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PROJECT MANUAL

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1 General

1.1 **GENERAL**

- .1 Unless specified otherwise, instructions and requirements specified in this section shall apply to all sections of the Work.
- .2 It is the responsibility of the Contractor to direct and implement all the Work shown and specified, including construction facilities and requirements specified herein.
- .3 Work specified in the Specification has been divided into technical sections for the purpose of ready reference. Division of Work among Subcontractors and Suppliers is solely the Contractor's responsibility and Consultant assumes no liability to act as an arbiter to establish subcontract limits between sections or divisions of Work.
- .4 Do not scale Drawings. Use dimensions indicated.
- .5 The General Requirements in this section are over and above the requirements listed in the City of Toronto Master Services Agreement; wherever there is an overlap or conflict, the more stringent requirement is to be followed.

1.2 **DEFINITIONS**

- .1 Provide: This term means to Furnish, supply, Install and connect, complete and in place, including accessories, finishes, tests, and services required to render item so specified complete ready for use.
- .2 Furnish: This term means fabrication or procurement of materials, equipment, or components, or performance of services to the extent specified and shown. Where used with respect to materials, equipment, or components, the term includes crating and delivery to Project site but is not intended to include installation of item, either temporary or final.
- .3 Install: This term means placement of materials, equipment, or components, including receiving, unloading, transporting, storage, uncrating and installing, and performance of such testing and finish Work as is compatible with degree of installation specified.

1.3 **EXAMINATION OF BID DOCUMENTS**

- .1 The Contractor shall have read all the Bid Documents in conjunction with one another and Consultant shall assume that they are in agreement. Contractor shall have examined all the Bid Documents as soon as possible after receipt thereof and if he had discovered any discrepancies, omissions, errors, ambiguities or conflicts in or among the Bid Documents, or be in doubt as to their meaning or intent, shall have brought the matter to the attention of the Consultant at least four (4) Business Days prior to the date set for receiving Bids.
- .2 The Contractor shall understand and agree that where a discrepancy in Products or systems between Consultant Drawings exists, Contractor shall have allowed in its Bid for the most expensive Product or system indicated, and a Request for Information (RFI) issued to the Consultant to clarify the issue at no increase in Contract Price.
- .3 Contractor shall avoid submitting RFI's on information readily available within the Contract Documents.

1.4 **WORK OF CONTRACT**

- .1 Work of this Contract comprises the supply of all material, equipment and labour necessary for the complete construction of new works, alterations and additions and all other related Work as shown on the Contract Drawings, specified herein or both, all in accordance with the terms of the Contract.

1.5 SCHEDULING OF THE WORK

- .1 The Contractor shall be required to start work immediately upon the execution of the Contract.
- .2 The Contractor shall include all costs on account of premium time or overtime required and all costs on account of premium prices required in order to obtain labour, plant, materials or equipment or other critical items including waiting time, double handling, after hours delivery and installation, protection of new and existing services at the site in order to meet the completion dates of the scope of work and the project completion date.
- .3 The Contractor shall include all costs on account of schedule interfacing, coordination and cooperation with other Contractors or Subcontractors who will be carrying out work during the progress of this Contract in order to meet the completion date for the work and the overall completion date of the project.
- .4 The Owner will not entertain hardship claims or tolerate delays and interruptions in the work.

1.6 DRAWINGS AND INSTALLATION

- .1 The Drawings are intended to show the general character and scope of the Work and not necessarily the detail design, or exact details of the installation. Contractor shall provide all items, articles, materials, services and incidentals, including detail design with Drawings, whether or not expressly specified or shown on Drawings, to make finished Work complete and fully operational, consistent with the intent of the Contract Documents.
- .2 The Contractor shall supply and install all items of Work, goods and services that are listed or shown, or that may reasonably be inferred from the Contract Documents, as being required to produce the intended result.
- .3 The location, arrangement and connection of equipment and materials shown on the Drawings represent a close approximation to the intent and requirements of the Contract. The right is reserved by the Consultant to make reasonable changes required to accommodate conditions arising during the progress of the Work, at no extra cost to the Owner.
- .4 The location and size of existing services shown on the Drawings are based on the best available information. The Contractor shall ensure that the actual location of existing services be verified in the field before Work is commenced. Particular attention shall be paid to buried or concealed services and structures.
- .5 Changes and modifications necessary to ensure coordination and avoidance of interference and conflicts with other trades or to accommodate existing conditions, shall be the responsibility of the Contractor and made at no extra cost to the Owner.
- .6 The Contractor shall reimburse the Consultant for the latter's time spent on answering any questions or requests for information where the answer is clearly stated or shown on the Drawings or Specifications.

1.7 EXISTING CONDITIONS

- .1 In the case of renovation projects, certain new installations may be dependent upon existing conditions for support as indicated on Drawings. The Contractor shall, by way of a Site visit during Bidding period, carefully examine such existing conditions and satisfy itself as to the structural adequacy of such existing substrates. Failure to visit the site in no way relieves the Contractor from the necessity of furnishing any material, or performing any work in accordance with drawings and specifications, without additional cost to the Owner

- .2 By commencing Work in the field, Contractor implies acceptance of existing conditions.

1.8 **CULTURAL HERITAGE RESOURCES**

- .1 If cultural heritage resources (such as archaeological sites, artifacts, building and structural remains, and/or human burials) are encountered during performance of Work, contact Consultant immediately and suspend Work in immediate area until assessment has been completed by Ministry of Culture, Tourism and Recreation. Perform required measures to mitigate negative impacts on found resources to acceptance of Consultant.

1.9 **REGULATORY DOCUMENTS**

- .1 Nothing contained in the Drawings and Specifications shall be so construed as to conflict with any law, by-law or regulation of the municipal, provincial or other authorities having jurisdiction. Work shall be performed in conformity with all such laws, by-laws and regulations.

- .2 Contract forms, codes, Specifications, standards, manuals and installation, application and maintenance instructions referred to in the Specifications are to be of the latest published editions at the date of signing the Contract.

- .3 In addition to codes and standards specified in individual sections of the Specifications, comply with the latest edition of the following:

- .1 Association of Heating, Refrigeration and Air-Conditioning Engineers
- .2 American Society for Testing and Materials
- .3 Canadian Gas Association
- .4 Canadian General Standards Board
- .5 Canadian Standards Association
- .6 Illuminating Engineering Society of North America
- .7 National Building Code of Canada
- .8 National Fire Prevention Association
- .9 National Standards of Canada
- .10 Ontario Building Code
- .11 Ontario Hydro Electrical Safety Code
- .12 Ontario Ministry of the Environment and Climate Change
- .13 Ontario Ministry of Labour
- .14 Ontario Occupational Health and Safety Association
- .15 Underwriters' Laboratories of Canada

1.10 **PERMITS**

- .1 The Owner will apply and pay for the building permit. Contractor shall expedite and pick up the building permit.

