harnessed within the equipment rack.

3.11.4. All cable bundles within equipment racks should be neatly and logically routed and organized. Bundles of varying signal level should be spaced at least 10 cm apart and secured using lacing bars. AC power cabling should be separated from low voltage cabling.

3.11.5. All runs of shielded twisted pair and coaxial cable shall be continuous.

3.11.6. Only cables and connectors listed in specifications and drawings shall be used.

3.11.7. All cable run free-air in ceiling spaces and in raised-access floors shall be FT-6 rated.

3.11.8. All IP-based audiovisual solutions utilizing category cabling shall terminate to patch panels at the equipment rack.

3.12. INTERCONNECTION BEST PRACTICES

3.12.1. All audio level wires shall be balanced and floating unless otherwise specified.

3.12.2. Where audio cables share conduits with control cables, appropriate precautions should be taken to prevent pops, clicks and noise in the system.

3.12.3. All shielded cables shall have their shields isolated from both the conduit system and any other shielded cables.

3.12.4. All BNC-type video connectors shall be of high quality with crimp style strain relief.

3.12.5. All BNC-type RF connectors shall be of high quality with compression style strain relief.

3.12.6. All XLR connectors should be inserted into panels from the rear. Ensure labelling strips do not interfere with the connector releasing mechanisms.

3.13. LABELLING

3.13.1. Wire Labelling

.1 All adhesive cable labels shall meet the legibility, defacement, and adhesion requirements specified in UL 969 (Ref. D-16). In addition the labels shall meet the general exposure requirements in UL 969 for indoor use.

.2 Cable Labels shall be of self-laminating vinyl construction with a white printing area and a clear tail that self laminates the printed area when wrapped around a cable. The clear area should be of sufficient length to wrap around the cable at least one and one-half times.

.3 All labels must be mechanically printed using a laser printer. Hand-written labels are not permitted.

.4 All wires shall be marked as indicated on functional diagrams and cable schedules.

3.13.2. Wall Plate, Floorbox Plate and Patch Panels

.1 Ensure each wall plate and floorbox plate is identified to indicate the physical location of the outlet, the designation and the circuit number of termination.

.2 All panels are to be laser engraved or marked with lamacoid label strips.

.3 Submit samples to AV Consultant for approval prior to manufacturing.

3.13.3. Network Cabling

.1 Ensure all new network cable naming conventions are consistent with building infrastructure as specified by the Owner.

3.14. FIELD PANELS

3.14.1. All plates shall be 0.125” aluminum stock with 0.125” bevelled edges. All panels shall have anodized finishes.

3.14.2. Plastic decora style plates are unacceptable for field connections.

3.14.3. All panels shall be labelled and laser engraved.

3.15. METALWORK

3.15.1. All metalwork shall have a minimum tolerance of 0.63 mm (0.025”). All edges shall be smooth and free of burrs and other defects.

3.15.2. Holes on panels should line up on centers with consistent spacings as shown on fabrication drawings.

3.15.3. Finished panel surfaces should be free of any surface defects. Coordinate finishes with Owner.

3.15.4. Provide fabrication drawings to AV Consultant for approval prior to fabrication.

3.16. POWER

3.16.1. Verify all AC power on site serves the needs of the AV systems and report any concerns to the AV Consultant and the Owner prior to final acceptance testing.

3.16.2. Equipment racks shall be wired to AC circuits dedicated to AV systems.

3.16.3. The AV Contractor is responsible for AC power distribution within the racks. For fixed equipment racks, provide plug strips (free of switches, fuses and circuit breakers) and direct connect to supply provided by electrical Contractor.

3.16.4. All power cords of rack-mounted equipment shall be neatly dressed so the plug is easily associated with the connected equipment. Where this is not possible clearly label the plug and associated piece of equipment.

3.16.5. Ensure that low voltage cabling is dressed separately from high voltage cabling.

3.17. RIGGING AND OVERHEAD EQUIPMENT

3.17.1. All suspended systems shall use load-rated metallic fitting designed for a load safety factor of five or greater. All fasteners should be a minimum grade 8 steel.

3.17.2. All suspended systems shall be independently supported from structure using appropriate rigging fixtures approved by the manufacturer.

3.17.3. When total suspended mass exceeds 90 kg, a Structural Engineer with appropriate jurisdiction in the province of that installation shall approve all custom-built rigging fixtures.

3.18. PORTABLE CABLING

3.18.1. All portable cable shall be stranded copper, flexible and durable for heavy use.

3.18.2. Portable cable exposed to damp environments shall be tinned copper.

3.18.3. All portable cable for AC power distribution shall conform to all National regulations.

3.18.4. All portable cables shall be permanently identified with system information and function. All labels should be heavy-duty type and covered with clear shrink-wrap.

3.19. SCHEDULE, ACCESS, PROTECTION AND CLEAN-UP

3.19.1. Clean all equipment that has been exposed to construction dust and dirt.

3.19.2. The AV Contractor to clean all electrical equipment, inside and out, prior to turn over to Owner. Equipment is subject to inspection by AV Consultant and/or Owner.

3.19.3. The AV Contractor is responsible to remove their own waste from the site. All re-usable materials shall be recycled.

3.19.4. There shall be no smoking, and the site shall be kept clean at all times.

3.20. PREPARATION

3.20.1. Clean surfaces thoroughly prior to installation.

3.20.2. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.21. EXISTING SERVICES AND EQUIPMENT

3.21.1. All changes and connections to existing services shall be made only in a manner and at a time approved by the AV Consultant and/or the Owner so as to avoid any interruption of such services during normal working hours. If necessary, changes and connections to existing services shall be made outside of normal working hours, at no extra cost to the Contract.

3.21.2. Where connections are made to existing services, existing fire stopping shall be made good under this Division.

3.22. OWNER FURNISHED EQUIPMENT

3.22.1. All Owner Furnished Equipment (OFE) specified shall be installed by the AV Contractor.

3.22.2. Warranty for Owner Furnished Equipment shall be the equipment's warranty. The AV Contractor shall be responsible for any new programming that is supporting the system.

3.23. ACCESS DOORS

3.23.1. Adequate access or an Access Door shall be provided or arranged for with Division responsible for installation, for all audiovisual equipment that is concealed and requires accessibility, maintenance and or adjustment.

3.23.2. Exact details showing size, type and location shall be submitted to the AV Consultant for review and inclusion in floor plans and shop drawings.

3.23.3. Access Door details shall also be captured on as-built drawings and notations shall be included to indicate frequency of maintenance required for concealed equipment.

3.24. CUTTING, PATCHING AND REPAIRING

3.24.1. It is the responsibility of the AV Contractor to coordinate all cutting and patching required for AV Cabling work with the General Contractor.

3.25. PROTECTION

3.25.1. Protect installed products until completion of project.

3.25.2. Touch-up, repair or replace damaged products before Substantial Completion.

3.26. TESTING

3.26.1. Provide a test plan for approval by the Owner. Test plan shall identify all testing activities, include sample test reports and accommodate scheduling and sequencing.

3.26.2. Typical test plans/reports shall include full testing of all: Video inputs, Video outputs and switching, all device control. Touch panel/programming testing report. Audio inputs, Audio outputs and switching. DSP settings and test calls. Video conferencing test calls.

3.26.3. Supply completed testing reports verifying accurate implementation of all signal connections. Provide a written report to the AV Consultant verifying accuracy prior to software deployment on site.

3.26.4. Provide test reports of commissioning process for each area according to approved test plan prior to deficiency walk-through by AV Consultant.

3.26.5. Include in report confirmation of system implementation as per specification and whether it is inspection ready. Installation Supervisor shall sign-off.

3.26.6. All test results and set-ups must be reproducible by the AV Contractor.

3.26.7. AV Consultant may elect to perform additional testing during the deficiency walk-through, with the assistance of the AV Contractor.

3.26.8. All wiring shall be tested for continuity and short-circuits between conductors and shields. Confirm isolation of conductors and shields, back boxes and conduit systems. Failure of any equipment, system or functionality as intended, shall be revised or replaced by the AV Contractor in full.

3.26.9. The following includes, but is not limited to, a list of sub-systems anticipated that shall require testing:

.1 Equipment testing

.2 Power, Cable Systems and Isolated Ground

.3 Audio Systems

.4 Distribution outputs and inputs

.5 Computer System Hardware

.6 Control and Switching

.7 Video Systems
.8 Network Cable Systems
.9 Digital AV Systems
.10 RF Systems
.11 Signal System.
.12 Control Applications
.13 Cabling systems

3.27. PROJECT CLOSE OUT DOCUMENTATION

3.27.1. Provide the following items in this section upon project completion to form as-built documentation.

3.27.2. As-built Drawings

.1 Refer to section 3.3.1 in this specification for requirements.

3.27.3. Compliance Checklist

.1 Refer to section 3.26.5 in this specification for requirements

3.27.4. Control System Code

.1 Refer to section 3.9.1 and 3.9.2 in this specification for requirements

3.27.5. Manuals

.1 Refer to section 3.4 in this specification for requirements.

3.27.6. Network Information with Systems Passwords

.1 For passwords, refer to section 3.8.4 this specification for requirements.
.2 For network information, refer to specification 27 51 50 – Audiovisual Networking.

3.27.7. Test Reports

.1 Refer to section 3.26.3 and 3.26.4 in this specification for requirements.

3.27.8. Training

.1 Refer to section 1.11.2 in this specification to provide a written sign off by the Owner of completed training sessions.

3.27.9. Warranty

.1 Refer to section 1.12.1 in this specification to provide a written warranty letter.

3.27.10.

END OF SECTION

27 41 00.00 Audiovisual System Scope of Work

1. General

1.1. IMPORTANT NOTES AND RELATED SECTIONS

1.1.1. Bidders are required to review the Tender Specifications and Drawings in their entirety in order to understand the complete scope of work described herein.

1.1.2. Errors and omissions are to be addressed during the tender period. Refer to subsection 1.3 of 27 40 10.00 – General Instructions for Audiovisual System Installation for further detail.

1.1.3. All clarifications and substitution requests must be submitted to the Tender administrator before the end of question period, otherwise a response shall not be provided by the Consultant.

1.1.4. Provide all interconnecting cables required to complete a fully functioning system. Refer to section 27 41 23.11 - Audiovisual Cabling for further detail.

1.1.5. All graphical user interfaces (GUI) must be simple to operate and developed with input from Owner. GUI's must be consistent between system types. Refer to sections 27 40 10.00 – General Instructions for Audiovisual System Installation and 27 41 16.15 - Control Systems for further detail.

1.1.6. Throughout the entirety of the tender Specifications and Drawings, the term 'provide' means 'supply, install, terminate, test and commission'.

1.2. TYPE 1 – MULTI-PURPOSE SPACE

1.2.1. This room type shall feature the following functionality for users:

.1 Presentation
  .1 Wired
  .2 Wireless
  .3 In-room PC
.2 Integrated Web-based Video Conferencing
  .1 In-Room PC
.3 Public Address

1.2.2. A credenza shall be provided by Owner and shall be located at front of the room. The following shall be located at the credenza:

.1 Provide a credenza style equipment rack to mounted inside the credenza provided by others. This will include:
  .1 A pivoting/swivel mount to allow for easy service of the equipment.
  .2 An uninterruptable power supply.
  .3 A power distribution system
  .4 All rack accessories required.
.2 Provide a table-mounted graphical control touchscreen interface. This unit shall be mounted on the surface of the credenza. The control interface shall allow for:
  .1 System on/off
  .2 Input source selection
  .3 Volume control

.4 Camera controls

.5 Lighting controls

.6 Shades & blinds controls

.7 Room controls

.8 Room presets

.3 Provide presentation cables to allow users to connect devices. The cables shall reside on the credenza surface with cables 6' in length above the surface, with connectivity for:

.1 HDMI

.2 USB-C

.4 Provide a wireless collaboration system to allow for laptops to conveniently connect to the display via the Owner's network.

.5 A dedicated in-room computer, with wireless keyboard and mouse, shall be supplied by the Owner and installed by the AV Contractor. The AV Contractor shall provide the requirement mounting solution to secure this device.

.6 Provide a video and audio presentation switcher, with an onboard control processor to allow for the routing of video & audio signals within the space. The system shall be programmed to allow different video sources to be displayed.

.7 Provide an audio digital signal processor (DSP) to allow for automated microphone processing, routing, acoustic echo cancellation and USB connectivity.

.8 Provide an audio amplifier to drive the local speakers.

.9 Provide a wireless assistive listening system to support user with hearing challenges or disabilities. This is a requirement by the regional Disabilities Act.

.10 Provide a network switch. This unit shall be provided to connect to all field equipment to allow all the AV equipment to reside on a common local area network. This network switch shall also provide an uplink to the client local area network.

1.2.3. Provide an ultra-short-throw video projection system for video playback. This system shall include a wall-mounted high-definition video projector and video scaling receiver that shall be fed by the presentation switcher. The projector shall project onto the wall.

1.2.4. Provide a camera, with motorized pan, tilt, and zoom features to capture video of local participants. The AV Contractor shall mount the camera at the rear of the room to capture the instructor. The camera shall include an extension system. The audio from the main audio system shall be fed into the camera. The camera shall be connected to the in-room PC mentioned above for distance learning.

1.2.5. Provide a ceiling-mounted digital microphone to allow users in the room be heard for web-conference calls.

1.2.6. Provide pendant style hanging speakers to support audio playback in the space.

1.2.7. An interconnection to the fire-alarm system shall be supplied by others and shall be connected to the AV system by the AV Contractor. This connection shall trigger a mute of the AV systems when a fire alarm is activated.

1.2.8. Provide all required interconnecting video, control and audio interface cables for a fully functional system.

1.3. TYPE 2 – AV GRAD & FLEX SPACE OFFICES

1.3.1. This room type shall feature the following functionality for users:

.1 Presentation

.1 Wired

.2 In-room PC

.2 Integrated Web-based Video Conferencing

.1 In-Room PC

1.3.2. Provide a wall-mounted button panel control interface in each room. This unit shall be located on the wall beside the display. The control interface shall allow for:

.1 System on/off

.2 Input source selection

.3 Volume control

1.3.3. A table mounted input shall be provided by the furniture vendor to allow users to connect devices. The AV Contractor shall provide inserts for this and presentation cables 6' in length. This shall have connectivity for:

.1 HDMI

.2 USB-C

1.3.4. A dedicated in-room computer, with wireless keyboard and mouse, shall be supplied by the Owner and installed by the AV Contractor. This device shall be mounted behind the display. The AV Contractor shall provide the requirement mounting solution to secure this device.

1.3.5. Provide a 65" wall-mounted flat panel display with integrated speakers for playback of video. This unit shall also include a wall-mount system for installation.

1.3.6. Provide a USB web-conference bar, with integrated microphone, speakers and camera to capture video of local participants. This shall also include a wall mount system and the device shall be connected to the in-room computer.

1.3.7. Provide extension systems as required and shown on provided drawings.

1.3.8. Provide all required interconnecting video, control and audio interface cables for a fully functional system.

1.4. TYPE 3 – FORENSIC TEACHING CLASSROOM

1.4.1. This room type shall feature the following functionality for users:

.1 Presentation

.1 Wired

.2 Wireless

.3 In-room PC

.2 Integrated Distance Learning

.1 In-Room PC

.3 Public Address

1.4.2. Provide a teaching station podium which shall be located at the front of the room which shall be fed by a floorbox below, and shall feature an integrated equipment rack. The following shall be located at the podium:

.1 Provide a table-top graphical control touchscreen interface. This unit shall be located on the same mount of the computer monitor mentioned further in this document with a custom interface mount. The control interface shall allow for:

.1 System on/off

.2 Input source selection

.3 Volume control

.4 Camera controls

.5 Recording controls

.6 Lighting controls

.7 Room controls

.8 Room presets

.2 Provide an input plate to allow users to connect devices. The plate shall include presentation cables in 12' length, with connectivity for:

.1 3.5 mm

.2 Dual XLR Microphone

.3 Provide presentation cables to allow users to connect devices. The cables shall reside on the teaching station surface with cables 6' in length above the surface, with connectivity for:

.1 HDMI

.2 USB-C

.4 Provide a table monument to allow users to connect devices. The monument shall allow for the following connectivity:

.1 Dual USB for charging

.2 Dual AC Power

.3 Dual USB 3.0 keystones and cables that shall connect to the in-room computer mentioned further in this document.

.5 Provide a wireless collaboration system to allow for laptops to conveniently connect to the display via the Owner's network.

.6 Provide a document camera. This shall be connected to the presentation switcher as well as the in-room computer, both mentioned below.

.7 A dedicated in-room computer with a monitor, keyboard and mouse, shall be supplied by the Owner and installed by the AV Contractor. For this computer:

.1 Provide the requirement mounting solution to secure the computer in the equipment rack.

.2 Provide a mount for the monitor that shall be shared with the touchscreen interface.

.3 Provide a HDMI-USB interface to capture an output of the presentation switcher.

.8 Provide a video and audio presentation switcher, with an onboard control processor to allow for the routing of video & audio signals within the space. The system shall be programmed to allow different video sources to be displayed.

.9 Provide a table-mounted gooseneck microphone to allow the instructor. This shall be used for voicelift in the space and distance learning.

.10 Provide two (2) wireless microphone systems to be used for voicelift in the space and distance learning. This shall include:

.1 Two (2) pin-on lavaliere microphones

.2 Two (2) body pack transmitters

.3 Two (2) receivers

.4 An antenna combining system

.5 Antenna extension cables

.6 Two (2) remote antennas

.11 Provide an audio amplifier to drive the local speakers.

.12 Provide a wireless RF assistive listening system to support user with hearing challenges or disabilities. This is a requirement by the regional Disabilities Act.

.13 Provide an integrated equipment rack. This shall include:

.1 An uninterruptable power supply

.2 A power distribution system

.3 All rack accessories required.

1.4.3. Provide two (2) ultra-short-throw video projection systems for video playback. This system shall include a wall-mounted high-definition video projector and video scaling receiver that shall be fed by the presentation switcher. The projectors shall project onto the wall.

1.4.4. Provide a camera, with motorized pan, tilt and zoom features to capture video of local participants. The AV Contractor shall mount the camera at the rear of the room to capture the instructor. The camera shall include a extension system. The audio from the main audio system shall be fed in the camera. The camera shall be connected to the in-room PC mentioned above for distance learning.

1.4.5. Provide pendant style hanging speakers to support audio playback in the space.

1.4.6. An interconnection to the fire-alarm system shall be supplied by others and shall be connected to the AV system by the AV Contractor. This connection shall trigger a mute of the AV systems when a fire alarm is activated.

1.4.7. Provide all required interconnecting video, control and audio interface cables for a fully functional system.

1.5. TYPE 4 – FORENSIC GARAGE

1.5.1. This room type shall provide user with the following functionality:

.1 Presentation

.1 In-room PC

1.5.2. A dedicated in-room computer with a keyboard and mouse, shall be supplied by the Owner and installed by the AV Contractor. Provide a computer monitor with an articulating arm wall-mounting solution.

1.5.3. Provide a camera, with motorized pan, tilt and zoom features to capture video of the garage. The AV Contractor shall mount the camera at the ceiling. The camera shall include a extension system. The camera shall be connected to the in-room PC mentioned above.

1.5.4. Provide all required interconnecting video, control and audio interface cables for a fully functional system.

1.6. ITEMS IN THE SCOPE OF OWNER/OTHERS

1.6.1. Owner shall supply dedicated in-room PCs with wireless keyboards and mice as required.

1.6.2. Refer to the following table for the division of responsibility for IT department regarding AV systems:

IT Systems Information	
AV Monitoring System:	Crestron Fusion
AV / IT Division of Responsibility Matrix	

System Type	AV Contractor	IT
Network Configuration	- Spreadsheet List of devices to be attached to network with device information - Document Data Jack AV network switch will connect to - Configuration of Devices for Multicast and static IP addressing - Update of Spreadsheet with IP addresses once assigned.	- Network Security Rules - Wall jack patching in Telecom Room - Provide IP addresses or IP subnet ranges for devices that will reside on the Owner's network.
AV System Monitoring	- In-room systems hardware configuration - Configuration of System Monitoring hardware. - Addition of all devices for operation as described in this document. - All Fusion programming on server, control processors and devices. Manufacturer modules must be used.	- Network Configuration - Allocation of Network Drop and Activation - Installation and Configuration of System Monitoring Software - Provide access to AV Contractor to server.

2. Products

2.1. SHORT THROW PROJECTOR - (TYPE – PROJ)

2.1.1. Projector shall have a resolution of 1920 x 1080 with aspect ratio of 16:9.

2.1.2. Projector shall have a minimum brightness of 5000 ANSI lumens.

2.1.3. Projector shall have an ultra short-throw lens.

2.1.4. Projector shall have solid state, laser phosphor, with a minimum light output expectancy of 20,000 hours.

.1 Projectors shall be configured to operate with a constant brightness strategy

2.1.5. Projector shall have a minimum of the following inputs:

.1 HDMI, qty:2

.2 HDBaseT, qty:1

2.1.6. Projector shall have an analog audio output.

2.1.7. Provide appropriate wall-mount solution.

2.1.8. Typical device shall be Epson Powerlite 815e series or approved equivalent.

2.2. FLAT PANEL DISPLAY - 65" 4K COMMERCIAL (TYPE – FPD1)

2.2.1. Flat panel display shall have a minimum diagonal of 65” and resolution of 4K UHD (3840 x 2160) with an aspect ratio of 16:9.

2.2.2. Flat panel display shall have either LED edge lit or full LED array backlight system.

2.2.3. Flat panel display shall have a minimum brightness of 500 cd/m2 (nits).

2.2.4. Flat panel display shall have built-in audio speakers.

2.2.5. Flat panel display shall be commercial grade and have an operational rating of 24-hours per day, for 7-days a week for a minimum period of three years.

2.2.6. Flat panel display shall have the following inputs and not limited to:

.1 HDMI (Qty: 3)

.2 RS232C

.3 RJ45

2.2.7. Flat panel display screen shall have a haze 25% value.

2.2.8. Provide a mounting solution.

2.2.9. Provide trim kit for the display to provide an aesthetic as well as tamper-resistant coverage for the sides of the display.

2.2.10. Typical device shall be Samsung QM-series or approved equivalent.

2.3. FLAT PANEL DISPLAY - 32" 4K COMMERCIAL (TYPE – FPD2)

2.3.1. Flat panel display shall have a minimum diagonal of 32” and resolution of 4K UHD (3840 x 2160) with an aspect ratio of 16:9.

2.3.2. Flat panel display shall have either LED edge lit or full LED array backlight system.

2.3.3. Flat panel display shall have a minimum brightness of 350 cd/m2 (nits).

2.3.4. Flat panel display shall have built-in audio speakers.

2.3.5. Flat panel display shall be commercial grade and have an operational rating of 16-hours per day, for 7-days a week for a minimum period of three years.

2.3.6. Flat panel display shall have the following inputs and not limited to:

.1 HDMI (Qty: 1)

.2 USB-C (Qty: 1)

2.3.7. Provide a mounting solution.

2.3.8. Provide trim kit for the display to provide an aesthetic as well as tamper-resistant coverage for the sides of the display.

2.3.9. Typical device shall be Samsung LS-series or approved equivalent.

2.4. WALL DISPLAY MOUNT

2.4.1. Display Mount shall have a leveling control for post-installation for fine tuning of height and leveling to provide post-installation height adjustment and lateral shift for faster and easier installation.

2.4.2. Display Mount shall be an ultra-low-profile display mounting solution.

2.4.3. Display Mount shall have a minimum tilt range of -12 to 2-degree.

2.4.4. Display Mount shall be rated for the appropriate required display being mounted.

2.4.5. Provide a CPU mounting accessory and extenders for a low-profile installation (FCA series) as required if mentioned above.

2.4.6. Typical device shall be Chief Fusion series or approved equivalent.

2.5. WALL MONITOR ARM – PULLOUT

2.5.1. Display Mount shall have a leveling control for post-installation for fine tuning of height and leveling to provide post-installation height adjustment and lateral shift for faster and easier installation.

2.5.2. Display Mount shall allow for extension of up to 21” (55mm).

2.5.3. Display Mount shall have a minimum tilt range of 75-degree.

2.5.4. Typical device shall be Ergotron LX series or approved equivalent.

2.6. PRESENTATION 4K SWITCHER - 8X4

2.6.1. Presentation Switcher shall support HDBaseT audio video transport protocol.

2.6.2. Presentation Switcher shall be high-definition AV switcher with integrated microphone mixer, audio DSP, amplifier and control system.

2.6.3. Provide input and outputs to support functionality as written in documents and shown on drawings.

2.6.4. Presentation Switcher shall support 4K resolutions.

2.6.5. Conform to requirements in section 27 41 16.16 – Audio Video Over Structured Cabling.

2.6.6. Typical device shall be Crestron DMPS3-4K-350-C or approved equivalent.

2.7. AV SCALER RECEIVER

2.7.1. AV Scaler Receiver shall have a build-in 4K scaler and audio extractor.

2.7.2. AV Scaler Receiver shall support HDBaseT and HDCP.

2.7.3. AV Scaler Receiver shall at minimum support the following video resolutions: UHD, 4K60, WUXGA, 1080p and WXGA.

2.7.4. AV Scaler Receiver shall support 4:4:4 chroma sampling.

2.7.5. AV Scaler Receiver shall support and management of EDID (Extended Display Identification Data).

2.7.6. Conform to requirements in section 27 41 16.16 – Audio Video Over Structured Cabling.

2.7.7. Typical device shall be Crestron DM-RMC-4KZ-SCALER-C or approved equivalent.

2.8. DM TRANSMITTER

2.8.1. HDMI transmitter shall be HDCP compliant and passes EDID signals between the source and display over shielded twisted pair cabling a minimum of 70 metres (230').

2.8.2. HDMI transmitter shall at minimum support the following video resolutions: UHD, 4K DCI, WUXGA, 1080p and WXGA.

2.8.3. Conform to requirements in section 27 41 16.16 – Audio Video Over Structured Cabling.

2.8.4. Typical device shall be Crestron HD-TX-4KZ-421-CHGR series or approved equivalent.

2.9. DM RECEIVER

2.9.1. HDMI receiver shall be HDCP compliant and passes EDID signals between the source and display over shielded twisted pair cabling a minimum of 70 metres (230').

2.9.2. HDMI receiver shall at minimum support the following video resolutions: UHD, 4K DCI, WUXGA, 1080p and WXGA.

2.9.3. Conform to requirements in section 27 41 16.16 – Audio Video Over Structured Cabling.

2.9.4. Typical device shall be Crestron HD-RXC-4KZ-101 series or approved equivalent.

2.10. DOCUMENT CAMERA

2.10.1. Document Camera shall have 2.7 inch CMOS image sensor.

2.10.2. Document Camera shall have a 12X optical zoom.

2.10.3. Document Camera shall have 2M pixels progressive.

2.10.4. Document Camera shall have a digital video output.

2.10.5. Typical device shall be Epson DC-21 series or approved equivalent.

2.11. NETWORKED WIRELESS PRESENTATION SYSTEM

2.11.1. Wireless Presenter shall support wireless video connections for content sharing both via proprietary software that allows for AirPlay, as well as MiraCast.

2.11.2. Wireless Presenter shall support audio and video playback up to 30 fps.

2.11.3. Wireless Presenter shall support the following operating systems for full screen sharing:

.1 Windows 7/8/10 32 & 64 bit

.2 Mac OSX 10.6/10.7/10.8/10.9

.3 Android, Chrome OS and iOS through mobile applications

2.11.4. Wireless Presenter shall support input resolutions of up to 1920 x 1200 (WUXGA).

2.11.5. Wireless Presenter shall support the following output resolutions:

.1 HDMI: 1280x720 (720P), 1920x1080 (1080p), 3840x2160 (2160p)

2.11.6. Wireless presenter shall allow for remote network management.

2.11.7. Typical device shall be Atlona Wave-101 series or approved equivalent.

2.12. USB PTZ CAMERA WITH CONNECT BOX

2.12.1. PTZ Camera shall have 1/2 inch CMOS image sensor.

2.12.2. PTZ Camera shall have a 20X optical zoom lens.

2.12.3. PTZ Camera shall have 1920x1080 pixels progressive at 60 fps.

2.12.4. PTZ Camera shall have RS232 for external controls.

2.12.5. PTZ Camera shall transmit video to the connected personal computer utilizing standard USB UVC protocols.

2.12.6. Provide a twisted pair camera extension system as required. See drawings for distances and design details.

2.12.7. Typical device shall be Vaddio RoboSHOT series or approved equivalent.

2.13. HDMI-USB AV INTERFACE

2.13.1. AV USB Interface shall support capture and stream video and audio directly to USB (PC).

2.13.2. AV USB Interface shall support HD encoding of audio/video sources

2.13.3. AV USB Interface shall stream direct to PC with USB 1080p/30 sources using MJPEG encoding with PCM uncompressed audio.

2.13.4. Typical device shall be Magewell USB Capture HDMI series or approved equivalent.

2.14. GOOSENECK MICROPHONE

2.14.1. Gooseneck Microphone shall have a frequency response of 50 to 17,000 Hz.

2.14.2. Gooseneck Microphone shall include base.

2.14.3. Typical device shall be Shure Microflex Gooseneck Microphone w/Base or approved equivalent.

2.15. CEILING MICROPHONE ARRAY (DIGITAL)

2.15.1. Ceiling Microphone shall have a 360 degree directional pick-up pattern with eight (8) steerable lobes.

2.15.2. Ceiling Microphone shall have onboard audio digital signal processing.

2.15.3. Ceiling Microphone shall have utilize DANTE digital audio network transport protocol.

2.15.4. Ceiling Microphone shall be sized to fit within standard ceiling tile size opening.

2.15.5. Typical device shall be Shure MXA920 series or approved equivalent.

2.16. LAVALIER WIRELESS MICROPHONE SYSTEM

2.16.1. Type 1 Wireless Microphone System with Lavaliere

2.16.2. Wireless Microphone System shall operate on multiple frequency bands (up to 900MHz) as appropriate for the location the system shall be installed into.

2.16.3. Wireless microphone system shall have a minimum frequency bandwidth response of 45 Hz to 15 kHz.

2.16.4. Transmitters shall operate a minimum of eight hours on two “AA” size batteries.

2.16.5. Receivers shall have XLR and ¼ inch outputs.

2.16.6. Receivers shall have detachable antennas.

2.16.7. Receivers shall be ethernet controlled.

2.16.8. Refer to drawings for antenna mounting locations. Provide all appropriate antenna distribution (combiners, power distribution amplifiers, splitters/combiners) for systems of two or more.

2.16.9. Provide ½ wave antennas.

2.16.10. Wireless Microphone System shall include a bodypack style transmitter.

2.16.11. Wireless Microphone System shall include a detachable lavaliere microphone.

2.16.12. Lavaliere microphone shall have a directional pick-up pattern with a condenser cardioid element per microphone.

2.16.13. Typical device shall be Shure SLXD series with SLXD1 transmitter and WL185 or approved equivalent.

2.17. AUDIO INPUT PLATE

2.17.1. Audio input plate shall have two-gang plate.

2.17.2. Audio input plate shall have XLR & 3.5mm inputs.

2.17.3. Typical device shall be RDL D-TPS2AM or approved equivalent.

2.18. ASSISTIVE LISTENING SYSTEM - RF

2.18.1. Assistive Listening Transmitter shall operate on multiple frequency bands (72 MHz or 216MHz) as appropriate for the location the system shall be installed into.

2.18.2. Assistive Listening Transmitter shall have a minimum frequency bandwidth response of 50 Hz to 15 kHz.

2.18.3. Assistive Listening Transmitter shall have 57 selectable transmitting channels.

2.18.4. Assistive Listening Transmitter shall have 60 dB SNR (mono) or greater, end-to-end.

2.18.5. Assistive Listening Transmitter shall have XLR and ¼ inch outputs.

2.18.6. Assistive Listening Transmitter have detachable antennas.

2.18.7. Provide antennas as required.

2.18.8. Assistive Listening Transmitter shall include a rack mounting kit.

2.18.9. Receivers shall incorporate a stereo headset jack that allows the user to plug in either a mono or stereo headset and listen to audio normally.

2.18.10. Assistive Listening System shall come complete with:

.1 Listening receivers

.1 Provide quantities in accordance with local ADA requirements.

.2 Rechargeable batteries

.3 Ear speaker

.4 Charging and carrying case for receivers.

2.18.11. Typical device shall be Listen Tech LS-54-072 with LR-4200 unit as required or approved equivalent.

2.19. DSP 12X8

2.19.1. Audio DSP shall have inputs and outputs as shown on drawings (with minimum two spare inputs and outputs).

2.19.2. Conform to requirements of 27 41 16.10 – Sound System General Requirements.

2.19.3. Frequency response shall be 20-20,000 Hz, +0.1/-0.4 dB with a dynamic range of minimum 100dB.

2.19.4. Audio DSP shall have acoustic echo cancellation on each of the input channel.

2.19.5. Audio DSP shall have support AES67 and DANTE protocols as required by the project.

2.19.6. Typical device shall be Biamp Tesira Forte DAN CI or approved equivalent.

2.20. AUDIO AMPLIFIER 2CH 60W

2.20.1. Amplifier shall have two channels and provide 60 watts of power per channel.

2.20.2. Conform to requirements of 27 41 16.10 – Sound System General Requirements.

2.20.3. Amplifier shall support stereo low impedance, or mono 70V, loudspeaker systems.

2.20.4. Typical device shall be QSC SPA2-60 series or approved equivalent.

2.21. WEB CONFERENCE BAR

2.21.1. Conference Bar shall have onboard speakers, microphone and camera.

2.21.2. Conference Bar shall connect in BYOD mode (USB passthrough).

2.21.3. Conference Bar shall come complete with a VESA display mounting bracket.

2.21.4. Conference Bar shall have an integrated USB Camera, array microphone and DSP.

2.21.5. Conference Bar shall have three (3) video outputs, capable of 4K resolution each.

2.21.6. Conference Bar shall have a hybrid zoom up to 16X digital zoom in Full HD

2.21.7. Conference Bar shall feature a minimum 113-degree horizontal field of view.

2.21.8. Conference Bar shall feature a sixteen (16) mic array.

2.21.9. Conference Bar shall have the available for expansion to secondary microphones and cameras.

2.21.10. Conference Bar shall transmit video and audio to the connected personal computer utilizing standard USB UVC and AVC protocols.

2.21.11. Conference Bar shall include a 10” tabletop touch screen.

2.21.12. Conference Bar shall have an onboard appliance capable of operating the latest versions of Microsoft Teams or Zoom.

2.21.13. Typical device shall be Neat Bar Pro or approved equivalent .

2.22. PENDANT SPEAKER (TYPE – S1)

2.22.1. Ceiling Speaker shall have a coaxially mounted 165mm (6.5 inch) woofer and 19mm (0.75”) dome high frequency unit for full range sonic reproduction.

2.22.2. Ceiling Speaker shall have a minimum (-3 dB) frequency response of 55 Hz to 20 kHz measured on axis at a distance of 1 metre.

2.22.3. Ceiling Speaker shall have a minimum 88db sensitivity measured at 1 watt and 1 meter from the speaker on the central axis.

2.22.4. Speaker shall have a minimum 135° conical coverage.

2.22.5. Speaker shall be rated for minimum program wattage of 60W.

2.22.6. Speaker shall have a line transformer for 70V operation. Minimum transformer taps shall be 30W, 15W and 7.5 W.

2.22.7. Typical device shall be QSC AD-P6T or approved equivalent.

2.23. TOUCH PANEL - 10"

2.23.1. 10” Touch Panel shall have a 10” TFT active matrix colour LCD display with aspect ratio of 16:9 pixels and resolution of 1920x1080 pixels.

2.23.2. 10” Touch Panel shall provide 400 nits brightness.

2.23.3. 10” Touch Panel shall utilize capacitive touch technology.

2.23.4. 10” Touch Panel shall support H.264 streaming.

2.23.5. 10” Touch Panel shall utilize PoE protocol.

2.23.6. 10” Touch Panel shall not have an onboard camera or microphone unless required in scope. Confirm with project team prior to ordering.

2.23.7. 10” Touch Panel shall include a table top mount.

2.23.8. Typical device for table-top mounting provide TS-1070 series with Red Dot S400CN or approved equivalent.

2.24. BUTTON PANEL CONTROLLER (TYPE – BP)

2.24.1. Button Panel shall have 9 assignable pushbuttons with interchangeable pre-labeled button caps, with volume up/down, mute and power on/off buttons.

2.24.2. Button Panel shall include 1 LED per hard key for feedback, configurable for momentary, toggle, or interlock functionality.

2.24.3. Button Panel shall have an onboard control system.

2.24.4. Button Panel shall have the following connectivity:

.1 RS-232

.2 GPIO, qty:3

.3 Infrared

.4 Relay, qy:2

.5 Ethernet LAN

2.24.5. Button Panel shall be ethernet powered. Provide PoE injector or PoE network port as required.

2.24.6. Button Panel shall include custom engraved button inserts specific to the project.

2.24.7. Typical device shall be Creston MPC3-102 or approved equivalent.

2.25. NETWORK SWITCH

2.25.1. Network Switch shall support Layer-3 Gigabit Ethernet switching.

2.25.2. Network Switch shall provide Power Over Ethernet + (PoE+) on all ports.

2.25.3. Network Switch shall be managed.

2.25.4. Network Switch shall support 10Base-T/100Base-TX/1000Base-T Ethernet with network standards of IEEE 802.3, 802.3u, 802.3ab, 802.3x, & 802.3af.