1.11 **CONSTRUCTOR**

- .1 The Contractor shall be the "Constructor" as defined in the Occupational Health and Safety Act. As such, the Contractor shall be responsible for ensuring that the provisions of the statutes, regulations and by-laws pertaining to the duties, obligations, and safe performance of the Work in accordance with the obligations of the Constructor as set out in the Occupational Health and Safety Act are observed.

1.12 **MANDATORY PRE-CONSTRUCTION SITE MEETINGS**

- .1 After the tender award, the Contractor and applicable Subcontractor shall attend a pre-construction site meeting at each building address included as part of the Work.
- .2 Contractor shall bring their abatement Subcontractor to the pre-construction site meeting of buildings where abatement work is going to occur.

2 Environmental Protection

2.1 **GENERAL**

- .1 The Contractor shall be responsible for monitoring, reporting and ensuring the Work is done in compliance with the requirements of all environmental legislation and regulations governing the Place of the Project.
- .2 Protection of the environment in all aspects of the Project is of prime importance to the Owner.
- .3 Should the Contractor fail to comply with any environmental requirements when instructed, the Owner will undertake the corrective action and the costs for such corrective action shall be borne by the Contractor.
- .4 Directions given by the Owner or Consultant with respect to action to be taken to correct environmental deficiencies must be acted upon immediately.

3 Project Coordination

3.1 **GENERAL**

- .1 The Contractor shall ensure that the Contract Documents are fully coordinated with all trades involved in the Project.
- .2 The Contractor shall perform a site survey to ensure all buried, embedded, and underground pipes, conduits, power lines, elements and utilities are identified prior to beginning any demolition work both inside and outside of a building
- .3 The Contractor shall coordinate progress of the Work, progress schedules, submittals, use of Site, temporary utilities, construction facilities and construction Work, in conjunction with the progress of work of other Contractors.
- .4 The Contractor shall ensure all trades cooperate with and work together so that the Work will fit together and make a complete and satisfactory job in every detail. Ensure each Subcontractor maintains its own quality assurance program.
- .5 The Contractor shall comply with Owner's instructions for access to Owner occupied areas.
- .6 The Contractor shall coordinate with all government departments and agencies, Authorities Having Jurisdiction and utilities such as the City's Building Department, ESA, TSSA, Toronto Hydro, Enbridge Gas, but not limited to, and organize all required inspections and approvals for the completion of construction Work. It will be the full responsibility of the Contractor to ensure that all conditions of permits and approvals are met during construction Work and all permits are closed.

3.2 CONSTRUCTION ORGANIZATION AND START-UP

- .1 The Contractor shall comply with Contract requirements for staging areas of the Site; field offices and storage areas; access and parking facilities, and temporary utilities and construction facilities.
- .2 Refer to Division 00 and 01 for required staging.

3.3 WORK SEQUENCE

- .1 The Contractor shall coordinate the stages of Work to accommodate Project requirements during construction; and the sequence and direction of execution to meet Project schedule.
- .2 The Contractor shall coordinate the progress schedule with the Owner's requirements during construction.
- .3 The Contractor shall construct Work in stages or manner to provide for continuous operation of all facilities under this Contract. Do not close off public or Owner usage of any area of the Site which are not defined as part of the Contractor's work areas.
- .4 Work is not to proceed on site until all required materials are in place for each stage or area of Work, including demolition of areas and spaces. It is the Contractor's sole responsibility to ensure that material is on site prior to starting demolition or Work. No delays for supplier delivery times will be accepted.

3.4 COORDINATION AND INTERFERENCE DRAWINGS

- .1 The Contractor shall coordinate placement of materials and equipment to ensure that all components will be properly accommodated within the spaces provided prior to commencement of Work.
- .2 The Contractor shall take complete responsibility for any remedial Work that results from failure to coordinate any aspect of the Work prior to its fabrication/installation.
- .3 The Contractor shall ensure that all accesses and clearances required by jurisdictional authorities and/or for easy maintenance of equipment are provided in the layout of equipment and services.
- .4 The Contractor shall prepare interference Drawings indicating the co-relation of the architectural, mechanical, electrical, security/communications and process systems and the building structure, and review with trades at Contractor's coordination meetings. Agree with trades on proposed installation and routing of systems prior to installation. Interference Drawings shall contain information based on reviewed Shop Drawings.
- .5 The purpose of the interference Drawings coordination is to enable efficient use of available space, proper sequencing of the Work, and to resolve conflicts or interferences at no extra cost to the Owner. The Contractor shall sequence the production and review of interference Drawings in advance of the actual Work being performed to allow construction to proceed as scheduled.
- .6 The Contractor shall prepare and distribute minutes of interference coordination meetings to all parties.

3.5 CONTRACTOR'S USE OF PREMISES

- .1 The Contractor shall carry out Work in such manner as to cause a minimum of noise or interference to adjacent properties. Secure the approval of authorities having jurisdiction before proceeding with any Work which may cause interference. Provide all necessary precautions to protect existing property and people.

- .2 To ensure coordination and communication is maintained between the Contractor, Owner, and building occupants, the Contractor is required to provide an up-to-date Construction Schedule and phasing plan to the building occupants 2 weeks prior to the start of Work. Day to day operations and housekeeping rules are to be discussed and adhered to by the Contractor. Schedule and Phasing plan to be discussed with the Owner and building occupants and revised as needed prior to commencing Work. Any changes to the Schedule and Phasing Plan are to be discussed first with the Owner and building occupants.
- .3 The Contractor shall coordinate use of premises with Owner and building end users to avoid interference with the Owner's normal operations of the facility. Day to day operations and housekeeping rules are to be discussed and adhered to by the Contractor.
- .4 The Contractor shall assume full responsibility for protection and security of Products and Work under this Contract.
- .5 The Contractor shall limit operations to the prescribed areas including installation operations, storage areas and movement of vehicles and equipment.
- .6 Access and egress to and from the Site of Work areas shall be by the prescribed routes only.
- .7 The Contractor shall allow free and unrestrictive access to the Site by Owner, Consultant or his Representatives, or by any authorized person representing the Owner, and allow them to enter upon and inspect any or all parts of the Work under this Contract.

3.6 **NOISE**

- .1 Construction Work undertaken shall not contravene the requirements of local noise and pollution by-laws and all other regulatory requirements. Any construction Work that requires drilling, cutting, coring or hammering, must be undertaken after hours and/or on weekends. No additional overtime charges will be paid for the Work performed after hours and/or on weekends.

3.7 **OWNER'S OCCUPANCY**

- .1 The Contractor shall coordinate with the Owner in scheduling operations to minimize conflict and to facilitate Owner's usage.
- .2 The Contractor shall provide an emergency contact list to the Owner and building occupants.
- .3 Contractor shall allow for:
 - .1 Access for Owner's personnel
 - .2 Maintenance and use of parking facilities outside of the Contractor's areas as defined in the Contract Documents
 - .3 Owner's movement of equipment, vehicles and material
 - .4 Operation of HVAC, electrical systems and equipment

3.8 **SUPERINTENDENCE**

- .1 The Contractor shall provide the following full-time staff with responsibilities as stated below. All staff shall have relevant formal training and experience with similar Project size and complexity.
 - .1 Project Manager or Construction Manager and Site Supervisor whose responsibilities include managing all administrative aspects of the Project including administration of Contracts and changes with the Owner, the Subcontractors and Suppliers. This role will also include for administration of all Contract administration documents required by the Contract Documents including schedules, logs, reports, meeting minutes, RFI's, Site instruction, change orders, change directives, and monthly progress payment invoice. This person shall be on Site full time for the complete duration of the Project and must chair the site kick-off meeting, and the regular progress and coordination meetings. The Project Manager will be the main point of contact for the City and for the Consultant on this Project, shall maintain complete involvement, coordinate with all stakeholders (internal and external to the City) and attend regular construction progress on site bi weekly meetings.
 - .2 Site Engineer or Site Coordinator whose responsibility includes planning and coordination of the Work, review of submittals and Shop Drawings, maintaining as-built records, and assisting the Site Superintendent and Construction Manager. This person shall be on Site full time for the complete duration of the Project.
- .2 The Contractor shall provide other foremen as necessary to direct and control the Work on Site, such personnel to be well experienced, competent in their specialized fields and having full knowledge and experience in directing the Work under their charge.
- .3 In addition to the full time Superintendent that the Contractor shall place in full charge of the Work on Site, ensure that each major Subcontractor maintains a full time Superintendent to be in charge and responsible for their respective Work and who shall report to the Contractor's site superintendent.
- .4 In addition to the above, a Representative of the Contractor is required to be present when work is occurring on a building.

4 Cutting and Patching

4.1 **APPROVALS**

- .1 The Contractor shall submit written request in advance of cutting or alteration which affects:
 - .1 Structural integrity of any element of the Project.
 - .2 Integrity of weather-exposed or moisture-resistant elements.
 - .3 Efficiency, maintenance, or safety of any operational element.
 - .4 Visual qualities of sight-exposed elements.
 - .5 Work of Owner or separate Contractor.

4.2 **INSPECTION**

- .1 The Contractor shall inspect existing conditions, including elements subject to damage or movement during cutting and patching.
- .2 After uncovering, Contractor shall inspect conditions affecting performance of Work.
- .3 Beginning of cutting or patching means acceptance of existing conditions.

4.3

EXECUTION

- .1 The Contractor shall execute cutting, fitting, and patching to complete the Work.
- .2 The Contractor shall provide supports to assure structural integrity of surroundings; including devices and methods to protect other portions of the Project from damage.
- .3 The Contractor shall employ appropriate trades with skilled labour to perform cutting Work.
- .4 Cut materials using proper equipment and methods.
- .5 The Contractor shall remove and replace defective and non-conforming Work.
- .6 The Contractor shall execute Work to avoid damage to other Work.
- .7 Prepare proper surfaces to receive patching and finishing.
- .8 Fit all Work segments together to integrate with penetrations through surfaces and with other Work.
- .9 Provide openings in non-structural elements of Work for penetrations of mechanical and electrical Work.
- .10 At penetration of fire-rated wall, ceiling, or floor construction, completely seal voids with fire-rated or fire-resistant material, specified to the full thickness of the construction element.
- .11 Existing exterior walls with glazing when exposed to construction in progress must be protected by 5/8" type "X" gypsum board on suitable framing for the duration of the construction. Other openings in the existing exterior walls such as doors, louvers, etc., must be similarly protected.
- .12 Refinish surfaces to match adjacent finishes; for continuous surfaces refinish to nearest intersection; for an assembly, refinish entire unit.
- .13 Where Drawings indicate or Specifications call for items to be relocated, perform Work to the same quality of workmanship specified for new Work. Replace damaged or missing items at no extra cost to the Owner. Provide new fasteners; for exterior, use stainless steel.

5

Field Engineering

5.1

NOT USED

6

Project Meetings

6.1

ADMINISTRATIVE

- .1 The Consultant will schedule and chair bi-weekly Project meetings throughout the progress of the Work.
- .2 The Consultant will record the minutes of the meetings. Minutes to include significant proceedings and decisions and identify "action by" parties. Meeting minutes will be issued to all attendees within 42 hours after the meeting is concluded.
- .3 Representatives of Contractor, Subcontractor and Suppliers attending meetings shall be qualified and authorized to act on behalf of the party each represents.
- .4 The Contractor shall present, at each meeting, scheduled Work activities in the format acceptable to the Owner. Contractor to prepare and issue Work performance dashboards to be included in the meeting minutes.

6.2 KICK-OFF MEETING

- .1 The Consultant will arrange a kick-off meeting immediately upon award of Contract. Attendance by authorized Representatives of Owner, Consultant and Contractor is mandatory. The purpose of this meeting is to commence the Work under this Contract, to acquaint the Contractor's and Owner's designated personnel with each other, and to discuss methods and means by which full cooperation and coordination of all participants can be achieved during the execution of the Work.

6.3 SAFETY MEETING

- .1 The Contractor shall conduct safety meetings as required by the Owner and OHS.A.
- .2 Agenda may include the following:
 - .1 Safe work practices
 - .2 Accident reporting and investigations
 - .3 Health and safety inspections
 - .4 Health and safety committees
 - .5 Orientation and training
 - .6 Emergency preparedness

6.4 PROGRESS AND COORDINATION MEETINGS

- .1 The Consultant will conduct and record bi-weekly progress and coordination meetings and other extraordinary meetings as may be required from time to time by the Owner.
- .2 Agenda may include the following:
 - .1 Review, approval of minutes of previous meeting;
 - .2 Review of Work progress since previous meeting;
 - .3 Field observations, problems, conflicts and interferences
 - .4 Problems which impede construction schedule;
 - .5 Review of off-site fabrication delivery schedules;
 - .6 Corrective measures and procedures to regain Project schedule;
 - .7 Revisions to construction schedule;
 - .8 Progress, schedule, during forthcoming work period;
 - .9 Review submittal schedules; expedite as required;
 - .10 Maintenance of quality standards;
 - .11 Pending changes and substitutions;
 - .12 Review proposed changes for effect on construction schedule and on completion date;
 - .13 Other business.