2.25.5. Network Switch shall have sufficient ports to accommodate all system AV devices, with an additional 4-ports for expansion or uplink.

2.25.6. Network Switch shall be compatible with digital audio and video multicast protocols required as part of this project.

2.25.7. Network Switch shall be network stackable.

2.25.8. Network Switch shall be allow for proper bandwidth traffic to traverse across switches as required.

2.25.9. Network Switch shall be rackmountable.

2.25.10. Typical device shall be NetGear M4250 series or approved equivalent.

2.26. TABLE MONUMENT

2.26.1. Table monument shall accommodate the connectivity mentioned in previous sections.

2.26.2. Typical device shall be Extron Cable Cubby 700 series or approved equivalent.

2.27. TEACHING STATION PODIUMTeaching Station Podium shall be ADA compliant.

2.27.2. Teaching Station Podium shall have a minimum of 23 useable rack spaces integrated.

2.27.3. Teaching Station Podium shall support attachments for monitor mounts and cable cubbies.

2.27.4. Contact the manufacturer for Owner specific details of the unit.

2.27.5. Typical device shall be Middle Atlantic Viewpoint or approved equivalent.

2.28. DUAL MONITOR MOUNT

2.28.1. Dual Monitor Mount shall be compatible with 2 monitors up to 32".

2.28.2. Dual Monitor Mount shall have 25" wide tray for a keyboard and mouse side-by-side.

2.28.3. Dual Monitor Mount shall be up to 28" height adjustment.

2.28.4. Dual Monitor Mount shall support tilt and swivel to set.

2.28.5. Typical device shall be Mount-IT MOUT 7996 or approved equivalent.

2.29. CREDENZA EQUIPMENT RACK – 19RU

2.29.1. Equipment Rack shall be vented with thermostatically controlled DC fan tops for thermal management.

2.29.2. Equipment Rack shall have space to mount all required equipment.

2.29.3. Equipment Rack shall allow for the rack to be fastened to the credenza base.

2.29.4. Equipment Rack shall allow for the rack to slide out from the credenza, as well as pivot, for service.

2.29.5. Equipment Rack shall have a horizontal rack-mounted power strip with surge and spike protection.

2.29.6. Typical device shall be Middle Atlantic SRSR series with accessories or approved equivalent.

2.30. UNINTERRUPTABLE POWER SUPPLY - MEDIUM

2.30.1. Uninterruptable power supply shall be a series mode UPS.

2.30.2. Uninterruptable power supply shall provide 1000VA capacity.

2.30.3. Uninterruptable power supply shall be rack mountable.

2.30.4. Uninterruptable power supply shall have a maximum transfer time of 4 milliseconds.

2.30.5. Uninterruptable power supply shall have automatic voltage regulation.

2.30.6. Uninterruptable power supply shall have a minimum of eight (8) NEMA5-20R outlets that are able to be remotely controlled in two (2) banks.

2.30.7. Uninterruptable power supply shall provide the ability to connect an expansion battery.

2.30.8. Uninterruptable power supply shall have ethernet connectivity.

2.30.9. Typical device shall be Middle Atlantic UPX-RLNK-1000R-2 or approved equivalent.

2.31. RACK ACCESSORIES

2.31.1. Provide a series mode UPS for all equipment racks that house microprocessor devices such as control systems and DSP. UPS shall be Surgex, Middle Atlantic or approved equal.

2.31.2. Supply cable tie bars for all horizontal cable transitions and vertical lacing bars.

2.31.3. Supply vent panels at the top and bottom of all 44RU equipment racks.

2.31.4. Supply blank panels to fill all empty rack spaces. Panels can be 1, 2 or 3 RU.

2.31.5. Provide one 3 RU steel pull out drawer in each rack unless specified otherwise above in section 1.

2.31.6. Provide a multi-duplex AC outlet plug strip in each rack, one outlet for each 3 RU.

2.31.7. Where isolated ground systems are specified provide copper ground buss bar with tapped holes. Provide copper cable clamps (“Burndy”) for connection to equipment. Provide 12 AWG stranded copper strap between buss bar and each rack mount component.

2.31.8. Provide adjustable front and rear mounted rails tapped with #10-32 mounting holes.

2.31.9. Provide all mounting hardware and rack screws with nylon washers.

2.32. AUDIO AND VIDEO RACK PATCH PANELS

2.32.1. For audio and video cable interconnectivity, provide custom rack patch panels with the following requirements:

2.32.2. Nominal panel dimensions to be 19” wide and 1.75” (1RU), 3.5” (2RU), 5.25” (3RU) or 7” (4RU) high as required. Refer to EIA Standard RS-310-C for allowable tolerances.

2.32.3. Panels shall be made of #16 C.R.S. folded back ½” top and bottom.

2.32.4. Panel shall have integrated “tie-bar” to support cables at rear of panel of sufficient depth not to impede connector wiring.

2.32.5. All connector cut-outs shall be sized to accommodate Neutrik D-format or equivalent connectors.

2.32.6. All rack panel mount audio connectors shall be XLR-type, premium quality with metallic shells, universal Neutrik D-format, gold contacts.

2.32.7. All panel mount video connectors shall be coaxial 75 ohm BNC, isolated ground, suited for bandwidth and signal type.

2.32.8. All jack panel designations shall be silk-screened.

2.32.9. Data patch panels with the following requirements:

.1 Data patch panels shall be rack-mountable

.2 Data patch panels shall be 24-port CAT6 RJ45, 1RU

.3 Data patch panels shall have labelling strip to allow three lines of text

2.32.10. Data patch panels shall be Blackbox, Panduit or approved equal.

2.33. AV FIELD PANEL

2.33.1. All field panels shall be 0.125” aluminum stock with 1/8” bevelled edges. Alternate metal stock shall be submitted to AV Consultant for approval.

2.33.2. Standard finish shall be anodized with vertical brush

2.33.3. Submit shop drawings of panels for Owner/architect/AV Consultant approval before fabrication. Indicate on drawings locations for each type of panel and finish.

2.33.4. Panels to be engraved and paint filled.

2.33.5. XLR connectors shall be inserted into panels from rear. Ensure labelling strips do not interfere with the operation of the connector release mechanisms. Holes shall be sized to suit male or female shell interchangeably.

2.34. WIRE

2.34.1. Refer to section 27 41 23.11 Cables and Pathway for Audiovisual Systems for all cabling requirements.

2.34.2. All equipment connected with RJ45 cable from device to device in the AV scope shall utilize purple jacketed cable to distinguish between AV cabling and cables running to a network drop. Any RJ45 cable running from an AV device to a network drop shall be standard blue jacket.

2.35. CONNECTORS

2.35.1. All input and output connectors for field plates and equipment rack patch panels shall be Neutrik D-series.

3. Execution

3.1. GENERAL REQUIREMENTS

3.1.1. All equipment supplied as part of this project shall conform to the requirements described in the following sections:

.1 SECTION 27 40 10.00 – GENERAL INSTRUCTIONS FOR AUDIOVISUAL SYSTEM INSTALLATION

END OF SECTION

27 41 16.10 Sound System General Requirements

1. General

1.1. PROGRAM SOUND SYSTEM REQUIREMENTS

1.1.1. These are the minimum specifications unless otherwise stated in specific subsections. All equipment selected must meet or exceed these expectations.

1.1.2. All AC powered equipment shall be CSA or ULC approved devices.

1.1.3. Input and output power levels are expressed in dBm.

1.1.4. It is not the intention of the AV Consultant to direct the AV Contractor to verify all manufacturer performance specifications on an individual component level unless it is a necessary process to identify and resolve a fault in the system.

1.2. LOUDSPEAKER PERFORMANCE CRITERIA DEFINITIONS

1.2.1. Equipment

Performance Criteria	**Definition**
Measured Sound Pressure Level (SPL)	This is the long term SPL capability as measured with a sound level meter using A-weighting and slow response using pink noise. It is measured on axis of the loudspeaker at ear height at the intended listening position. It is measured in free field (direct plus reverberant) with an omnidirectional microphone. It is measured after the system is equalized to installed frequency response.
Predicted Sound Pressure Level (SPL)	This is the maximum long term SPL capability as calculated from manufacturer's data and location design data using inverse square law or approved computer design package, A weighted, slow response (average). It is calculated on axis of loudspeaker at ear height at the intended listening position.
Coverage area	This area is defined as the area where the off-axis attenuation of the direct SPL of the loudspeaker is less than 6 dB at 2 kHz.
Coverage variance	This is the variation in A-weighted SPL due to listener location within the coverage area of the loudspeaker as measured in the room free field. It is measured at ear height at the intended listening position.
Passband (bandwidth)	This is the nominal operating range of unequalized loudspeakers. It is determined by the 3 dB down points of the raw frequency response.
Installed frequency response	This is measured on-site after optimization of aiming and equalization. It is flat (maximum deviation of +1/-3 dB on tone-third octave intervals) within pass band at maximum SPL.
Loudspeaker Headroom	This is the nominal long term power handling capability above that needed to achieve maximum desired SPL. It is expressed in dB.

Amplifier headroom	The difference between the EIA power rating of power amplifier and the power required to achieve maximum SPL, expressed in dB

1.3. ELECTRONIC SIGNAL CHAIN PERFORMANCE REQUIREMENTS

1.3.1. The following minimum end-to-end specifications must be met by the electronic signal chain:

Performance Criteria	**Value**
Distortion	Less than 0.01% at full output
Nominal signal level	+4 dBm
Maximum output level	+22 dBm
Frequency response	20 Hz to 20 kHz, +/- 0.5 dB
Signal to noise	Greater than 90 dB
Balanced input common mode rejection	Minimum 70 dB at 15 kHz
Nominal line input impedance	10 K
Balanced line output impedance	600 Ω or less
Crosstalk (for multi-channel units)	More than 70 dB down

1.4. PROGRAM AUDIO SYSTEM PERFORMANCE REQUIREMENTS

1.4.1. Provide an audio system to meet the requirements defined in the Audiovisual System Scope of Work.

1.4.2. The following minimum must be met by the audio system:

Performance Criteria	**Value**
Measured sound pressure level capability	85 dBA (minimum)
Minimum bandwidth (-3 dB points)	125 Hz to 8 kHz
Distortion and noise (electronic)	Less than 3%
Coverage variance	+/- 3 dB SPL
Acoustic noise (as measured with SPL meter at any and all normal seated positions)	Greater than 25 dBA SPL
Switching noise (due to relays and electronics)	70 dB below nominal signal level

1.4.3. Program Loudspeakers Performance Requirements:

Performance Criteria	**Value**
Frequency response (minimum)	80 Hz to 12.5 kHz, +/- 3dB
Distortion	Less than 3% at 6 dB down from full output throughout stated frequency response
Drivers	Minimum 2-way

1.4.4. 70V Loudspeaker minimum performance requirements:

Performance Criteria	**Value**
Frequency response (minimum)	100 Hz to 12kHz, +/- 4dB
Minimum sensitivity	90dBm 1 watt @ 1m
Dispersion	90 degrees at 5 kHz
Distortion	Less than 3% at 6 dB down from full output throughout stated frequency response

1.4.5. For alternates to the proposed system design in the Audiovisual System Scope of Work aimed at providing value to the Owner while reducing cost, provide computer modelled speaker design data using industry standard speaker modelling software with the predicted SPL to meet the performance criteria described above.

1.5. AUDIO TRANSFORMER PERFORMANCE REQUIREMENTS

1.5.1. The following criteria must be met my any audio transformer except loudspeakers which are specified elsewhere:

Performance Criteria	**Value**
Frequency Response	30 Hz to 30 kHz +/- 1 dB
Insertion loss	Less than 1 dB
Primary nominal impedance	10k/40k
Secondary nominal impedance	10k/40k
Shield	Electrostatic shield between primary and secondary windings
Winding	Balanced winding

1.6. DIGITAL SIGNAL PROCESSOR (DSP) REQUIREMENTS

1.6.1. Digital signal processors provide audio signal mixing, routing and processing for sound system applications.

1.6.2. Provide a rack-mount digital signal processor. Include all rack-mounting and cabling accessories as required.

1.6.3. DSP platform shall allow the creation/connection of system components within each hardware unit. Available system components shall include (but not be limited to) mixers, equalizers, filters, crossovers, dynamics/gain controls, routers, delays, remote controls, meters, generators, and diagnostics.

1.6.4. Inputs/outputs of the DSP shall be sized accordingly to support the mic/line functionality illustrated as per AV concept functional drawings. Provide a minimum of two additional input and output channels to support user design changes.

1.6.5. Ethernet communications shall be utilized for software control and configuration. Provide all PC-based software and files to the Owner to allow programming access through the AV IP network or Owner network when specified.

1.6.6. DSP platform shall be RS-232 controllable for interface to third party control systems.

1.6.7. DSP platform shall have selectable Phantom Power per channel. Phantom Power, Signal Present and Clip information per channel is preferred without the requirement for a PC.

1.6.8. Performance requirements:

Performance Criteria	**Value**
Distortion	Less than 0.01% at full output
Nominal signal level	+4 dBm
Maximum input level	+18 dBm
Maximum output level	+22 dBm
Frequency response	20 Hz to 20 kHz, +/- 0.5 dB
Signal to noise	Greater than 90 dB
Balanced input common mode rejection	Minimum 70 dB at 15 kHz
Balanced nominal line input impedance	10 kΩ
Balanced line output impedance	600 Ω or less
Crosstalk (for multi-channel units)	Greater than 70 dB down
Minimum sampling frequency	48 kHz
Minimum converter resolution	20 bit
Processing resolution	24 bit minimum

1.7. AUDIO CONFERENCING DSP REQUIREMENTS

1.7.1. Provide a digital signal processor with wide-band AEC mic/line inputs, standard mic/line inputs, mic/line outputs, and a telephone interface.

1.7.2. Where the Owner phone system is analog, provide an RJ-11 port to enable the DSP to interface with a standard POTS (aka PSTN or Analog PBX) telephone network.

1.7.3. Where the Owner phone system is VOIP, provide an RJ45 VOIP port or else external VOIP adapter to enable the DSP to interface to Owner's network.

1.7.4. Provide dedicated acoustic echo cancellation (AEC) processing on all audio channels used for audio and video conferencing. The AEC algorithm can be applied to signals coming from the local analog inputs or from the digital audio bus. All microphone inputs shall be fed into an AEC channel.

1.7.5. Automatic Gain Control (AGC) and Noise Cancellation (NC) should also be provided per AEC algorithm. AGC ensures that microphone levels remain at an optimum level, and NC removes steady state noise (such as from a projector fan or air conditioning device) from the signal path.

1.8. AMPLIFIERS

1.8.1. Program amplifiers must be capable of providing 200% of the power required by the loudspeaker.

1.8.2. Low Impedance Amplifier Performance Requirements:

Performance Criteria	**Value**
Frequency response	20 Hz to 20 kHz, +/- 0.5 dB
Distortion	Less than 0.1% THD at rated output
Signal to noise ratio 20 Hz to 20 kHz	> -106 dB
Amplifier headroom in watts	200% above load requirement
Mechanical noise	At ambient or below
Dampening Factor	>500

1.8.3. 70V Amplifier Performance Requirements:

Performance Criteria	**Value**
Output Voltage	70.7 V
Distortion	Less than 0.05% THD at rated output
Frequency Response	60 Hz to 20 kHz, +/- 0.5 dB
Signal to noise ratio	Greater than 90 dB
Amplifier headroom in watts	50% above load requirement
Mechanical noise	At ambient or below

2. Products

2.1. DSP

2.1.1. Acceptable DSP brands are: QSC and BIAMP. Any other brand/model must be approved by AV Consultant.

2.2. AMPLIFIERS

2.2.1. Acceptable amplifier brands are: QSC, Crown, and LabGruppen. Any other brand/model must be approved by AV Consultant.

2.3. LOUDSPEAKERS

2.3.1. Acceptable loudspeaker brands are: QSC, Community, JBL and Electrovoice/Bosch. Submit all other speaker proposals for AV Consultant approval.

3. Execution

3.1. AUDIO SYSTEM TESTING AND CALIBRATION

3.1.1. Optimize the digital signal processors, amplifiers, loudspeakers, speaker power taps, phasing, and speaker aiming as required to achieve the system's optimal performance with reference to the intent of the design and the performance criteria defined in the specifications.

3.1.2. The system is intended to provide (without clipping) an average program level of at least 85 dBa at 1.5m above the floor.

.1 Using pink noise (with range of 250 Hz to 8 kHz), measure the sound pressure level at one randomly chosen position in each zone.

.2 Adjust signal so the variation in sound pressure level within in each area shall approach +/- 3dB or better, measured in 1/3 octave bandwidth across a frequency range of 250 Hz to 8 kHz)

3.1.3. The AV Contractor shall have as a minimum the following test equipment available on site during testing and performance acceptance:

.1 Sound-level meter (peak and average reading) c/w calibrated microphone

.2 Phase checker generator/receiver set

.3 Include all necessary cables and specialty adapters

3.1.4. All testing of loudspeakers to be installed overhead should be tested thoroughly prior to installation. It is important that all rigging systems are inspected for structural integrity and all fasteners are secured. Once installed, the speakers shall need to be tested for proper polarity.

3.1.5. The system shall be free of hum, clicks, RF pickup, thumps or other audible distortions in all configurations and phases of operation. Correct all deficiencies.

3.2. DIGITAL SIGNAL PROCESSORS

3.2.1. Where the DSP is used in conjunction with table microphones and audio/video conferencing, the DSP shall be configured for mix-minus operation to ensure maximum gain before feedback. Ensure room speakers are individually home run back to equipment rack. Provide enough DSP outputs and amplifier channels to support mix-minus operation.

3.2.2. DSP shall be programmed and commissioned by programmers and technicians certified on specified platform. Provide all certifications at time of bid.

3.2.3. Upon completion of the project, AV Contractor shall provide all custom programmed code to Owner on USB media or Owner identified preferred media format.

3.2.4. Provide all programming and end to end calibration to align the DSP with interconnected devices.

3.2.5. Provide all GUI's and interface control programming as required. Provide user manuals for custom GUIs.

3.2.6. Provide all software applications and tools to configure and maintain the DSP systems.

3.2.7. Provide system presets to capture and store signal routing and processing paths for table configurations.

3.2.8. Configure the software to allow full processing of all signal paths.

3.2.9. Where interfaced with a third party control system, control system shall hang up any open calls on system shutdown routines.

3.2.10. Microphone signal paths to include:

.1 High pass filter

.2 Compression

.3 3 band parametric EQ

.4 Gain control on each input Level metering on each input

3.2.11. Line signal paths to include:

.1 High pass filter

.2 Levelling

.3 3 band parametric EQ , Gain control on each input & Level metering on each input

3.2.12. Microphone mixing includes:

.1 Automatic gain sharing mixing (organised into groups)

.2 Individual and group master levels which can be controlled in real time.

.3 Full metering of microphone input

3.2.13. Mixing and routing to include:

.1 Matrix router to assign any combination of inputs to outs (some signals may be combined to reduce matrix size depending on facility operation)

.2 Microphones to be grouped and processed by gain sharing auto mixers

3.2.14. Loudspeaker signal paths to include:

.1 High pass filter

.2 6 band parametric EQ

.3 Limiting and compression with side chain

.4 Up to 100ms Delay

.5 Low pass filter

.6 Level control on each output & Metering on each output

3.3. DISTRIBUTED AUDIO SYSTEMS

3.3.1. Remove distributed audio line from the output of the distribution amplifiers.

3.3.2. Connect an impedance meter to the distributed loudspeaker line.

3.3.3. Use the meter to verify the total load on the distributed line. The line load shall not exceed the intended design limits.

3.3.4. System Contractor shall include test results in the system manual.

3.4. DIGITAL AUDIO SIGNAL SYSTEMS

3.4.1. Test digital audio signals for proper operation between devices. Ensure no additional noise is introduced into the analogue audio and digital signal paths when all devices are interconnected for normal operation.

3.4.2. Ensure all signals throughout the digital audio path are functioning at designed levels.

3.5. HEARING ASSISTANCE SYSTEMS

3.5.1. Verify Hearing Assistance systems are free of drop out and interference in the intended areas of operation. Change frequencies and/or relocate transmitters/antennas if necessary to correct such problems. Verify operation of all headsets and receivers.

END OF SECTION

27 41 16.11 Displays

1. General

1.1. FLAT PANEL DISPLAYS

1.1.1. All sources to flat panel display shall be scaled so display sees its native resolution. Scale input signal as required to ensure correct resolution and aspect ratio.

1.1.2. All displays must be bi-directional RS-232 or network controllable.

1.1.3. All efforts to provide an Energy Star / Green certified display model to be provided whenever possible.

1.1.4. When used in conjunction with audio-video transmission systems, the AV Contractor shall ensure display does not over scan the video signal when full-pixel sources are routed.

1.1.5. If consumer grade displays are specified, verify that the manufacturer warranty is not void if used in business applications. Bidders to notify the AV Contractor at time of bid if no such displays can be sourced. A minimum one year warranty for consumer grade displays shall be provided.

1.2. WALL MOUNTS FOR DISPLAYS

1.2.1. Displays shall be mounted as shown on architectural drawings.

1.2.2. The AV Contractor shall provide wall-mount that allows accessibility to infrastructure located at center of the display.

1.2.3. The AV Contractor shall select mounts to match blocking requirements shown on audiovisual and/or architectural drawings.

1.3. DIGITAL SIGNAGE DISPLAYS

1.3.1. All displays used for digital signage applications shall be commercial grade and designed to run 24/7 operation.

1.3.2. All digital signage displays shall have on-board scheduling systems for system power on and off.

1.3.3. Digital signage displays shall have a minimum three-year warranty.

1.3.4. Provide all necessary mounting accessories to professionally mount digital signage players behind the display. Velcro or zip ties are not acceptable.

1.4. VIDEOWALL DISPLAYS

1.4.1. All displays used for videowall applications shall be commercial grade and designed to run 24/7 operation.

1.4.2. All videowall displays shall have on-board scheduling systems for system power on and off.

1.4.3. Videowall displays shall have the connectivity to allow a video input to be passed-through natively to a video output.

1.4.4. Videowall display screens shall have a haze value between 25%-50%.

1.4.5. Videowall displays shall have a minimum three-year warranty.

1.4.6. All displays must be bi-directional RS-232 or network controllable.

1.4.7. Provide all necessary mounting accessories to properly align all display, as well as prevent the displays from coming out of alignment over time.

2. Products

2.1. FLAT PANEL DISPLAYS

2.1.1. Acceptable brands are: Sony and Samsung . Any other brand/model must be approved by AV Consultant.

2.2. WALL MOUNTS FOR FLAT PANEL DISPLAYS

2.2.1. Acceptable brands are Chief, Premier Mounts and Peerless. Any other model must be approved by the AV Consultant.

3. Execution

3.1. DISPLAYS

3.1.1. Provide all necessary mounting hardware to mount the displays to structural and route cabling concealed from view.

3.1.2. Displays to be wall mounted or ceiling mounted as per manufacturer's instruction.

3.1.3. Provide all necessary accessories and hardware for a fixed installation of the display system.

3.1.4. Locking display mounts shall contain the same locking mechanisms / keys on all mounts (unless specified otherwise).

3.1.5. The AV Contractor to confirm all required wall blocking, power and conduit required at display locations is adequate and properly installed prior to display installation.

3.2. VIDEOWALL DISPLAYS

3.2.1. Provide all necessary mounting hardware to mount the displays to structural and route cabling concealed from view.

3.2.2. Displays to be wall mounted or ceiling mounted as per manufacturer's instruction.

3.2.3. Provide all necessary accessories and hardware for a fixed installation of the display system.

3.2.4. All displays shall be calibrated to display uniform:

.1 Colour

.1 Including edge-to-edge in corners

.2 Brightness

.3 Contrast

3.2.5. Videowall displays shall be physically aligned on X, Y and Z-axis of all edges and corners to within 2mm tolerance.

3.2.6. The AV Contractor to confirm all required wall blocking, power and conduit required at display locations is adequate and properly installed prior to display installation.

END OF SECTION

27 41 16.12 Projection Systems

1. General

1.1. PROJECTORS

1.1.1. Projector must be bi-directional RS-232 or network controllable.

1.1.2. All efforts to provide an Energy Star / Green certified model to be provided whenever possible.

1.1.3. Provide zoom lens with throw distance appropriate to on-site conditions. The AV Contractor to confirm correct lens prior to purchase and installation of projector.

1.1.4. The AV Contractor to confirm projector power requirements on site with supplied electrical trade prior to deployment.

1.1.5. Projectors with solid state and/or laser phosphor light sources shall have a minimum lifecycle output expectancy of 20,000 hours.

1.2. MOTORIZED PROJECTION SCREENS

1.2.1. Motorized projection screens shall be black-backed.

1.2.2. All motorized projection screens shall have a standard 12” black drop unless indicated differently in section 27 41 00.

1.2.3. All motorized screens shall be supplied with an external low voltage controller and screen switch.

1.2.4. All motorized screens shall have quiet motors installed.

1.2.5. All motorized screens shall have a seamless screen surface.

1.3. LIFTS

1.3.1. For all products, if installed in a non-plenum space, or if installed in a plenum space with Environmental Airspace Housing and Closure, the entire unit is approved to UL 2442 and CSA C22.2 No. 60065-03 by Underwriters’ Laboratories for the U.S. and Canada.

1.3.2. Motors for projector lifts shall be certified for use in the United States and Canada by Underwriter’s Laboratory (UL) Inc and shall be UL label.

2. Products

2.1. PROJECTOR

2.1.1. Acceptable manufacturers are Christie Digital, Epson, NEC and Panasonic. Any other brand/model must be approved by AV Consultant.

2.2. MOTORIZED PROJECTION SCREENS

2.2.1. Acceptable manufacturers are Stewart Filmscreen and Da-Lite. Any other brand/model must be approved by AV Consultant.

2.3. LIFTS

2.3.1. Acceptable manufacturers are Draper, Da-Lite, SVS Lifts and Chief Manufacturing. Any other brand/model must be approved by AV Consultant.

3. Execution

3.1. PROJECTOR

3.1.1. Projector to be ceiling mounted as per manufacturer’s instruction.

3.1.2. Provide all necessary mounting hardware to mount the projector to structural and route cabling concealed from view.

3.1.3. Confirm correct lens prior to purchase and installation of projector.

3.1.4. Optimize and align viewing characteristics of projector. Keystoning is not an accepted practice.

3.1.5. Provide all necessary accessories and hardware for a fixed installation of the projection system.

3.1.6. For non-accessible ceilings, coordinate locations of access hatches with general Contractor.

3.1.7. Projectors with solid state and/or laser phosphor light sources shall be configured to operate with a manufacturer recommended constant brightness strategy to allow the light output of the device to be consistent throughout the life of the unit.

3.2. PROJECTION SCREENS

3.2.1. Install in accordance with manufacturer's instructions.

3.2.2. Install front projection screens with screen cases in position and relationship to adjoining construction, securely anchored to supporting substrate, and in manner that produces a smoothly operating screen with plumb and straight vertical edges and plumb and flat viewing surfaces when screen is lowered.

3.2.3. Test electrically operated units to verify that screen, controls, limit switches, closure and other operating components are in optimum functioning condition.

3.3. PROJECTOR LIFTS

3.3.1. Install in accordance with manufacturer’s instructions.

3.3.2. Shop drawings: Include dimensions, method of attachments, structural support, bracing and electrical wiring.

3.3.3. Provide finish samples.

3.3.4. Obtain motorized projector lifts from a single manufacturer as a complete unit including necessary mounting hardware and accessories.

3.3.5. Inspect motorized projector lifts for freight damage, upon delivery to project site. Report damage to freight carrier immediately for replacement of unit.

END OF SECTION

27 41 16.15 Control Systems

1. General

1.1. DESCRIPTION

1.1.1. The control system provides a central microprocessor for control and automation of project audiovisual systems and equipment, and interfaces for user interaction with all devices.

1.1.2. Control processors shall be rackmount based. Provide all rackmount accessories to properly mount and house processor.

1.1.3. Provide all networking components required to provide an audiovisual control network. Coordinate with Owner's IT officers to arrange an IP subnet range as required.

1.1.4. Supply, install and program all expansion modules to provide functionality and control as outlined in the Specification.

1.1.5. Where devices are under the control of the AV system controller, connections and hardware shall support bi-directional communications with the AV systems controller.

1.1.6. Coordinate with the Owner and/or appointed representative to provide a user intuitive and functional control methodology for all room uses, configurations and user skill sets.

1.1.7. System programming shall meet with all specified requirements for a complete control solution.

1.1.8. All control system program files shall be created by the AV Contractor. Reuse of old programming code on existing systems is not acceptable without approval of the Owner and AV Consultant.

1.1.9. Upon completion of the project, all control system software files shall be submitted in complied and uncompiled formats. Executable files that mimic the graphical control interfaces shall also be provided to the Owner to be used on designated computers.

2. Products

2.1. CONTROL SYSTEM

2.1.1. Acceptable control system products are: Crestron, QSC and AMX. Any other brand/model must be approved by AV Consultant.

3. Execution

3.1. CONTROL SYSTEM PROGRAMMING AND INSTALLATION STANDARDS

3.1.1. All control system programmers and field commissioning technicians must possess manufacturer specific programming certifications.

3.1.2. Where Touch Panels or button panels are used to control AV systems, the AV Contractor shall work with the AV Consultant and Owner to develop user interfaces that are intuitive for the Owner and system users to operate. This practice should occur in as far advance as possible prior to project deployment.

3.1.3. Where Touch Panels or button panels are used to control AV systems, the AV Contractor shall coordinate a minimum of two (2) development workshops, each being a minimum of four (4) hours in length, with the AV Consultant and Owner to develop user interfaces that are intuitive for the Owner and system users to operate. This practice should occur in as far advance as possible prior to project deployment.

3.1.4. Prior to commissioning, submit all software programming files to AV Consultant for review. All software submissions must be accompanied by documentation indicating the intent of the program, table of presets, flow diagrams, revision date and any omissions to overall functionality.

3.1.5. All hardware used to control and interface with the computer system shall be tested and fully functional prior to installation on site.

3.1.6. Control system shall manage all system devices and provide full feature control of the following devices using the protocols indicated in brackets.:

.1 Audiovisual Matrix Switchers (RS-232 or Ethernet)

.2 Flat panel displays (RS-232 or Ethernet)

.3 Projector/display lifts (Relay or contact closure)

.4 Video conference codec (RS-232 or Ethernet)

.5 Audio DSP (RS-232 or Ethernet)

.6 Document camera (RS-232 or Ethernet)

.7 Lighting (Ethernet or RS-232; Interface at AV rack location by others)

.8 Blinds and shades (Ethernet, Relay or RS-232; Interface at AV rack location by others)

.9 Projection screen low-voltage controller (Relay)

.10 Partition status and activation where applicable

3.1.7. In addition to typical device control, the AV Contractor programming is to include the following functionality within the control software and touch panel page design:

.1 Provide pop window to indicate “System initializing” upon system start when projection systems are utilized.

.2 Provide pop-up window to indicate “System shutting down”:

.1 Include countdown timer, or bar graph indication of time remaining

.1 Confirm timer setting during workshop

.2 Provide menu to cancel shutdown request.

.3 Upon timer expiration, the system shall automatically shutdown without user action.

.3 Automatic system shut down with timing to be confirmed with Owner. Provide 15 minute prompt screen pop-up

.4 Room program audio and voice reinforcement level and mute controls. Include master fader and mute control as required

.5 Password protected start up page (to be confirmed during workshop)

.6 Dynamic and speed dial facilities for audio conferencing

.7 Dynamic and speed dial facilities for video conferencing.

.8 Automated system on/off when a user connects a presentation device to the system such as a laptop/tablet to a input presentation cable.

.9 All other programming features deemed appropriate by the Owner and/or appointed representative to provide an intuitive and easy to understand user interface.

3.1.8. Where the project contains graphical user interfaces from multiple manufacturers, provide a consistent graphical user experience regardless of manufacturer. For example, if a project contains both Cisco and Crestron Touch panels, ensure the custom Crestron interfaces match the Cisco user interface/user experience as closely as possible. Provide mock-ups of interfaces for Owner/AV Consultant approval prior to the completion of development of custom software and the deployment of custom software to touch panel hardware on site.

3.1.9. All control programming with custom graphical user interfaces shall be controllable through the Owner's computers, mobile devices or tablets. Provide executable files of the control system program graphical user interface and deploy on computers as directed by the Owner. Submit executables as part of the as built documentation. Provide a method (eg. QR code) to allow the user to transfer the interface to their own device (mobile or tablet). Confirm with Owner/consulting preferred operating system and network configuration requirements

END OF SECTION

27 41 16.16 Audio Video Transmission Systems

1. General

1.1. MULTI-SIGNAL MATRIX SWITCHING AND TRANSMISSION SYSTEMS

1.1.1. Audio video transmission systems shall transcode multiple types of AV signals to a single signal type for distribution. The system shall support the following AV signal inputs:

.1 HDMI 2.0 (High Definition Multimedia Interface)

.2 DVI 1.1 (Digital Visual Interface)

.3 DisplayPort Multimode 1.1

.4 YPbPr

.5 Analog Stereo Audio

1.1.2. The AV distribution system shall use multimode fiber or shielded twisted pairs for AV signal distribution.

1.1.3. The twisted pair structured cabling used to carry the AV signals shall be shielded.

1.1.4. The AV Contractor shall verify the data rate supported by each shielded twisted pair cable used for AV distribution.

1.1.5. The AV distribution system shall route AV signals from any input to any output with less than 1ms of latency.

1.1.6. The AV switching system shall allow configuration of the EDID presented to sources on each AV input.

1.1.7. The AV switching system shall allow the user to enter each input's EDID video timings individually.

1.1.8. The AV distribution system shall allow all source and sink transmitters and receivers to be monitors through PC based software.

1.1.9. The AV distribution system shall transmit the following control signals for AV sources and sinks using the same cabling infrastructure:

.1 RS-232

.2 Infrared

.3 Ethernet

.4 Contact closure

1.2. HIGH BANDWIDTH DIGITAL CONTENT PROTECTION (HDCP) MANAGEMENT

1.2.1. The AV switching system shall support HDCP 1.1 or greater.

1.2.2. The AV switching system shall detect the number of KSVs supported by each source, and not send a source more Key Selection Vectors (KSVs) than it supports.

1.2.3. The AV switching system shall authenticate all cached KSVs with each source up to the source's KSV limit, so that authentication does not need to be re-started each time content is routed to a new output.

1.2.4. The AV Contractor shall notify AV Consultant if a particular AV source cannot provide enough KSVs to route to all sink destinations simultaneously.

1.3. HDBASET AUDIO VIDEO TRANSMISSION SYSTEM TRANSPORT

1.3.1. The audio video transmission system transport shall be an advanced signal extender capable of extending multiple AV signals from source to sink location using a single STP or fibre optic cable.

1.3.2. The system shall support the following features:

.1 Signal transmission up to 330 feet via STP cable

.2 Signal transmission up to 3000 feet via fiber

.3 Video resolutions up to 4096x2160 (4K DCI) or 3840 x 2160 (UHD)

.4 IR and RS-232 control

.5 Advanced video detection on every video type, including resolution, frame rate and color depth.

1.3.3. Cabling for all 4K DCI and UHD systems shall be shielded.

1.3.4. HDBaseT Audio video transmitters shall be able to extend HDMI (including digital audio), DVI-I, RGBHV, RGBS, RGsB, YPbPr, and Analog 2-channel audio.

1.3.5. HDBaseT Audio video receivers shall receive and decode any signal sent from a cabling transmitter or from matrix switch. All video and audio signals shall be output via the HDMI connector. HID data shall be carried via the USB connector. Scaling receivers are mandatory.

1.4. IP AUDIO VIDEO DISTRIBUTION SYSTEM TRANSPORT

1.4.1. The audio video distribution system shall be a Gigabit IP network based advanced signal distribution system capable of extending multiple AV signals from source to sink location(s) using a single UTP or fibre optic cable to each end device.

1.4.2. The system shall support the following features:

.1 Signal distribution up to 330 feet via STP cable

.2 Signal distribution up to 3000 feet via fiber

.3 Video resolutions up to 4096x2160 (4K DCI) or 3840 x 2160 (UHD)

.4 IR and RS-232 control

.5 Advanced video detection on every video type, including resolution, frame rate and color depth.

.6 USB HID

1.4.3. UTP cabling for all 4K DCI and UHD systems shall be rated for Gigabit speed or higher.

1.4.4. IP Audio Video encoder shall be able to ingest HDMI (including digital audio).

1.4.5. IP Audio Video decoder shall receive and decode any signal available from an encoder. All video and audio signals shall be output via the HDMI connector. HID data shall be carried via the USB connector. Scaling decoders are mandatory.

1.5. MATRIX SWITCHER

1.5.1. The matrix switcher shall consist of a card-cage type unit, capable of accepting different input and output cards while fulfilling the functionality described in sections 1.1, 1.2 and 1.3.

1.5.2. Any input shall be routable to any output. Matrix shall provide almost instantaneous HDMI switching for sources with HDCP. Breakaway audio, video, and USB switching shall also be available.

1.5.3. Configure switcher system to accommodate all inputs and outputs as indicating on project functional drawings. Provide two additional “spare” inputs, two additional “spare” DVI-I inputs and at least one spare output as part of each switcher configuration.

1.5.4. Provide fast HDMI switching with switch timings less than three seconds.

1.6. PRESENTATION SWITCHERS

1.6.1. The presentation switcher is a single central switching and control unit that integrates audio-video switching, audio mixing and amplification, and a complete system controller.

.1 The presentation system shall be a single central switching and control unit integrating the following functions:

.1 Audio matrix switching.

.2 Microphone pre-amplification.

.3 Acoustic echo cancellation where audio conferencing is specified.

.4 Microphone and program audio mixing.

.5 Audio amplification.

.6 Digital multi-channel audio router.

.7 Analog to digital video transcoding.

.8 Video matrix switching.

.9 Single Cable Signal Transmission.

.10 System control processing.

1.6.2. Ensure presentation switcher accepts and routes all signal types shown on functional drawings.

2. Products

2.1. AUDIO VIDEO TRANSMISSION SYSTEMS (HDBASE-T)

2.1.1. Acceptable products are: Crestron Digital Media and Extron XTP. Any other brand/model must be approved by AV Consultant.

3. Execution

3.1. COMMISSIONING

3.1.1. All field commissioning technicians must possess manufacturer specific certifications. The AV Contractor shall supply to AV Consultant all required system certifications at time of bid.

3.1.2. All infrastructure wiring should be tested before connecting any active equipment.

3.2. SHIELDED TWISTED PAIR (STP) CABLE

3.2.1. The installed twisted-pair horizontal links shall be tested from terminated end point to terminated end point for compliance with the "*Permanent Link*" performance specification as defined in the Category ANSI/TIA-568-C Standard.

3.2.2. Field structured cables should be tested for the following, in accordance with the field test specifications defined in ANSI/TIA-568-C.2 "Commercial Balanced Twisted-Pair Telecommunications Cabling and Components Standard".

3.2.3. Test Result Documentation

.1 An electronic or paper copy of the test results shall be provided if requested that lists all the links that have been tested with the standard summary testing results.

3.3. FIBER

3.3.1. Each fiber end should be inspected with a 100x-200x microscope and cleaned if necessary before testing. Each fiber should be tested for optical loss using the 'IEC 61280-4-1 single reference cable method' or 'TIA 526-14 OFSTP-14 Method B' with the acceptable link attenuation (insertion loss) on each fiber end-to-end link of <4dB @ 850nm and <4dB @ 1300nm.

3.3.2. Test Result Documentation

.1 An electronic or paper copy of the test results shall be provided if requested that lists all the links that have been tested with the standard summary testing results.

3.3.3.

3.4. SYSTEM TESTING AND COMMISSIONING

3.4.1. Testing

.1 A Manufacturer Certified Engineer shall perform the AV Contractor verification tests.

.2 The AV Contractor shall verify that all components of the system are installed according to manufacturer's specifications and are compliant with Division 27 specifications.

3.4.2. Commissioning

.1 A Manufacturer Certified Engineer shall perform acceptance testing and commissioning.

.2 The AV Contractor shall provide a copy of the system commissioning Test Report in electronic format upon request.

.1 All reported information shall be generated by the matrix unit and the configuration software and cable testing device.

.3 Commissioning engineer shall run all available tests and include all installed system components.

.4 Commissioning Test Report shall include the following:

.1 Tests Failures and Notices

.1 Sink Device EDID Test – Open items or failures shall not be accepted.

.2 Cable Length Test - Open items or failures shall not be accepted.

.3 HDCP KSV Limitations – Limitations shall not be accepted.

.4 Cable Limitations – Limitations shall not be accepted.

.5 EDID Limitations – Limitations shall not be accepted.

.6 Cable Length Limits exceeded – Failing cables shall not be accepted.

.2 Device Model Number, Serial Number, and Firmware Version for main chassis and each input and output card.

.3 Device Model Number, Serial Number, and Firmware Version for connected transmitter and receiver devices.

.4 EDID – Input Resolution and 3D support status for each input.

.5 EDID – Supported Output Resolution and 3D support status for devices connected to each output.

.6 EDID – Supported Audio formats for each input.

END OF SECTION

27 41 23.10 Audiovisual Cabinets, Racks, Frames and Enclosures

1. General

1.1. FIXED INSTALLED RACKS

1.1.1. All equipment racks must conform to the following standards:

.1 EIA RS-310-C, Racks, Panels and Associated Equipment

.2 AVIXA F502.01:2018 – Rack Building for Audiovisual Systems

.3 IEC 60297-3-100 – Mechanical Structures for Electronic Equipment

1.1.2. Provide openings top and bottom as required for cabling.

1.1.3. Provide rack elevations as part of shop drawing submissions.

1.1.4. Racks to be Black unless otherwise specified.

1.1.5. All racks to be of a professional quality, all steel welded construction, baked enamel finish, removable side panels, sliding front and rear equipment mounting rails, formed dress panels and a bottom dress panel.

1.1.6. PORTABLE RACKS

1.1.7. Provide portable steel equipment racks with dress panels and removable sides as required for a completed look and finish. Top panel should be solid or vented depending on cooling requirements and rear doors with flush key locks are required. Doors should be perforated unless solid doors are required in cooling scheme.

1.1.8. Top and bottom planes should incorporate a recess on the rear edge to allow for the passage of cables when the cabinet is located against a surface to the rear.

1.1.9. Provide approval drawing of this equipment for review by the AV Consultant prior to construction.

1.2. WALL MOUNT RACK REQUIREMENTS

1.2.1. For wall mounted racks, provide swing-out style steel racks with locking front doors and vented side panels. Ensure the rack has appropriate ventilation requirements.

1.3. RACK ACCESSORIES

1.3.1. Supply cable tie bars for all horizontal cable transitions and vertical lacing bars.

1.3.2. Supply blank panels (blank or vent) to fill all empty rack spaces. Panels can be 1, 2 or 3 RU.

1.3.3. Provide one 3 RU steel pull out drawer in each rack that is greater than 27RU in capacity.

1.3.4. Provide a multi-duplex AC outlet plug strip in each rack, one outlet for each 3 RU.

1.3.5. Provide a permanent work light with switch, mounted at the rear top of the rack to assist with service.

1.3.6. Provide adjustable front and rear mounted rails tapped with #10-32 mounting holes.

1.3.7. Provide all mounting hardware and rack screws with nylon washers.

1.4. UNINTERRUPTIBLE POWER SUPPLY (UPS)

1.4.1. Provide a series mode UPS for all equipment racks that house microprocessor devices such as control systems and DSP.

1.5. WORK INCLUDED

1.5.1. Conform to Section 27 40 10 – GENERAL INSTRUCTIONS FOR AUDIOVISUAL SYSTEM INSTALLATION.

2. Products

2.1. FIXED INSTALLED RACKS AND ACCESSORIES

2.1.1. Acceptable brands are: Middle Atlantic. Any other brand/model must be approved by AV Consultant.

2.2. PORTABLE RACKS

2.2.1. Acceptable brands are: Engineered Case Manufacturer. Any other brand/model must be approved by AV Consultant.

2.3. UNINTERRUPTIBLE POWER SUPPLY (UPS)

2.3.1. Acceptable brands are: Middle Atlantic, Surgex and APC. Any other brand/model must be approved by AV Consultant.

3. Execution

3.1. FIXED INSTALLED RACKS

3.1.1. Amplifiers should be mounted at the bottom rail of the equipment rack to maintain balance and stability. Support the weight of the amplifier with angle brackets attached to the side rails of the equipment rack or with the rear support flanges included with some amplifiers. Attach a label to the faceplate of each amplifier to indicate function.

3.2. EQUIPMENT RACKS IN MILLWORK

3.2.1. Racks in millwork must have a minimum of 2” clear space behind the racks and rear of the cabinet.

3.2.2. Millwork should be cut to allow access to electrical, data and AV wall boxes.

3.2.3. Millwork and credenza must have ventilation slots provided to allow for proper cooling of the audiovisual equipment.

3.3. VENTILATION

3.3.1. Provide vent panels at the top and bottom of all 44RU equipment racks.

3.3.2. Provide blank or perforated metal panels as required to provide adequate cooling. If rack is convection cooled, install a 1RU panel above and below each power amplifier.

3.3.3. Internal equipment rack temperature should not exceed 85°F. Provide passive or active thermal management solutions to maintain an internal temperature lower than stated.

3.3.4. For equipment racks mounted in credenzas, ensure adequate cutouts are provided to dissipate heat. Cutouts should be provided at the bottom and top (or rear) of all millwork for ventilation. Provide active thermal management if required to the millwork. Coordinate with millwork Contractor.

3.3.5. Avoid locating racks directly under supply ductwork. The flow of hot air rising from the top of the rack should have no impediments on its way back to the return air intake duct.

3.4. PORTABLE RACKS

3.4.1. Provide four high-quality locking casters, 4” wheel diameter for cabinets taller than 21”.wall mount RACK REQUIREMENTS

3.5. UNINTERRUPTIBLE POWER SUPPLY (UPS)

3.5.1. All connected equipment shall be considered critical use devices.

3.5.2. Ensure all power cords connected are properly labelled with destination device name.

END OF SECTION

27 41 23.11 Audiovisual Cabling

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 27 40 10 – GENERAL INSTRUCTIONS FOR AUDIOVISUAL SYSTEM INSTALLATION.

1.1.2. Supply and install cabling as detailed in Contract Documents. The AV Contractor shall provide all required pathways to distribute the cables throughout the facility where the pathway has not been provided by Division 26. Where cables leave the pathways, the AV Contractor shall supply and install cable slings and/or j-hooks to support cabling up to point of termination. Comply with the following section - *27 05 28.00 Pathways for Communication Systems*.

1.1.3. Supply and install conductors and cables as detailed in Contract Documents and as required and as recommended by the manufacturer to ensure proper operation of all systems. The AV Contractor shall use pathways (by Division 26) to distribute the cables throughout the facility. Where the cables leave the pathways and extend to the termination point the AV Contractor shall ensure cable have appropriate infrastructure to support and secure the cables.

1.1.4. Avoid scraping, denting, or otherwise damaging cables, before, during or after installation. The AV Contractor without any additional compensation shall replace damaged cables.

1.1.5. Ensure that all cable lengths are sufficient to allow for slack, vertical runs, wastage, connectorization and future moves.

1.2. CABLE ROUTING

1.2.1. Make any necessary changes or additions to routing of cables, pathways to accommodate structural, mechanical, electrical and architectural conditions. Where pathways or cables are shown diagrammatically run them parallel to building columns. If it is necessary to run cables otherwise to accommodate acceptable cable lengths, written permission must be obtained from the Audiovisual Engineer's Representative prior to installation.

1.2.2. For all schemes of cable routing, no point in the path shall be subjected to a bend radius of less than eight times the cable diameter or minimum cable bend radius specified by the manufacturer.

1.3. CABLE PROPERTIES

1.3.1. Conductors and cables shall be CMR where installed completely in conduit and/or where installed in non-plenum rated areas. Conductors and cables shall be CMP where not completely installed in conduit and/or installed in plenum rated areas. All cable shall conform to the recommendations of the manufacturers of the audiovisual systems.

1.3.2. Conductors and cables shall be outdoor rated where installed outdoor and /or installed in locations where exposed to weather elements.

1.3.3. Provide and install shielded cables where required and or recommended by the manufacturer of the audiovisual systems.

1.3.4. Wiring shown is for typical systems. All wiring shall be as required and recommended by the manufacture of the audiovisual systems.

1.3.5. All wiring shall be of proper gauge, type and quantity of conductors as required and as recommended by the manufacturer to ensure proper operation of audiovisual systems and peripheral devices.

1.3.6. Multi-conductor cables shall have color-coded conductors.

1.3.7. All conductors and cables shall be CSA approved and must bare stamping by the manufacturer. .

1.3.8. Consult drawings and provide FT-6 rated cable where cables are outside of conduit systems

1.4. CABLE DISTRIBUTION

1.4.1. Utilise all indicated and available cable pathways such as conduits, communications cable tray, ducts, surface raceways and furniture system channels except where otherwise noted.

1.4.2. Wires and cables shall be segregated according to signal type. In addition, audio cable shall be subdivided into three classes: microphone level circuits, analog line level circuits and speaker level circuits.

1.4.3. Microphone level audio circuits shall be kept at least 75mm (3") away from any other type of parallel signal circuits and at least 150mm (6") away from any parallel AC power circuits.

1.4.4. Speaker level audio circuits shall be kept a minimum of 75mm (3") from line level audio and AC power circuits. All other signal circuits shall be kept at least 75mm (3") away from any parallel AC power circuits. Where conditions allow, high impedance and low impedance (8 ohm) speaker levels shall be separated by minimum of 75mm (3").

1.4.5. Where circuits of different types must cross, they shall do so at right angles and then return to the above required separations in as short a distance as possible.

1.4.6. Inside buildings minimise any possibilities of disruption by maintaining the following minimum clearances from electrical and heat sources when routing cables.

Item	**Minimum Clearance**
Motors	1.20 m (4'-0")
Transformers	1.20 m (4'-0")
Conduit and cables used for electrical distribution less than 1kVA	0.30 m (1'-0")
Conduit and cables used for electrical distribution greater than 1kVA	1.00 m (3'-0")
Fluorescent Luminaries	12 cm (0'-5")
Pipes (gas, oil, water, etc.)	30 cm (1'-0")
HVAC (equipment, ducts, etc.)	15 cm (0'-6")

1.5. FIRE STOPPING

1.5.1. General

.1 Provide seals in all Fire Rated Separations and Firewalls to form tight barriers to retard the passage of flame and smoke.

.2 The installed seals shall provide and maintain the fire resistance rating of the adjacent floor, wall or other fire separation assembly to the Code Requirements.

.3 Moisture seals as well as fire and smoke seals shall be required for all floor penetrations in Laboratories and Operating Rooms in Hospitals, Universities and Schools.

.4 The Communications Contractor shall establish/re-establish the integrity of all fire-rated structures and assemblies that they have created or disturbed, or that were created by others for use by the Communications Contractor.

.5 Supply and install Fire Stop pillows for existing cable tray penetrations through firewalls.

.6 For the purposes of this specification, the only acceptable Fire Stop Systems shall be those that have been tested to the CAN/ULC S115 Standard.

.7 Supply and install non-permanent CSA approved Fire Stop systems that are dielectric, water resistant, non-hardening, permanently pliable/re-enterable putty along with the appropriate damming or backer materials (where required).

.8 All fire stopping shall maintain a minimum one hour rating and shall meet applicable Federal, Provincial and Local building codes.

.9 All Fire Stop Systems shall be listed and tested by an SCC and accredited Third Party Testing Agency in accordance with the Standards.

.10 Fire resistance ratings of installed Fire Stop Systems shall not be less than the fire resistance rating of the surrounding Fire Separation or Firewall.

.11 All Smoke Seals selected for use shall comply with Standards.

.12 Where moisture seals are required for floor penetrations in Operating Rooms, Morgues, and Laboratories in Hospitals, Universities and Schools, the Fire Stop Materials selected shall be compatible with Formalin.

.13 All Fire Stop Materials and Smoke Seals shall have elastomeric characteristics to allow for building settling and seismic movement. All Fire Stop Materials and Smoke Seals shall be free of asbestos.

1.5.2. Quality Assurance

.1 Provide fire stopping systems that comply with the following requirements following:

.1 Fire stopping tests are performed by a qualified, testing and inspection agency. A qualified testing and inspection agency is UL, or another agency performing testing and follow-up inspection services for fire stop system acceptable to authorities having jurisdiction.

.2 Fire stopping products bear the classification marking of qualified testing and inspection agency.

.2 Provide the work of this Section using competent installers, experienced in the application of the materials and systems being used, approved and trained by the material or system manufacturer.

.3 Fire Stop Systems shall conform to the fire (F), hose (H) and temperature (T) ratings of Codes.

.4 Fire Stop Materials and Smoke Seal materials shall have a flame spread rating of 25 or less, National Fire Protection Association (NFPA Class "A").

.5 For the purposes of this specification the only acceptable Fire Stop Systems are those that have been tested to the CAN/ULC S115 Standard.

1.5.3. Performance

.1 Fire rated pathway devices shall be the preferred product and shall be installed in all locations where frequent cable moves, add-ons and changes shall occur.

.2 Where non- mechanical products are utilized, provide products that upon curing do no re-emulsify, dissolve, leach, breakdown or otherwise deteriorate over time from exposure to atmospheric moisture, sweating pipes, ponding water or other forms of moisture characteristic during or after construction.

.3 Where it is not practical to use a mechanical device, openings within floors and walls designed to accommodate telecommunications and data cabling shall be provided with re-enterable products that do not cure or dry.

.4 Openings for cable trays shall be sealed using re-enterable fire stopping pillows.

1.5.4. Project Conditions

.1 Do not install fire stopping products when ambient or substrate temperatures are outside limitations recommended by manufacturer

.2 Do not install fire stopping products when substrates are wet due to rain, frost, condensation, or other causes.

.3 Maintain minimum temperature before, during, and for a minimum 3 days after installation of materials.

.4 Do not use materials that contain flammable solvents.

.5 Coordinate construction of openings and penetrating items to ensure that through-penetration fire stop systems are installed according to specified requirements.

.6 Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration fire stop systems.

.7 Schedule installation of fire stopping after completion of penetrating item installation but prior to covering or concealing of openings.

2. Products

2.1. MIC/LINE LEVEL ANALOG AUDIO CABLE (TYPE MLA)

2.1.1. The mic/line cable is an installation grade cable intended for permanent analog microphone and line level installations.

2.1.2. Mic/line level cable shall be minimum 22 AWG stranded twisted pair copper with propylene insulated conductors and PVC outer jacket.

2.1.3. Mic/line cable shall have 100% foil shield with 22 AWG drain wire.

2.1.4. Mic/line cable shall have a voltage rating of 300 V RMS.

2.1.5. Mic/line cable shall be Belden 9451 (FT-4), 9451P (FT-6) or approved equivalent.

2.2. MIC/LINE LEVEL DIGITAL AUDIO CABLE (TYPE MLD)

2.2.1. The mic/line level digital audio cable is an installation grade cable intended for digital audio (AES/EBU signals).

2.2.2. Mic/Line Level digital audio cable shall be minimum 24 AWG stranded shielded twisted pair copper with propylene or equivalent insulated conductors and PVC outer jacket.

2.2.3. Mic/Line Level digital audio cable shall have minimum 95% braided shield and bare copper 26 AWG drain wire.

2.2.4. Mic/Line Level digital audio cable shall have a voltage rating of minimum 300 V RMS.

2.2.5. Mic/Line Level digital audio cable shall have a nominal impedance of 110 ohms.

2.2.6. Mic/Line Level digital audio cable shall be Belden 1800B (FT-4), 1801B (FT-6) or approved equivalent.

2.3. SPEAKER CABLE HIGH IMPEDANCE (TYPE LS16 AND TYPE LS14)

2.3.1. The speaker cable –high impedance is an installation grade cable intended for permanent 70-volt speaker system installations.

2.3.2. Speaker cable – high impedance shall be unshielded stranded twisted pair copper with propylene insulated conductors and PVC outer jacket.

2.3.3. Speaker cable – high impedance shall be minimum 16 AWG for low power (under 200 watt loads) to a maximum of 500ft – 152m.

2.3.4. For higher than 200 watt loads or cable runs longer than 200ft, utilize a 14 AWG unless otherwise specified. See “Speaker Cable – Low Impedance”.

2.3.5. Speaker cable – high impedance shall have a voltage rating of 300 V RMS.

2.3.6. Speaker cable – high impedance shall be Belden 6200UE (16AWG FT-6), 5200UH (16AWG FT-4), 6100UE (14 AWG FT-6), 5100UH (14 AWG FT-4) or approved equivalent.

2.4. SPEAKER CABLE LOW IMPEDANCE (TYPE LS14 AND LS12)

2.4.1. Speaker cable – low impedance is an installation grade cable intended for permanent performance audio system installations.

2.4.2. Speaker cable – low impedance shall be unshielded stranded twisted pair copper with propylene insulated conductors and PVC outer jacket.

2.4.3. Speaker cable – low impedance shall be minimum 14 AWG for runs that are not longer than 75ft (23 metres).

2.4.4. Speaker cable – low impedance shall be minimum 12 AWG for runs that are longer than 75ft (23 metres) to a maximum of 200ft (63 metres).

2.4.5. Cabling for speaker cable runs longer than 200ft (63 metres) to be coordinated with the AV Consultant.

2.4.6. Speaker cable – low impedance shall be Belden 6100UE (14 AWG FT-6), 5100UH (14 AWG FT-4), 6000UE (12 AWG FT-6), 5000UH (12 AWG, FT-4) or approved equivalent.
AUDIOVISUAL STRUCTURED CABLING (TYPE D)

2.5.1. Audiovisual structured cabling is an installation grade cable used for IP control, video-over-IP solutions or audio-over-ethernet solutions (eg. Dante, AES67).

2.5.2. Cabling used for IP-based audiovisual solutions such as AES67 or H.264 shall comply with ANSI/EIA/TIA standards (minimum Category 6) and manufacturer specific networking requirements.

2.5.3. Comply with the following specifications:

.1 27 13 13.00 Communications Copper Backbone Cabling

.2 27 13 23.00 Communications Optical Fibre Backbone Cabling

.3 27 15 00.19 Data Communications Horizontal Cabling

.4 27 15 33.00 Communications Coaxial Horizontal Cabling

2.5.4. Refer to division of responsibility between AV Contractor and communications Contractor on AV drawings and scope of work specification (27 41 00.00) for project specific audiovisual structured cabling requirements.

2.6. ANTENNA CABLE UHF (TYPE ANT-U)

2.6.1. The antenna cable is an installation grade cable intended for permanent wireless microphone system antennas and assistive listening system transmitters (IR radiators and antennas) operating in the UHF frequency bands.

2.6.2. Antenna cable shall be RG-8X type with 10AWG solid copper conductor.

2.6.3. Antenna cable shall have minimum braided shield and over foil shield.

2.6.4. Antenna cable shall have a nominal impedance of 50 ohms.

2.6.5. Antenna cable shall be Belden 9913 (FT-4), 89913 (FT-6) or approved equivalent.

2.7. ANTENNA CABLE DECT (TYPE ANT-D)

2.7.1. The antenna cable is an installation grade cable intended for digital wireless systems operating the DECT frequency bands (above 1GHz).

2.7.2. Antenna cable shall have a frequency range of 30MHZ to 8000MHZ.

2.7.3. Antenna cable shall have minimum braided shield and over foil shield.

2.7.4. Antenna cable shall have a nominal impedance of 50 ohms.

2.7.5. Antenna cable shall be Times Microwave LMR-400-LLPX or approved equivalent.

2.8. 12 GHZ SERIAL DIGITAL INTERFACE COAXIAL VIDEO CABLE (TYPE SDI)

2.8.1. The 12G-SDI digital video cable is intended for permanent installations requiring transmission of uncompressed UHD and 4K-DCI video signals requiring an approximate 12 Gb/s data rate.

2.8.2. 12G-SDI Digital Video Cable shall be minimum 18 AWG bare silver-plated copper insulated conductor, shielded and PVC outer jacket.

2.8.3. 12G-SDI Digital Video Cable shall have a minimum 95% braided shield and 100% foil shield.

2.8.4. 12G-SDI Digital Video Cable shall have a nominal impedance of 75 ohms.

2.8.5. 12G-SDI Digital Video Cable shall adhere to SMPTE 2082-1 specifications.

2.8.6. 12G-SDI Digital Video Cable shall be Belden 4794R or approved equivalent.

2.9. HDBASE-T CABLE (TYPE HDBT)

2.9.1. Refer to 27 41 16.16 Audio Video Transmission Systems for projects with HDBase-T solutions.

2.10. FIRE STOP

2.10.1. Products manufactured by Hilti Corporation (or approved equivalent) are acceptable.

2.10.2. Obtain fire stop systems for each type of penetration and construction condition indicated only from a single manufacturer.

3. Execution

3.1. CABLE INSTALLATION

3.1.1. Exercise caution when pulling cables in pathways to avoid damage to any existing cables and follow manufacturer’s maximum pull-force and minimum bend radii.

3.1.2. All cables and components shall be installed and terminated in accordance with applicable Codes, Standards and Regulations.

3.1.3. Supply and install all wiring as required for the proper operating of each audiovisual system and each peripheral device.

3.1.4. After installation, and before termination, all wiring and cabling shall be checked and tested to insure there are no grounds, opens, or shorts on any conductors or shields.

3.1.5. Visually inspect wire and cable for faulty insulation prior to installation. Protect cable ends at all times with acceptable end caps except during actual termination.

3.1.6. Protect wire and cable from kinks.

3.1.7. Provide grommets and strain relief where required.

3.1.8. Comply with controller and peripheral device manufactures installation and termination recommendation.

3.1.9. Where more than two cables shall terminate at the output of a device a terminal block with identification must be provided near the device to gather the cables together so only one cable actually terminates on the device. Provide terminal blocks, marking and mounting systems.

3.1.10. Provide brush plates or scoop wall plates to cover all mudrings and backboxes used for cable passthrough.

3.2. CABLE SUPPORT

3.2.1. Hangers shall be installed at 4' intervals (maximum). Cables shall be run such that sag between supports does not exceed 4". Secure all cables to J-hooks/supports with Velcro tie-wraps. Cables shall be combed and dressed for all visible portions of the install. The above noted conditions shall be strictly checked and the AV Contractor shall be required to comb and redress any cables that are unsatisfactory at no additional cost.

3.2.2. Attaching to T-bar support rods is not acceptable. Anchors for hangers must not be drilled into post tensioned beams under any circumstances. The AV Contractor shall not use Hilti Pneumatic hammers. All anchors must be drilled into slab.

3.2.3. The AV Contractor must minimize the disturbance or removal of 'fire spray' insulation during installation of cable supports.

3.3. NON-CONTINUOUS CABLE SUPPORT

3.3.1. The AV Contractor shall supply and install cable support for the distribution of horizontal and backbone cables where conduit or ladder tray has not been provided.

3.3.2. The size of J-hooks/support shall suit quantity of cables in runs used for distribution.

3.3.3. Include any other miscellaneous hardware (angled hanger bracket, hammer/screw on clamps) required to support horizontal and backbone cabling.

3.4. GROUNDING WIRE

3.4.1. Supply and install #6 AWG green grounding wire for all metallic components that shall be grounded and Code Conductor Two Hole Long Barrel with Window Lug to bond the conductor to the ground bus.

3.5. VELCRO TIE-WRAPS

3.5.1. Velcro tie-wraps shall be used to neatly dress cables; they shall be placed at a maximum of 4' intervals for horizontal distribution (centre points between cable supports).

3.6. CABLE DISTRIBUTION

3.6.1. Do not exceed the copper cables maximum tensile rating during installation. Monitor tension of the cable during installation. Use a dynamometer to record installation tension. Use a tension limiting device to prevent the exceeding of maximum pulling tension specifications during installation. The tension limit shall be set at or below the manufacturer's limit. The cable shall be taken up at intermediate pulling points with an intermediate take-up device as approved by the Audiovisual Engineer's Representative, to prevent over tension on the cable.

3.6.2. Minimum bend radius shall be as per manufacturer's recommendations.

3.6.3. Make cable pulls continuous and steady between pull points. Do not interrupt the pull unless necessitated by excessive tension on the cable.

3.6.4. Protect exposed cable ends from moisture ingress.

3.7. DUCT AND CONDUIT

3.7.1. Clean out each section of duct or conduit by pulling a steel wire brush and mandrel of the correct size through the duct or conduit before pulling cables. Bush, ream and remove any sharp projections on all conduits prior to installation of cables. When cleaning ducts, if obstructions are encountered which cannot be removed, advise the Audiovisual Engineer's Representative of the problems encountered.

3.7.2. Apply manufacturer's recommended lubricant to cables to reduce friction between the cable and the conduit. Cable grip shall be attached to the sheath and its strength members so that no direct force is applied to the conductors/fibres. The cable grip shall have a ball bearing swivel to prevent the cable from twisting during pulling.

3.8. TESTING

3.8.1. Coaxial Cable Testing

.1 All horizontal CATV Coaxial cables shall be swept tested to industry standards using a Time Domain Reflectometer (TDR).

.2 All horizontal CATV Coaxial cables shall be sweep tested after installation for opens, shorts, and kinks. Damaged cables shall be replaced by installing a new cable. Indicate on the floor plans the actual length of each cable section as installed.

.3 The AV Contractor shall provide soft and hard copy of cable test result for each CATV cable. Cable test results shall identify cable numbers and associated test results.

3.8.2. Copper Cabling Test Requirements

.1 Every cabling link in the installation shall be tested (as required by the Cabling specified) in accordance with the Telecommunications Industry Association (TIA) Standard ANSI/TIA/EIA-568-B.1.

.2 The installed twisted-pair horizontal links shall be tested from the Telecom Room to the workstation against the "Permanent Link" performance limits Specification as defined in ANSI/TIA/EIA-568-B.1.

.3 Trained technicians who have successfully attended an appropriate training program and have obtained a certificate, as proof thereof shall execute the tests. Appropriate training programs include installation certification programs provided by BICSI or the ACP (Association of Cabling Professionals) and Vendor supplied certifications for their product.

.4 The test equipment shall comply with or exceed the accuracy requirements for enhanced level II and/or level III field testers (according to Cabling specified) as defined in TIA-568-B; Annex I: Section I.4. The tester including the appropriate interface adapter must meet the specified accuracy requirements. The accuracy requirements for the permanent link test configuration (baseline accuracy plus adapter contribution) are specified in Table I.4 of Annex I of TIA/EIA-568-B.2.

.5 The tester interface adapters must be of high quality and the cable shall not show any twisting or kinking resulting from coiling and storing of the tester interface adapters. In order to deliver optimum accuracy preference is given to a permanent link interface adapter for the tester that can be calibrated to extend the reference plane of the Return Loss measurement to the permanent link interface. The AV Contractor shall provide proof that the interface has been calibrated within the period recommended by the Vendor. To ensure that normal handling on the job does not cause measurable Return Loss change, the adapter cord cable shall not be of twisted-pair construction.

.6 The Pass or Fail condition for the link-under-test is determined by the results of the required individual tests. Any Fail or Fail* result yields a Fail for the link-under-test. In order to achieve an overall Pass condition, the results for each individual test parameter must Pass or Pass*.

.7 A Pass or Fail result for each parameter is determined by comparing the measured values with the specified test limits for that parameter. The test result of a parameter shall be marked with an asterisk (*) when the result is closer to the test limit than the accuracy of the field tester. The field tester manufacturer must provide documentation as an aid to interpret results marked with asterisks. (Reference TIA-568-B; Annex I: Section I.2.2).

3.8.3. Optical Fibre Cabling Test Requirements

.1 Every optical fibre cabling link in the installation shall be tested in accordance with the field test Specifications defined by the Telecommunications Industry Association (TIA) Standard ANSI/TIA/EIA- 568-C (or by the appropriate network application Standard(s) whichever is more demanding).

.2 ANSI/TIA/EIA-568-B, defines the passive cabling network, to include cable, connectors, and splices (if present), between two optical fibre patch panels (connecting hardware). A typical horizontal link segment is from the telecommunications outlet/connector to the horizontal cross-connect. This TIA document describes three typical backbone link segments: (1) main cross-connect to intermediate cross-connect, (2) main cross-connect to horizontal cross-connect, or (3) intermediate cross-connect to horizontal cross-connect. The test shall include the representative connector performance at the connecting hardware associated with the mating of patch cords. The test does not, however, include the performance of the connector at the interface with the test equipment.

.3 Trained technicians who have successfully attended an appropriate training program and have obtained a certificate, as proof thereof shall execute the tests. These certificates may have been issued by any of the following organisations or an equivalent organisation:

.1 The manufacturer of the optical fibre cable and/or the optical fibre connectors

.2 The manufacturer of the test equipment used for the field certification

.3 Training organisations authorised by BICSI (Building Industry Consulting Services International) or by the ACP (Association of Cabling Professionals™).

.4 Vendor supplied certifications for their product.

.4 Field test instruments for multimode fibre cabling shall meet the requirements of ANSI/TIA/EIA-526-14A. The light source shall meet the launch requirements of ANSI/EIA/TIA-455-50B; Method A. This launch condition can be achieved either within the field test equipment or by use of an external mandrel wrap (as described in clause 11 of ANSI/TIA/EIA-568-B.1) with a Category 1 light source. Field test instruments for singlemode fibre cabling shall meet the requirements of ANSI/EIA/TIA-526-7.

.5 The optical fibre launch cables and adapters must be of high quality and the cables shall not show excessive wear resulting from repetitive coiling and storing of the tester interface adapters.

.6 The Pass or Fail condition for the link-under-test is determined by the results of the required individual tests as detailed below.

.7 A Pass or Fail result for each parameter is determined by comparing the measured values with the specified test limits for that parameter.

3.8.4. Optical Fibre Cabling Performance Test Parameters

.1 ANSI/TIA/EIA Standard 568-C3 prescribes that the single performance parameter for field testing of optical fibre links is link attenuation when installing components compliant with this Standard.

.2 The link attenuation shall be calculated by the following formulas specified in ANSI/TIA/EIA 568-B:

.3	Link Attenuation =	.4	Cable_Attn + Connector_Attn + Splice_Attn
.5	Cable_Attn (dB) =	.6	Attenuation_Coefficient (dB/km) * Length (Km)
.7	Connector_Attn (dB) =	.8	Number_of_connector_pairs * connector_loss (dB)
		.9	(Maximum allowable connector_loss = 0.75 dB)
.10	Splice_Attn (dB) =	.11	Number of splices (S) * splice_loss (dB)
		.12	(Maximum allowable splice_loss = 0.3 dB)

.13 The values for the Attenuation_Coefficient are listed in the table below:

Type of Optical Fibre	Wavelength (nm)	Attenuation Coefficient (dB/km)
Multimode 62.5/125 µm	850	3.5
	1300	1.5
Multimode 50/125 µm	850	3.5
	1300	1.5
Single-mode (Inside plant)	1310	1.0
	1550	1.0
Single-mode (Outside plant)	1310	0.5
	1550	0.5

.14 Link attenuation does not include any active devices or passive devices other than cable, connectors, and splices, i.e. link attenuation does not include such devices as optical bypass switches, couplers, repeaters, or optical amplifiers.

.15 The above link test limits attenuation are based on the use of the One Reference Jumper Method specified by ANSI/TIA/EIA-526-14A, Method B and ANSI/TIA/EIA-526-7, Method A.1. The user shall follow the procedures established by these Standards or application notes to accurately conduct performance testing.

.16 The Horizontal Link (multimode): acceptable link attenuation for a multimode horizontal optical fibre Cabling Solution is based on the maximum 90 m (295 ft) distance. The horizontal optical fibre cabling link segments need to be tested at only one (1) wavelength. Because of the short length of cabling [90 m (295 ft) or less], attenuation deltas due to wavelength are insignificant. The horizontal link should be tested at 850 nm or 1300 nm in one direction in accordance with ANSI/EIA/TIA-526-14A, Method B, and One Reference Jumper. The horizontal link may be tested using a fixed upper limit for attenuation of 2.0 dB. This value is based on the loss of two (2) connector pairs, one (1) pair at the telecommunications outlet/connector and one (1) pair at the horizontal cross-connect, plus 90 m (295 ft) of optical fibre cable.

.17 The Backbone Link (multimode) shall be tested in one direction at both operating wavelengths to account for attenuation deltas associated with wavelength.

.18 Multimode Backbone Links shall be tested at 850 nm and 1300 nm in accordance with ANSI/EIA/TIA-526-14A. Because backbone length and the potential number of splices vary depending upon site conditions, the link attenuation equation shall be used to determine limit (acceptance) values.

.19 Singlemode Backbone Links shall be tested at 1310 nm and 1550 nm in accordance with ANSI/TIA/EIA-526-7, Method A.1, and One Reference Jumper. All singlemode

links shall be certified with test tools using laser light sources at 1310 nm and 1550 nm (See Note below).

.20 Notes:

.1 Link attenuation has been based upon the use of a light source categorised by a Coupled Power Ratio (CPR) of Category 2, Underfilled, per Annex B of ANSI/EIA/TIA-526-14A. The use of a light source categorised as Category 1, Overfilled, may provide results higher than the 2.0 dB limit. A field test tool based on LED (light emitting diode) light sources is a Category 1 device and typically yields high attenuation results.

.2 Links destined to be used with network applications that use laser light sources (underfilled launch conditions) shall be tested with test equipment based on laser light sources. This rule should be followed for Cabling Solutions to support Gigabit Ethernet. Gigabit Ethernet only specifies laser light sources.

.3 For Gigabit Ethernet compliant certification (IEEE STD 802.3z application), use test equipment which uses a VCSEL (Vertical cavity surface emitting laser) at 850 nm (compliant with 1000BASE-SX) and a FP laser at 1310 nm (compliant with 1000BASE-LX).

.21 Each optical fibreal link terminated with an optical adapter system which does not impose a transmission direction because the adapters are not or cannot be ganged should be tested and documented in both direction since the direction of the signal transmission cannot be predicted at the time of installation.

3.8.5. Test each strand of fibre with an Optical Time Domain Reflectometer for length and attenuation. Performance test must be below the total return loss budget for the cable connectors/balun. Provide comprehensive optical time domain reflectometry (OTDR) testing for all fibre runs. Include a hard copy chart recording with the test documentation.