- 7 Submittals
- .1 Refer to Section 01 33 00 Submittal Procedures.
- 7.2 **MONTHLY EARNED VALUE PROGRESS**
- .1 With each monthly progress claim provide an “S” curve indicating the actual earned progress compared against the planned earned progress.
- 7.3 **REQUEST FOR INFORMATION (RFI)**
- .1 Requests for Information shall be completed and submitted by the Contractor if items are not indicated on the Drawings or contained in the Project Manual that is required to properly perform the Work. RFI’s shall include a detailed written statement that indicates the specific Drawings or specification sections that require clarification.
- .2 Upon receipt of a RFI the Consultant will provide a response to the Contractor within five Business Days. Business Days are considered Monday to Friday.
- 7.4 **CONTEMPLATED CHANGE ORDERS**
- .1 The Contractor shall prepare, as a minimum, a detailed, itemized Contemplated Change Order breakdown in accordance with, but not limited to, the requirements below. Subcontractor or Material Supplier pricing shall follow the same requirements.
- .1 Labour: Include hourly wage, number of hours including overtime.
- .2 Equipment rentals: No rental charges will be allowed for hand tools, minor equipment, etc.
- .3 Materials: Material purchased by the Contractor and incorporated into the Work, showing costs, quantities or unit prices of all items, as appropriate.
- .4 Delivery charges for material or equipment.
- .5 Overhead and taxes.
- .2 The following shall *not* be included in a Contemplated Change Order breakdown:
- .1 Owned equipment costs.
- .3 The Contract Administrator or the Owner reserves the right to request reasonable additional information to support the Contemplated Change Order.
- 8 Schedules
- 8.1 **SCHEDULES REQUIRED**
- .1 Construction schedule with all tasks and critical path shown for the entire Group.
- .2 Detailed Schedules with all tasks and critical path shown.
- .3 Work schedule with workforce loading.
- .4 Submittal Schedule for System Design and Engineering, Shop Drawings, Product Data, As-Built Drawings, Operating and Maintenance Manuals, Samples.
- .5 Delineation Plan
- 8.2 **SUBMISSION**

- .1 The Contractor shall submit initial schedules within seven days after award of Contract.
- .2 Consultant and Owner will review schedule and return reviewed copy within ten (10) Business Days after receipt.
- .3 The Contractor shall resubmit finalized schedule within three days after return of reviewed copy.
- .4 Submit updated progress schedule with each application for payment and as otherwise instructed by Owner.
- .5 Distribute copies of the reviewed schedule to job Site, Subcontractors and other concerned parties.

8.3 **RESPONSIBILITY**

- .1 The Contractor shall perform overall planning and control of the Project.
- .2 Plan and schedule the Work to provide a continuous and efficient flow of the Work to achieve the Contract completion date.
- .3 The Contractor shall develop a detailed schedule as previously described, based on sequencing, phasing, and direction of installation required by the Project.
- .4 At the regular scheduling meetings, The Contractor shall report on the actual progress of each element of Work, including work of Subcontractors.
- .5 The Contractor shall report on firm established delivery and/or start dates for all critical material and equipment, of own trades and of Subcontractors. Immediate notice shall be given to the Owner of all problems or anticipated problems in respect of deliveries of critical materials or trade operations.

8.4 **CONSTRUCTION SCHEDULES**

- .1 The Contractor shall prepare and submit to the Owner a detailed schedule. Schedule shall be created using the scheduling software Microsoft Project at no extra cost to the Owner, based on sequencing, phasing, and direction of installation required by the Project.
 - .1 Prepare schedule in the form of a horizontal bar chart and with manpower loading figures based on average weekly loading.
 - .2 Provide a separate bar line for each trade or operation. Identify all tie-ins to Owner's existing facilities.
 - .3 Provide horizontal time scale identifying the first work day of each week.
 - .4 Format in chronological order of the start of each item of Work.
 - .5 Format schedules to allow plotting of actual progress against scheduled progress.
- .2 Update for progress and submit weekly or as requested by Owner.

8.5 **WEEKLY SCHEDULE WITH MANPOWER LOADING**

- .1 For weekly coordination meeting provide a detailed two-week work schedule outlining Work activities and manpower requirements (by trade) planned for that period. Update and submit weekly.
- .2 Identify problems on the past week's operation and submit proposed solutions at coordination meetings.

8.6 **SHOP DRAWINGS AND PRODUCT DATA**

- .1 Contractor's detailed schedule of Work or a separate schedule shall identify the development and submission of Shop Drawings and submission of Product data.
- .2 The Contractor shall provide Shop Drawings in the form specified and in an orderly sequence as directed by the Consultant.
- .3 The Contractor shall provide sufficient information for comprehensive review of Shop Drawings.
- .4 At the start of the Project, review the Contract Documents and compile a submittal schedule which shall include all submittals required by the Contract Documents. Coordinate the submittal schedule with the construction schedule, show all scheduled dates the submittals are to be submitted, and the latest review return date from the Consultant.
- .5 At the time of submission, the Contractor shall notify the Owner in writing of deviations in Shop Drawings from the requirements of the Contract Documents.
- .6 Shop Drawings and all other submittals to be issued to the Consultant via a browser based contract administration software such as Part3 .
 - .1 Part3 is a browser Contract Administration software the Consultant is using exclusively for the program.
 - .2 The Consultant will provide access and log information for Part3 to the Contractor prior to the start of Work.
- .7 Shop drawings and all other submittals issued in any other form outside of Part3 will not be accepted.
- .8 Upon receipt of a Shop Drawing the Consultant will provide a response to the Contractor within ten Business Days. Business days are considered Monday to Friday.
- .9 Delineation
 - .1 The Contractor shall coordinate with other contractors at the facility and arrange for delineation in time and space as required for the completion of construction Work. There could be multiple contractors performing Work at the facility. No additional/overtime charges will be paid if the construction Work is delayed because of coordination with other contractors performing Work at the facility.
 - .2 The Contractor shall develop Construction Delineation Plan and implement to ensure that delineation in both time and space is established and maintained among two or more Contractors. Additionally, ensure site coordination during construction Work activities performed at the facility and that there is only one Constructor (Contractor) at the facility at any point in time in the construction Work area.

9 Quality Control

9.1 **INSPECTION AND TESTING BY CONTRACTOR**

- .1 The Contractor shall be responsible for inspection and testing as required by the Contract Documents, statutes, regulations, by-laws, standards or codes or any other jurisdictional authority. Give the Consultant timely notice of the readiness for inspection, date and time for such inspection for attendance by the Consultant.