3.9. FIRE STOPPING

3.9.1. Before beginning installation, verify that substrate conditions previously installed under other sections are acceptable for installation of fire stopping in accordance with manufacturer’s installation instructions and technical information

3.9.2. Examine sizes and conditions of voids to be filled to establish correct thickness and installation of Fire Stop Materials.

3.9.3. Surfaces shall be free of dirt, grease, oil, scale, laitance, rust, release agents, water repellents, and any other substances that may inhibit optimum adhesion

3.9.4. Prepare surfaces in contact with Fire Stop Systems and Smoke Seals to manufacturer's instructions. Mask where necessary to avoid spillage and over coating onto adjoining surfaces; remove stains on adjacent surfaces.

3.9.5. The Communications Contractor shall install/replace sound barrier/fire stopping materials as soon as cables have been pulled through the opening.

3.9.6. In all Fire Stop Systems that require mineral wool or ceramic fibre backer or filler materials, these materials shall be dry and free of other contaminants before, during and after installation of sealant Fire Stop Materials. Alkaline water contamination of the backer or filler materials may cause corrosion of metallic penetrating items.

3.9.7. Apply Fire Stop Systems and Smoke Seals in strict accordance with manufacturer's instructions to prevent the passage of fire and smoke, and where required and / or specifically designated, the passage of fluids.

3.9.8. Provide temporary forming and packing as required. Tool or trowel all exposed surfaces to smooth, neat and tidy finish.

3.9.9. Fire Stop and smoke seal gaps and holes in all Fire Separation and Firewall construction through which cables pass as a result of work in this document.

3.9.10. In Combustible Construction (membrane GWB type) where the framing members are wood or where paper faced insulation is incorporated within the separation, a Fire and Temperature rise "FT" rating is required equal to that of the rating of the Fire Separation. Include openings which have been formed and sleeved.

3.9.11. Where the bottom of a Fire Stop System is exposed, seal bottom side of the assembly with a fire rated elastomeric Fire Stop sealant.

END OF SECTION

27 41 23.12 Grounding and Bonding for Audiovisual Systems

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 27 40 10 – GENERAL INSTRUCTIONS FOR AUDIOVISUAL SYSTEM INSTALLATION.

1.2. APPLICABLE CODES & STANDARDS

1.2.1. Provide grounding & bonding in accordance with good industry practices and in accordance with the following codes and standards:

.1 CSA Standard C22.2 No.41-M1987 – Grounding & Bonding Equipment

.2 CSA Standard T527 (ANSI/TIA/EIA-607)

.3 Provincial Hydro Electrical Safety Code

.4 Provincial Building Code

.5 Local Codes & Bylaws

.6 BICSI requirements

.7 AVIXA/Infocomm AV Installation Handbook, latest edition

1.3. GROUNDING PRACTICES

1.3.1. It is the responsibility of the AV Contractor to follow good engineering practices to minimize crosstalk and maximize signal-to-noise ratios in audiovisual systems.

1.3.2. The AV Contractor shall take care to consider ground references within each device and ground factors on site.

2. Products

2.1. RACK ACCESSORIES

2.1.1. Provide rack isolation kits to maintain galvanic isolation between the equipment rack and semi-conductive flooring.

3. Execution

3.1. GENERAL REQUIREMENTS

3.1.1. Ensure ganged equipment racks are bonded. Scrape paint off adjacent racks and utilize a stranded bonding jumper with a lug to connect racks to the same ground reference. Bolting racks together is an insufficient bonding method.

3.1.2. The AV Contractor shall ensure that there is complete metal-to-metal contact is made when grounding to painted or powder coated metal surfaces.

3.1.3. Grounding & bonding installed by the AV Contractor shall not interfere with the existing grounding practices within the customer premises.

3.1.4. The AV Contractor shall utilize thread-forming screws, bonding screws & any other hardware necessary to complete the ground system.

END OF SECTION

27 51 50.00 Audiovisual Networking

1. General

1.1. WORK INCLUDED

1.1.1. Conform with Section 27 40 10.00 – General Instructions for Audiovisual Systems

1.2. CODES,STANDARDS AND CERTIFICATION

1.2.1. Data communication network shall be in accordance with CSA T529, TIA/EIA-568, CSA T530, TIA/EIA-569-A, and TBITS 6.9.

1.2.2. Equipment shall meet all applicable FCC/CRTC Regulations.

1.3. DEFINITIONS

1.3.1. Cyber Assets: Systems (including hardware, software, and data) and communication networks (including hardware, software, and data).

1.3.2. Critical Cyber Assets: Those cyber assets that perform critical system functions. The loss or compromise of these cyber assets would adversely affect the operational reliability of the system.

1.3.3. Cyber Attack: The use of electronic means to interrupt, manipulate, destroy, or gain unauthorized access to a computer system, network, or device.

1.3.4. Cybercrime: to be any crime where cyber – the internet and information technologies, such as software, firmware, computers, tablets, personal digital assistants or mobile devices – has a substantial role in the commission of a criminal offence.

1.3.5. Cyber Hygiene: is a reference to the practices and steps that users of computers and other devices take to maintain system health and improve online security. These practices are often part of a routine to ensure the safety of identity and other details that could be stolen or corrupted.

1.3.6. Cyber Incident: Any unauthorized attempt, whether successful or not, to gain access to, modify, destroy, delete, or render unavailable any computer network or system resource.

1.3.7. Cyber Security: refers to the body of technologies, processes and practices designed to protect networks, devices, programs, and data from attack, damage, or unauthorized access.

1.3.8. Cyber Threat or Cyber Security Threat: is a malicious act that seeks to damage data, steal data, or disrupt digital life in general. Cyber threats include computer viruses, data breaches, Denial of Service (DDoS/DoS) attacks and other attack vectors.

1.3.9. Cyber Threat Actors: is a broad term for any states, groups, or individuals who, with malicious intent, aim to take advantage of vulnerabilities, low cyber Security awareness, and technological developments to gain unauthorized access to information systems in order to access or otherwise affect victims' data, devices, systems and networks.

1.3.10. Network Certificates: are also known as a Digital Certificates, which are an electronic "password" that allows a person, organization to exchange data securely over the internet using the public key infrastructure (PKI). Digital Certificates are also known as a public key certificate or identity certificate. There are 3 Main types of certificates:

1.3.11. Secure Socket Layer Certificate (SSL) Digi-SSL

1.3.12. Software Signing (Code Signing Certificate) Digi-Code

1.3.13. Client Certificate (Digital ID) Digi-ID

1.3.14. Social Engineering: are exploitation methods that target human vulnerabilities, such as carelessness and trust.

1.3.15. Technical Vulnerabilities: are weaknesses or flaws in the design, implementation, operation, or management of an information technology system, device, or service.

1.3.16. Power-Over-Ethernet (POE)

1.3.17. Next Generation Firewall (NGFW)

1.3.18. Transport Layer Security (TLS)

1.4. DESCRIPTION

1.4.1. Network Switch

.1 Network Switch shall support Layer-3 Gigabit Ethernet switching.

.2 Network Switch shall provide Power Over Ethernet (PoE) on all ports and to provide wattage as required for the project.

.3 Network Switch shall be managed.

.4 Network Switch shall allow for a minimum of ten (10) configurable VLANs.

.5 Network Switch shall support 10Base-T/100Base-TX/1000Base-T Ethernet with network standards of IEEE 802.3, 802.3u, 802.3ab, 802.3x, & 802.3af.

.6 Network Switch shall have sufficient host ports to accommodate all system AV devices, with an additional 4-ports for expansion.

.7 Network Switches that have more than eight (8) host ports shall be network stackable using a single IP management and have uplink ports.

.8 Network Switch with uplink ports shall have a minimum of four (4) uplink ports that support 1000BaseSX, 1000BaseLX, 10GBase-SR and 10GBase-LR.

.9 Network Switch shall be compatible with all digital audio and video multicast protocols and products required as part of the project. Refer to Scope of Work 27 41 00.

.10 Network Switch shall be allow for proper bandwidth traffic to traverse across switches as required.

.11 Network Switch shall be rackmountable.

1.4.2. Firewall

.1 Firewall shall have a minimum NGFW throughput of 3.5 Gbps.

.2 Firewall shall have a minimum Threat Protection throughput of 3 Gbps.

.3 Firewall shall have a SSL inspection throughput of 4 Gbps.

.4 Firewall shall have a maximum latency of 5 microseconds.

.5 Firewall shall support a minimum of 100 VLANs.

.6 Firewall shall support a minimum of 20 concurrent users.

1.4.3. PoE Injector

.1 PoE injector shall feature two RJ45 connections.

.2 PoE Injector shall support IEEE 802.3af Class 0 PoE Power Sourcing Equipment.

1.5. COORDINATION

1.5.1. IP Addressing

.1 Do not use default IP addresses for configuration, all systems shall be configured based on the Owner’s preferred method of either assigned static IP addressing or DHCP

reservation scheme. In cases that the network shall be standalone, assigned static IP addressing shall be used.

1.5.2. Cyber Security

.1 Coordinate with Owner's Information Technology representatives, obtain a copy of Owner's cyber security policy and provide all applicable cyber security configurations.

2. Products

2.1. NETWORK SWITCHES

2.1.1. Acceptable manufacturers are Cisco, HP Aruba, Extreme Networks and NetGear. Any other brand/model must be approved by AV Consultant.

2.2. FIREWALLS

2.2.1. Acceptable manufacturers are Fortigate and Palo Alto. Any other brand/model must be approved by AV Consultant.

3. Execution

3.1. INSTALLATION

3.1.1. Install equipment and components in accordance with applicable standards and manufacturer's recommendations.

3.1.2. Install components securely, properly aligned, and in locations as shown on drawings or as determined by site conditions.

3.1.3. Enable authentication and encryption TLS 1.2 (128kbit) technology for all network attached equipment.

3.1.4. Employ network security best practices when programming and configuring network equipment:

.1 Configure dedicated VLAN's for each protocol such as control, digital audio, digital video, etc.

.2 Restrict access on network switch ports to assigned device addresses.

3.1.5. Employ network security best practices when programming and configuring workstations:

.1 Restrict the use of external memory.

.2 Set up all security features on client software including passwords, user profiles, and operator action logging.

.3 Enable password change on scheduled interval.

.4 Enable auto-logoff timer.

.5 Enable and configure anti-virus software.

3.1.6. Setup a domain for all audiovisual systems on the network. Coordinate with Owner if the network shall be part of the Owner's corporate network.

3.1.7. Provide certification of vulnerable-free devices for all active equipment.

3.1.8. Provide end-of-life information, including an anticipated timeline of ending security support for active equipment.

3.1.9. Provide notice of a security incident within 24 hours of becoming aware of any incident as it relates to the active equipment supplied.

3.2. DOCUMENTATION

3.2.1. Provide a full design architecture design during the shop drawings process.

3.2.2. Provide a full device schedule for the entire network listing each device, including but not limited to:

- .1 Device manufacturer and model
- .2 Device ID
- .3 Device Host Name
- .4 Device IP
  - .1 Provide multicast address if applicable
- .5 Device serial number
- .6 Device MAC address
- .7 Device VLAN assignment (name and number)
- .8 Last firmware version number running
- .9 Device location, including room or rack number
- .10 Connected switch number/name and port
- .11 Port Required
- .12 Device Username and Password
- .13 Any additional notes to provide better support

3.3. CYBER SECURITY

3.3.1. Cyber Security Measures

- .1 The following multi-layered Cyber Security measures shall be implemented at minimum to limit and or reduce the Owner's potential risk from a cyber threat event; Such as a Cyber Security data breach or Cyber Security attack.
- .2 Password Management
  - .1 Employ password management best practices such as:
    - .1 All device access and configuration passwords for devices shall be changed from default to a custom password.
    - .2 Use strong and unique passwords for all applications. Where there is no password policy inherent in the software use a minimum of 8 characters; use a mixture of uppercase and lowercase letters, numbers, and include at least one special character (! @ # ?]).
    - .3 Reset passwords at regular intervals.
    - .4 Configure two-factor authentication for all accounts where possible in the system software.
    - .5 Do not use System Admin logins for simple tasks, Create separate User accounts with rights levels appropriate for the job function. These user accounts can be defined and created in many ways such as Role based, Individual logins or assigned roles.
    - .6 Use different passwords for every account
    - .7 Enforce secure password policies within the business environment.

.8 Have interface lock after a predefined # of failed login attempts for a pre determined time interval.

.3 Port and Interface Management

.1 Employ Port Management techniques such as:

.1 Restrict access on network switch ports to assigned devices addresses.

.2 Be sure to lock down all open, unused and unsecure ports on the networking devices such as switches, routers, and firewalls.

.3 Shut off all unused communication services and hardware interfaces.

.4 The use of 3rd party port security monitoring such as Solarwinds should be investigated and is highly recommended.

.4 Physical and Virtual Networks

.1 Where a dedicated LAN has not been provided a dedicated VLAN for the audiovisual system is required.

.5 Encryption

.1 Minimum TLS 1.2 should be used and where available use most current version of TLS encryption for all network attached equipment.

.6 Network Certificates

.1 Make sure Network Certificates are up to date and not expired for all equipment and systems.

.7 Firmware & Software Update Management

.1 Be sure to have the latest stable Firmware / Software version on all devices/ equipment/ as well as implement a Firmware/Software Update management process and procedure.

.8 Manufacturer’s System Hardening Guides

.1 Be sure to have the Manufacturers System hardening guides provided for the equipment being installed and implement as many recommendations/features as practical to do so.

.9 External Memory

.1 Restrict the use of external memory. The use of devices such as external USB Thumb drives should be restricted or not used at all unless expressly allowed by the Owner’s Information Technology representatives.

.10 Log Off

.1 Enable auto-logoff timer. Be sure to have the local Workstation being used to access the equipment has an auto–logoff timer set with a reasonable timer in the case that the employee leaves it unattended for any amount of time.

.11 Anti-Virus Software

.1 Enable and configure anti-virus software on PC endpoints in accordance with the Owner’s Information Technology requirements, unless it is to be installed and configured by the Owner.

.12 Filtering Techniques

.1 There are many types of filtering techniques and filters that can be applied and should be investigated for specific project requirements. Some of these filtering techniques are:

.2 Web Filtering: A Web filter adds another layer to your anti-phishing defences by blocking the web based component of phishing and malware attacks.

.3 Multicast Message Filtering: Filters the packets sent to multicast groups they are not subscribed to.

.4 Content Filtering: is the use of a program to screen and or exclude access to web pages or email deemed objectionable. A content filter shall then block access to this content

.13 Back up Regularly

.1 Provide backup schedule in the closeout submittals and configure system for automatic backups wherever possible. Regularly back up important files either manually or through a scheduled backup procedure. This helps to protect against many types of data loss, especially if a Cyber Threat Actor gains access.

3.3.2. IT Devices and Systems

.1 The above listed Cyber security measures can be applied in part or in full to a wide range of Information Technology (IT) Devices. A list of some of these device types are:

.1 Firewalls

.2 Routers

.3 Network switches (Core and Edge Devices)

.4 Servers and databases

.5 Workstation computers

.6 Network connected system devices and controllers

.7 Wireless Access Points and wireless controllers

.8 Mobile phones and tablets

.9 Any IT System or endpoint connected to the network can have some form of Cyber security measure applied to it.

3.3.3. OT Devices and Systems

.1 These Cyber security measures can also be applied in part or in full to a wide range of Operational Technology (OT) Network devices.

.1 AV Control System Processors and Touch Panels

.2 Digital Signal Processors

.3 Digital Signage Players

.4 Collaboration/conferencing codecs

.5 Industrial Control Systems such as:

.1 (PLC's) Programmable Logic Controllers are an industrial digital computer which has been ruggedized and adapted for the control of manufacturing processes, such as assembly lines, or robotic devices.

.2 (SCADA) Supervisory Control and Data Acquisition is a control system architecture comprising of computers, networked data communications and graphical user interfaces (GUI) for high level process supervisory management.

.3 (DCS) Distributed Control System is a computerized control system for a process or plant usually with many control loops, in which autonomous controllers are distributed throughout the system.

3.3.4. Report Cybercrime

.1 When performing any work on a network connected system advise the Owner and or their representatives of any indication of a Cyber Incident of a criminal nature.

3.3.5. Cyber Security Report Letter

.1 When implementing any and or all of the Cyber Security Measures mentioned in this Specification, be sure to include a Report letter in the closeout documents to the client stating which Cyber Security measures have been implemented.

END OF SECTION

HIDI

DIVISION 28 – ELECTRONIC SECURITY AND SAFETY

SPECIFICATIONS

FOR THE

UNIVERSITY OF TORONTO MISSISSAUGA - PRE-ENGINEERED BUILDING

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DISCIPLINES
MECHANICAL
ELECTRICAL
FIRE PROTECTION
LIGHTING DESIGN
COMMUNICATIONS & AV
SECURITY & RISK
COMMISSIONING
ENERGY SERVICES

Our Project No. 2023-0059

SEAL:

LICENSED PROFESSIONAL ENGINEER
A. TAN
100087772
15-Nov-2024
PROVINCE OF ONTARIO

November 15, 2024
Issued for Tender

SECTION 28 31 00 FIRE DETECTION AND ALARM

1 GENERAL

1.1 RELATED WORK

1.1.1 Prior to the commencement of work, the contractor shall obtain all permits necessary for installation of the work. All permit costs and inspection fees shall be included as part of the required work.

1.1.2 Local requirements shall be adhered to with regard to submitting specifications, wiring diagrams, shop drawings and plans. Responsibility for furnishing the quantities of copies on cloth and/or paper, as directed by such requirements, shall be included as part of the work of this section.

1.1.3 Prior to commencement and after completion of work, the contractor shall notify all authorities having jurisdiction.

1.1.4 The contractor shall submit a letter of approval of the installation, from the local code authority, before requesting final acceptance of the system.

1.2 REFERENCED DOCUMENTS

1.2.1 CAN/ULC-S524 Standard for the Installation of Fire Alarm Systems

1.2.2 CAN/ULC-S527 Standard for Control Units for Fire Alarm Systems

1.2.3 CAN/ULC-S536 Standard for the Inspection and Testing of Fire Alarm Systems

1.2.4 CAN/ULC-S537 Standard for the Verification of Fire Alarm Systems.

1.2.5 OBC-2012 Ontario Building Code.

1.2.6 Ontario Fire Code.

1.2.7 Ontario Electrical Safety Code.

1.2.8 Local Authorities having Jurisdiction.

1.3 DESCRIPTION OF WORK

1.3.1 Supply and installation, including all associated wiring and field testing, of a new single-stage, addressable fire detection and alarm system complete with all field devices including but not limited to:

1.3.1.1 Fire alarm control panel.

1.3.1.2 Remote annunciation panels as indicated on plans and riser diagrams.

1.3.1.3 Alarm initiating devices as shown on drawings.

1.3.1.4 Audible signaling devices as shown on drawings.

1.3.1.5 Visual signaling devices as shown on drawings.

1.3.1.6 Any interconnections to other building systems as notes.

1.3.1.7 Ancillary devices such as relays, power supplies, etc. to suit devices as mentioned above.

1.3.1.8 Installation of wiring, EMT conduit, junction boxes, terminal cabinets, etc. for the initiating, signaling devices, and ancillary devices.

1.3.1.9 Making necessary wiring connections between the fire alarm system auxiliary relay outputs and existing ancillary devices such as Fan Shut down Relays, electro-magnetic lock release, elevator homing, etc.

1.3.1.10 Provision and installation of new addressable initiating devices as shown on the drawings.

1.3.1.11 Provision and installation of new audible signaling devices as shown on the drawings.

1.3.1.12 Tests and adjustment or equipment and systems.

1.3.1.13 Preparation and submittal of shop drawings, maintenance manuals, and other submittals required herein.

1.3.1.14 Coordination of work with other Contractors working at the site.

1.3.1.15 Ensure equipment supplier provides information regarding wiring requirements before bidding. Consultant will not be responsible for added cost and changes due to additional manufacturer's requirements.

1.3.1.16 Manual and motorized fan and damper control as indicated.

1.3.1.17 Provide Training as per description elsewhere in this section.

1.3.2 Installation of wiring, EMT conduit, junction boxes, terminal cabinets, etc. for the initiating, signaling devices, FACP, Annunciation panel, and ancillary devices.

1.3.3 Provision and installation of devices, equipment and wiring as necessary to monitor the activation of the sprinkler and standpipe system supervisory devices and alarm devices. Separate indications shall be provided for flow switches, tamper switches and pressure switches.

1.3.4 Provision to turn all lights controlled by the dimming and lighting control system to 100%.

1.3.5 Making necessary wiring connections between the fire alarm system auxiliary relay outputs and existing ancillary devices such as Fan Shut down Relays, electro-magnetic lock release, elevator homing, etc.

1.3.6 Provisions and installation of devices, equipment, and wiring to monitor ancillary devices.

1.3.7 Provision and installation of new addressable initiating devices as shown on the drawings.

1.3.8 Provision and installation of new audible signaling devices as shown on the drawings.

1.3.9 Provision of a method of dust protection for installed smoke detectors until system commissioning.

1.3.10 Provision and programming as required for smoke venting operation. Include hand-off-auto switches to manually control smoke venting sequence per floor, unless noted otherwise. Allow for coordination with mechanical trades.

1.3.11 Tests and adjustment or equipment and systems.

1.3.12 Preparation and submittal of shop drawings, maintenance manuals, and other submittals required herein.

1.3.13 Coordination of work with other Contractors working at the site.

1.3.14 Provision of all extra hardware, software, programming, re-programming, and labour necessary to facilitate uninterruptable fire detection and signaling in the Complex.

1.3.15 Allow a minimum of three (3) software changes during installation

and commissioning period as per Consultant's directions and an additional three (3) after total completion and verification.

1.3.16 For the purpose of this specification, a software change is defined as all the programming required in order to add a total of 30% addressable inputs points, and a total of 30% output points. Addressable relays and conventional relays are considered as output points. Software changes required in order to accomplish a phasing construction, sequence of operation, descriptions of fire alarm zones as required by owner and fire department shall be counted as part of the above software changes.

1.3.17 Ensure equipment supplier provides information regarding wiring requirements before bidding. Consultant will not be responsible for added cost and changes due to additional manufacturer's requirements.

1.3.18 Provide Training as per description elsewhere in this section.

1.4 SUBMITTALS

1.4.1 Submit shop drawings in accordance with Section 26 05 01 and Division 01 requirements. Do not commence installation, software programming prior to receipt of reviewed and approved shop drawings. Do work in accordance with approved shop drawings only. Shop drawings shall include but not be limited to the following:

1.4.1.1 Systems functional description, and sequence of operation for all input and output circuits.

1.4.1.2 Manufacturer data sheets on devices, modules, and subsystems of proposed systems. If data sheets show more than one product, the proposed product shall be clearly indicated by arrows or other suitable means.

1.4.1.3 Cable and wiring layout drawings.

1.4.1.4 Battery calculations listing amperage draw for quiescent and alarm conditions and supplied batteries amp/hour rating. For design criteria, underrate manufacturers listed battery capacity by 15%.

1.4.1.5 Installation riser diagram, showing number and size of riser conduits, number size and type of conductors in each riser, and number and type of devices on each circuit.

1.4.1.6 Summary of Contractors understanding of the project.

1.4.1.7 A detailed sequence of installation and corresponding schedule.

1.4.1.8 Ensure shop drawings adequately cover all requirements above, prior to submittal to Consultant. Additional time required for subsequent reviews of shop drawings due to failure to comply with requirements above will be back-charged to the Contractor and deducted from the Contract Price.

1.5 REGULATORY REQUIREMENTS

1.5.1 Cables, wires, conduits, standard electrical back boxes etc. shall be approved by Canadian Standards Association (CSA).

1.5.2 Install new devices in accordance with requirements of applicable Electrical Safety Code and Underwriters' Laboratories of Canada Standard CAN/ULC-S524.

1.6 QUALITY ASSUARANCE

1.6.1 Qualifications of Equipment Supplier/Distributor and Manufacturer

1.6.1.1 Supplied equipment must be fully supported (service, repairs, spare parts, software, etc.) by the manufacturer and/or equipment supplier/distributor for at least five (5) years from year of installation. Equipment supplier/distributor shall provide written guaranties by the manufacturer to this effect.

1.6.1.2 Equipment Supplier/Distributor shall have a proven record of successful experiences in the supply, installation and servicing of similar computer based fire alarm systems, and shall maintain, or has approved contracted access to, local supplies of essential parts.

1.6.1.3 Equipment Supplier/Distributor shall have trained personnel capable of giving instructions and providing routine and emergency service on the system and all components within 1 hour of call, 24 hours per day, 7 days per week. Technician and personnel assigned to this project shall be certified by the equipment manufacturer to program and service the proposed system. The certificate must be attached with the shop drawing submission.

1.6.1.4 All Equipment Supplier/Distributors testing technicians shall be a current standing member of CFAA, and shall have at least five years of experience with the products and system.

1.6.1.5 Submit the above requirements to the Consultant for review and approved during shop drawings submission prior to carry out the test & verification.

1.6.2 Qualifications of Installing Contractor (electrical)

1.6.2.1 Installing Contractor shall have a proven record of successful experiences in the installation of computer based, addressable, networked, fire alarm systems for at least five (5) years.

1.6.2.2 Comply with all referenced fire alarm codes and standards.

1.6.2.3 Installing Contractor shall provide a foreman or similar to oversee, manage, and be responsible for the installation at all times. Foreman shall be certified by an accredited organization as a Fire Alarm Technician.

1.6.3 Regulatory Requirements

1.6.3.1 Entire Fire Alarm System shall be listed by Underwriters' Laboratories of Canada (ULC) for fire alarm application and non-fire alarm applications such as Security, Burglary, Plant Monitoring, Medical Alarm, etc.

1.6.3.2 FACP and DGP's, all networking equipment, and Servers (if used) shall be listed by Underwriters' Laboratories of Canada (ULC) as per CAN/ULC-S527-99.

1.6.3.3 Install system in accordance with requirements of applicable Ontario Electrical Safety Code and Underwriters' Laboratories of Canada Standard CAN/ULC-S524-06.

1.7 <u>SEQUENCE OF OPERATION</u>

1.7.1 Refer to sequence of operations on drawings for additional requirements.

1.7.2 Alarm Condition– Activation of a manual pull station or an automatic fire alarm initiating device shall:

1.7.2.1 Display location description of the alarm at the following locations:

1.7.2.1.1 The Sequential Display (LCD, etc.) of the FACP.

1.7.2.1.2 Remote annunciator panels.

1.7.2.2 Corresponding zone LED (red) shall illuminate.

1.7.2.3 Sound the local audible in the alarm mode at the following locations:

1.7.2.3.1 The Sequential Display (LCD, etc.) of the FACP.

1.7.2.4 Send signal to the fire alarm panel in the Central Utilities Plant to indicate an alarm has occurred in this building.

1.7.2.5 Event complete with time and date shall be logged in the historical data file of the Work Station and the FACP.

1.7.2.6 Cause the corresponding input circuit to latch in the off normal condition until the alarm-initiating device has returned to its normal state and system has been manually reset. Reset function shall only be possible after alarm has been acknowledged or signals have been manually silenced.

1.7.2.7 Dial out to notify 3rd party remote monitoring company of an alarm.

1.7.2.7.1 Remote Annunciator Panels.

1.7.2.8 Corresponding zone LED (red) shall illuminate.

1.7.2.9 Sound the local audible in the alarm mode at the following locations:

1.7.2.9.1 The Sequential Display (LCD, etc.) of the corresponding FACP.

1.7.2.10 Operation of the Signals Silence at the FACP shall silence all Audible Signaling appliances and de-activate the Visual Signaling appliances. A subsequent alarm or operation of the Un-silence switch of the FACP shall re-instate audible and visual signaling.

1.7.3 Supervisory Condition – Activation of any field supervisory device (valve tamper switch, low pressure switch, etc.) shall cause the following to occur:

1.7.3.1 Display location description of the alarm at the following locations:

1.7.3.1.1 The Sequential Display (LCD, etc.) of the FACP.

1.7.3.1.2 Remote Annunciator Panels.

1.7.3.2 Corresponding zone LED (amber) shall illuminate.

1.7.3.3 Initiate the system trouble sequence as outlined below.

1.7.3.4 Event complete with time and date shall be logged in the historical data file of the Work Station and the FACP.

1.7.3.5 Cause the corresponding input circuit to latch in the off normal condition until the supervisory initiating device has returned to its normal state and system has been manually reset. Reset function shall only be possible after off normal condition has been acknowledged.

1.7.3.6 Send signal to the fire alarm panel in the Central Utilities Plant to indicate an alarm of a supervisory zone has occurred in this building.

1.7.4 Trouble Condition – Activation of any supervisory device or detection of any system trouble condition (fault on field wiring, system over current device or critical component fault) shall cause the following to occur:

1.7.4.1 Display location description of the alarm at the following locations:

1.7.4.1.1 The Sequential Display (LED etc.) of the FACP.

1.7.4.1.2 Remote Annunciator Panels.

1.7.4.2 Sound the common trouble audible at the following locations:

1.7.4.2.1 The Sequential Display (LCD, etc.) of the FACP.

1.7.4.3 Send signal to the fire alarm panel in the Central Utilities Plant to indicate Trouble has occurred in this building.

1.7.4.4 Trouble conditions related to addressable devices, input circuits, or output circuits shall be indicated individually at the following

locations:

1.7.4.4.1 Remote Annunciator Panels.

1.7.5 *Alarm* (manual evacuation) Operation

1.7.5.1 It shall be possible to activate manually the Audible Signaling Appliances in the *alarm* mode and the Visual Signaling Appliances (where provided) on a per zone basis from the FACP. This shall be possible while the system is in normal condition, a fire alarm condition, and/or during a trouble condition.

1.7.6 Upon detection of smoke by a duct-type smoke detector in an air handling unit serving more than one storey or one suite will be designed to automatically shut down.

2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURER

2.1.1 System modules and components shall be new and from the same manufacturer. Initiating and signaling devices shall be from the same manufacturer as the system, must be ULC recognized with system supplied at the time of tender and approved by the Consultant.

2.1.2 Acceptable manufacturers are as follows:

2.1.2.1 Mircom

2.1.2.2 JCI/Tyco – Simplex

2.1.2.3 Honeywell – Notifier

2.1.3 Any fire alarm system provider shall have ability to communicate with the panel in the Central Utilities Plant.

3 SYSTEM CONFIGURATION

3.1 GENERAL

3.1.1 The Fire Alarm Systems shall be electrically supervised, automatic single- stage, addressable base, networked, complete with integrated three channel emergency voice communication system for broadcasting emergency voice messages, *alert* tones, and *alarm* tones over system audible signaling appliances.

3.1.2 System shall consist of a Fire Alarm Control Panel, Data Gathering Panels and Annunciator Panels.

3.1.3 FACP and DGP's and the annunciators shall communicate via a

DCLC type Data Communication Link.

3.1.4 All wiring required for the distribution and control of the audio, alarm and alert signaling, and Firefighters' Telephones between the FACP and the annunciators shall be supervised against opens, shorts and grounds.

3.1.5 Cables and/or conduits of Items .3, and .4 above shall have a minimum *Fire-Resistance Rating* of two hours or shall be in an environment having a minimum *Fire-Resistance Rating* of two hours. Acceptable brands of Fire Rated cables/conduits are MICC, and VITALink. Other brands may be submitted for approval by Consultant prior to tender closing.

3.2 NETWORK OPERATION

3.2.1 FACP and DGP's (nodes) residing on the DCLC network shall communicate in a peer to peer manner. Control by event of input(s) to desired output(s) shall be distributed between the nodes such that there is no need for a Central Processing Unit (Head End).

3.2.2 The FACP or DGP's that become isolated from the rest of the network shall go into a degraded mode of operation by forming a sub network capable of performing all control by event functions within the domain of the sub network. The network shall be notified with the details of the lost communications.

3.2.3 A FACP or DGP that becomes isolated from the rest of the network shall go into a stand-alone mode of operation of performing all control by event functions within its domain. The network shall be notified with the details of the lost communications.

3.3 FIRE ALARM CONTROL PANELS/DGP'S

3.3.1 FACP/DGP's shall be self-contained capable of executing the required sequence of operations for the inputs and outputs connected to them.

3.3.2 FACP/DGP's shall be of modular construction and provided with 30% spare capacity. Enclosures, utilization of each addressable loop, overall input and output point capacity, input and output point capacity per FACP/DGP's, and operating system software shall be sized according to this 30% requirement.

3.3.3 Power supplies, batteries, and audio amplifiers shall only be utilized to a maximum of 70% of their rated output and/or capacity. This spare capacity may be required in order to increase audibility and candela rating of strobes in areas as per Consultant's instructions.

3.3.4 FACP/DGP's shall be completely field programmable. Provide hardware and software means to accomplish this. Utilities shall be provided to generate, upload and download site-specific data from the system to a PC and vise versa. Site-specific data base generation program shall have a "compare" utility that will indicate all changes between the database before and after editing.

3.3.5 FACP/DGP's shall be provided with software utilities for grouping addressable devices into logical zones for annunciation, audible signaling, group (zone) arming and disarming, and control by event purposes.

3.3.6 FACP/DGP's shall be provided with software utilities for disarming (by-pass) zones, addressable field devices and performing other arming and disarming functions via the integral LCD/keyboard or from the FACP location. Any such disarming shall initiate the trouble sequence complete with appropriate annunciation of disarmed zone, device, or circuit. It shall be possible to review at the FACP location the status of the disarmed zone, device, or circuit prior to re-arming it in order to prevent a potential unwanted (false) alarm condition. Provide proper password for accessing these features to the Owner.

3.3.7 Provide event logging to store minimum of 500 events in historical data file. Provide software utilities to download stored events to a PC.

3.3.8 Provide an indication for operation in degraded mode, and an indication for operation in *stand-alone* mode.

3.3.9 Provide a RS232 communications port for communicating with a commercially available serial printer. Port shall be enabled and ready to communicate with the printer. Provide communication format (baud rate, number of bits, number of start and stop bits, parity, etc.)

3.3.10 Integral LCD/Keyboard

3.3.10.1 Provide an audible and an audible silence pushbutton. Audible to sound upon any new event which requires operator's attention (device actuation, system trouble, etc.). Pressing the silence pushbutton will silence the audible. A new event shall re-sound the audible.

3.3.10.2 Alphanumeric display shall be capable to display the following:

3.3.10.2.1 Addressable device activated and trouble status.

3.3.10.2.2 Alarm zone activated and trouble status.

3.3.10.2.3 Supervisory zone off normal and trouble status.

3.3.10.2.4 Audible zone trouble status.

3.3.10.2.5 Addressable relay activated status.

3.3.10.2.6 All system messages requiring operator's attention and/or

response.

3.3.10.2.7 During FACP/DGP's Normal mode LCD shall display time and date with words "System is Normal" or similar.

3.3.10.3 Provide a keypad for executing system commands such as Acknowledge, Reset, arm/disarm input and output devices and/or zones. It shall also be possible to check and change device sensitivity setting, and obtain system diagnostics reports.

3.3.11 Power Supplies

3.3.11.1 Provide two sources of power to every power supply. Primary source of supply shall be 120 Volt AC, 60 Hz circuit, transformed to 24 Volt AC and rectified to 24 Volt DC. Emergency (stand-by) supply shall be 24 Volt DC batteries. Provide ground bus complete with adequate lugs and screws or bonding of ground wires, which can be located in separate terminal box.

3.3.11.2 Power supply(s) shall transfer automatically to the emergency source (batteries) upon failure of the primary source. (120 Volt AC). Temporary AC power outages (30 seconds or less) shall not be indicated or treated as a trouble condition. If AC failure is for more than 30 seconds, operate trouble signals and indicate failure condition showing "System on Battery". When primary power is restored, transfer system automatically back. Failure of any over-current device on the primary source must not cause trouble signals to become inoperative.

3.3.11.3 Provide a separate 24 VDC 2A, fused output for ancillary devices.

3.3.11.4 Provide sufficient battery capacity for stand-by operation of entire system for 24 hours followed by two hours under full load. i.e. in alarm condition with all audible signalling devices sounding in second stage and visual signalling devices flashing at the rate of 1 flash per second. Batteries shall only be utilized to a maximum of 70% of their rated capacity.

3.3.11.5 Batteries shall be 24 V, rechargeable, totally sealed using self generating process requiring no water addition, fully charged with interconnections ready for service. Maintenance free, long-life guarantee by battery manufacturers for 4 years from date of Substantial Performance as per General Terms and Conditions. Mark batteries to indicate battery manufacturing date and such date cannot be more than two (2) months before verification.

3.3.11.6 Requirements in Items .1-.5 above shall apply to every power supply and battery set used for the Fire Alarm System in the entire complex.

3.3.11.7 Connect each fire alarm panel to power distribution circuit(s) as instructed by Owner. Contractor is to supply and install all necessary wiring, conduit and breakers to connect to emergency power distribution supplied by the emergency generator.

3.3.12 Addressable Input Circuits (Fire Alarm Initiating, Supervisory, Non-Fire)

3.3.12.1 Provide receiving circuits for addressable devices such as smoke detectors, heat detectors, manual stations, and monitoring modules to supervise wiring and status of normally open contacts.

3.3.12.2 Each addressable loop shall be able to support a minimum of 255 addressable devices.

3.3.12.3 Addressable receiving circuits to provide DCLA performance as per CAN/ULC-S524-06.

3.3.12.4 Provide Fault Isolators if one addressable loop serves more than one fire compartment. Fault isolators to be deployed in such a manner that a fault in one fire zone shall not prevent the proper operation of the addressable loop in all other fire zones it serves.

3.3.12.5 Each addressable receiving circuit shall continue to function properly with a minimum of 50% of the devices connected to it in their actuated state.

3.3.12.6 Each addressable receiving circuit shall revert to a degraded mode of operation (class B conventional or similar) upon failure of its microprocessor.

3.3.12.7 Addressable loop shall not be utilized for external addressable field devices if more than five points of the above addressable loop are utilized for internal FACP/DGP's functions and controls.

3.3.13 Conventional Input Circuits (Alarm Initiating and Supervisory)

3.3.13.1 FACP/DGP's shall be capable of accepting Class "B" style receiving circuits to supervise wiring and status of conventional initiating devices such as smoke detectors, heat detectors, manual stations, sprinkler flow switches, and sprinkler valve supervisory switches.

3.3.14 Tone Generators

3.3.14.1 Provide tone generators (or WAV files) for the *alert, alarm,* pre-announce, and All Clear tones. The *alert* and *alarm* tone generators (or WAV files) shall be on site programmable and/or downloadable to produce the following tones:

3.3.14.1.1 1000Hz pulsed at the rate of 20 Pulses Per Minute (PPM).

3.3.14.1.2 1000Hz pulsed at the rate of 120 Pulses Per Minute. (PPM).

3.3.14.1.3 1000Hz pulsed at the temporal rate.

3.3.14.2 Initially the *alert* tone shall be 1000Hz pulsed at the rate of 20 PPM and the *alarm* tone shall be 1000Hz pulsed at the temporal rate.

3.3.14.3 FACP/DGP's local tones shall only be used when the FACP/DGP's is in degraded mode of operation, in *stand-alone* mode, or when the centrally generated *alert* and *alarm* tones are not present at the FACP/DGP's. In all other cases, the FACP/DGP's shall utilize the tones available on the *alert* and *alarm* risers initiated at the FACP location.

3.3.15 Amplifiers

3.3.15.1 Amplifiers shall be modular construction, 70 Volt (RMS) constant voltage distribution.

3.3.15.2 Amplifiers shall be supervised for proper operation as per CAN/ULC-S527-99. An amplifier failure shall initiate the common trouble sequence and logged in the historical data file of the FACP/DGP's. Failure of an amplifier shall also illuminate the corresponding speaker zone trouble LED if an individual amplifier is provided per speaker circuit.

3.3.15.3 Stand-by Amplifier to be sized to meet requirements of largest amplifier it is meant to replace. Transfer between the faulty amplifier and the stand-by amplifier shall be automatic. Circuitry shall be provided to prevent an overload of the stand-by amplifier should more than one of the main amplifiers fail.

3.3.15.4 Maximum rated output capacity of a single amplifier shall not exceed 100 Watt. Output power utilization of the amplifier shall be as per Items 2.3.3.3 above.

3.3.16 Signal/Page Output Circuits

3.3.16.1 Provide Class “B” style signal/page output circuits for audible signal appliances such as speakers and horn-speakers.

3.3.16.2 Support each signal/page output circuit by audio amplifiers as required by speaker load.

3.3.16.3 Provide automatic short protection (in addition to fuses and/or circuit breakers). It shall not be possible to activate a circuit while a short condition exists on the corresponding field wires.

3.3.16.4 In cases where several signal/page circuits are fed from a single amplifier, a field wiring or internal fault on one speaker circuit shall not prevent the other speaker circuits fed from the same amplifier to continue to operate properly.

3.3.16.5 Signal/Page circuits shall be able to operate properly and be approved by the manufacturer for installation in the same conduit with Addressable Input Circuits and Conventional Input Circuits. Signal/Page circuits shall be ULC listed for this type of installation.

3.3.17 Firefighters’ Telephone Circuits

3.3.17.1 Provide Class “B” style input/output circuits for supervision and communication with Firefighters’ Telephones.

3.3.17.2 Circuits shall be able to distinguish between a short circuit and low impedance as a result of a lifted handset.

3.3.18 Visual Signaling Output Circuits

3.3.18.1 Provide Class B style signal output circuits for visual signal appliances.

3.3.18.2 Support each signal output circuit by power supplies as required by visual signal appliances load.

3.3.18.3 Provide automatic short protection (in addition to fuses and/or circuit breakers). It shall not be possible to activate a circuit while a short condition exists on the corresponding field wires.

3.3.18.4 In cases where several circuits are fed from a single power supply, a field wiring or internal fault on one signal circuit shall not prevent the other signal circuits fed from the same power supply to continue to operate properly.

3.3.18.5 Provide circuits as necessary to synchronize all visual signalling appliances installed in the Complex. i.e. also visual signalling

appliances connected to different FACP/DGP's.

3.3.19 Ancillary Circuits

3.3.19.1 Provide relays for control of ancillary functions such as fan control, door release, and elevator capture. Relays to be of the conventional and/or addressable type as shown on drawings.

3.3.19.2 Relays shall be user programmable for desired control by event operation.

3.3.20 FACP/DGP's enclosures shall be finished in enamel and provided with a 50 mm lamicoid sign riveted to the front cover.

3.3.21 Provide a plug-in type input for a microphone and necessary hardware and software to support it. It shall be possible to perform a page on an "All Call" basis or only to the FACP/DGP's resides in.

3.4 FIELD DEVICES

3.4.1 Addressable Input Devices

3.4.1.1 Smoke Detectors

3.4.1.1.1 Photoelectric type, operating on the light scattering principle. Solid state and virtually sealed to prevent being influenced by dirt, dust or humidity. Circuitry shall be protected against electrical transients and electromagnetic interference and damage to detector due to polarity reversal or fault on circuit wiring.

3.4.1.1.2 Detector shall constantly communicate to the fire alarm panel the digital equivalent of the analog smoke chamber value. Fire alarm panel or smoke detector shall be able to automatically compensate for gradual slow changes of detector sensitivity as it becomes contaminated by dust or other particles.

3.4.1.1.3 Should smoke detector become too contaminated then Fire alarm panel shall automatically generate a "smoke detector dirty" message with appropriate address.

3.4.1.1.4 It shall be possible to adjust detector's sensitivity from the fire alarm panel. Provide at least four (4) programmable sensitivity levels.

3.4.1.1.5 Detector shall be able to withstand air-gusts up to 15 m/sec velocity, have a fine mesh insect screen and be completely sealed at back to prevent entry of dust, moisture and air turbulence.

Totally shield electronics of unit to protect against false alarms due to EMI and RFI.

3.4.1.1.6 Detectors shall be easily disassembled for cleaning, servicing and installation. Installation wiring wired to base only, thus when removing head for maintenance or cleaning no wiring is disturbed. Local Status LED to indicate status of detector. Output to operate remove relay or LED. Complete with mechanical means to prevent unauthorized removal of head from the base.

3.4.1.2 Duct type smoke detectors

3.4.1.2.1 Consisting of an addressable smoke detector as described above, and air-tight housing assembly, mounted on side of duct, accommodating sampling tubes which extend into and across ventilating duct.

3.4.1.2.2 Provide one air-sampling tube length to suit width of duct and air exhaust tube with proper alignment of tubes using mounting plate.

3.4.1.2.3 While fans are operating, there shall be a continuous cross-sectional sampling of air flows from ventilation duct for presence of smoke.

3.4.1.2.4 Air velocity range shall be from between 18 m/sec – 2.5 m/sec.

3.4.1.2.5 Provisions to measure detector sensitivity under actual air-flow conditions, while detector is mounted in its permanent position.

3.4.1.2.6 Local status LED.

3.4.1.3 Heat Detectors – Combination rate of rise and fixed temperate:

3.4.1.3.1 Addressable, combination rate of rise and fixed temperature, 8.4°C per minute rate of rise and 57°C fixed temperature, with smooth ceiling rating of 225 m2 and integral indication lamp.

3.4.1.3.2 Detector shall be able to operate properly and approved by the manufacturer in a wall mounted configuration.

3.4.1.4 Manual Pull Stations – Two Stage

3.4.1.4.1 Metal, pull-lever, open circuit type for first stage. Station finish shall be red with white bilingual lettered instructions.

3.4.1.4.2 Provide a key-operated second stage switch, keyed alike.

3.4.1.4.3 Provide addressability to first stage and second stage.

3.4.1.4.4 Appearance and activation method of all manual pull stations (addressable and conventional) shall be identical.

3.4.1.4.5 Provide appropriate back box with the same finish as the manual pull station for surface mounting installations.

3.4.1.4.6 A special tool not readily available shall be required to reset the manual pull station once it was activated.

3.4.1.5 Manual Pull Stations – Two Stage complete with N.C. contact

3.4.1.5.1 Same as Manual Pull Station of Item .4 above with the addition of a Normally Closed contact which will open upon pull station activation.

3.4.1.6 Monitoring Modules:

3.4.1.6.1 These modules shall provide the means of interfacing initiating devices of the normally open contact type such as sprinkler flow switches, sprinkler supervised valve switches, sprinkler pressure switches, damper position switches, etc. to the addressable loops.

3.4.1.6.2 Wires between the Monitoring Module and the monitored device shall be supervised against opens, shorts, and ground faults.

3.4.1.7 Fault Isolators

3.4.1.7.1 Dual-port, bi-directional communications.

3.4.1.7.2 It shall be possible to use either port as an input or output.

3.4.1.7.3 Ports shall automatically separate when a communications short circuit occurs.

3.4.2 Addressable Output Devices

3.4.2.1 Addressable Relay Module

3.4.2.1.1 Compatible with addressable loop.

3.4.2.1.2 Form ‘C’ relay output with minimum contacts rating of 1.0 Amp @ 30 VDC and 0.5 Amp @ 115 VAC.

3.4.2.1.3 Mountable to a standard electrical back box. Provide back box if device does not mount into a standard, readily available electrical

back box.

3.4.2.1.4 Terminal block for field wiring.

3.4.2.1.5 Addressable Relay shall derive its power off the addressable loop and shall not require an additional power source.

3.4.3 Conventional Field Devices

3.4.3.1 Heat Detector 57°C fixed temperature

3.4.3.1.1 Activate at 57°C fixed temperature, with smooth ceiling rating of 83 m^2.

3.4.3.1.2 Normally open contact, with an operating temperature range of (-36°C – 49°C).

3.4.3.2 Heat Detector 88°C fixed temperature

3.4.3.2.1 Activate at 88°C fixed temperature, with smooth ceiling rating of 83 m^2.

3.4.3.2.2 Normally open contact, with an operating temperature range of (-36°C – 49°C).

3.4.3.3 Manual Station (two stage)

3.4.3.3.1 Metal, pull-lever, open circuit type for first stage. Station finish shall be red with white bilingual lettered instructions.

3.4.3.3.2 Provide a key-operated second stage switch, keyed alike.

3.4.3.3.3 Second stage key switch contacts can be connected on a common class ‘B’ circuit with the rest of the key switch contacts on the same loop and same floor/level.

3.4.3.3.4 Appearance and activation method of all manual pull stations (addressable and conventional) shall be identical.

3.4.3.3.5 Provide appropriate back box with the same finish as the manual pull station for surface mounting installations.

3.4.3.3.6 Provide manual stations with plastic protective covers and local son-alert alarm circuits.

3.4.3.4 End of Line Devices

3.4.3.4.1 Single gang painted red with terminal block for field wiring.

3.4.3.4.2 Provide and attach to outside of plate a nameplate identifying zone number and type.

3.4.3.4.3 End of Line devices may be installed within the field device if there is only one (1) device on the circuit. In such cases, the nameplate of Item 2.10.2 above shall be attached to the field device in a visible location.

3.4.4 Audible Signalling Devices.

3.4.4.1 100 mm (4") Cone Speakers

3.4.4.1.1 100 mm (4") ceiling or wall mountable in appropriate enclosure and baffle.

3.4.4.1.2 Line matching transformer with selectable power taps of 0.25 W to 2 W, with minimum sound level of 88 dB at 3 m distance with 1 watt power input. Pre-wired to 1W.

3.4.4.1.3 White finish.

3.4.4.1.4 Overall frequency response of 400 – 4000 Hz and a minimum dispersion angle of 90°.

3.4.4.1.5 Operating temperature 0 – 49°C.

3.4.4.1.6 Provide a terminal block for field wire connections. Terminals to accept #12 -#18 wire sizes.

3.4.4.1.7 Suitable for 70 Volt (RMS) constant voltage distribution.

3.4.4.2 Horn-Speakers

3.4.4.2.1 Die-cast aluminum construction, 100 mm square, water sealed, corrosion and moisture resistant.

3.4.4.2.2 Red enamel Finish for horn and back box. Back box shall be approved for horn-speaker.

3.4.4.2.3 Operable in temperatures from -34°C to 65°C.

3.4.4.2.4 Overall frequency response of 400 – 4000 Hz and a minimum dispersion angle of 90°.

3.4.4.2.5 Line matching transformer with selectable power taps of ½ W to 8

W, with sound level of 90 dB at 3 m distance with 1 watt power input. Pre-wired at 2 W.

3.4.4.2.6 Provided with a terminal block for field wire connections.

3.4.4.2.7 Suitable for 70 Volt (RMS) constant voltage distribution.

3.4.4.3 High Output Horn-Speaker

3.4.4.3.1 Wheelock model number STH-15SR-ULC or equivalent.

3.4.4.3.2 Pre-wire Horn-speaker for 4W.

3.4.5 Visual Signaling Devices

3.4.5.1 Strobe

3.4.5.1.1 ULC Listed voltage range of 20-31 V dc, 0.23 amps max at 24V dc.

3.4.5.1.2 Zero inrush current.

3.4.5.1.3 Produce a flash rate of approximately 1 per second over the listed voltage range.

3.4.5.1.4 Minimum of four selectable candela settings, 15, 30, 75, and 110.

3.4.5.1.5 Capable of being synchronized.

3.4.5.1.6 Compatible with proposed output circuits.

3.4.6 Audible Visual Signaling Devices

3.4.6.1 Horn-Speaker/Strobe

3.4.6.1.1 Horn portion shall be as per 2.4.4.2 above.

3.4.6.1.2 Strobe portion shall be as per 2.4.5.1 above.

3.4.7 Firefighters' Telephones

3.4.7.1 Surface mount red back box.

3.4.7.2 Surface mount red door and trim.

3.4.7.3 Telephone handset shall be constructed of red high impact durable plastic.

3.4.7.4 Handset cradle with hook switch.

3.4.7.5 Complete with door lock. All door locks to be keyed alike all other fire alarm system enclosures used in this project.

3.4.8 Fire-Do-Not-Enter Signs

3.4.8.1 "FIRE-DO-NOT-ENTER" signs shall be custom, illuminated, flashing, 24 volt D.C., ULC listed and labeled warning sign with slimline satin aluminum housing and with black face and red letters. Fixtures shall be equipped with long life LED illuminators rated at 131,000 hour life, flasher and Lexan guard. Minimum letter size shall be 2@ high. Lettering shall not be visible until sign is energized.

3.4.9 Electromagnetic Door Holders

3.4.9.1 Provide door holders of four mounting types. Coordinate locations and types with architect:

3.4.9.1.1 Semi-flush wall mount for shallow box applications.

3.4.9.1.2 Surface wall mount with matching box.

3.4.9.1.3 Flush wall mount with recessed magnet for low profile applications.

3.4.9.1.4 Floor mount, for single or double doors.

3.4.9.2 Finish shall be high luster plating of chrome.

3.4.9.3 UL listed to Standard 228.

3.5 ELECTRICAL MATERIAL

3.5.1 Use EMT type conduit or aluminum interlocked armour cable when running new conduit in concealed areas.

3.5.2 Use Wiremold type approved for fire alarm installation and of appropriate size when installing exposed conduit in public areas.

3.5.3 Aluminum Interlocked Armoured Cables shall be Delco model Nos. 7400xyz and 7400xyz or equivalent (x-number of conductors, yz-Wire gauge).

3.5.4 All conduit for outdoor installations shall be rigid and water tight, outlet boxes, pull boxes, and any other electrical material utilized in outdoor installations shall be water tight.

3.5.5 All wires shall be FAS-105 type and as per manufacturer

recommendation.

3.6 ANNUNCIATORS

3.6.1 In addition to the LED/LCD annunciator, provide the graphic diagram with a computer drawn representation of each floor level complete with each alarm and supervisory device indicated. The graphics shall show all main corridors, exit doors, stairs, elevators, location of main FACP and remote data gathering panels, any high hazard areas (in red), north symbol and “you are here” designation.

3.6.2 The background of the diagram shall be white. The floor outlines and lettering shall be color. Minimum of three color shall be provided. The graphic to be built part of the FACP and remote annunciator. Submit shop drawings for review prior to manufacture. Active graphics shall be approximately 72” H x 75” W x 8”D.

3.6.3 LED shall be provided for each new zone on the plan with proper description.

3.6.4 Update or replace the LED annunciator a semi-flush mounted LED type remote active graphic annunciator as indicated on the plans. The annunciator shall consist of the required number of LED indicators, for each initiating and supervisory zone including spares as indicated and an LCD display, connected to the control panel via supervised minimum wire serial output data. The LCD annunciator shall be as per requirements described in FACP section. The annunciator must be able to automatically seek specific messages from other parts of the network if no message resides in its data base.

3.6.5 All indicators and common control features shall be mounted behind a protective cover and shall be visible through a clear plexiglass window. Provide a graphic mounted on the annunciator trim. The trim shall be sized to accommodate all component required and space for 25% future expansion.

3.6.6 Each indicator and control feature shall provide a designation area for customer identification.

3.6.7 All fire alarm zones’ descriptions shall be done on a separate sheet of film to allow the graphic to be modified in the future with minimal cost.

3.6.8 The annunciator shall provide a common control adder with:

3.6.8.1 Power on (LED) green

3.6.8.2 System trouble LED (amber)

3.6.8.3 System trouble signal

3.6.8.4 A spare switch and 4 LED's (amber) are to be assigned by the user and shall be wired to the fire alarm panel to provide duplicate controls and indications of the system.

3.6.9 Pull, Outlet and Junction Boxes

3.6.9.1 Provide steel pull and junction boxes of sufficient size to take raceways entering them and conductors, and connections thereto without crowding.

3.6.9.2 Provide boxes with screwed covers, unless otherwise indicated on Drawings.

3.6.9.3 Install outlets and receptacles for exposed work in FS and FD cast galvanized steel or aluminum fittings.

3.6.9.4 Use tamper proof screws for all box covers in exposed areas.

3.6.10 Terminal Boxes

3.6.10.1 Size as required by job condition with 19-mm gypsum board on plywood back, with mounted terminal strips.

3.6.10.2 Provide tamper proof screws for all suite audible devices. Provide Owner with 3 driver sets for the tamper proof screws.

4 EXECUTION

4.1 INSTALLATION

4.1.1 General

4.1.1.1 Prior to commencing with the installation, check schedule, drawings and site conditions to ensure that listed equipment is suitable by type and function for the intended purpose. Report in writing any discrepancy to Consultant

4.1.1.2 Follow manufacturer's instructions and recommended installation details and procedures in addition to the requirements of the Contract Documents.

4.1.1.3 The new fire alarm/voice communication devices shall be put into service as soon as they are functional. Once put into service, they shall not be removed from service without the Owner's written authorization.

4.1.1.4 The Contractor is responsible to restore the fire resistance rating of ceilings or floors to their original rating.

4.1.1.5 Removal and repair of finished surfaces shall be coordinated with the Owner and is subject to approval.

4.1.1.6 New piping and conduit shall be installed at a height so as not to obstruct any portion of a window, doorway, stairway or passageway and shall not interfere with the operation of existing mechanical or electrical equipment. System riser(s) shall be installed in metal raceways or conduit, located to avoid physical harm.

4.1.1.7 Conduit, raceways, junction boxes and device back boxes may be exposed in unfinished areas or mechanical equipment rooms. Conduit, raceways, junction boxes and device back boxes in these areas shall be concealed as much as possible in walls, ceiling spaces, electrical shafts or closets in finished areas. Style 7 (DCLR) wiring shall not have the incoming and return loop installed in the same areas/shaft.

4.1.1.8 Exposed conduit, raceways, junction boxes, and other associated items related to the conduit network installed above drop ceilings and in exposed mechanical type areas shall be provided with red bands every ten feet. Junction box covers shall be painted red, unless specifically instructed otherwise.

4.1.1.9 Provide, install and connect wiring and interconnecting wires and cables as specified herein, as required by control panel manufacturer and as indicated on drawings.

4.1.1.10 For moisture-proof, corrosion resistant or waterproof detectors, use rain tight connectors with waterproof gasketted back box and tape wiring connectors.

4.1.1.11 Fire Alarm System Manufacture/Supplier/Distributor shall be prepared to provide the installing contractor with reasonable amounts of technical assistance during Installation, Inspection, and Verification period.

4.1.2 Installation

4.1.2.1 Conduits and wiring for the Data Communication Network, Paging, Alarm and Alert Tones Busses, Firefighters' Telephone Buss.

4.1.2.1.1 Install conduit and wiring as required for the Fire Alarm Data Communication Network Paging and Alarm Busses, Firefighters' Telephone Buss as shown on drawings.

4.1.2.1.2 All cables shall have a two hours fire resistance rating.

4.1.2.1.3 Data Communication Network, Paging, Alarm and Alert Tones Busses shall be installed in a class 'A' style and shall have DCLC performance.

4.1.2.1.4 Firefighters' Telephone Buss shall be installed in a class 'A' style. Class 'A' performance is acceptable.

4.1.2.2 Fire Alarm Control Equipment (FACP/DGP's, Annunciators)

4.1.2.2.1 Install FACP/DGP's in location indicated on drawings.

4.1.2.2.2 Take power from the emergency power distribution supplied by the emergency generator.

4.1.2.2.3 Take all necessary steps in order to make the FACP/DGP equipment fully functional and ready to accept, interpret, and control input, output, and ancillary field devices.

4.1.2.2.4 Connect to the fire alarm network, paging alarm and Firefighters' Telephone busses. Ensure proper communications and operation with the rest of the network, and the annunciator.

4.1.2.3 Addressable Loops

4.1.2.3.1 Addressable loop wiring shall be DCLA type, meaning continuous path connecting components and terminated in source enclosure. Protect each loop with fault isolator modules at every fire compartment change. Fault isolator module shall automatically go into an open circuit upon sensing a circuit derangement on its output side that will adversely affect the rest of the addressable loop. Fault isolators to be deployed in such a manner that a fault in one fire compartment shall not prevent the proper operation of the addressable loop in all other fire compartment it serves.

4.1.2.3.2 Wiring for primary addressable loop shall be installed in a separate raceway and take a different path from the return loop.

4.1.2.3.3 When using shielded wires, connect shield in continuous pat as

single point ground at Fire Alarm Control Panel.

4.1.2.3.4 Install wiring for addressable loops and conventional alarm initiating circuits in separate raceway system from alarm signal circuits, unless wiring is individually shielded and single point ground connected and acceptable to equipment manufacturer.

4.1.2.3.5 Provide Fault Isolators and Lightning Arrestors when the Addressable Loop exits the building.

4.1.2.4 Audible and Visual Output Circuits.

4.1.2.4.1 Wire audible signaling circuits and visual signaling circuits so that a pair of wires starts at the corresponding output circuit field terminals and ends at End of Line device.

4.1.2.4.2 Connect signaling appliances in a manner that facilitates electrical supervision of the devices as per CAN/ULC-S524-06. At the control panel, properly arrange and connect audible circuit wiring and strobe circuit wiring to their respective circuits.

4.1.2.4.3 All wires and/or cables shall be continuous from the point of origin to the first device, between devices, and from the last device to the End Of Line. Splicing of wires and/or cables is not permitted. Use pull-boxes when required.

4.1.2.4.4 Wire electrically adjacent speakers horn-speakers, and strobes to alternate circuits when the corresponding area is served by more than one circuit.

4.1.2.4.5 Wires and cables shall comply with referenced specification section, standards and manufacturers recommendations.

4.1.2.4.6 Provide Lightning Arrestors when an audible signaling circuits or visual signaling circuits exits the building.

4.1.2.5 Smoke Detectors and Heat Detectors

4.1.2.5.1 Install smoke detectors and heat detectors as shown on drawings. Installation shall be as per Standard CAN/ULC-S524-06.

4.1.2.5.2 Should interference from obstruction, lamp positions, air outlets or heat radiating surfaces be encountered in locating any detector where indicated, locate detector as near as possible to indicated position, clear of obstacles, to satisfaction of Consultant.

4.1.2.6 Manual Pull Stations

4.1.2.6.1 Install Manual Pull Stations as shown on drawings. Installation shall be as per Standard CAN/ULC-S524-06.

4.1.2.6.2 Install Manual Pull Stations as shown on drawings. Installation shall be as per Standard CAN/ULC-S524-06.

4.1.2.7 Audible and Visual Signalling Devices

4.1.2.7.1 Install Audible and Visual Signalling Devices as shown on drawings. Installation shall be as per Standard CAN/ULC-S52-06.

4.1.2.7.2 Should interference from obstruction, lamp positions, air outlets or heat radiating surfaces be encountered in locating any device where indicated, locate device as near as possible to indicate position, clear of obstacles, to satisfaction of Consultant.

4.1.2.8 End of Line Devices (EOL)

4.1.2.8.1 EOL components may be installed in the field device for circuits with a single field device. Provide appropriate labeling of the field device as containing the EOL component.

4.1.2.8.2 Install EOL devices as per Standard CAN/ULC-S524-06.

4.1.2.9 Cable and Wire Identification

4.1.2.9.1 Identify each signal circuit, alarm initiating circuit, auxiliary circuit and other wiring at FACP and DGP's, and terminal boxes with appropriate marking labels. Mark single conductors with suitable self-adhesive type, numbered markers, identify cables with clear polyester tag, attached with self-locking TY-RAP. These identifications shall be used for the schematic and wiring diagrams of the Operation and Maintenance Manual as referenced in other section of this specification.

4.1.2.10 Device Identification

4.1.2.10.1 Identify each device with an appropriate tag. Addressable device identification shall include: node number, loop number, and device number. Conventional devices and signaling appliances shall include: node number, and circuit (zone) number.

4.1.3 Tie-in to auxiliary systems (fan shut down, elevator recall, maglocks, door hold-open devices)

4.1.3.1 Connect addressable relays contacts to existing wiring of auxiliary systems in order to facilitate the same operation as before. Use additional power relays as necessary if the addressable relay contact rating is not sufficient to carry the required voltage and/or current.

4.2 FIELD QUALITY CONTROL

4.2.1 Factory Acceptance Testing (FAT)

4.2.1.1 A Factory Acceptance Testing of the equipment (FAT) by the Consultant is required prior to shipping the FACP and DGPs to the site. Contractor shall coordinate the testing with the equipment supplier and the Consultant.

4.2.1.2 A site testing of the backbone control equipment by the Consultant is required prior to continuing with the installation of the field devices. Contractor shall coordinate the testing with the equipment supplier and the Consultant.

4.2.2 Inspection, Testing, and Verification after completion of the installation.

4.2.2.1 Co-ordinate schedule with Owner or Owner's designated representatives and Consultant prior to commencement.

4.2.2.2 Inspect, Test, and Check the fire alarm control equipment related to this stage as per CAN/ULC-S537-04.

4.2.2.3 Inspect, Test, and Check all initiating devices and signaling appliances installed under this stage with proper connection, supervision, and function in accordance with CAN/ULC-S537-04. Identify initiating devices, and signal appliances not installed within requirements of CAN/ULC-S524-01 in remarks column of verification report and bring to Consultant's attention.

4.2.2.4 Verify that all auxiliary and/or ancillary devices connected and controlled by the fire alarm equipment installed under this stage is operating as required under normal condition and under fire alarm condition.

4.2.2.5 Obtain verification certificate, and report from the company performing the verification showing each device and appropriate columns are checked off. Use Canadian Fire Alarm Association (C.F.A.A.) verification forms or similar.

4.2.2.6 Smoke detector sensitivity reading shall be done while smoke detector is at its installed location. Submit smoke detectors sensitivity reading as part of the verification report.

4.2.2.7 Inspection and Verification of the Fire Alarm System and related field devices shall be performed by a sufficient number of representatives of the company performing the verification to facilitate the manning of the FACP's/DGP's location while the Inspection and Verification is performed by other representative(s).

4.2.2.8 In no way shall re-programming introduce errors and/or omissions in the data of portions of the project which have already been tested and verified. Should such an error and/or omission be discovered, entire verification must be repeated.

4.2.2.9 Issue certificate or verification only after completion of deficiencies noted during verification have been corrected and re-verified.

4.2.2.10 As part of the functional tests of the fire alarm system, Consultant may choose to conduct additional inspections and/or tests during the installation period and verification period. Provide assistance to the Consultant during these tests as requested by Consultant.

4.2.2.11 After completing work related to a Building and issuance of verification certification arrange with Consultant to have acceptance tests of the system.

4.2.2.12 Provide for the duration of these tests one person who is knowledgeable with the Fire Alarm System supplied and familiar with the installation.

4.2.2.13 Provide all required tools, material, radio communication devices, and test equipment as specified by Consultant and as needed to perform the inspection, testing and verification.

4.2.2.14 Ensure that the entire system being tested functions properly and as per specifications prior to the Consultant's acceptance tests. Additional time required for subsequent tests due to unacceptable test results will be back charged to the Contractor and deducted from the Contract Price.

4.2.3 Inspection and Testing, after completion of the entire Installation

4.2.3.1 Coordinate schedule with Owner and Owner's designated representatives and Consultant prior to commencement.

4.2.3.2 Inspect, Test, and Check the fire alarm control equipment for the entire complex as per CAN/ULC-S536 04.

4.2.3.3 Verify that all auxiliary and/or ancillary devices connected and controlled by the fire alarm equipment is operating as required under normal condition and under fire alarm condition.

4.2.3.4 Obtain Inspection and Testing certificate, and report from the company performing the Inspection and Testing showing each device and appropriate columns are checked off. Use Canadian Fire Alarm Association (C.F.A.A.) Inspection and Testing forms or similar.

4.2.3.5 Smoke detector sensitivity reading shall be done while smoke detector is at its installed location. Submit smoke detectors sensitivity reading as part of the verification report.

4.2.3.6 Inspection and Testing of the Fire Alarm System and related field devices shall be performed by a sufficient number of representatives of the company performing the Inspection and Testing to facilitate the manning of the FACP's/DGP's location while the Inspection and Testing is performed by other representative(s).

4.2.3.7 Issue certificate of Inspection and Testing only after completion of deficiencies noted during Inspection and Testing have been corrected and re-verified.

4.2.3.8 As part of the functional tests of the entire fire alarm system, Consultant may choose to conduct additional inspections and/or tests during the installation period and verification period. Provide assistance to the Consultant during these tests as requested by Consultant.

4.2.3.9 After completing the Inspection and Testing and issuance of Inspection and Testing certificate arrange with Consultant to have acceptance tests of the entire system.

4.2.3.10 Provide for the duration of these tests one person who is knowledgeable with the Fire Alarm System supplied and familiar with the installation.

4.2.3.11 Provide all required tools, material, radio communication devices, and test equipment as specified by Consultant and as needed to perform the Inspection and Testing.

4.2.3.12 Ensure that the entire system being tested functions properly and as per specifications prior to the Consultant's acceptance tests. Additional time required for subsequent tests due to unacceptable test results will be back charged to the Contractor and deducted from the Contract Price.

4.2.4 Final Commissioning and acceptance by local authorities having jurisdiction and local fire services.

4.2.4.1 After completion of the tests under Item 4.2.3 above, make arrangement with the local fire services, the Owner or designated representatives, the Consultant, and the Fire Alarm System Supplier to have final acceptance test, giving two weeks notice to all parties concerned to be present.

4.2.4.2 Provide for the duration of the Final Commissioning and Acceptance Tests at least three persons who are knowledgeable with the Fire Alarm System supplied and familiar with the installation. Provide all required tools, material, test equipment and radio communication devices.

4.2.4.3 Ensure that the system in the entire installation functions properly and as per specifications prior to the Final Commissioning and Acceptance Tests. Additional time and costs required for subsequent tests due to unacceptable test results will be back charged to the Contractor and deducted from the Contract Price.

4.3 SUBSTANTIAL PERFORMANCE AND TOTAL PERFORMANCE

4.3.1 Substantial Performance of the Work will be given by the Owner or Owner's designated representative and Consultant when:

4.3.1.1 The conditions as defined in the CCDC2 contract document have been satisfied.

4.3.1.2 The complete system has operated for thirty (30) consecutive days without a malfunction of the control equipment or any new field device.

4.3.1.3 The complete system has been inspected, tested, and accepted in writing by the Owner or Owner's designated representative and Consultant.

4.3.1.4 Required submittals, including Maintenance Manuals, test-reports, spare parts, special tools, training, and copies of training certificates have been provided to, reviewed by and accepted in writing by Owner and Owner's designated representative and Consultant.

4.3.2 Total Performance of work will be given by the Owner's Designee and Consultant when:

4.3.2.1 Substantial Performance has been achieved.

4.3.2.2 All outstanding items and deficiencies after accomplishing Substantial Performance have been completed and accepted in writing by Owner or Owner's designated representative and Consultant.

4.4 WARRANTY

4.4.1 Provide emergency and non-emergency repair service for the Work at no additional cost (parts and labour) to the Owner, within four hours of a request for such service by the Owner's Designee during both the installation and the warranty periods. This service shall be provided on a twenty-four (24) hour per day, 7 (seven) days per week.

4.4.2 Warranty period for the Work shall be twelve (12) months starting after Total Performance of the project as defined in 3.3 above has been achieved.

4.5 TRAINING

4.5.1 Technical Staff Training – Provide training of maintenance personnel in the proper operation of all system functions, basic troubleshooting, and the performance of basic service and maintenance functions. Some typical functions are:

4.5.1.1 Device replacement.

4.5.1.2 Initiating Zone Bypass.

4.5.1.3 Addressable Device Bypass.

4.5.1.4 Output Circuit Bypass.

4.5.1.5 Ancillary Circuit Bypass.

4.5.1.6 Change Zone, Device, Circuit Description.

4.5.1.7 Perform the Yearly Inspection and Testing of Fire Alarm Systems as per CAN/ULC-S536-04.

4.5.1.8 Basic troubleshooting of Data Communication Networks and addressable loops.

4.5.1.9 Training shall be conducted by technical representatives of the equipment manufacturer. Allow for three (3) training sessions each consisting of a minimum four (4) hours.

4.5.1.10 Proposed training outline shall be submitted to the Owner or Owner's designated representative for acceptance prior to scheduling of the training sessions.

4.5.2 Training of System Operators – Provide training to System Operators in the proper operation of all system operational functions.

4.5.2.1 Training shall be conducted by technical representatives of the equipment manufacturer. Allow for three (3) training sessions each consisting of a minimum four (4) hours.

4.5.2.2 Proposed training outline shall be submitted to the Owner or Owner's designated representative for acceptance prior to scheduling of the training session(s).

4.6 TOTAL PERFORMANCE

4.6.1 Total Performance of work will be given by the Owners Designee and Consultant when:

4.6.1.1 Substantial Performance has been achieved.

4.6.1.2 All outstanding deficiencies have been corrected.

4.6.1.3 The complete system has been inspected, tested and accepted in writing by the Owners Designee and the Consultant.

4.6.1.4 Training is complete.

4.7 CAN/ULS-S1001 INTEGRATED SYSTEMS TESTING (IST)

4.7.1 Integrated Systems Test Coordinator will be engaged by the Owner.

4.7.2 Allow for supporting the Integrated Systems Testing in accordance with the requirements of CAN/ULS-S1001 and as outlined in the IST testing plan prepared by the Integrated Systems Test Coordinator.

END OF SECTION

1 GENERAL

1.01 SUMMARY

.1 Section includes all methods, materials and installation as required to complete the Work of this Section in accordance with the Conditions of the Contract.

.2 Work may include, but is not limited to;
- .1 Shoring, bracing and underpinning.
- .2 Dewatering.
- .3 Excavation.
- .4 Trenching.
- .5 Backfilling.
- .6 Grading.

1.02 REFERENCES

.1 ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).

.2 CAN/CSA A23.1/A23.2 - Concrete Materials and Methods of Concrete Construction/Methods of Test for Concrete.

.3 CSA A3000 - Cementitious Materials Compendium.

.4 OPSS.PROV 1004 - Aggregates - Miscellaneous.

.5 OPSS.PROV 1010 - Aggregates - Base, Subbase Select Subgrade and Backfill Material.

1.03 ADMINISTRATIVE REQUIREMENTS

.1 Coordination: Arrange with authority having jurisdiction for relocation of buried services that interfere with execution of work.
- .1 Pay costs of relocating services.
- .2 Before commencing work verify and/or establish location of buried services on and adjacent to site.
- .3 Arrange with appropriate authority for relocation of buried services that interfere with execution of work: pay costs of relocating services.
- .4 Remove obsolete buried services within 2 m of foundations: cap cut-offs.

.2 Examine soil report, titled Geotechnical Investigation, dated November 19, 2020 by DS Consults Ltd.