9.2 **INSPECTION AND TESTING BY INDEPENDENT AGENCIES**

- .1 Independent inspection/testing firms may be engaged by Owner for the purpose of inspecting and/or testing portions of Work. Cost of such services will be borne by Owner.
- .2 Employment of inspection/testing firms does not relieve the Contractor's responsibility to perform Work in accordance with Contract Documents. Defective materials and/or workmanship may be rejected, regardless of previous inspection, whenever found.
- .3 The Contractor shall provide assistance required for executing inspection and testing by the appointed firms. Allow access and facilities for inspection and testing.
- .4 If defects are revealed during inspection and/or testing, the Owner will request additional inspection and/or testing to ascertain the full degree of the defect. Correct defects and irregularities as advised by Owner at no cost to Owner. Pay costs for retesting and re-inspection.

9.3 **PROCEDURES**

- .1 The Contractor shall allow inspection/testing agencies access to the Work on the Site, at off-site manufacturing and fabrication plants.
- .2 The Contractor shall notify the appropriate agency and Owner and Consultant in advance of the requirement for tests, in order that attendance arrangements can be made.
- .3 The Contractor shall submit samples and/or materials required for testing. Submit with reasonable promptness and in an orderly sequence so as not to cause delay in the Work.

9.4 **REPORTS**

- .1 Copies of inspection and test reports will be issued to prime Contractor, Owner and Consultant.
- .2 The Contractor shall provide copies to Subcontractor of work being inspected/tested.

9.5 **EQUIPMENT/SYSTEMS**

- .1 The Contractor shall submit adjustment and balancing reports for mechanical, electrical and building equipment systems.

10 Temporary Construction Facilities and Controls

10.1 **INSTALLATION/REMOVAL**

- .1 The Contractor shall provide construction facilities and temporary controls to execute the Work expeditiously.
- .2 The Contractor shall remove from Site all such Work after use.

10.2 **GUARD RAILS, BARRICADES AND TRAFFIC CONTROL**

- .1 The Contractor shall provide secure, rigid guard railings and barricades where required for protection of Work, workers and public.
- .2 The Contractor shall provide flag-persons, traffic signals, flares, lights or lanterns as required to perform the Work and protect the public.
- .3 Provide as required by governing authorities.

10.3 **CONSTRUCTION TRAILERS AND TEMPORARY BUILDINGS**

- .1 Where applicable, Provide temporary facilities, including but not limited to washroom, locker rooms and office space. If required, move existing equipment into the temporary facility to ensure continuity of space use. Provide signage and ensure the path of travel to temporary facilities is kept clean and safe for all building occupants.
- .2 Stay within the working limits defined in the Contract Documents. If the Contractor can prove that there are additional or alternate requirements, the Contractor shall define the extent of space required for construction trailers, laydown areas, storage containers or buildings, construction access roads, etc. and submit a proposal to the Contract Administrator for review and approval.
- .3 Where not available, Provide means of storage and protection of furniture, equipment and existing Work moved or altered to facilitate construction.
- .4 Locate construction trailers, laydown areas, and temporary buildings as arranged with the stakeholders and Contract Administrator.
- .5 When temporary building facilities and/or laydown areas are no longer required, promptly remove all contractor equipment, including all construction waste, unless otherwise specified or directed. Restore all areas to conditions at start of Contract to the satisfaction of the Contract Administrator.

10.4 **HOARDING**

- .1 Contractor shall submit Shop Drawings indicating locations of hoarding, barriers, fencing and dust tight screens prior to commencement of Work. Shop drawings shall illustrate plan for maintaining clear exits during each stage of the Work. Refer to Section 02 41 19 for specific requirements for construction hoarding and dust tight screens.
- .2 Provide hoarding where required to protect the public, workers and private property from injury or damage.
- .3 Provide protection from damage for all existing trees and plants that are not indicated to be removed.
- .4 Install hoarding, fencing, barriers and dust-tight partitions to protect the parts of the building that are not under construction.
- .5 Provide alternative exits when an existing exit is closed off due to construction activities. Alternative exits must be acceptable to both the Owner and to Authorities Having Jurisdiction. All temporary exits must be clearly identified with appropriate signage.
- .6 Provide and maintain, at all times, appropriate protection to fully weatherproof areas of the facility which may become exposed due to demolition, removals, and construction. Prevent ingress of water, snow, etc., into the interior or building components. All costs for clean-up and restoration of damages resulting from failure to comply are the responsibility of the Contractor.
- .7 All Furniture, Equipment and existing Work moved or altered to facilitate construction or movement of material or equipment to be stored and protected with dust-tight covers. Storage space to be provided by the Contractor where not possible to store on site. All Furniture, Equipment and existing Work to be subsequently returned to its original location by the Contractor or be relocated as indicated on Drawings or on Furniture Schedule.
- .8 Contractor is responsible for ensuring at all times any hoarding within a building, and/or outside of a building is not obstructing or impeding any Fire Exiting routes and Emergency access routes.

.1 Contractor shall prepare a hoarding schedule for the duration of the Contract prior to start of the Work so as to not impact the Construction Schedule. Hoarding around emergency exits and emergency exit pathways is to be coordinated with the Fire Inspectors for their review and approval prior to commencement of the Work.

.9 The Contractor shall not use any areas inside or outside of a building for hoarding, storage, or activity unless with the written consent of the building stakeholder

10.5 **DUST TIGHT SCREENS**

.1 Provide dust tight screens or partitions to localize dust generating activities and for the protection of workers, finished areas of the Work and the public.

.2 Maintain and relocate protection until such Work is complete.

10.6 **ACCESS AND CONSTRUCTION PARKING**

.1 Use entrances, exits and on-Site routes as directed by Owner.

.2 Parking is not permitted on any Site. Contractor to arrange for their own parking. Comply with the Owner's requirements for daily site access.

.3 Before Contractor enters the Site with his vehicles or equipment, he shall coordinate with the Owner and appropriately barricade, stake off or snow fence the access routes and storage areas and around the construction area in order to prevent damage to buildings, grounds, plantings, turf and surrounding facilities at the Site, and to restrict unauthorized persons from entering the construction area. The Contractor shall be responsible for making good any and all damages caused by his operations on Site. Restoration of such damages shall be to the original condition or better, and to the satisfaction of, and at no extra cost to, the Owner.

.4 All construction activities must not obstruct the access roadways designated for fire department equipment. If it is necessary that existing access be obstructed or removed, alternative access, acceptable to the fire department, must be pre-planned and provided prior to commencement of construction.

10.7 **USE OF THE WORK**

.1 Confine the Work and the operations of employees to limits indicated by the Contract Documents. Do not unreasonably encumber the premises with Products.

.2 Storage of material shall be outside of the building with exception of material for each day's work requirements.

.3 Fabrication shops shall not be set up within the building except as directed by the Owner.

.4 Do not load or permit to be loaded any part of the Work with a weight or force that will endanger the Work.

.5 The Contractor shall be responsible for careful and reasonable use of any Owner-supplied water and power.

10.8 **TEMPORARY SIGNAGE**

.1 Ensure that employees and the public are informed of the Work being performed in the work area a minimum of 5 days in advance of Work commencing and that signage is installed noting the nature of Work being performed, anticipated start and end dates and any dangers that may result from the Work.

- .2 Provide temporary wayfinding signage as needed around hoarding, area and room closures, stair closures, exit closures, or otherwise as needed to ensure safe passage and exiting.
- .3 Replace existing signage as it is removed in the course of the Work with temporary signage. Replace with new signage where indicated on Drawings upon completion of the Work.
- .4 Fabricate temporary signage from corrugated plastic. Where required, add grommets for installation.

10.9 **SANITARY FACILITIES**

- .1 The Contractor shall provide weatherproof sanitary facilities as required portable, trailer type washrooms which consist of flush toilets and wash basins in accordance with local health and other authorities.
- .2 The Contractor shall maintain in clean condition.
- .3 Contractors and Subcontractors are not allowed to use the buildings existing facilities.

10.10 **WATER SUPPLY**

- .1 For water required for construction, refer to City of Toronto Master Services Agreement.

10.11 **TEMPORARY POWER AND LIGHTING**

- .1 Refer to the City of Toronto Master Services Agreement.

10.12 **EQUIPMENT/TOOL/MATERIALS STORAGE**

- .1 The Contractor shall provide and maintain, in a clean and orderly condition, lockable weatherproof sheds for storage of tools, equipment and materials. Locate as directed by Owner.
- .2 The Contractor shall locate materials not required to be stored in weatherproof sheds on Site in a manner to cause the least interference with Work activities, as directed by Owner.

10.13 **SECURITY**

- .1 Be responsible for the security of Work and material supplied, stored and installed until all Work is complete and accepted by Owner.
- .2 Any security guard patrol or service provided by Owner is for the protection of the Owner's interest in the Work on the Site, and shall not relieve the Contractor of his responsibility to protect the Work of the Contract.

10.14 **PROJECT CLEANLINESS**

- .1 The Owner reserves the right to perform clean-up Work not expeditiously completed by the Contractor and deduct such costs from the Contract Price.

10.15 **ROAD CLEAN-UP**

- .1 The Contractor shall take all precautions to avoid depositing materials, debris and mud on the Owner's roadways and parking areas and on roads and streets adjoining the Owner's property from vehicles and equipment operating to and from the construction Site, and be responsible for removal of such deposits by brooming and washing.

11 Fire and Life Safety

11.1 **SAFETY PLAN**

- .1 The Contractor shall submit to the Owner for review, prior to the Commencement date or as directed by the Owner, the following:
 - .1 The Contractor's occupational health and safety policy and procedures.
 - .2 The Contractor's site-specific safety plan and associated procedures.
 - .3 The site-specific emergency response plan listed below:
 - .1 Site-specific emergency response plan guideline.
 - .2 Emergency Response Planning for Construction Projects by the Provincial Labour-Management Health and Safety Committee.
 - .4 The site-specific traffic control plan.
 - .5 The Contractor's site orientation package.
- .2 Depending on the nature of the construction, it may be necessary to modify the fire emergency procedures. Such changes may be temporary to accommodate revised exits, modifications to the fire alarm system operation, etc., in which case the procedures must be returned to the original format at the completion of the Project. In some cases, permanent revisions to the emergency procedures are required when the construction is completed.

11.2 **TRAINING, AWARENESS AND ORIENTATION**

- .1 The Contractor shall provide the Owner, Consultant and visitors to the Site, training, awareness, orientation, or familiarization in advance of Site visit.

11.3 **FIRE PROTECTION**

- .1 The Contractor shall provide and maintain temporary fire protection equipment e.g. portable fire extinguishers, during performance of Work required by authorities having jurisdiction, governing codes, regulations and by-laws, to the satisfaction of the Owner and all local and insurance authorities in order to protect the property of the Owner and the Contractor against fire hazards during construction.
- .2 Bulk storage of flammable liquids and other hazardous materials is not allowed on the Site.
- .3 Flammable liquids must be handled in approved containers.
- .4 The bringing in, use, and disposal of gasoline, benzine or other flammable materials shall be handled with good and safe practice as required by authorities having jurisdiction.
- .5 The Contractor shall provide fire extinguishers of the non-freezing chemical type in each temporary building, enclosure, and trailer.
- .6 The Contractor shall use fire-proofed tarpaulins.
- .7 A technical representative from the fire alarm manufacturer shall be assigned to the Project to coordinate the stages of modifications and/or extensions to the fire alarm system. Whenever there is an outage of at least a portion of the fire alarm system, the Contractor must notify the municipal fire department and the building stakeholders of the temporary shutdown two weeks in advance.

- .8 A fire watch shall be required for each of the following activities regardless of the number, duration, or size of the activity in operation on a single floor:
 - .1 Any open flame activities (e.g. soldering and welding);
 - .2 Shutdown of fire detection system;
 - .3 Shutdown of sprinkler system;
 - .4 Connection to drain line.
- .9 Temporary fire separations of steel studs and gypsum board construction equivalent to a 45 minute fire resistance rating must be erected in existing corridors on occupied floor areas exposed to new corridors under construction. Where access is required, protect the opening with a solid core wood or hollow metal door with self-closing and latching hardware. If temporary fire separations cut off or eliminate the required access to exits, alternative access must be provided.

11.4 **OCCUPATIONAL HEALTH AND SAFETY**

- .1 The Contractor shall conform to safe Work practices in accordance with regulations and authorities having jurisdiction.
- .2 The Contractor shall promptly report to Owner all accidents or if any claim is made by anyone against the Contractor or Subcontractor on account of any accident.
- .3 The Contractor shall provide at the Site, equipment to supply first aid service.
- .4 The Contractor shall enforce proper Work methods and act immediately on directions regarding safety and Work practices given by authorities having jurisdiction or the Owner at no additional cost to Owner.
- .5 Failure of Contractor to comply with verbal or written instructions or orders from the Ministry of Labour inspector or other authorities as well as instructions from the Owner or Consultant regarding safe Work practices or provision of specified requirements under the act shall be considered non-compliance of the Contract.
- .6 The Contractor shall maintain on Site a copy of the latest edition of the "Occupational Health and Safety Act, Construction Projects, issued April 2009", and "Occupational Health and Safety Act, Industrial Establishments, issued October 2006".
- .7 The Contractor shall ensure that all personnel are adequately equipped to comply with safety regulations and that sufficient safety equipment is available.
- .8 Lack of equipment will not be reason for non-compliance.

11.5 **SAFETY SUPERVISOR**

- .1 The Contractor shall designate a senior employee as Contractor's safety supervisor.
 - .1 Duties will include involvement in training, instruction, planning, safety patrols, and enforcement of rules.
 - .2 The Contractor shall provide name and telephone number (site, office and residential) to Owner.
- .2 The Contractor shall ensure that a designated person is certified by IHSA (Infrastructure Health and Safety Association).