1.04 ACTION SUBMITTALS

.1 Submit action submittals in accordance with Section 01 33 00.

.2 Shop Drawings: Submit Shop Drawings as follows:
- .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.
- .2 Shop Drawings to illustrate shoring, bracing, underpinning and dewatering as required to complete the Work of this Section.

.3 Submit proposed dewatering and heave prevention methods for review by Consultant a minimum 30 days prior to commencing work.

.4 Reports/certificates: Submit the following:
- .1 Written laboratory test reports.
- .2 Field inspection and testing reports.

1.05 EXISTING CONDITIONS

.1 Buried services:
- .1 Before commencing work verify location of buried services on and adjacent to site.
- .2 Arrange with appropriate authority for relocation of buried services that interfere with execution of work: pay costs of relocating services.
- .3 Remove obsolete buried services within 2 m of foundations: cap cut-offs.
- .4 Size, depth and location of existing utilities and structures as indicated are for guidance only. Completeness and accuracy are not guaranteed.
- .5 Prior to beginning excavation Work, notify Consultant and applicable authorities having jurisdiction of established location and state of use of buried utilities and structures. Authorities having jurisdiction to clearly mark such locations to prevent disturbance during Work.
- .6 Confirm locations of buried utilities by careful test excavations.
- .7 Maintain and protect from damage, water, sewer, gas, electric, telephone and other utilities and structures encountered.
- .8 Where utility lines or structures exist in area of excavation, obtain direction of Consultant before removing or re-routing.
- .9 Record location of maintained, re-routed and abandoned underground lines.
- .10 Confirm locations of recent excavations adjacent to area of excavation.

.2 Existing buildings and surface features:
- .1 Conduct, with Consultant, condition survey of existing buildings, trees and other plants, lawns, fencing, service poles, wires, pavement, survey bench marks and monuments which may be affected by Work.
- .2 Protect existing buildings and surface features from damage while Work is in progress. In event of damage, immediately make repair as directed by Consultant.

.3 Where required for excavation, cut roots or branches as directed by authorities having jurisdiction.

.3 Cultural heritage and archaeological resources: If cultural heritage and archaeological resources are encountered during the Work, contact Consultant immediately and suspend all Work in immediate area until assessment has been completed by Ministry of Heritage, Sport, Tourism and Culture Industries. Perform required measures outlined in completed assessment.

2 PRODUCTS

2.01 MATERIALS

.1 Granular fill:
- .1 Type 1 fill: Imported Granular A to OPSS.PROV 1010, free of organic matter.
- .2 Type 2 fill: Imported Granular B to OPSS.PROV 1010, free of organic matter.
- .3 Clear stone fill: 19 mm clear stone to OPSS.PROV 1004, free of organic material.

.2 Type 3 fill: Selected material from excavation or other sources, approved by Consultant for use intended, unfrozen and free from rocks larger than 75 mm, cinders, ashes, sods, refuse or other deleterious materials.

.3 Sand: Clean, washed, minimum 100% passing 4.75 mm sieve, maximum 5% passing 0.075 mm sieve to OPSS.PROV 1004.

.4 Unshrinkable fill: proportioned and mixed to provide:
- .1 Maximum compressive strength of 0.4 MPa at 28 days.
- .2 Maximum Portland cement content of 25 kg/m³.
- .3 Minimum strength of 0.07 MPa at 24 hours.
- .4 Concrete aggregates: to CAN/CSA A23.1/A23.2.
- .5 Cement: to CSA A3000, Type GU.
- .6 Slump: 160 to 200 mm.

3 EXECUTION

3.01 EXAMINATION

.1 Examine and verify previously installed Work upon which this Section depends. Report defects or unsatisfactory conditions to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.02 PREPARATION

.1 Temporary erosion and sedimentation control:
- .1 Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to requirements of authorities having jurisdiction.
- .2 Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.
- .3 Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

.2 Protection of in-place conditions:
- .1 Protect excavations from freezing.
- .2 Keep excavations clean, free of standing water, and loose soil.
- .3 Where soil is subject to significant volume change due to change in moisture content, cover and protect to Consultant's approval.
- .4 Protect natural and man-made features required to remain undisturbed. Unless otherwise indicated or located in an area to be occupied by new construction, protect existing trees from damage.
- .5 Protect buried services that are required to remain undisturbed.

.3 Removal:
- .1 Remove trees, stumps, logs, brush, shrubs, bushes, vines, undergrowth, rotten wood, dead plant material, exposed boulders and debris within areas designated on drawings.
- .2 Remove stumps and tree roots below footings, slabs, and paving, and to 600 mm below finished grade elsewhere.
- .3 Remove obsolete buried services within 2 m of foundations: cap cut-offs.

3.03 STRIPPING OF TOPSOIL

.1 Begin topsoil stripping of areas as indicated after area has been cleared of brush, weeds and grasses and removed from site.

.2 Strip topsoil to depths as indicated and avoid mixing with subsoil.

.3 Stockpile in locations as directed by Consultant. Stockpile height not to exceed 2 m and protect from erosion.

.4 Dispose of unused topsoil off site.

3.04 SHORING, BRACING AND UNDERPINNING

.1 Maintain sides and slopes of excavations in safe condition by appropriate methods and in accordance with Health and Safety Act for the Province of Ontario.

.2 Obtain permit from authority having jurisdiction for diversion of water course.

.3 Construct temporary Works to depths, heights and locations as indicated.

.4 During backfill operation:
- .1 Unless otherwise indicated or directed by Consultant, remove sheeting and shoring from excavations.
- .2 Do not remove bracing until backfilling has reached respective levels of such bracing.
- .3 Pull sheeting in increments that will ensure compacted backfill is maintained at elevation at least 500 mm above toe of sheeting.

.5 When sheeting is required to remain in place, cut off tops at elevations as indicated.

.6 Upon completion of substructure construction:
- .1 Remove shoring and bracing.
- .2 Remove excess materials from site and restore watercourses as indicated.

3.05 DEWATERING AND HEAVE PROTECTION

.1 Keep excavations free of water while Work is in progress.

.2 Provide for Consultant's review details of proposed dewatering or heave prevention methods, including dikes, well points, and sheet pile cut-offs.

.3 Avoid excavation below groundwater table if quick condition or heave is likely to occur. Prevent piping or bottom heave of excavations by groundwater lowering, sheet pile cut-offs, or other means.

.4 Protect open excavations against flooding and damage due to surface run-off.

.5 Dispose of water in accordance with applicable by-laws and in manner not detrimental to public and private property, or portion of Work completed or under construction. Provide and maintain temporary drainage ditches and other diversions outside of excavation limits.

.6 Where necessary provide flocculation tanks, settling basins, or other treatment facilities to remove suspended solids or other materials before discharging to storm sewers, watercourses or drainage areas.

3.06 EXCAVATION

.1 Excavate to lines, grades, elevations and dimensions as indicated.

.2 Remove concrete, masonry, paving, walks, and demolished foundations and rubble and other obstructions encountered during excavation.

.3 Excavation must not interfere with bearing capacity of adjacent foundations.

.4 Do not disturb soil within branch spread of trees or shrubs that are to remain. If excavating through roots, excavate by hand and cut roots with sharp axe or saw.

.5 For trench excavation, unless otherwise authorized by Consultant in writing, do not excavate more than 30 m of trench in advance of installation operations and do not leave open more than 15 m at end of day's operation.

.6 Keep excavated and stockpiled materials safe distance away from edge of trench as directed by Consultant.

.7 Restrict vehicle operations directly adjacent to open trenches.

.8 Dispose of surplus and unsuitable excavated material off site.

.9 Do not obstruct flow of surface drainage or natural watercourses.

.10 Earth bottoms of excavations to be undisturbed soil, level, free from loose, soft or organic matter.

.11 Notify Consultant when bottom of excavation is reached.

.12 Obtain Consultant approval of completed excavation.

.13 Remove unsuitable material from trench bottom including those that extend below required elevations to extent and depth as directed by Consultant.

.14 Correct unauthorized over-excavation as follows:
- .1 Fill under bearing surfaces and footings with concrete specified for footings or fill concrete as approved by Engineer compacted to not less than 100% of corrected Standard Proctor maximum dry density.
- .2 Fill under other areas with Type 2 fill compacted to not less than 95% of corrected Standard Proctor maximum dry density.

.15 Hand trim, make firm and remove loose material and debris from excavations.
- .1 Where material at bottom of excavation is disturbed, compact foundation soil to density at least equal to undisturbed soil.
- .2 Clean out rock seams and fill with concrete mortar or grout to approval of Consultant.

3.07 TRENCHING

.1 Excavate trenches to lines, grades, elevations and dimensions as indicated.

.2 Excavation must not interfere with bearing capacity of adjacent foundations.

.3 Do not disturb soil within branch spread of trees or shrubs that are to remain. If excavating through roots, excavate by hand and cut roots with sharp axe or saw.

.4 For trench excavation, unless otherwise authorized by Consultant in writing, do not excavate more than 30 m of trench in advance of installation operations and do not leave open more than 15 m at end of day's operation.

.5 Keep excavated and stockpiled materials safe distance away from edge of trench as directed by Consultant.

.6 Restrict vehicle operations directly adjacent to open trenches.

.7 Dispose of surplus and unsuitable excavated material off site.

.8 Do not obstruct flow of surface drainage or natural watercourses.

.9 Remove unsuitable material from trench bottom including those that extend below required elevations to extent and depth as directed by Consultant.

.10 Where trench has been over-excavated provide granular material and compact.

3.08 BACKFILLING

.1 Do not proceed with backfilling operations until completion of following:
- .1 Consultant has inspected and approved all construction below finish grade.
- .2 Inspection, testing, approval, and recording location of underground utilities.
- .3 Removal of concrete formwork.
- .4 Removal of shoring and bracing; backfilling of voids with satisfactory soil material.

.2 Areas to be backfilled to be free from debris, snow, ice, water and frozen ground.

.3 Do not use backfill material which is frozen or contains ice, snow or debris.

.4 Place backfill material in uniform layers not exceeding 150 mm compacted thickness up to grades indicated. Compact each layer before placing succeeding layer.

.5 Backfilling around installations:
- .1 Place bedding and surround material as specified elsewhere.

.2 Do not backfill around or over cast-in-place concrete within 24 hours after placing of concrete.
.3 Place layers simultaneously on both sides of installed Work to equalize loading. Difference not to exceed 1.3 m.
.4 Where temporary unbalanced earth pressures are liable to develop on walls or other structures, erect bracing or shoring to counteract unbalance, and leave in place until removal is approved by Engineer.

.6 Place unshrinkable fill in areas as indicated.

.7 Consolidate and level unshrinkable fill with internal vibrators.

3.09 COMPACTION

.1 Compact existing subgrade under walks, paving, and slabs on grade, to same compaction as fill. Fill excavated areas with selected subgrade material compacted as specified for fill.

.2 Place backfill, fill and base course material in 150 mm lifts: add water as required to achieve specified density.

.3 Place unshrinkable fill in areas as indicated: consolidate and level unshrinkable fill with internal vibrators.

.4 Compact backfill materials to ASTM D698 in accordance with Geotechnical Report, providing the following as a minimum:
.1 To underside of base courses: 95%.
.2 Base courses: 100%.
.3 Under landscaped areas: 85%.
.4 Under paved and walk areas: 95%.
.5 Elsewhere: 90%.

3.10 GRADING

.1 Grade so that water will drain away from buildings, walls and paved areas, to catch basins and other disposal areas approved by Consultant.

.2 Grade to be gradual between finished spot elevations shown on drawings.

.3 Fill and grade site to achieve elevations indicated.

.4 Rough grade to levels, profiles, and contours allowing for surface treatment as indicated.

.5 Slope rough grade away from building 1:50 minimum.

.6 Grade ditches to depth as indicated.

.7 Prior to placing fill over existing ground, scarify surface to depth of 150 mm minimum before placing fill over existing ground. Maintain fill and existing surface at approximately same moisture content to facilitate bonding.

.8 Do not disturb soil within branch spread of trees or shrubs to remain.

3.11 RESTORATION

.1 Remove waste materials and debris. Trim slopes and correct defects as directed by Consultant.

.2 Replace topsoil as indicated.

.3 Clean and reinstate areas affected by Work as directed by Consultant.

.4 Protect newly graded areas from traffic and erosion and maintain free of trash or debris.

END OF SECTION

1 GENERAL

1.01 SUMMARY

.1 Section includes all methods, materials and installation as required to complete the Work of this Section in accordance with the Conditions of the Contract.

1.02 REFERENCES

.1 ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).

.2 MPI - Master Painters Institute.

.3 OPSS - Ontario Provincial Standard Specification:
- .1 OPSS 302 - Priming Granular Base.
- .2 OPSS 310 - Construction Specification for Hot Mix Asphalt.
- .3 OPSS 314 - Untreated Granular, Subbase, Base, Surface, Shoulder and Stockpiling.
- .4 OPSS 1010 - Aggregates, including amendment SSP 110S06.
- .5 OPSS 1103 - Emulsified Asphalt.
- .6 OPSS 1150 - Hot Mix Asphalt.

1.03 ADMINISTRATIVE REQUIREMENTS

.1 Site Meetings: Arrange a pre-installation meeting on Site to be attended by Consultant, Contractor, and any other parties directly affecting work of this Section to:
- .1 Examine substrate conditions for compliance with manufacturer's requirements.
- .2 Review methods and procedures related to installation.
- .3 Review all typical and special details as required to complete the work of this section.

1.04 ACTION SUBMITTALS

.1 Submit action submittals in accordance with Section 01 33 00.

.2 Product data: Submit manufacturers product data for asphalt materials and aggregates including product characteristics, performance criteria, and limitations.

.3 Reports/certificates: Submit the following:
- .1 Submit asphalt mix design.
- .2 Submit product source and testing data.
- .3 Submit written field inspection and test reports.

1.05 CLOSEOUT AND MAINTENANCE SUBMITTALS

.1 Submit closeout and maintenance submittals in accordance with Section 01 78 00.

.2 Closeout Product data: Submit product warranty documentation.

1.06 DELIVERY, STORAGE, AND HANDLING

.1 When necessary to blend aggregates from one or more sources to produce required gradation, do not blend in stockpiles.

.2 Stockpile fine aggregate separately from coarse aggregate, although separate stockpiles for more than two mix components are permitted.

.3 Provide approved storage, heating tanks and pumping facilities for asphalt cement.

1.07 SITE CONDITIONS

.1 Ambient Conditions: Work of this Section shall be performed when air and surface temperatures are conform to OPSS 310.

.2 Do not apply pavement during wet weather, or when standing water is present.

1.08 WARRANTY

.1 Provide extended warranty for asphalt paving in accordance with the General Conditions, except warranty is extended to two (2) years from date Ready-for-Takeover has been attained:
- .1 Warranty to cover defects including sagging, separation and excessive wear of asphalt surfacing and base.
- .2 Warranty shall cover complete replacement of Work, including adjacent work impacted.

2 PRODUCTS

2.01 MATERIALS

.1 Aggregates: to OPSS 1010:
- .1 Granular A.
- .2 Granular B, Type I or Type II.
- .3 Select subgrade.

.2 Prime coat: SS-1 to OPSS 1103.

.3 Tack coat: SS-1 to OPSS 1103.

.4 Asphalt concrete: to OPSS 1150.

.5 Recycled asphalt:
- .1 Crushed and screened to ensure 100% of RAP material passes 50 mm screen before mixing.
- .2 Use of recycled asphalt product (RAP) in binder/base course mixes is permitted. Recycled asphalt product is NOT permitted in wearing course.

.6 Traffic paint: Latex traffic marking paint to MPI EXT 2.1A. Provide glass reflective beads of type suitable for application to a wet paint surface for light reflectance. Apply beads at a minimum rate of 0.5 kg/l to traffic marking paint. Allow for the following paint colours:
- .1 Blue: Accessible parking lot stalls and symbols.
- .2 Yellow: parking lot stalls and directional lines.
- .3 White: all remaining areas.

2.02 MIXES

.1 Mix design to be in accordance with OPSS 310.

.2 Mix to contain maximum 50% by mass of RAP. Consultant may approve higher proportion of RAP if Contractor demonstrates ability to produce mix meeting requirements of specification.

3 EXECUTION

3.01 EXAMINATION

.1 Examine and verify previously installed Work upon which this Section depends. Report defects or unsatisfactory conditions to Consultant. Commencement of work of this Section means acceptance of existing conditions.

.2 Examine grades of items set in paving area to ensure they conform with elevations and sections before starting the Work of this Section.

.3 Coordinate elevations of maintenance holes and other appurtenances and make flush with top of finish asphalt concrete paving.

3.02 PLACEMENT REQUIREMENTS

.1 Foundations:
- .1 Foundations for heavy duty parking comprise:
  - .1 350 mm compacted thickness of granular subbase B or 50 mm crusher run limestone.

.2 150 mm compacted thickness of granular base A or 20 mm crusher run limestone.

.2 Foundations for light duty parking to comprise:

.1 250 mm compacted thickness of granular subbase B or 50 mm crusher run limestone.

.2 150 mm compacted thickness of granular base A or 20 mm crusher run limestone.

.3 Construction of granular foundations: OPSS 314.

.4 Compaction: compact each lift of granular material to 100% maximum density to ASTM D698. Maximum lift thickness: 150 mm.

.2 Pavement Thicknesses:

.1 Pavements for heavy duty parking:

.1 Base course: 60 mm HL8 or SP 19.0.

.2 Wear course: 40 mm HL3 or SP 12.5.

.2 Pavements for light duty parking:

.1 Base course: 40 mm HL8 or SP 19.0.

.2 Wear course: 40 mm HL3 or SP 12.5.

3.03 INSTALLATION

.1 Application of prime coat: OPSS 302.

.2 Construction of asphalt concrete: OPSS 310.

.3 Roll asphalt continuously to density not less than 98% of Marshall density.

.4 Provide equipment as necessary to achieve specified pavement design.

.5 Start rolling operations as soon as placed mix can bear weight of roller without excess displacement of material or cracking of surface.

.6 Operate roller slowly initially to avoid displacement of material. Do not exceed 5 km/h for breakdown and intermediate rolling for static steel-wheeled and pneumatic tired rollers. Do not exceed 9 km/h for finish rolling.

.7 Use static compaction for levelling coarse less than 25 mm thick.

.8 For lifts 50 mm thick and greater, adjust speed and vibration frequency of vibratory rollers to produce minimum of 25 impacts per metre of travel. For lifts less than 50 mm thick, impact spacing not to exceed compacted lift thickness.

.9 Overlap successive passes of roller by minimum of 200 mm and vary pass lengths.

.10 Keep wheels of roller slightly moistened with water to prevent pick-up of material but do not over-water.

.11 Do not stop vibratory rollers on pavement that is being compacted with vibratory mechanism operating.

.12 Do not permit heavy equipment or rollers to stand on finished surface before it has been compacted and has thoroughly cooled.

.13 After traverse and longitudinal joints and outside edge have been compacted, start rolling longitudinally at low side and progress to high side.

.14 Where rolling causes displacement of material, loosen affected areas at once with lutes or shovels and restore to original grade of loose material before re-rolling.

.15 Joints:
- .1 Remove surplus material from surface of previously laid strip.
- .2 Do not deposit on surface of freshly laid strip.
- .3 Construct joints between asphalt concrete pavement and Portland cement concrete pavement as indicated.
- .4 Paint contact surfaces of existing structures such as manholes, curbs or gutters with bituminous material prior to placing adjacent pavement.

.16 Finish tolerances:
- .1 Finished asphalt surface to be within 5 mm of design elevation but not uniformly high or low.
- .2 Finished asphalt surface not to have irregularities exceeding 5 mm when checked with 4.5 m straight edge placed in any direction.

3.04 PAVEMENT MARKINGS

.1 Paint parking space divisions and other pavement markings in accordance with manufacturers recommendations and as indicated.

.2 Painted lines and symbols shall be straight or uniformly curved with well defined edges and full paint coverage.

.3 Paint lines a minimum 100 mm wide unless noted otherwise on drawings.

.4 Protect newly painted markings from traffic or disturbance until dry.

3.05 SITE QUALITY CONTROL

.1 Conduct testing and inspection to ensure compliance with the Specifications including the following:
- .1 Composition and grading of granular materials.
- .2 Compaction of granular materials and asphalt paving.

3.06 PROTECTION

.1 Prevent vehicular access and parking on newly paved areas until surface has cured and hardened for a minimum of 24 hours and paving surface temperature has dropped below 38 degree C.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 03 10 01 Landscape Concrete Forming and Accessories

.2 Section 03 30 01 Landscape Cast-in-Place Concrete

1.2 REFERENCE STANDARDS

.1 ASTM International

.1 ASTM C117-[13] , Standard Test Method for Materials Finer than 0.075 mm (No. 200) Sieve in Mineral Aggregates by Washing.

.2 ASTM C136/C136M-[14] , Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.

.3 ASTM C 309 [03] , Liquid Membrane Forming Compounds for Curing Concrete.

.4 ASTM D1751, Standard Specification For Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).

.5 ASTM D698-[12e2] , Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400ft-lbf/ft^3) (600 kN-m/m^3).

.2 CSA Group

.1 CSA-A23.1-[14] /A23.2-[14] , Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete, Including Update No. 1 [2015] .

.2 CSA B651-[2012] Accessible Design for the Built Environment.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheet and include product characteristics, and limitations.

.2 Inform Consultant of proposed source of materials and provide access for sampling minimum 4 weeks prior to commencing work.

.3 If materials have been tested by independent testing laboratory within previous 2 months and have passed tests equal to requirements of this specification, submit test certificates from testing laboratory showing suitability of materials for this project.

Part 2 Products

2.1 MATERIALS

.1 Concrete mixes and materials: in accordance with Section 03 30 01 - Landscape Cast-in-Place Concrete.

.2 Reinforcing steel:

.1 For paved surfaces: WWM 152 x 152 MW11.1

.2 For Curbs and Edges: three #10M, or two #15M, epoxy coated continuous bars, placed as indicated on drawings.

.3 Joint filler: in accordance with Section 03 30 01 – Landscape Cast-in-Place Concrete.

.4 Granular base:

.1 Granular 'A' in accordance with OPSS 101.05.02.

.5 Non-staining mineral type form release agent: chemically active release agents containing compounds reacting with free lime to provide water-soluble soap.

.6 Curing Agent: to ASTM C309, Type 1.

.7 Expansion Joint Filler: Premoulded bituminuous fibre board, conforming to ASTM D1751.

.8 Tactile Walking Surface Indicators: In accordance with Section 32 33 00 Site Furnishings and AODA compliant.

Part 3 Execution

3.1 GRADE PREPARATION

.1 Do grade preparation work in accordance with Section 31 23 33.01- Excavating, Trenching and Backfilling.

.2 Construct embankments using excavated material free from organic matter or other objectionable materials.

.1 Dispose of surplus and unsuitable excavated material off site.

.3 Place fill in maximum 150mm layers and compact to minimum 98% of maximum dry density to ASTM D698.

3.2 GRANULAR BASE

.1 Obtain Consultant's approval of subgrade before placing granular base.

.2 Place granular base material to lines, widths, and depths as indicated.

.3 Compact granular base in maximum 150 mm layers to minimum 98 % of maximum density to ASTM D698.

3.3 CONCRETE

.1 Obtain Consultant's approval of granular base and reinforcing steel prior to placing concrete.

.2 Do concrete work in accordance with Section 03 30 01 – Landscape Cast-in-Place Concrete.

.3 Immediately after floating, give sidewalk surface uniform broom finish to produce regular corrugations not exceeding 2mm deep, by drawing broom side to side across sidewalk.

.4 Provide edging as indicated on drawings.

.5 Slip-form pavers equipped with string line system for line and grade control may be used if quality of work acceptable to Consultant can be demonstrated. Hand finish surfaces when directed by Consultant.

3.4 TOLERANCES

.1 Finish surfaces to within 3mm in 3m as measured with 3m straightedge placed on surface.

3.5 EXPANSION AND CONTRACTION JOINTS

.1 Install transverse contraction joints after floating, when concrete stiff, but still plastic, at intervals of shown on drawings.

.2 Install expansion joints as indicated on drawings or at intervals of no more than 6m.

.3 When sidewalk adjacent to curb, make joints of curb, gutters and sidewalk coincide.

3.6 ISOLATION JOINTS

.1 Install isolation joints around manholes and catch basins and along length adjacent to concrete curbs, catch basins, buildings, or permanent structures.

.2 Install joint filler in isolation joints in accordance with Section 03 30 01 - Cast-in-Place Concrete.

.3 Seal isolation joints with sealant approved by Consultant.

3.7 TACTILE WALKING SURFACE INDICATORS

.1 Install tactile walking surface indicators at curb ramp edges, top of ramps and stairs, where indicated on drawings and in accordance with local municipal by-laws and AODA.

3.8 CURING

.1 Cure concrete by adding moisture continuously in accordance with CSA-A23.1/A23.2 to exposed finished surfaces for minimum 1 day after placing, or sealing moisture in by curing compound.

.2 Where burlap used for moist curing, place two prewetted layers on concrete surface and keep continuously wet during curing period.

.3 Apply curing compound evenly to form continuous film, in accordance with manufacturer's requirements.

3.9 BACKFILL

.1 Allow concrete to cure for 7 days prior to backfilling.

.2 Backfill to designated elevations with material as directed by Consultant.

.1 Compact and shape to required contours as indicated.

3.10 CLEANING

.1 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 32 91 19 Topsoil and Fine Grading

1.2 REFERENCE STANDARDS

.1 ASTM International

.1 ASTM C136-[13] , Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.

.2 ASTM C140, Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.

.3 ASTM C936, Standard Specification for Solid Concrete Interlocking Paving Units.

.4 ASTM C979/C979M-[10] , Standard Specification for Pigments for Integrally Colored Concrete.

.5 ASTM C1645 Standard Test Method for Freeze-thaw and De-icing Salt Durability of Solid Concrete Interlocking Paving Units

.2 CSA Group

.1 CSA A23.1/A23.2-[09] , Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete.

.2 CAN/CSA-A179-[04(R2009)] , Mortar and Grout for Unit Masonry.

.3 CSA A231.1/A231.2-[06(R2010)] , Precast Concrete Paving Slabs/Precast Concrete Pavers.

.4 CSA A283-[06(R2011)] , Qualification Code for Concrete Testing Laboratories.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00- Submittal Procedures.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for precast concrete unit paving and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Samples:

.1 Submit full size samples of each paver type, thickness, colour and finish that indicate the range of colour variation and texture expected upon project completion for consultant approval.

.2 Accepted samples become the standard of acceptance for the product produced.

.4 Test and Evaluation Reports:

.1 Submit following sampling and testing data:

.1 Sieve analysis for gradation of bedding and joint material.

.2 Unit paver sampling and testing.

.3 Certificates: submit product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

1.4 QUALITY ASSURANCE

.1 Qualifications:

.1 Installer: company or person specializing in precast concrete paver installations of similar complexity, size and material with 5 documented years of experience.

.2 Mock-ups:

.1 Construct 3 x 3 m area mock-up.

.2 Mock-up will be used:

.1 To judge quality of work, substrate preparation, operation of equipment and material application.

.2 To determine surcharge of bedding layer, joint sizes, lines, laying patterns, colours, texture and levelness.

.3 Locate mock-up where directed by Consultant.

.4 Allow 48 hours for inspection of mock-up before proceeding with work.

.5 When accepted, mock-up will demonstrate minimum standard of quality required for this work. Approved mock-up may remain as part of finished work.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials off ground in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect materials free from mud, dirt, and other foreign materials.

.3 Store and protect precast concrete units from nicks, scratches, and blemishes.

.4 Replace defective or damaged materials with new.

.4 Coordinate delivery and paving schedule to minimize interference with normal use of streets and sidewalks adjacent to paver installation.

.5 Prevent joint and sand setting bed sand from exposure to rainfall, or removal by wind with secure, waterproof covering.

1.6 PROJECT / SITE CONDITIONS

.1 Environmental Requirements:

.1 Install pavers only on unfrozen setting bed aggregate materials

.2 Install pavers only on unfrozen base or sub-base aggregate materials

.3 Install base or subbase only over unfrozen subgrade

.4 Install setting bed sand or pavers only when there is no heavy rain or snowfall.

1.7 CONCRETE PAVER OVERAGE AND ATTIC STOCK

.1 Provide a minimum of 5% additional material for overage to be used during construction.

.2 Contractor to provide a minimum of 10 sq. m of each product and size used to owner for maintenance and repair. Furnish pavers from the same production run as installed materials.

Part 2 Products

2.1 CONCRETE PAVERS

.1 Concrete pavers to be manufactured by Techo-Bloc Inc.

.1 Contact: Jada Blackwood, jada.blackwood@techo-bloc.com

.2 Concrete Paver Type 1: Aquastorm Commercial

.1 Size: 225 (w) x 510(L) x 100(D)mm

.2 Colour: Grey

.3 Finish:Smooth

.3 Pavers shall meet the minimum material and physical properties set forth in ASTM C936.

.1 Average compressive strength 8000psi (55 MPa) with no individual unit under 7,200 psi (50 MPa)

.2 Average absorption of 5% with no greater than 7% when tested according to ASTM C140.

.3 Conforming to ASTM C 1645 when tested for freeze-thaw requirements.

.4 Height tolerances +/- 3.2mm.

.4 Pigment in concrete pavers: to ASTM C979/C979M.

.5 Maximum allowable breakage of product is 5%.

2.2 PRECAST MAINTENANCE EDGE

.1 Concrete pavers to be manufactured by Unilock or approved equivalent.

.1 Contact: Philip Clark, T: 416-646-9000.

.2 Concrete Maintenance Edge: SiennaStone Coping

.1 Size: 600 (w) x 1200(L) x 185(D)mm

.2 Colour: Natural

2.3 JOINT MATERIAL

.1 Turfstone pavers to receive topsoil and sod plugs in voids. Refer to Section 32 91 19 Topsoil and Fine Grade and drawing details.

2.4 SETTING BED

.1 Unit Paving Setting Bed Sand

.1 Washed, clean, non-plastic, free from deleterious or foreign matter, symmetrically shaped, natural or manufactured from crushed rock.

.2 Do not use limestone screenings, stone dust, or sand material that does not conform to conform to the grading requirements of ASTM C 33.

.3 Do not use mason sand or sand conforming to ASTM C 144.

.4 Utilize sands that are as hard as practically available where concrete pavers are subject to vehicular traffic.

.5 Conform to the grading requirements of ASTM C 33 with modifications as shown in Table below:

Table – Setting Bed Sand Gradation Requirements for Setting Bed Sand	
ASTM C 33	
Sieve Size	**Percent Passing**
3/8 in (9.5 mm)	100
No. 4 (4.75 mm)	95 to 100
No. 8 (2.36 mm)	85 to 100
No. 16 (1.18 mm)	50 to 85
No. 30 (0.600 mm)	25 to 60
No. 50 (0.300 mm)	10 to 30
No. 100 (0.150 mm)	2 to 10
No. 200 (0.075)	0 to 1

2.5 BASE AGGREGATE

.1 Unit Paving Base Aggregate

.1 Provide Base Aggregate materials conforming to ASTM D 2940 and gradation requirements as presented in Table below:

Table – Base Aggregate Gradation Requirements	
ASTM D 2940	
Sieve Size	**Percent Passing**
2 in (50 mm)	100
1-1/2 in (37.5 mm)	95 to 100
3/4 in (19 mm)	70 to 92
3/8 in (9.5 mm)	50 to 70
No. 4 (4.75 mm)	35 to 55
No. 30 (600 µm)	12 to 25
No. 200 (75 µm)	0 to 8

2.6 EDGE RESTRAINTS

.1 Edge restraints shall be concrete. Refer to Civil.

2.7 CLEANING COMPOUND

.1 Clear, organic solvent, designed and recommended by manufacturer for cleaning concrete pavers of contamination encountered.

.2 Acid based chemical detergent, designed and recommended by manufacturer for removal of contamination encountered on pavers.

2.8 SEALING COMPOUND

.1 Sealing compound to be used only as recommended by manufacturer where applicable.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for precast concrete unit paving installation in accordance with manufacturer's written instructions and requirements for installation tolerances and other conditions affecting performance prior to placing concrete pavers.

.1 Unit Paving on Aggregate Base:

.1 Verify that the Base and Sub-base aggregate materials, thickness, compacted density, surface tolerances and elevations conform to specified requirements.

.2 Provide written density test results for soil subgrade, base and subbase aggregate to Owner and Consultant.

.3 Verify location, type, and elevations of edge restraints, concrete curbs, concrete collars around utility structures and drainage inlets.

.2 Inform Consultant of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied.

.1 Beginning Paver installation signifies acceptance of base and edge restraint conditions.

3.2 INSTALLATION OF EDGE RESTRAINTS

.1 Install restraints true to grade, in accordance with manufacturer's recommendations and as shown on drawing details.

3.3 BASE AND SUBBASE AGGREGATES

.1 Unit Paving Base:

.1 Provide the Base Aggregate material in uniform lifts not exceeding 6 in. (150 mm) over the compacted Subbase Aggregate (or Subgrade) material and compact to at least 100 percent Standard Proctor Density as per ASTM D 698.

.2 Compact the Base Aggregate material with at least two passes in the vibratory mode then at least two in the static mode with a minimum 10 ton vibratory roller until there is no visible movement. Do not crush aggregate with the roller.

.3 Tolerance: Do not exceed the specified surface grade of the compacted Base Aggregate material more than ±3/8 in. (10 mm) over a 10 ft. (3 m) long straightedge laid in any direction.

.4 Compact and grade the upper surface of the base sufficiently to prevent infiltration of the bedding sand into the base both during construction and

throughout its service life. Blend segregated areas of the granular base by the application of crushed fines that have been watered and compacted into the surface.

3.4 SETTING BED

.1 Unit Paving:

.1 Provide, spread and screed Setting Bed Sand evenly over the compacted Base Aggregate course.

.1 Protect screeded Setting Bed Sand from being disturbed by either pedestrian or vehicular traffic.

.2 Screed only the area which can be covered by pavers in one day.

.3 Do not use Setting Bed Sand material to fill depressions in the aggregate base surface.

.2 Keep moisture content constant and density loose and constant until Concrete Pavers are set and compacted.

.3 Screed Setting Bed Sand using either an approved mechanical spreader (e.g.: an asphalt paver) or by the use of screed rails and boards. Maintain in a loose condition slightly ahead of the paving units and fully protect against incidental compaction following screeding. Loosen compacted sand by rain or screeded sand left overnight before further paving units are placed.

.4 Inspect the Setting Bed Sand course prior to commencing the placement of the Concrete Pavers. Acceptance of the Setting Bed Sand occurs with the initiation of Concrete Paver placement.

3.5 INSTALLATION OF CONCRETE PAVERS

.1 Replace Concrete Pavers with chips, cracks, voids, discolorations, and other defects that might be visible in finished work.

.2 Mix Concrete Pavers from a minimum of three (3) bundles simultaneously drawing the paver vertically rather than horizontally, as they are placed, to produce uniform blend of colors and textures.

.3 Exercise care in handling face mix concrete pavers to prevent surfaces from contacting backs or edges of other units.

.4 Provide Concrete Pavers using laying pattern as indicated. Adjust laying pattern at pavement edges such that cutting of edge pavers is minimized. Cut all pavers exposed to vehicular tires no smaller than one-third of a whole paver.

.5 Use string lines or chalk lines on Setting Bed to hold all pattern lines true.

.6 Set surface elevation of pavers 1/8 in. (3 mm) above adjacent drainage inlets, concrete collars or channels.

.7 Place units hand tight against spacer bars. Adjust horizontal placement of laid pavers to align straight.

.1 When installation is performed with mechanical equipment, use only unit pavers with spacer bars on sides of each unit.

.8 Provide space between paver units of 1/32 in. (1 mm) wide to achieve straight bond lines.

.9 Prevent joint (bond) lines from shifting more than ±1/2 in. (±13 mm) over 50 ft. (15 m) from string lines.

.10 Fill gaps between units or at edges of the paved area that exceed 3/8 inch (10 mm) with pieces cut to fit from full-size unit pavers.

.11 Cut unit pavers with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.

.12 Prevent all traffic on installed Concrete Pavers until joint material has been vibrated into joints. Keep skid steer and forklift equipment off newly laid Concrete Pavers that have not received initial compaction and Joint material.

.13 Vibrate Concrete Pavers into leveling course with a low-amplitude plate vibrator capable of a to 5000-lbf (22-kN) compaction force at 80 to 90 Hz. Perform at least three passes across paving with vibrator. Vibrate under the following conditions:

.1 After edge pavers are installed and there is a completed surface or before surface is exposed to rain.

.2 Compact installed Concrete Pavers to within 6 feet (1.8 meters) of the laying face before ending each day's work. Cover Concrete Pavers that have not been compacted and leveling course on which pavers have not been placed, with nonstaining plastic sheets to prevent Setting Bed from becoming disturbed.

.14 Protect face mix Concrete Paver surface from scuffing during compaction by utilizing a urethane pad.

3.6 INSTALLATION OF JOINT MATERIAL

.1 Remove any cracked or structurally damaged Concrete Pavers and replace with new units prior to installing Joint material.

.2 Provide, spread and sweep topsoil material into joints immediately after vibrating pavers into Setting Bed course until full. Compact topsoil to 70% SPD Joint material until voids are completely filled, 25mm below top of paver to ensure sod installation sits flush with top of paver.