- .3 The designated safety supervisor must be familiar with Workplace Hazardous Materials Information System (WHMIS) regulations and be responsible for compliance.
- .4 The Contractor shall ensure that Controlled Products shall be properly labeled.
- .5 The Contractor shall provide proper warning labels and training at the workplace.
- .6 The Contractor shall provide copies of material safety data sheets for any controlled Product in the workplace.
- .7 The Contractor shall be responsible for all other requirements of the regulations as applicable to employers.
- .8 Before commencing any Work on the Site, The Contractor shall attend Owner's safety orientation meeting and provide Owner with a proposal as to how hazardous materials will be stored and dispensed on the Site area, in addition, specifically outline the measures which Contractor will undertake to prevent damage or injury in the event of an accidental spill.
- .9 The Contractor's "Handling Procedure" will be provided no later than ten days following the health and safety orientation meeting.

12 Material and Equipment

12.1 **PRODUCTS - GENERAL**

- .1 The Specifications may contain Product brands that form the basis of some design, and the Specifications will explicitly state so. Such "basis of design" Products are indicated as first listed item in the Product Specifications.
 - .1 Other listed manufacturers' Products are acceptable only on the condition that they comply with, or are modified as necessary, to comply with specified and indicated requirements and conform to quality levels and functional requirements of "basis of design" Product.
 - .2 Inclusion of a manufacturer's model number does not void any specified or indicated requirements.
- .2 When manufacturers' catalogued trade name and model number is specified for a Product, any specified Product will be acceptable.
- .3 When a Product is specified by reference to a standard only, any Product that meets the specified standard may be selected. Products meeting minimum reference standards will be accepted subject to the Consultant's review for compliance with the Specifications.
- .4 When a Product is specified by performance Specification without manufacturers specified, any Product meeting the requirements of the Specification may be accepted subject to Consultant's review.
- .5 Unless otherwise indicated in the Specifications, maintain uniformity of manufacture for any particular or like item throughout the Work.
- .6 Where a warranty is not specified in the specification section, the manufacturer's standard warranty shall apply.

12.2 **PRODUCT AND MATERIAL QUALITY**

- .1 Products, materials, equipment, and articles referred to as Products throughout the Specifications incorporated in the Work shall be new, not damaged or defective, and of the

best quality compatible with Specifications for the purpose intended. If requested, furnish evidence as to type, source and quality of Products provided.

- .2 Defective Products will be rejected, regardless of previous inspections. Inspection does not relieve responsibility, but is a precaution against oversight or error. Remove and replace defective Products at own expense and be responsible for delays and expenses caused by rejection.
- .3 Unless otherwise indicated in the Specifications, maintain uniformity of manufacturers for any particular or like item.

12.3 **SUBSTITUTIONS**

- .1 Refer to Section 01 62 01 Substitution Request Form.

12.4 **EXPEDITING**

- .1 Immediately after award of Contract, The Contractor shall review Product delivery requirements and anticipate foreseeable supply delays for any item. If delays in supply of Products are foreseeable, notify the Owner of such, in order that substitutions or other remedial action may be authorized in sufficient time to prevent delay in performance of Work.
- .2 In the event of failure to notify the Owner at commencement of Work and should it subsequently appear that Work may be delayed for such reason, the Owner reserves the right to substitute more readily available Products of similar character at no increase in Contract Price.
- .3 The Contractor shall utilize Canadian materials and Products if available and equivalent in price and quality.
- .4 The Contractor shall submit, when requested by Owner, an updated material procurement/expediting record clearly indicating the status of material delivery and fabrication. Particulars to be covered by this record shall include the item identification, sub-vendor, order date, order number, Shop Drawing submission date(s) and review date(s), required delivery date, promised delivery date, date received, date checked and general remarks.
- .5 The Contractor shall accumulate and submit similar records from (assigned) Subcontractors and ensure that Subcontractors are properly and frequently expediting all equipment and material to meet delivery deadlines to suit installation schedule.
- .6 Allow the Owner or their Representative free access to the Contractor's plant and to Subcontractor's plants for visual inspection of allotted material and/or progress of the Work.

12.5 **TRANSPORTATION**

- .1 The Contractor shall pay transportation costs to Site of Products required in the performance of Work.

12.6 **STORAGE, HANDLING AND PROTECTION**

- .1 The Contractor shall handle and store Products in a manner to prevent damage and deterioration.
- .2 The Contractor shall remove and replace damaged Products at own expense and to the satisfaction of Owner.

12.7 **WORKMANSHIP**

- .1 Workmanship shall be the best quality, executed by workers experienced and skilled in the respective duties for which they are employed.
- .2 The Contactor shall immediately notify the Owner if required Work is such as to make it impractical to produce required results.
- .3 Do not employ any unfit person or anyone unskilled in their required duties. The Owner reserves the right to require the dismissal from the Site of workers deemed incompetent, careless, insubordinate, or otherwise objectionable.

12.8 **CUTTING AND REMEDIAL WORK**

- .1 Refer to article - Cutting and Patching.

12.9 **FASTENINGS**

- .1 The Contractor shall provide metal fastenings and accessories in same texture, colour and finish as adjacent material unless indicated otherwise.
- .2 The Contractor shall prevent electrolytic action between dissimilar metals and materials.
- .3 The Contractor shall use non-corrosive hot dipped galvanized steel fasteners and anchors for securing exterior Work, unless stainless steel or other material is specifically requested in the affected Specification section.
- .4 Space anchors within their load limit or shear capacity and ensure that they provide positive permanent anchorage. Wood or any other organic material plugs are not acceptable.
- .5 The Contractor shall keep exposed fastenings to a minimum, space evenly and install neatly.
- .6 Fastenings which cause spalling or cracking of material to which anchorage is made are not acceptable.

12.10 **PROTECTION OF WORK**

- .1 The Contractor shall adequately protect Work completed or in progress. Work damaged or defaced due to failure in providing such protection is to be removed and replaced, or repaired, as directed by the Owner, at no increase in Contract Price.
- .2 The Contractor shall prevent overloading of any part of the Work or building. Do not cut, drill or sleeve any load bearing structural member, unless specifically indicated without written approval of the Owner.
- .3 The Contractor shall maintain and monitor protection of roofing membrane when Work is done on or above finished roofing system.

12.11 **EXISTING UTILITIES**

- .1 Connect to existing services or utilities at times directed by Owner or local governing authorities, with a minimum of disturbance to Work, building occupants, pedestrian and vehicular traffic.
- .2 The Contractor shall protect and maintain existing active services. When inactive services are encountered cap off in a manner approved by authority having jurisdiction and stake or otherwise record location of capped service.