.3 Remove excess topsoil material broom clean from surface when installation is complete.

.4 Cleanly cut sod to fit in paver voids snugly. Roll surface to ensure proper knitting with topsoil.

3.7 FIELD QUALITY CONTROL

.1 Verify final elevations for conformance to the drawings after sweeping the surface clean.

.1 Prevent final Concrete Paver finished grade elevations from deviating more than ±3/8 in. (±10 mm) under a 10 ft (3 m) straightedge or indicated slope, for finished surface of paving.

.2 Paver-to-Paver Lippage:

.1 No greater than 3 mm (1/8 inch) difference in height between adjacent pavers.

3.8 REPAIRING, CLEANING AND SEALING

.1 Remove and replace unit pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.

.2 Cleaning: Remove excess dirt, debris, stains, grit, etc. from exposed paver surfaces; wash and scrub clean.

.1 Clean Concrete Pavers in accordance with the manufacturer's written recommendations.

3.9 PROTECTION

.1 Protect completed work from damage due to subsequent construction activity on the site.

END OF SECTION

Part 1 General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

.1 Product Data:

.1 Submit images of crushed stone to be supplied for consultant approval.

.2 Upon request of the Consultant, supply samples of crushed stone for Consultant review and Approval.

Part 2 Products

2.1 MATERIALS

.1 Subdrain Pipe: corrugated, plastic drainage tubing to CGSB 41-GP-29M, Type 1 (non-perforated) for discharge lines, Type 2 (perforated) for collector lines.

.2 Drop in Grate: 4” pipe grate, round, black, as manufactured by NDS (National Diversified Sales) or equivalent.

.3 Granular base: Granular ‘A’.

.4 Clear Stone: washed, 19mm crushed clear aggregate.

.5 Metal edge: ‘Cleanline XL’ 3/16” thickness as manufactured by Permaloc. 1-800-356-9660 (US & Canada) info@permaloc.com, or approved equivalent.

.6 Filter Cloth: "Terrafix 270R " by Terrafix Erosion Control Products Inc.

.7 Granite Chip:

.1 Clear, washed, 6mm, grey granite chippings.

.1 As supplied by Fowler Construction, 1 800 268 7687.

.2 Approved equivalent

.2 Provide sample for approval.

.8 River Stone:

.1 Clear, washed, 25-38mm, natural round river stone.

.2 Provide sample for approval.

.9 Gravel Binder:

.1 Romex Profi-Decko Permeable Gravel Binder or approved equivalent.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify conditions of substrate previously installed under other Sections or Contracts are acceptable for installation.

.2 Visually inspect substrate and inform Consultant of unacceptable conditions immediately upon discovery.

.1 Proceed with installation only after unacceptable conditions have been remedied.

3.2 INSTALLATION - GENERAL

.1 The subgrade shall be graded smooth and compacted to 98% Standard Proctor Maximum Dry Density.

.2 Compact specified depth of granular base material, placing appropriate width of filter cloth on the top.

.3 Install metal edging as per manufacturer's instructions.

.4 Install stone and pack into place with hand tamper.

.5 Install Gravel Binder as per manufacturer's instructions.

3.3 COMPLETION

.1 At the completion of stone installation and prior to final inspection, clean all adjacent areas of loose stone.

.2 Upon completion of the work in this section, remove surplus materials, tools, equipment and debris, and leave site in a clean and tidy condition to the complete satisfaction of the Owner.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 32 13 13 Concrete Paving and Edges

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide in accordance with Section 01 33 00- Submittal Procedures.

.2 Product Data:

.1 Provide manufacturer's instructions, printed product literature and data sheets for furniture and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Submit shop drawings indicating dimensions, sizes, assembly, anchorage and installation details for each furnishing specified.

1.3 CLOSEOUT SUBMITTALS

.1 Provide maintenance data for care and cleaning of site furnishings for incorporation into manual specified in Section 01 78 00- Closeout Submittals.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials off ground and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect furnishings from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

Part 2 Products

2.1 PRECAST CONCRETE BENCH

.1 Product:

.1 Cubic Series, CU-Tilt as manufactured by Ed’s Concrete Products.

.2 Dimensions:

.1 Height: 498mm

.2 Length: 2000mm

.3 Depth: 498mm

.3 Finish:

.1 Colour: Grey Standard

.2 Finish: Smooth Precast

.4 Quantity: 1

2.2 BICYCLE RACK

.1 Product:

.1 Expo Series, W4508 as manufactured by Cora Bike Rack LTD, 1-800-739-4609

.2 Basic Construction Material: pre-finished tubular steel.

.3 Finish: Powdercoat Black

.4 Quantity: 2

2.3 WASTE RECEPTACLES

.1 Product:

.1 XS35-3, University of Toronto Mississauga Standard, Version 2, Revision D as manufactured by CleanRiver Solutions, 1-888-646-4246.

.2 Size: 47-3/4” (H) x 62” (W) x 19” (D) 41-3/4” (H)

.2 Quantity: 1

2.4 TACTILE WARNING SURFACE INDICATORS

.1 Product:

.1 Advantage ADV-CI-2424 as manufactured by Kinesik Engineer Products.

.2 Approved equivalent.

.2 Basic Construction Material: Cast iron

.3 Dimensions: 610x610mm

.4 Finish: Onyx Black

.5 Quantity: As Required.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for exterior site furnishing installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate in presence of Consultant.

.2 Inform Consultant of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 PREPARATION

.1 Locate and protect utility lines.

.2 Notify and acquire written acknowledgement from utility authorities before beginning installation Work

3.3 INSTALLATION

.1 Assemble furnishings in accordance with manufacturer's written recommendations.

.2 Install anchored, true, level, and plumb.

.3 Touch-up damaged finishes to approval of Consultant, by method as recommended by manufacturer.

3.4 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11- Cleaning.

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11- Cleaning.

3.5 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by site furnishings installation.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 32 92 19 Seeding

.2 Section 32 93 10 Trees, Shrubs and Groundcover Planting

1.2 SCOPE

.1 This section addresses the labour, materials, tools, services and equipment necessary for the supply and installation of Topsoil and Planting Soil.

1.3 REFERENCE STANDARDS

.1 Agriculture and Agri-Food Canada

.1 The Canadian System of Soil Classification, Third Edition, 1998.

.2 Canadian Council of Ministers of the Environment

.1 PN1340-[2005] , Guidelines for Compost Quality.

1.4 DEFINITIONS

.1 Compost:

.1 Mixture of soil and decomposing organic matter used as fertilizer, mulch, or soil conditioner.

.2 Compost is processed organic matter containing 40% or more organic matter as determined by Walkley-Black or Loss On Ignition (LOI) test.

.3 Product must be sufficiently decomposed (i.e. stable) so that any further decomposition does not adversely affect plant growth (C:N ratio below (25) (50)), and contain no toxic or growth inhibiting contaminates.

.4 Composed bio-solids to: CCME Guidelines for Compost Quality, Category (A).

1.5 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00- Submittal Procedures .

.2 Quality control submittals:

.1 Soil testing: submit certified test reports showing compliance with specified performance characteristics and physical properties as described in PART 2 - SOURCE QUALITY CONTROL.

.2 Certificates: submit product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

Part 2 Products

2.1 TOPSOIL

.1 Topsoil for seeded sodded areas and planting mixture base: mixture of particulates, micro organisms and organic matter which provides suitable medium for supporting intended plant growth.

- .1 Soil texture based on The Canadian System of Soil Classification, to consist of 45 % sand, 35% silt and 20 % clay, and contain 5 % organic matter by weight.
- .2 Contain no toxic elements or growth inhibiting materials.
- .3 Finished surface free from:
  - .1 Debris and stones over 50 mm diameter.
  - .2 Course vegetative material, 10 mm diameter and 100 mm length, occupying more than 2% of soil volume.
- .4 Consistence: friable when moist.

2.2 PLANTING SOIL

.1 Planting Soil: pH range of 6.5 to 7.5, mixture to be 50% topsoil, 25% peat moss, 25% well rotted manure, and 500g bonemeal per cubic metre of planting soil; screened and free of stones 1 inch or larger in any dimension and other extraneous materials harmful to plant growth.

.2 Clean soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.

2.3 SOIL AMENDMENTS

.1 Fertilizer:

- .1 Fertility: major soil nutrients present in following amounts:
- .2 Nitrogen (N): [20] to [40] micrograms of available N per gram of topsoil.
- .3 Phosphorus (P): [40] to [50] micrograms of phosphate per gram of topsoil.
- .4 Potassium (K): [75] to [110] micrograms of potassium per gram of topsoil.
- .5 Calcium, magnesium, sulphur and micro-nutrients present in balanced ratios to support germination and/or establishment of intended vegetation.
- .6 Ph value: 6.5 to 7.5 .

.2 Peatmoss:

- .1 Derived from partially decomposed species of Sphagnum Mosses.
- .2 Elastic and homogeneous, brown in colour.
- .3 Free of wood and deleterious material which could prohibit growth.
- .4 Shredded particle minimum size: [5] mm.

.3 Sand: washed coarse silica sand, medium to course textured.

.4 Organic matter: compost Category A, in accordance with CCME PN1340 , unprocessed organic matter, such as rotted manure, hay, straw, bark residue or sawdust, meeting the organic matter, stability and contaminant requirements.

.5 Use composts meeting Category B requirements for land fill reclamation and large scale industrial applications.

.6 Limestone:

.1 Ground agricultural limestone.

.2 Gradation requirements: percentage passing by weight, 90% passing 1.0 mm sieve, 50% passing 0.125 mm sieve.

.7 Fertilizer: industry accepted standard medium containing nitrogen, phosphorous, potassium and other micro-nutrients suitable to specific plant species or application or defined by soil test.

2.4 SOURCE QUALITY CONTROL

.1 Advise Consultant of sources of topsoil to be utilized with sufficient lead time for testing.

.2 Soil testing to be completed by recognized testing facility for pH, P and K, soil texture and organic matter, as well as recommended amendments to ensure topsoil is suitable for intended use.

.3 Testing of topsoil will be carried out by SGS Agrifood Laboratories (T:519-837-1242).

.1 Soil sampling, testing and analysis to be in accordance with Provincial standards.

.4 Contractor is responsible for amendments to topsoil, as recommended within testing report at no additional cost to Owner.

Part 3 Execution

3.1 TEMPORARY EROSION AND SEDIMENTATION CONTROL

.1 Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to [sediment and erosion control plan, specific to site, that complies with EPA 832/R-92-005 or requirements of authorities having jurisdiction, whichever is more stringent] [sediment and erosion control drawings] [requirements of authorities having jurisdiction] .

.2 Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.

.3 Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.2 PREPARATION OF EXISTING GRADE

.1 Verify that grades are correct.

.1 If discrepancies occur, notify Consultant and do not commence work until instructed by Consultant.

.2 Grade soil, eliminating uneven areas and low spots, ensuring positive drainage.

.3 Remove debris, roots, branches, stones in excess of 50 mm diameter and other deleterious materials.

.1 Remove soil contaminated with calcium chloride, toxic materials and petroleum products.

.2 Remove debris which protrudes more than 75 mm above surface.

.3 Dispose of removed material off site.

.4 Cultivate entire area which is to receive topsoil to minimum depth of 100 mm.

.1 Cross cultivate those areas where equipment used for hauling and spreading has compacted soil.

3.3 PLACING AND SPREADING OF TOPSOIL / PLANTING SOIL

.1 Place topsoil after Consultant has accepted subgrade.

.2 Spread topsoil in uniform layers not exceeding 150 mm.

.3 For sodded areas keep topsoil 15 mm below finished grade.

.4 Spread topsoil or planting soil to following minimum depths after settlement.

.1 100 mm for seeded areas.

.2 300 mm for perennial beds.

.3 500 mm for shrub beds.

.5 Manually spread topsoil/planting soil around trees, shrubs and obstacles.

3.4 SOIL AMENDMENTS

.1 Apply and thoroughly mix soil amendments into full specified depth of topsoil at rates recommended within soil testing reports.

3.5 FINISH GRADING

.1 Grade to eliminate rough spots and low areas and ensure positive drainage.

.1 Prepare loose friable bed by means of cultivation and subsequent raking.

.2 Leave surfaces smooth, uniform and firm against deep footprinting.

3.6 ACCEPTANCE

.1 Consultant will inspect and test topsoil in place and determine acceptance of material, depth of topsoil and finish grading.

3.7 SURPLUS MATERIAL

.1 Dispose of materials except topsoil not required off site at no additional cost to Owner.

3.8 CLEANING

.1 Upon completion of installation, remove surplus materials, rubbish, tools and equipment barriers.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 23 91 19 Topsoil and Finish Grading

1.2 ADMINISTRATIVE REQUIREMENTS

.1 Scheduling:

.1 Schedule seeding to coincide with preparation of soil surface.

.2 Schedule seeding installation when frost is not present in ground.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for seed, and fertilizer.

1.4 QUALITY ASSURANCE

.1 Qualifications:

.1 Landscape Contractor: to be a Member in Good Standing of Landscape Ontario.

.2 Landscape Planting Supervisor: Landscape Industry Certified Technician with Softscape Installation designation.

.3 Landscape Maintenance Supervisor: Landscape Industry Certified Technician with Turf Maintenance designation.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements:

.1 Labelled bags of fertilizer identifying mass in kg, mix components and percentages, date of bagging, supplier's name and lot number.

.2 Fertilizer must be dry.

.3 Storage and Handling Requirements:

.1 Seed: Store seed in a dry, weatherproof storage place and protect from damage by heat, moisture, rodents or other causes until time of seeding. Do not remove or deface labels or other identification markers.

.2 Mulch: Store dry in bales.

.3 Store fertilizer in weatherproof location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.4 Topsoil: Do not spread, cultivate or otherwise handle while in frozen or muddy condition.

.5 Replace defective or damaged materials with new.

1.6 WARRANTY

.1 For seeding, 12 months warranty period is extended to 1 full growing season.

.2 Contractor hereby warrants that seeding will remain free of defects for 1 full growing season.

.3 End-of-warranty inspection will be conducted by Consultant.

Part 2 Products

2.1 SEED MIXTURES

.1 Seed mix: The mixture is available from the Ontario Seed Company, 1-519-866-0557, or approved equal, and shall be mixed and supplied by a recognized seed house with tested rates for purity and germination of not less than government standard rates. Seeds shall be certified, meeting the requirements of the Seeds Act of Canada No. 1 Seed, and mixed as specified as follows:

.1 CVC 1 – Upland Mix

Scientific Name	Common Name	%
Anemone canadensis	Canada Anemone	1%
Asclepias syriaca	Common Milkweed	2%
Carex granularis	Limestone Meadow Sedge	15%
Elymus virginicus var. virginicus	Virginia Wildrye	40%
Euthamia graminifolia	Grass Leaved Goldenrod	1%
Monarda fistulosa var. fistulosa	Wild Bergamot	1%
Oenethera biennis	Common Evening Primrose	25%
Rudbeckia hirta	Black Eyed Susan	10%
Solidago canadensis var. canadensis	Canada Goldenrod	1%
Solidago juncea	Early Goldenrod	1%
Solidago nemoralis ssp. Nemoralis	Gray-stemmed Goldenrod	1%
Symphyotrichum novae-angliae	New England Aster	1%
Verbena urticifolia	White Vervain	1%

.2 CVC 2 – Low Land Mixture (semi-moist)

Scientific Name	Common Name	%
Carex vulpinoidea	Fox Sedge	25%
Elymus virginicus var. virginicus	Virginia Wildrye	35%
Juncus tenuis	Path Rush	5%
Poa palustris	Fowl Bluegrass	25%
Scirpus atrovirens	Dark-green Bulrush	5%
Verbena hastata	Blue Vervain	5%

.3 Cover Crop

Avena sativa	Oats	40%
Hordeum vulgare	Barley	45%

.2 In packages individually labelled in accordance with "Seeds Regulations" and indicating name of supplier.

2.2 WATER

.1 Potable, free of impurities that would inhibit germination and growth.

.2 Supply water for required irrigation.

2.3 TOPSOIL

.1 As per Section 32 91 19 Topsoil and Finish Grading.

2.4 FERTILIZER

.1 To Canada "Fertilizers Act" and Regulations.

.2 Shall be considered as being included in the contract price. Type and application rate as recommended by manufacturer for specified seed mixture type.

2.5 EROSION CONTROL BLANKET

.1 Type 1: Terrafix S100 or equivalent.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify conditions of substrate previously installed under other Sections or Contracts are acceptable for [mechanical] [hydraulic] seeding installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate.

.2 Inform Consultant of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 INSTALLERS

.1 Use installers members in Good Standing of Landscape Ontario.

3.3 SEED BED PREPARATION

.1 Do not perform work under adverse field conditions as determined by Consultant

.2 Remove and dispose of weeds; debris; stones 50 mm in diameter and larger; soil contaminated by oil, gasoline and other deleterious materials; off site.

.3 Verify that grades are correct. If discrepancies occur, notify Consultant and commence work when instructed by Consultant.

.4 Fine grade surface free of humps and hollows to smooth, even grade, elevations indicated to tolerance of plus or minus 15 mm, surface draining naturally.

.5 Cultivate fine graded surface approved by to 25 mm depth immediately prior to seeding.

3.4 SEED PLACEMENT

.1 Operational Requirements

.1 The composted topsoil and seeding application and/or re-application shall not be carried out under adverse field conditions such as high wind, frozen soil or soil covered with snow, ice or in areas of standing water or a concentrated flow of water unless directed by the Engineer / Project Manager.

.2 The Contractor shall maintain the site and control erosion until conditions permit application or reapplication of seed and composted topsoil.

.3 The surface to be seeded shall be prepared not more than 7 calendar days before the seeding operation.

.4 No seed or composted topsoil application shall come in contact with the foliage of any trees, shrubs, or other vegetation.

.5 No seed or composted topsoil application shall come in contact with water bodies.

.2 Seed between October 15th and November 15th, and between April 15th and May 1st unless otherwise directed by the Consultant.

.3 Pneumatic Blower

.1 The pneumatic blower shall be a custom manufactured, fully integrated, blower truck unit. The blower shall be equipped with a computer-calibrated seed injection system and shall be capable of uniformly and simultaneously applying growing medium and seed at a rate greater than 0.25 cubic meters of material per minute. The blower truck shall also be equipped with an application hose capable of extending 90 meters from the blower truck unit.

.4 Blower Calibration

.1 Prior to the application of the growing medium and seed, the Contractor shall ensure that the pneumatic blower has been properly calibrated to provide the specified amounts of seed and that the blower can adequately uniformly apply growing medium and seed at a rate greater than 0.25 cubic meters of material per minute.

.2 Once the blower has been calibrated, the Contractor shall apply composted topsoil and seeding uniformly at specified depths to all areas identified for cover in the contract drawings or as directed by the Contract Administrator.

.3 Growing medium and seed shall overlap the adjoining ground cover by 300 mm unless specified.

3.5 APPLICATION RATES

.1 Growing Medium

.1 Growing Medium application depth may be modified based on specific site (e.g., soil characteristics, existing vegetation) and climatic conditions, as well as particular project related requirements.

.2 Application depth of Growing Medium shall vary as per site instructions between 100mm and 900mm.

.2 Seed

.1 Growing Medium and seed shall be uniformly and simultaneously applied directly to the soil surface with a pneumatic blower.

.2 Only the upper 50mm shall be TerraSeeded unless directed by the landscape architect

.3 Remediation: Remedy all damages, wash outs and eroded areas resulting from weather, improper protection or other causes.

3.6 Erosion control

.1 Cover all prepared and seeded slopes 3:1 or steeper with erosion control blanket.

.2 Unroll blanket either horizontally or vertically to the slope without stretching or pulling.

.3 Lay blanket smoothly on soil surface. Overlap adjacent sections of blanket minimum 100 mm and use metal staples.

.4 Secure blanket to ground with staples in accordance with the erosion control blanket manufacturer's instructions.

.5 Minimize damage to seedbed during installation of blanket. Re-grade by hand raking as required, to correct any damage.

.6 In ditches and swales, unroll blanket in the direction of flow. Overlap adjacent sections of blanket minimum of 100 mm with upstream section on top and stapled. Follow manufacturer's installation recommendations.

3.7 CLEANING

.1 Leave Work area clean at end of each day.

.1 Keep pavement and area adjacent to site clean and free from mud, dirt, and debris at all times.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

.1 Clean and reinstate areas affected by Work.

.3 Clean water shall be used to immediately wash seed or cover materials that have been applied to the foliage of trees, shrubs or other susceptible plant growth.

3.8 PROTECTION

.1 Erect plastic snow fence around newly seeded areas sufficient to protect against deterioration due to pedestrian or other traffic. All seeded areas shall be protected with warning signs telling of the condition of the area.

3.9 FERTILIZING PROGRAM

.1 Fertilize during establishment and warranty periods to following program as recommended by manufacturer.

3.10 MAINTENANCE DURING ESTABLISHMENT PERIOD

.1 Ensure maintenance is curried out under supervision of certified Landscape Maintenance Supervisor.

.2 Perform following operations from time of seed application until acceptance by Consultant:

.1 Water seeded area to maintain optimum soil moisture level for germination and continued growth of grass. Control watering to prevent washouts.

.2 Repair and reseed dead or bare spots to allow establishment of seed prior to acceptance.

.3 Maintain seeded areas, weed free.

.4 Adjust protection barrier as necessary to protect against deterioration due to pedestrian or other traffic as needed.

3.11 Acceptance

.1 All composted organics and seeded areas will be reviewed to ensure compliance with this specification at thirty, sixty and ninety day periods following the composted organics and seeding operation.

.1 At the thirty day inspection within the seeded earth area

.1 the composted organics shall be visually intact and shall form a uniform cohesive mat

.2 germination of the nurse crop shall be visually evident

.2 At the sixty day inspection within the seeded earth area

.1 the nurse crop shall be evident at mature height in an evenly dispersed, uniform cover

.2 germination of the specified, permanent seed species shall be visually evident in an evenly dispersed uniform cover

.3 there shall not be any significant bare areas, both in terms of quantity and size

.4 non-seeded, non-specified vegetation shall not exceed 20% of the seeded earth area.

.3 At the ninety day inspection within the seeded earth area

.1 the permanent seed species shall be at an average height of 50mm in an evenly dispersed, uniform cover; representative of the specified, permanent seed mixes;

.2 there shall not be any significant bare areas, both in terms of quantity and size;

.3 non-seeded, non-specified vegetation shall not exceed 20% of the seeded earth area.

.2 No inspections will be held during the winter dormant period or when site conditions prohibit a visual field inspection. The timing intervals between inspections will be suspended during the winter dormant period.

.3 Areas seeded in fall will be accepted in following spring, one month after start of growing season provided acceptance conditions are fulfilled.

.4 If the completed work does not meet the Performance Measure after the sixty or ninety day inspection, the Contract Administrator shall notify the Contractor in writing and the Contractor shall re-apply the specified materials in accordance with this specification within 14 calendar days of receiving the notification.

.1 The Contractor shall maintain the site and control erosion until conditions permit application or reapplication of and composted organics seed. All replaced composted organics and seed shall be subject to the Quality Assurance section of this specification.

3.12 MAINTENANCE DURING WARRANTY PERIOD

.1 Perform following operations from time of acceptance until end of warranty period.

.1 Water seeded area to maintain optimum soil moisture level for continued growth of plant material. Control watering to prevent washouts.

.2 Repair and reseed dead or bare spots to satisfaction of Consultant.

.3 Maintain seeded areas, weed free.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 32 91 19 Topsoil and Finish Grading

1.2 REFERENCE STANDARDS

.1 Agriculture and Agri-Food Canada (AAFC).

.1 Plant Hardiness Zones in Canada-[2000] .

.2 Canadian Nursery Landscape Association (CNLA)

.1 Canadian Standards for Nursery Stock-[2006] .

1.3 DEFINITIONS

.1 Mycorrhiza: association between fungus and roots of plants. This symbiosis, enhances plant establishment in newly landscaped and imported soils.

1.4 ADMINISTRATIVE REQUIREMENTS

.1 Scheduling: obtain approval from Consultant of schedule 7 days in advance of shipment of plant material.

.2 Schedule to include:

.1 Quantity and type of plant material.

.2 Shipping dates.

.3 Arrival dates on site.

.4 Planting Dates.

1.5 ACTION AND INFORMATIONAL SUBMITTALS

.1 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for [trees, shrubs, ground cover, fertilizer, mycorrhiza, anti-desiccant, anchoring equipment, and mulch] and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Samples:

.1 Submit samples of mulch.

1.6 QUALITY ASSURANCE

.1 Qualifications:

.1 Landscape Contractor: to be a Member in Good Standing of Landscape Ontario.

.2 Landscape Planting Supervisor: Landscape Industry Certified Technician with Softscape Installation designation.

.3 Landscape Maintenance Supervisor: Landscape Industry Certified Technician with Ornamental Maintenance designation.

1.7 DELIVERY, STORAGE AND HANDLING

.1 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.1 Protect plant material from frost, excessive heat, wind and sun during delivery.

.2 Protect plant material from damage during transportation:

.1 Delivery distance is less than 30 km and vehicle travels at speeds under 80 km/h, tie tarpaulins around plants or over vehicle box.

.2 Delivery distance exceeds 30 km or vehicle travels at speeds over 80 km/h, use enclosed vehicle where practical.

.3 Protect foliage and root balls using anti-desiccants and tarpaulins, where use of enclosed vehicle is impractical due to size and weight of plant material.

.2 Storage and Handling Requirements:

.1 Immediately store and protect plant material which will not be installed within on working day in accordance with supplier's written recommendations and after arrival at site.

.2 Protect stored plant material from frost, wind and sun and as follows:

.1 For bare root plant material, preserve moisture around roots by heeling-in or burying roots in topsoil and watering to full depth of root zone.

.2 For pots and containers, maintain moisture level in containers.

.3 For balled and burlapped and wire basket root balls, place to protect branches from damage. Maintain moisture level in root zones.

.3 Store and manage hazardous materials in accordance with manufacturer's written instructions.

1.8 WARRANTY

.1 Plant material as itemized on plant list to include the 24 months warranty period from time of acceptance. Plant material that is planted after leaf drop will be reviewed for acceptance the following spring, after leaf-out.

.2 Contractor hereby warrants that plant material as itemized on plant list will remain free of defects, in healthy and vigorous growing condition, for 2 full growing seasons, providing adequate maintenance has been provided.

.3 End-of-warranty inspection will be conducted by Consultant.

.4 Consultant reserves the right to extend Contractor's warranty responsibilities for an additional one year if, at end of initial warranty period, leaf development and growth is not sufficient to ensure future survival.

Part 2 Products

2.1 PLANT MATERIAL

.1 Type of root preparation, sizing, grading and quality: comply to Canadian Standards for Nursery Stock.

.1 Source of plant material: grown in Zone 5

.2 Plant material must be planted in zone specified as appropriate for its species.

.3 Plant material in location appropriate for its species.

.2 Plant material: free of disease, insects, defects or injuries and structurally sound with strong fibrous root system.

.3 Trees: with straight trunks, well and characteristically branched for species.

.4 Bare root stock: nursery grown, in dormant stage, not balled and burlapped or container grown.

2.2 WATER

.1 Potable and free of impurities that would inhibit plant growth.

2.3 STAKES

.1 T-bar, steel, 40 x 40 x 5 x 2440 mm.

2.4 GUYING WIRE

.1 Type 2: Green Arbortie or equivalent, secured to stake.

2.5 TRUNK PROTECTION

.1 Plastic: Flexi-pipe plastic guard, 500mm high, 100mm dia. side split vertically

2.6 MULCH

.1 Shredded wood: varying in size from 25 to 125mm in length, from pine trees.

2.7 FERTILIZER

.1 Synthetic commercial type as recommended by manufacturer or soil test report.

.1 Ensure new root growth is in contact with mycorrhiza.

.2 Use mycorrhiza as recommended by manufacturer's written recommendations.

2.8 ANTI-DESICCANT

.1 Wax-like emulsion to provide film over plant surfaces reducing evaporation but permeable enough to permit transpiration.

2.9 FLAGGING TAPE

.1 Fluorescent, orange

2.10 SOURCE QUALITY CONTROL

.1 Obtain approval from Consultant of plant material prior to planting.

2.11 ADDITIONAL PLANT MATERIAL QUALIFICATIONS

.1 Plant material obtained from areas with milder climatic conditions from those of site acceptable only when moved to site prior to the breaking of buds in their original location and heeled-in, in a protected area until conditions suitable for planting.

.2 Use trees and shrubs must have been root pruned regularly, but not later than one growing season prior to arrival on site.

.3 Cold storage: written request and approval required for plant material which has been held in cold storage.

.4 Container-grown stock: acceptable if containers large enough for root development. Shrubs must have grown in container for minimum of one growing season but not longer than two. Root system must be able to "hold" soil when removed from container. Plants that have become root bound are not acceptable. Container stock must have been fertilized with slow releasing fertilizer.

.5 Balled and burlapped: coniferous and broad-leafed evergreens over 500mm. tall must be dug with soil ball. Deciduous trees in excess of 3m height must have been dug with large ball. Root balls must include 75% of fibrous and feeder root system. This excludes use of native trees grown in light sandy or rocky soil. Secure root balls with burlap and heavy twine, rope or a wire basket.

.6 Collected plant material: will not be permitted.

.7 Substitutions to plant material as indicated on planting plan not permitted unless written approval has been obtained as to type, variety and size. Plant substitutions must be of similar species and of equal size as those originally specified.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify conditions of substrate previously installed under other Sections or Contracts are acceptable for planting installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate.

.2 Inform Consultant of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 PRE-PLANTING PREPARATION

.1 Proceed only after receipt of written acceptability of plant material from Consultant.

.2 Remove damaged roots and branches from plant material.

.3 Apply anti-desiccant to conifers and deciduous trees in leaf in accordance with manufacturer's instructions.

.4 Locate and protect utility lines.

.5 Notify and acquire written acknowledgement from utility authorities before beginning excavation of planting pits for trees and shrubs.

3.3 EXCAVATION AND PREPARATION OF PLANTING BEDS

.1 Preparation of planting beds in accordance with Section 32 91 19- Topsoil and Finish Grading.

.2 For individual planting holes:

.1 Stake out location and obtain approval from Consultant prior to excavating.

.2 Excavate to depth and width as indicated. All pits and beds shall be shaped and prepared as to allow for free drainage from the excavation.

.3 Scarify subgrade surfaces sides of planting hole to a depth of 75mm in areas where planting soil will be placed to produce an even, loose textured surface, free from line weeds, stones, roots, branches and similar materials larger than 50mm.

.4 Dispose of surplus excavated materials off-site.

.5 Remove water which enters excavations prior to planting. Notify Consultant if water source is ground water.

.6 Prevent freezing of bottom of plant pits.

.7 Excavate plant pits to receive frozen root balls while soil is unfrozen, and mulch with straw to protect from freezing until trees are planted.

3.4 PLANTING

.1 Planting shall be done during periods suitable with respect to weather conditions and locally accepted practice.

.2 Handle plants carefully, supporting entire plant while moving.

.3 For bare root stock, place 75 mm backfill soil in bottom of hole.

.1 Plant trees and shrubs with roots placed straight out in hole.

.4 For jute burlapped root balls, cut away top one third of wrapping and wire basket without damaging root ball.

.1 Do not pull burlap or rope from under root ball.

.5 For container stock or root balls in non-degradable wrapping, remove entire container or wrapping without damaging root ball.

.6 Plant vertically in locations as indicated.

.1 Orient plant material to give best appearance in relation to structure, roads and walks and to the approval of Consultant.

.2 Tag specimen trees (over 75mm caliper) in the nursery and install with same north-south orientation on site

.7 For trees and shrubs:

.1 Backfill soil in 150 mm lifts.

.1 Tamp each lift to eliminate air pockets.

.2 When two thirds of depth of planting pit has been backfilled, fill remaining space with water.

.3 After water has penetrated into soil, backfill to finish grade.

.2 Form earth watering saucer at the base of each plant with a diameter as large as the excavated area.

.8 For ground covers, backfill soil evenly to finish grade and tamp to eliminate air pockets.

.9 Water plant material thoroughly.

.10 After soil settlement has occurred, fill with soil to finish grade.

.11 After plant installation, remove all labels attached by wire or cord.

3.5 TRUNK PROTECTION

.1 Install trunk protection on deciduous trees as indicated.

.1 Wrap the main stem of each tree having caliper of 50mm or greater.

.2 Apply wrapping in a spiral manner with one-half overlap, each time starting at grade and extending upwards to just above the second branches.

.3 Make sure all wrapping is neat and snug and held in place by suitable cord. All areas of contact with support systems shall be double wrapped.

.1 Install trunk protection before installation of tree supports.

3.6 TREE SUPPORTS

.1 Stake or guy all plants as shown on drawings for individual materials with all supports, guys and fasteners snug and secure

.2 Space stake equally around plant and drive into undisturbed soil beneath roots, 150 mm minimum. Ensure stake is secure, vertical and unsplit.

.3 Ensure stakes are placed on prevailing wind side.

.4 Install guying collars above branch to prevent slipping at approximately 2/3 height for evergreens and 1/2 height for deciduous trees. Collar mounting height not to exceed 2.5 m above grade.

.5 Guying collars to be of sufficient length to encircle tree plus [50] mm space for trunk clearance. Thread guy wire through collar encircling tree trunk and secure to lead wire by clamp or multi-wraps; cut wire ends close to wrap.

.6 Install flagging tape to guys as indicated.

3.7 PRUNING

.1 After tree supports have been installed, remove broken branches with clean, sharp tools. Do not prune plants except to remove dead or injured branches.

.2 Prune in such a manner as to preserve the natural character of the plants. Do not remove leaders.

3.8 MULCHING

.1 Ensure soil settlement has been corrected prior to mulching.

.2 Spread mulch as indicated.

3.9 MAINTENANCE DURING ESTABLISHMENT PERIOD

.1 Perform following maintenance operations from time of planting to acceptance by Consultant.

.1 Water to maintain soil moisture conditions for optimum establishment, growth and health of plant material without causing erosion.

.2 For evergreen plant material, water thoroughly in late fall prior to freeze-up to saturate soil around root system.

.3 Remove weeds monthly.

.4 Replace or respread damaged, missing or disturbed mulch.

.5 For non-mulched areas, cultivate as required to keep top layer of soil friable.

.6 If required to control insects, fungus and disease, use appropriate control methods in accordance with Municipal regulations. Obtain product approval from Consultant prior to application.

.7 Remove dead or broken branches from plant material.

.8 Keep trunk protection and guy wires in proper repair and adjustment.

.9 Remove and replace dead plants and plants not in healthy and vigorous growing condition. Make replacements in same manner as specified for original plantings.

3.10 MAINTENANCE DURING WARRANTY PERIOD

.1 From time of acceptance by Consultant to end of warranty period, perform following maintenance operations.

.1 Water to maintain soil moisture conditions for optimum growth and health of plant material without causing erosion.

.2 Reform damaged watering saucers.

.3 Remove weeds monthly.

.4 Replace or respread damaged, missing or disturbed mulch.

.5 For non-mulched areas, cultivate monthly to keep top layer of soil friable.

.6 If required to control insects, fungus and disease, use appropriate control methods in accordance with Municipal regulations. Obtain product approval from Consultant prior to application.

.7 Apply fertilizer in early spring as indicated by soil test.

.8 Remove dead, broken or hazardous branches from plant material.

.9 Keep trunk protection and tree supports in proper repair and adjustment.

.10 Remove trunk protection, tree supports and level watering saucers at end of warranty period.

.11 Remove and replace dead plants and plants not in healthy and vigorous growing condition. Make replacements in same manner as specified for original plantings.

.12 Submit monthly written reports to Consultant identifying:

.1 Maintenance work carried out.

.2 Development and condition of plant material.

.3 Preventative or corrective measures required which are outside Contractor's responsibility.

.2 Provide written warranty for 2 years from date of acceptance. Replace any exterior plants which in the opinion of the Consultant, are not in acceptable condition at the end of the warranty period.

.3 Any damage to plant materials from any source whatsoever shall be reported in writing to the Consultant and Owner.

3.11 CLEANING

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

3.12 CLOSEOUT ACTIVITIES

.1 Submit maintenance reports for trees, shrubs, and other plantings.

.2 Remove stakes and guys at the end of the warranty period.

END OF SECTION

1 GENERAL

1.01 SUMMARY

.1 Section includes all methods, materials and installation as required to complete the Work of this Section in accordance with the Conditions of the Contract.

.2 Work may include, but is not limited to;
.1 Perimeter foundation drainage.

1.02 REFERENCES

.1 ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).

.2 ASTM D1621 - Standard Test Method for Compressive Properties of Rigid Cellular Plastics.

.3 ASTM D3350 - Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.

.4 ASTM D4716 - Standard Test Methods for Determining the (In-PLace) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head.

.5 ASTM F449 - Standard Practice for Subsurface Installation of Corrugated Polyethylene Pipe for Agricultural Drainage or Water Table Control.

.6 ASTM F667 - Standard Specification for 3 through 24 in. Corrugated Polyethylene Pipe and Fittings.

.7 OPSS - Ontario Provincial Standard Specification.

1.03 ACTION SUBMITTALS

.1 Submit action submittals in accordance with Section 01 33 00.

.2 Product data: Submit manufacturers product data for foundation drainage including product characteristics, performance criteria, and limitations.

.3 Shop Drawings: Submit Shop Drawings as follows:
.1 Shop Drawings to illustrate layout, corner details, intersections, terminations, accessories and installation details.

1.04 DELIVERY, STORAGE, AND HANDLING

.1 Store and protect drainage material from damage.

1.05 SITE CONDITIONS

.1 Refer to sub-surface investigation report(s) to review known underground utility lines and buried objects.

2 PRODUCTS

2.01 MATERIALS

.1 Aggregate:
- .1 Foundation drainage Pipe Fill: 19 mm clear stone in accordance with OPSS 1004.
- .2 Granular fill: Free draining, sharp, hard, durable, granular material conforming to OPSS 1010, Type A.

.2 Filter fabric: Non-woven filter cloth; Terrafix Type 270R or approved equal.

.3 Drainage board: Three-dimensional dimpled core and geotextile fabric complete with adhesive or fasteners as required for installation.
- .1 Compressive strength: Minimum 525 kPa to ASTM D1621.
- .2 Flow rate: Minimum 196 L/min/m to ASTM D4716.
- .3 Basis of Design:
  - .1 Sopradrain 10-G by Soprema Inc.
  - .2 Or approved equal.

.4 Perimeter drainage:
- .1 Drainage system to consist of one of the following two options:
  - .1 Drainage Pipe: ASTM D3350 and ASTM F667, 100 mm diameter HDPE, perforated with fittings and prewrapped with filter cloth.
  - .2 Integrated drainage mat with drain: Two-layer drainage mat with transition section for connection to drainage pipes. TREMDrain Total Drain by Tremco or approved equal.
- .2 Perimeter drainage system to be complete with accessories as required for complete installation including but not limited to corner guard pieces and outlet pipe connections.

.5 Drainage pipe: ASTM D3350 and ASTM F667, 100 mm diameter HDPE pipe both unperforated with fittings, and perforated with fittings prewrapped with filter cloth, in locations as indicated on drawings or as specified herein.

.6 Clean outs: 100 mm HDPE outlets, tees, extension pipes, reducers, flush plugs, and any additional components as necessary, suitable for use with drainage pipe.

3 EXECUTION

3.01 EXAMINATION

.1 Examine and verify previously installed Work upon which this Section depends. Report defects or unsatisfactory conditions to Consultant. Commencement of work of this Section means acceptance of existing conditions.

.2 Examine existing conditions to ensure the following:
- .1 Make sure graded subgrade, sub-base, and/or base conforms with required drainage pattern before placing bedding material.
- .2 Make sure improper slopes, unstable areas, areas requiring additional compaction or other unsatisfactory conditions are corrected to approval of Consultant.
- .3 Make sure foundation wall and waterproofing have been installed and approved by Consultant before placing bedding material.

3.02 PREPARATION

.1 Cut trenches and place bedding material in uniform layers not exceeding 150 mm compacted thickness to depth as indicated.

.2 Shape bed true to grade and to provide continuous, uniform bearing surface for pipe.

.3 Shape transverse depressions, as required, to suit joints.

.4 Compact each layer full width of bed to at least 95% maximum density to ASTM D698.

.5 Fill excavation below design elevation of bottom of specified bedding with material acceptable to Consultant.

3.03 INSTALLATION OF DRAINAGE BOARD

.1 Install drainage board in accordance with ASTM F449 and manufacturer's recommendations.

.2 Drainage board shall extend full height of foundation wall to top of footing where indicated on Drawings.

.3 Install drainage board after installation of waterproofing membrane is complete. Position panel with flat side against wall and filter fabric toward soil/drainage side and attach to foundation wall using manufacturer approved fastening system.

3.04 INSTALLATION OF DRAINAGE PIPE

.1 Ensure pipe interior and coupling surfaces are clean before laying.

.2 Lay perforated pipe to minimum slope as indicated. For pipe face perforations and coupling slots downward.

.3 Lay non-perforated pipe to slope as indicated from perforated pipe to disposal area. Make joints watertight.

.4 Grade bedding to establish pipe slope.

.5 Install end plugs at ends of collector drains to protect pipe ends from damage and ingress of foreign material.

.6 Connect non-perforated pipe to drain connection by appropriate adapters manufactured for this purpose.

.7 Provide cleanouts on non-perforated pipe at changes of pipe direction and in runs greater than 15 m.

.8 Provide flush cleanouts where directed by Consultant.

.9 Connect drainage system to building storm sewers, as indicated.

3.05 GRANULAR SURROUND MATERIAL

.1 Upon completion of pipe laying and after Consultant has inspected and approved Work in place, surround and cover pipe and install geotextile filter as indicated.

.2 Hand place surround material in uniform layers not exceeding 150 mm compacted thickness, as indicated. Do not drop material on pipe.

.3 Place layers uniformly and simultaneously on each side of pipe.

.4 Compact each layer from pipe invert to mid-height of pipe to at least 95% maximum density to ASTM D698.

.5 Compact each layer from mid-height of pipe to underside of backfill to at least 90% maximum density to ASTM D698.

.6 Place low strength unshrinkable fill where compaction cannot be achieved using mechanical methods.

END OF SECTION

1. Scope of Work

1.1. General Scope of Work

1.1.1. Refer to CSSBI S17-2005 Guide Specification for Steel Building Systems and follow all noted requirements not otherwise specified herein, including but not limited to design requirements, fabrication requirements, material standards, erection standards and procedures, and shop and field quality control procedures.

1.1.2. Steel building system including all primary and secondary framing. All steel to be delivered with shop applied primer ready for field painting. Shop applied primer to CISC/CPMA Standard 2-75.

1.1.3. Anchor bolts and base plates

1.1.4. Metal Roof and Wall cladding system

1.1.5. Reinforcement and framing required to accommodate mechanical penetrations and projections; doors; windows; and curtain walls.

1.1.6. All applicable roof and wall accessories related to, and normally included to, achieve structural performance and enclosure as complete Pre Eng system.

1.1.6.1. Including but not limited to snow guards (as required and designed by professional engineer), rails, flashings, clips, brackets, gutters and rainwater leaders etc

1.1.7. Additional framing to support roof-top mechanical equipment, and and structural reinforcing as required at all roof penetrations for mechanical curbs, pipes, vents etc as indicated on mechanical and architectural drawings.

1.2. Submittals

1.2.1. Submit engineered shop drawings and design calculations prior to fabrication

1.2.1.1. General schedule of materials and material data sheets for all proposed products and materials, including insulated metal panels, primary and secondary framing materials, snow guards, gutters and downspouts, fasteners, sealants, membranes and all other components and accessories required or proposed.

1.2.1.2. Provide thermal modelling and testing data for thermal performance of roof and wall systems reflecting effective R value or U factors which account for all system components and internal system joints.

1.2.1.3. Provide drawings prepared under the supervision of and bearing the seal of a professional engineer licenced in the province of Ontario for the following:

1.2.1.3.1. Primary and secondary building framing, including base plates, connection details, fasteners, welds etc

1.2.1.3.2. Wall and roof assembly installation details including attachment methods joints, perimeter terminations, corners, and all openings and penetrations, gutters and downspouts

1.2.1.3.3. Ice and snow guard layout, and engineered anchorage.

1.2.2. Review of shop and erection drawings by Owner's Consultants does not relieve the pre-engineered building supplier of contractual and professional responsibilities with respect to the work.

1.3. Warranty

1.3.1. Repair and replace work that becomes defective or that fails during the guarantee periods specified at no additional expense to the Owner, except as stated herein.

1.3.2. The manufacturer shall warranty, for a period of 20 years from the date of installation that the finish of the roof panels will not blister, peel, crack, flake, check, chip or corrode.

1.3.3. The manufacturer shall warranty roof panel material against leaks, rupture, structural failure or perforation for a period of 20 years.

1.3.4. The manufacturer shall warranty, for a period of 20 years from date of installation, that the structural steel, roof cladding, and all metal fabrications will not corrode or rust or fail

2. **Design**

2.1. Reference Standards

2.1.1. Unless higher performance is specified, design shall provide minimum conformance with all applicable codes and standards, including but not limited to those listed below.

2.1.1.1. Ontario Building Code (latest edition with updates) including Supplementary Standard SB-10 (OBC SB-10)

2.1.1.2. CSA S478:19 Durability in Buildings

2.1.1.3. Thermal Transmittance of Insulated Sheet Steel Wall and Roof Assemblies (CSSBI B20-15)

2.1.1.4. CSA – S136 North American Specification for the Design of Cold-Formed Steel Structural Members

2.1.1.5. CISC Code of Standard Practice.

2.1.1.6. All other applicable ASTM, CISC, CSSBI, and CSA standards as outlined in CSSBI S17-2005 Guide specification for Steel Building Systems

2.1.2. Design structural steel to CAN/CSA A-S16-01

2.1.3. Design cold formed steel sections to CAN/CSA-S136-01

2.2. Minimum Qualifications

2.2.1. Fabricators shall be certified by the Canadian Welding Bureau to the requirements of CSA Standard W47.1, Division 1 or 2.1.

2.2.2. Companies performing field welding shall be certified by the Canadian Welding Bureau to the requirements of CSA Standard W47.1.

2.2.3. Erect to the CISC Code of Standard Practice

2.2.4. Building manufacturer shall be certified to CAN/CSA-A660-04 and be a member in good standing with the Canadian Sheet Steel Building Institute (CSSBI)

2.3. Project Info

2.3.1. SB-1 Location: Mississauga, Zone 5

2.3.2. Major Occupancy: A2, Use: Institutional Teaching

2.3.3. Building Area/Footprint: 860 sq.m.

2.3.4. Building Size and Configuration: See Attached Drawings

2.3.5. Construction Type: Combustible Permitted

2.3.6. Importance Category: Normal

2.4. System Description

2.4.1. Rigid frame with vertically braced bays as indicated.

2.4.2. Wall and roof system assembly: Insulated metal panels. Multiple types as specified.

2.5. Design Criteria – Enclosure

2.5.1. Spacing of rigid frames shall be as indicated on the plans

2.5.2. The minimum clear internal height shall be as indicated on the drawings

2.5.3. The main building frames shall be designed as steel moment-resisting frames.

2.5.4. Provide diagonal bracing perpendicular to main building frames, and provide portal frame bracing where required to avoid interference with required openings.

2.5.5. Design building walls and roof to allow for thermal movement of component materials caused by ambient temperate range of 75 deg C without causing buckling, failure of joint seals, undue stress on fasteners or other detrimental effects.

2.5.6. Ensure total absence of condensation on the interior surfaces under following minimum conditions

2.5.6.1. Interior 22 deg C, 40% relative humidity, still air. Exterior -40 deg C, 25 km/h wind.

2.5.7. Building shall be weather tight.

2.5.8. Provide for positive drainage to exterior of condensation occurring within wall construction and water entering at joints

2.5.9. Design building enclosure elements to accommodate, by means of expansion joints, any movement in element itself and between elements and building structure caused by structural movements without permanent distortion, damage to infills, racking of joints, breakage of seals, water penetration or glass breakage.

2.5.10. Provide sub-framing for all openings, indicated on the plans.

2.6. Performance Criteria

2.6.1. Wall and Roof assemblies to meet all applicable performance requirements in latest Ontario Building Code.

2.6.2. Ensure compliance with CSA S478:19 Durability in Buildings and as required by the Ontario Building Code. Design Service Life category for this university facility per CSA S478:19 Table 1 is 'Long Life' and shall be not less than 50 years.

2.6.3. Install materials and accessories to provide a continuous air and vapour membrane assembly having an air leakage rate not exceeding 0.20 l/sec-m2 measured at 75 Pa pressure differential in accordance with ASTM E2357

2.6.4. Provide for movement of components without causing buckling, failure of joint seals, undue stress on fasteners when subject to seasonal temperature range from -40°C (-40°F) to +50°C (120°F), and wind loads noted in the Structural Outline Specification

2.6.5. Erect to the CISC Code of Standard Practice.

2.7. Components

2.7.1. Wall System

2.7.1.1. Insulated Metal Panels

2.7.1.1.1. Basis of Design (BOD):

a. Norbec : Norex-L Series, Noroc-L (1 hour fire-rated, non combustible) where indicated
b. Or approved equivalent

2.7.1.1.2. Min. Effective R-Value for fully assembled wall, including Z-girts.Effective R-Value: 45hr·ft2·°F/Btu.

1.1.1.1.1. Air Infiltration: Provide metal panel assemblies tested per ASTM E283

a. Air leakage shall not exceed 0.01 cfm/ft2 at a static air pressure differential of 20 PSF

1.1.1.1.2. Water Penetration: Provide metal panel assemblies tested per ASTM E331:

a. Water penetration shall not be observed at the panel joint at a static pressure differential of 20 PSF

1.1.1.1.3. Insulation Type: Polyisocyanurate at non fire rated panels. Non combustible mineral wool at fire rated panels.

1.1.1.1.4. Insulation Thickness: as required to meet minimum Effective R-Value requirement.

1.1.1.1.5. Exterior Metal facing material per basis of design products specified.

1.1.1.1.6. Profile: Flat or microrib, from full range of supplier's standard options to later selection by Architect (provide min. three samples for review). Finish profile of non fire rated and fire rated panels to match.

1.1.1.1.7. Interior and Exterior Metal Facing thickness: min. 24 Ga

1.1.1.1.8. Exterior and Interior Colour and Finish: Prefinished colour selected from manufacturer's standard range using 10000 series paint system. Coil Coated Materials: Prefinished materials coated to film thickness as recommended by coating manufacturer, and designed specifically for vertical surfaces to 30° from vertical, and horizontal surfaces 5° up to 60° from horizontal, acceptable colours and materials and in accordance with ASTM A755/A755M. Exterior colour: provide for 3 colours, including: metallic silver, dark grey/black, and metallic red/orange. Interior colour: white.

1.1.1.1.9. Accessories: Provide components required for a complete wall cladding assembly including trim, copings, fascia, mullions, sills, corner units, clips, seam covers, flashings, louvers, sealants, gaskets, fillers, closure strips, and similar items; to match materials and finishes of panels.

a. Panel Fasteners: Self-drilling or self-tapping screws and other acceptable fasteners recommended by panel manufacturer. Where exposed fasteners cannot be avoided, supply corrosion-resistant fasteners with heads matching color of metal panels by factory-applied coating, with weather tight sealing washers.

b. Provide closure strips and thermal breaks to maintain weather tight construction with minimized thermal bridging as required to help achieve min. Effective R-value

c. Fire Rating: provide 1hr FRR non combustible panels for walls as noted on drawings.

2.7.2. R**oof System**

2.7.2.1. Insulated Metal Panels

2.7.2.1.1. Basis of Design:

a. Metl-Span CFR

b. Or approved equivalent

1.1.1.2. Min. Effective R-Value for fully assembled roof, including Z-girts: Effective R-Value: 45hr·ft2·°F/Btu.

1.1.1.1.10. Air Infiltration: Provide metal panel assemblies tested per ASTM E1680:

a. Air leakage shall not exceed 0.01 cfm/ft2 at a static air pressure differential of 12 PSF

1.1.1.1.11. Water Penetration: Provide metal panel assemblies tested per ASTM E1646:

a. Water penetration shall not be observed at the panel joint at a static pressure differential of 20 PSF

1.1.1.1.12. Insulation Type: Polyisocyanurate

1.1.1.1.13. Insulation Thickness: as required to meet minimum Effective R-Value requirement

1.1.1.1.14. Standing Seam Exterior Sheet Roof Panel material: per BOD products specified.

2.7.2.1.2. Interior and Exterior facing thickness: min 24 Ga

2.7.2.1.3. Exterior and Interior Colour and Finish: Prefinished colour selected from manufacturer's standard range using 10000 series paint system. Coil Coated Materials: Prefinished materials coated to film thickness as recommended by coating manufacturer, and designed specifically for vertical surfaces

to 30° from vertical, and horizontal surfaces 5° up to 60° from horizontal, acceptable colours and materials and in accordance with ASTM A755/A755M. Exterior colour: light grey. Interior colour: white.

2.7.2.1.4. Panel Fasteners: Self-drilling or self-tapping screws and other acceptable fasteners recommended by panel manufacturer. Where exposed fasteners cannot be avoided, supply corrosion-resistant fasteners with heads matching color of metal panels by factory-applied coating, with weather tight sealing washers.

2.7.2.1.5. Accessories: Provide components required for complete metal roofing system assembly including trim, copings, fasciae, corner units, ridge closures, clips, flashings, sealants, gaskets, fillers, closure strips, and integrated downspouts and eave protection; match material and finish of metal roofing system.

2.7.2.1.5.1. Roof penetrations

- Pipe penetrations
  - Seal pipe penetrations with single component polyurethane and bitumen based waterproofing coating. Soprema Alsan Flashing or equivalent. Install as per manufacturer's details, including fleece flashing reinforcement.
  - Provide flexible metal roof vent pipe flashing with flexible metal perimeter flange. Seal flange metal roof panel with butyl seal and stainless steel mechanical fasteners.
  - Fill void between roof opening and pipe with spray applied 2lb polyurethane foam insulation on interior.
  - Cover with 26ga prefinished metal flashing plate to match interior finish of IMP.
- Roof Curbs (mechanical units and roof access openings)
  - Install flanged roof curb or roof access door as per insulated metal panel manufacturer standard details and installation requirements. Field cut panel seams at upslope side of curb and crimp seams at downslope side of curb as required. Coordinate installation of roof penetration in sequence with roof panel installation to ensure all lap joints at panel to panel and panel to curb flange are facing downslope. Seal all laps with triple bead butyl tape and mechanically fasten with stainless steel pancake head fasteners.

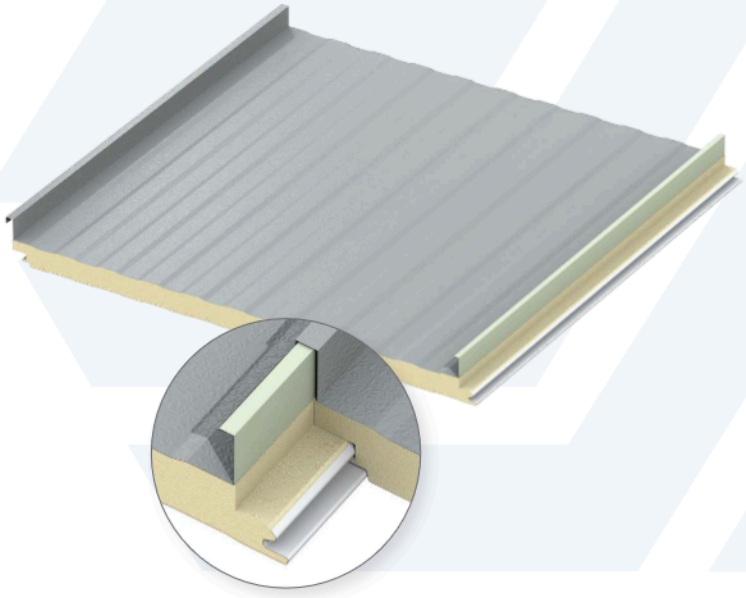
2.7.2.1.6. Snow retention system. Full engineered non penetrating standing seam snow retention system. ColourGuard by S5! Or equivalent. Provide a fully engineered complete design meeting applicable codes.

2.7.2.1.7. Rooftop equipment screen. Equipment screen by others to be secured to insulated metal roof panel standing seam using engineered standing seam clips and strut and rail system. Coordinate with other trade for imposed wind loads on standing seam system.

CFR

INSULATED METAL ROOF PANEL WITH PIR FOAM CORE

The CFR roof standing seam panels combine durable interior and exterior faces with an unsurpassed energy efficient insulated core. CFR panels can be used on roof slopes as low as ½":12" and are ideal for temperature-controlled buildings. CFR panels come with factory-cut panel ends, factory notching, and factory-swaged ends eliminating field work and erection costs. The CFR panel also has factory-installed backer plates at the endlaps eliminating pre-drilling for fasteners. Trust Metl-Span's CFR roof panel, produced using veteran knowledge and experience for the industry's best contractors.



PRODUCT SPECIFICATIONS

WIDTH	36", 42"
THICKNESS	2", 21/2", 3", 4", 5", 6"
LENGTHS	NON-DIRECTIONAL EMBOSSED 9'-6" to 53'-0"; standard *Contact Metl-Span for information and pricing on longer lengths.*
EXTERIOR PROFILE	2" high standing seam with a Mesa profile between the seams, embossed
EXTERIOR FACE	G-90 galvanized or AZ-50 aluminum-zinc coated steel in 24 and 22 Ga.; or AZ-55 aluminum-zinc coated steel with a clear acrylic coating in 24 Ga.
INTERIOR PROFILE	Mesa, nominal 1/8", deep embossed or unembossed
INTERIOR FACE	G-90 galvanized or AZ-50 aluminum-zinc coated steel in 26, 24 and 22 Ga.
CORE	Foamed-in-place, PIR Foam Core, zero ozone depleting (zero ODP) Class 1 foam
JOINT	Concealed clip mechanically seamed singlelock standing seam at the exterior side joint. The interior side joint is a single tongue-and-groove interlock.
UPLIFT PERFORMANCE	UL 90 rated, FM Approvals Standard 4471, and State of Florida Product Approval

**R-Value & U-Factor per ASTM C518 & ASTM C1363/Simulation, respectively, based on a mean temperature of 35° F*

PANEL PROFILE

U-FACTORS AND R-VALUES*

U-FACTOR (BTU/H·FT²·°F)*

PANEL WIDTH: 42"

	35°
2"	0.063
2½"	0.051
3"	0.043
4"	0.033
5"	0.026
6"	0.022

R-VALUE (H·FT²·°F/BTU)*

PANEL WIDTH: 42"

	35°
2"	17.9
2½"	22.4
3"	26.9
4"	35.9
5"	44.8
6"	53.8

DESIGN FEATURES & BENEFITS

- Weathertight vertical side seaming and installation savings with fewer side joints to seal
- Factory-cut panel ends, factory notching and factory-swaged ends eliminate field work and erection costs
- Factory-installed backer plates at the endlaps eliminate pre-drilling for special fasteners
- Installed from the top side to provide concealed clips and fasteners

Metl-Span: All-In-One Performance
700 State Hwy 121 Suite 200 | Lewisville, Texas 75067 | P: 877.585.9969 F: 972.420.9382 | metlspan.com

CFRPS_NJ/10_15_24

TESTING: CFR INSULATED METAL ROOF PANEL

TEST/APPROVAL	TEST METHOD	TEST TITLE	RESULTS
Fire US	ASTM E84	Surface Burning Characteristics of Building Materials	Flame spread <25, smoke developed <450
	ASTM E108	Standard Test Methods for Fire Tests of Roof Coverings	Passed Class A
	FM 4880	Class 1 Fire Rating of Insulated Wall, Ceiling and Roof Panels	Product approved Exterior wall requires FM 4881 approval
	NFPA 286	Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth	Test specimen met the criteria of the IBC Section 803.1.2.1
Fire Canada	CAN/ULC S102	Surface Burning Characteristics of Building Materials and Assemblies	Meets the National Building Code of Canada requirements
	CAN/ULC S107	Methods of Fire Tests of Roof Coverings	Passed Class A
Structural	ASTM E72	Standard Test Methods of Conducting Strength Tests of Panels for Building Construction	See Load Chart
	ASTM E1592	Structural Performance of Metal Roof and Siding Systems by Uniform Static Air Pressure Differences	See Load Chart
	FM 4471	Class 1 Exterior Roof Structural Performance	See FM Roof Load Chart
	UL 580	Uplift Resistance of Roof Assemblies	UL Class 90 Uplift at 5' and 7'
	UL 1897	Uplift Tests for Roof Covering Systems	Uplift Resistance of 166 psf at 5' Uplift Resistance of 140 psf at 7'
Thermal Performance	ASTM C518	Steady-State Thermal Transmission Properties by Means of the Heat-Flow Meter Apparatus	2" R= 17.9 2½" R= 22.4 3" R= 26.9 4" R= 35.9 5" R= 44.8 6" R= 53.8
	ASTM C1363	Thermal Performance of Building Materials and Envelope Assemblies	35° 2" 0.063 2½" 0.051 3" 0.043 4" 0.033 5" 0.026 6" 0.022
Air Infiltration	ASTM E1680	Rate of Air Leakage Through Exterior Metal Roof Panel Systems	<0.017 cfm/ft2 air infiltration rate at static pressure differential of 15 psf
Water Infiltration	ASTM E1646	Water Penetration of Exterior Metal Roof Panel Systems by Static Air Pressure Differences	No uncontrolled leakage when tested to a static pressure of 15 psf
	FM 4471 - Appendix G	Susceptibility to Leakage	No leakage after subjecting a multi-panel assembly to 6 in. static water head
	ASTM E2140	Standard Test Method for Water Penetration of Metal Roof Panel Systems by Static Water Pressure Head	No leakage after subjecting a multi-panel assembly to 6 in. static water head
Special Approval	State of Florida	Product Approval for the State of Florida	Product has State of Florida approval

PANEL WITH POLYISOCYANURATE (POLYURETHANE)

Norex® architectural panels are high-energy-efficient insulated panels designed for building envelopes.

SPECIFICATIONS

	NOREX-H	NOREX-L	NOREX-S
DESCRIPTION	> Horizontal & vertical mounting > Joint with concealed fasteners > Deep fluting ¾ in. (19 mm) deep or ¾ in. (19 mm) wide > Different architectural arrangements > Applications: outdoor wall	> Vertical mounting > Joint with concealed fasteners > Applications: outdoor wall, indoor ceilings > Pressure Equalized Rainscreen Joint	> Vertical mounting with straight joint > Applications: interior partitions
WIDTH [1][2]	24, 30, 36 or 41 ½ in.	36 or 42 ½ in.	44 in.
THICKNESS	3 and 4 in.	3, 4, 5, 6 and 8 in.	4 in.
R-VALUE	R 7.41 / in. (ASTM C-518 13°C - 35°C)		
LENGTH	7 to 52 ft. 3 in.		
STEEL INNER FACE	> Standard thickness – 26 Ga > Optional thickness – 24 Ga		
STEEL OUTER FACE	> Standard thickness – 22 Ga	> Standard thickness – 26, 22 Ga > Optional thickness – 24 Ga	
JOINTS			

WEIGHT [3][4]	Thickness (in.)	3	4	5	6	8
	Weight (lbs/ft²)	2.44	2.66	2.88	3.11	3.55

[1] The final module width may change due to variations in fabrication and installation. We do not recommend designing a panel arrangement in which the module width plays a critical role. [2] Product availability is subject to change without notice and minimum quantities may be required for some products configurations. For more information, please contact your local representative. [3] Panel weight for a Norex-L 42½ in. wide panel. [4] Calculations based on 26 gauge steel on both sides and an insulated density of 2.65.

APPLICATIONS

Norex panels can be found in a variety of applications including industrial and commercial buildings, cold-storage and controlled-environment buildings, sports centers, interior partitions and suspended ceilings with limited load-bearing capacity.

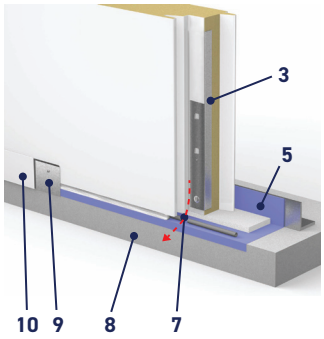
FEATURES / BENEFITS

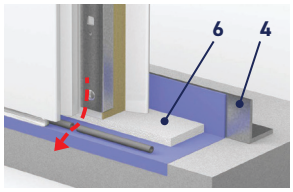
> Exclusive and superior fastening system
> Wider girt spacing reduces costs
> Fast, simple & economical installation

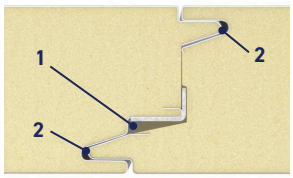
> The materials are environmentally friendly and nontoxic
> Can contribute to obtaining LEED certification for a project

> No cavities, moisture penetration, thermal bridges, risk of interstitial condensation, or lack of insulation
> Norex-L pressure-equalized rainscreen joint ensures that the building envelope is well sealed
> Factory-applied butyl joint sealer ensures maximum seal

PRESSURE-EQUALIZED RAINSCREEN JOINT







1 AIR CAVITY
2 BUTYL
3 NOREX® FASTENER
4 STRUCTURAL ANGLE
5 VAPOR BARRIER
6 POLYETHYLENE
7 WEEP HOLE
8 FOUNDATION
9 TRIM HANGER
10 TRIM

MAIN PHYSICAL PROPERTIES OF POLYISOCYANURATE

PROPERTY	METHOD	RESULTS
R Value / in. of thickness	ASTM C518	7.41
Density (lb/ft^3)	ASTM D1622	Density (pcf) 2.29 Std dev 0.01
Compressive strength (psi)	ASTMD1621	13.7 PSI (3 in. Thick Sample)
Flextural strength (psi)	ASTM C203	25 – 30
Permeability to water vapor (perms/in.)	ASTM E96/E96M	< 2,0
Water absorption (max.)	ASTM D2842	< 1.5 %
Dimensional stability (max.)	ASTM 2126	Dimensional Stability Std dev 0.2 7 day Vol Chg @ 70 °C/97 % R.H 4.3
Linear thermal dilation coefficient (in./in./°F)	ASTM D696	35.47 x 10 – 6

TESTS

	PROCEDURE	TITLE	RESULTS
FIRE CANADA	CAN/ULC-S101	Fire endurance tests of building construction and materials	Meets 10 minutes stay-in-place requirements
	CAN/ULC-S102	Surface burning characteristics of building materials and assemblies	Meets the National Building Code of Canada requirements
	CAN/ULC-S134	Fire test of exterior wall assemblies	Complies with the fire-spread and heat-flux limitations required by the National Building Code of Canada
	CAN/ULC-S138	Fire growth of insulated building panels in a full-scale room configuration	Test requirements have been met
	S-126	Fire spread under roof deck assembly	Test requirements have been met
FIRE US	ASTM E84	Surface burning characteristics of building materials	Flame spread < 25 Smoke developed < 450
	FM 4880	Class 1 fire rating of insulated wall, ceiling and roof panels	Product approved up to 6 in. thick
	NFPA 259	Standard test method for potential heat of building materials	Product tested
	NFPA 286	Standard test method for evaluating contribution of wall and ceiling interior finish to room fire growth	Test requirements have been met
	NFPA 285	Standard Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components	Test requirements have been met
STRUCTURAL	ASTM E72	Deflexion tests of panels for building construction	See Load Chart
	FM 4881	Class 1 exterior wall structural performance	See FM Wall load Chart
AIR INFILTRATION	ASTM E283	Rate of air leakage through curtain walls under specified pressure differences	Test requirements have been met
	ASTM E330	Structural performance of exterior walls by uniform static air pressure difference	Test requirements have been met
	CAN-ULC-S741	Tests methods for air barrier materials used in building applications	Test requirements have been met
	CAN-ULC-S742	Tests methods for an air barrier assembly used in applications for both low-rise and high-rise buildings	Test requirements have been met

TESTS

	PROCEDURE	TITLE	RESULTS
THERMAL PERFORMANCE	ASTM C518	Steady-sate thermal transmission properties by means of heat-flow meter apparatus	R 7.41 - Value 35/13°C k factor (W/m2 – K/m) 19.5 R 769 - Value 18/-4°C k factor (W/m2 – K/m) 18.8
	CAN/ULC-S770-09	Long term thermal resistance	Testing requirements have been met per CAN/ ULC-S704-11
WATER INFILTRATION	ASTM E331	Water penetration of exterior walls by uniform static air pressure differences	Test requirements have been met
	AAMA 501.1	Water penetration of exterior walls by dynamic air pressure	Test requirements have been met

PANEL WITH MINERAL FIBER CORE

The Noroc® architectural panel is a fire-rated, insulated panel designed for highly energy efficient buildings. The core comprises a noncombustible, rigid stone-fiber insulation board made from natural basalt rock and recycled slag. The core's natural inorganic content yields an environmentally friendly, fully recyclable panel.

NOROC®-L

SPECIFICATIONS

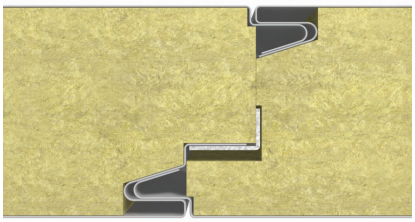
DESCRIPTION	> Vertical mounting > Joint that conceals the clip > Different architectural arrangements > Applications: exterior walls and interior partitions In addition to resisting fire and meeting hygienic requirements, Noroc products offer several applications: industrial or commercial buildings, cold storage, sports centers and more
WIDTH [1][2]	42 ½''
THICKNESS	7' to 40'
R-VALUE	5'', 6'' and 8''
MAXIMUM LENGTH	> R4/in @ mean temp 75F [5]
STEEL INNER FACE	Silkline - Grooved (coming in 2025)
STEEL OUTER FACE	Microribbed - Silkline - Grooved (coming in 2025)
JOINTS	Double tongue and groove interlocking with integrated pressure equalized rainscreen

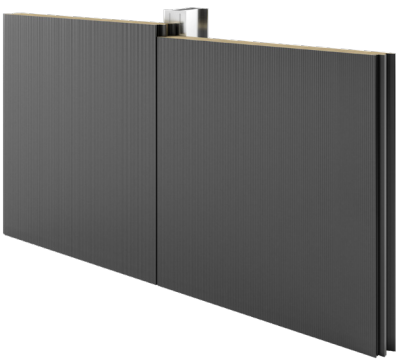
WEIGHT [3][4]

	5	6	8
26/26	5.04	5.75	7.17
24/24	5.54	6.25	7.67
22/22	6.04	6.75	8.17

CERTIFICATIONS

JOINTS





(1) The final module width may change due to variations in fabrication and installation. We do not recommend designing a panel arrangement in which the module dimension plays a critical role. (2) Panel weight for a Noroc-L 42 1/2 wide panel. (3) Data calculated using 0.019 in. thick steel and stone fiber with a density of 8.50 lb/ft3 (4) Calculations based on 26-gauge steel on both faces, with an insulated density of 2.65. (5) Results as per ASTM C518, ASTM C1363 testing and technical evaluation

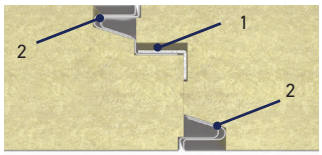
FEATURES / BENEFITS

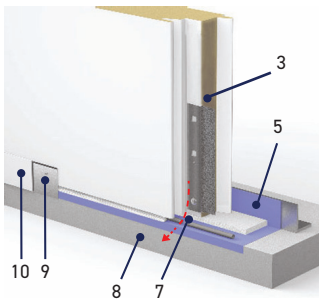
- Exclusive and superior clip system
- Wider girt spacing reduces costs
- Fast, simple & economical installation

- The materials are environmentally friendly, nontoxic & energy efficient
- Can contribute to obtaining LEED certification for a project
- Stone fiber has an ozone-depletion potential (ODP) of zero
- Noncombustible building materials with excellent fire resistant properties

- No cavities, moisture penetration, thermal bridges, risk of interstitial condensation, or lack of insulation
- Noroc® pressure-equalized rainscreen joint ensures that the building envelope is well sealed
- Factory-applied butyl joint sealer ensures maximum seal

PRESSURE EQUALIZED RAINSCREEN JOINT





1. Air cavity
2. Butyl
3. Noroc® clip
4. Structural angle
5. Vapor barrier
6. Polyethylene
7. Weep hole
8. Foundation
9. Trim hanger
10. Trim

MAIN PHYSICAL PROPERTIES OF ROCK WOOL

PROPRETY	METHOD	RESULTS
Surface burning characteristics	ASTM E84 (UL723)	FSI = 0 SDI = 0
Non-combustibility test	CAN4-S-114	Non combustible
Moisture absorption (96-h exposure to high humidity atmosphere)	ASTM C1104	0.05 % by weight
Linear shrinkage	ASTM C356	0.19%
Thermal resistance (R-value/inch @ 75 °C)	ASTM C518 (C177)	R4/in @ mean temp 75F [5]
Corrosiveness	ASTM C665	Passed
Stainless-Steel Stress Corrosion specification as per test method C871 and C692 : Nuclear regulatory Commission, Reg. Guide #1.36 : US Military Specifications MIL-I-24244 (all versions, including B and C)	ASTM C795	Conforms
Density (lb/ft^3)		8.5 lb/ft^3
Compressive strength (at 10%) (4 in. panels)	ASTM C165	6.64 PSI (45.8 KPA)

TESTS

	PROCEDURE	RESULTS
Fire – Canada	CAN/ULC-S101	5" = 60 min | 6" = 120 min | 8" = 180 min [6]
	CAN/ULC-S102	Flame spread < 25 Smoke developed < 45
	CAN/ULC-S126	Meets requirements
Fire – US	ASTM E84	Flame spread < 25 Smoke developed < 450
Structural	ASTM E72	See load tables
Air infiltration	ASTM E283	Meets requirements
	ASTM E330	Meets requirements
	CAN-ULC-S741	Meets requirements
	CAN-ULC-S742	Meets requirements
Thermal performance	ASTM C518	R4/in @ mean temp 75F [5]
Water infiltration	ASTM E331	Meets requirements
	AAMA 501.1	Meets requirements

(6) See detail ROC-IC-7.04 for installation procedures for interior partitions.