13 Systems Demonstrations

13.1 **NOT USED**

14 Contract Closeout

14.1 **FINAL CLEANING**

.1 When the Work is substantially performed, the Contractor shall remove surplus Products, tools, construction machinery and equipment not required for the performance of the remaining Work. Final cleaning shall include, but are not limited to the following:

- .1 Remove waste materials and debris from the Site at regularly scheduled times or dispose of as directed by the Owner. Do not burn waste materials on Site, unless approved by the Owner.
- .2 Use professional cleaners for final cleaning. Use only cleaning material recommended by manufacturer of surface to be cleaned.
- .3 Provide adequate ventilation during use of volatile or noxious substances. Use of building ventilation system is not permitted for this purpose.
- .4 Schedule cleaning operations so that resulting dust, debris and other contaminants will not fall on previously cleaned surfaces
- .5 Remove dirt and broom clean, wash and sweep exterior walks, steps and paved surfaces. Leave exterior Work broom clean before the inspection process commences.
- .6 Remove dust, dirt and other foreign disfigurements from exposed surfaces.
- .7 Vacuum clean and dust building interiors, behind grilles, louvres and screens. Leave Work vacuum-clean before the inspection process commences.
- .8 Clean and polish glass, mirrors, hardware, wall tile, stainless steel, chrome, porcelain enamel, baked enamel, plastic laminate, mechanical and electrical fixtures and equipment. Replace broken, scratched or disfigured items at no extra cost to the Owner.
- .9 Remove grease, stains, spots, marks, dust and dirt from decorative Work, electrical and mechanical fixtures, furniture, fittings, and walls and floors.
- .10 Remove from building and site, snow and ice that would prevent operation and activities of the facility.

14.2 **DOCUMENTS**

.1 The Contractor shall submit close-out documents to the Consultant in electronic copy format within 45 days of the issuance of Substantial Performance. Closeout documents submissions includes, but is not limited to:

- .1 As-Built Drawings
 - .1 Two (2) sets in high quality indexed electronic format for both PDF and AutoCAD drawings that includes all a built conditions.
- .2 Notice of Project
- .3 Health & Safety Pre-start report and Policy.

- .4 Project Schedules
- .5 Warranties and bonds, including the Two-Year Warranty Certification for all Work.
- .6 Specifications
 - .1 Two (2) PDF copies of specifications with contract modifications including, but not limited to the following:
 - .2 Change Orders and Change Directives
 - .3 Addenda
 - .4 Site Instructions
- .7 Testing and inspection certificates required by municipal, provincial and other authorities having jurisdiction.
- .8 Final adjustment in cash allowances.
- .9 Product data, materials and finishes and related information.
- .10 Commissioning reports.
- .11 Substantial Performance Certificate and Advertisement
- .12 Contact List for Design and Construction Teams
- .13 Prime Consultant Final Completion Certificate.
- .2 Collect reviewed submittals and assemble documents executed by Subcontractors, Suppliers, and manufacturers.
- .3 Submit material in a neatly indexed package, prior to final application for payment.
- .4 All Warranties shall commence from date of Certificate of Substantial Performance unless indicated otherwise.
- .5 Contractor shall be responsible for obtaining and enforcing all required warranties.
- .6 Examine all sections of the Specification to ensure inclusion of all warranties specified.

14.3 **INSPECTION/TAKEOVER PROCEDURES**

- .1 Prior to application for certificate of Substantial Performance, The Contractor shall carefully inspect the Work and ensure it is complete, that major and minor construction deficiencies are complete, defects are corrected and the building is clean and in condition for occupancy. Notify the Owner in writing of satisfactory completion of the Work and request an inspection.
- .2 The Contractor shall conform to OAA/OGCA document No.100 for takeover procedures.
- .3 Consultant will allow a maximum of two final inspections for each discipline for rectifying all defects. Beyond this all additional visits will be charged to the General Contractor at a rate of \$1000.00 per visit/report per person.
- .4 During inspection by the Owner and Consultant, a list of deficiencies and defects will be tabulated. Correct within agreed time schedules.

14.4 **EQUIPMENT HANDOVER LIST**

- .1 The Contractor shall submit Equipment Handover List in accordance with Section 01 33 00, containing specific technical data for each equipment which has, or shall have, an Asset Tag number allocated. List shall include but not limited to the equipment name, quantity and equipment model.

- .2 The template format will be provided by the Owner.
End of Section

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1 **GENERAL**

- .1 This Section is intended to provide basic identification of the Work, for the Contractor to determine upfront, the nature of the Work involved in this Contract. In no way shall this section be interpreted as being a full representation of the Work of this Contract.
- .2 It is the Contractor's sole responsibility to examine the Commercial Documents, Specifications and Drawings issued to establish/determine total scope of Work.
- .3 Work of this Contract comprises of demolition and renovation to existing City of Toronto building at 95 The Esplanade, Toronto, Ontario.

2 **PROJECT SCHEDULE**

- .1 The Contractor shall submit a detailed construction schedule to the Consultant for review prior to the commencement of the Work and take into account the overall schedule timelines and phasing requirements shown on the Drawings.
- .2 The Contractor shall indicate on the construction schedule and phasing plan if the Work will impact beds moving offline during the winter months. Indicate the expected rooms affected and the number of hours/days the rooms will be out of service during construction. Provide the City a minimum of fourteen (14) working days written notice of any contemplated and/or intended interruptions to the operation of each facility.

3 **OWNER-SUPPLIED PRODUCTS**

- .1 Owner's may furnish products indicated on Drawings and schedule and may supply stored furniture to be installed by the Contractor. It will be the Contractor's responsibility to
 - .1 Confirm orders
 - .2 Receive and unload Product at site
 - .3 Schedule and coordinate deliveries of various furniture items
 - .4 Store as required
 - .5 Provide security
 - .6 Provide all required voice/data/power connections
 - .7 Clean and polish furniture

4 **DESCRIPTION OF CONTRACT**

- .1 The Contract comprises building modifications Work which consists of, but is not limited to, the following:
 - .1 Architectural scope; including but not limited to the following:
 - .1 Demolition of existing drywall partitions, concrete block/concrete walls and wall openings, doors, and frames
 - .2 Removal of floor finishes, flooring materials and bases, plumbing fixtures and millwork.
 - .3 Demolition of existing drywall ceilings and reflected ceilings and tiles

- .4 New Installations of millwork, doors and hardware, door operators and controls
- .5 New installation of floor finishes including tiles, carpets, VCT, etc., floor transitions and bases, wall finishes, and signage.
- .6 New installation of suspended ceiling and grid, gypsum board ceiling, drywall partitions,
- .7 Patching and painting
- .8 Relocating and reinstalling furniture and equipment
- .2 Mechanical scope; including but not limited to the following:
 - .1 Demolition of ductwork, plumbing fixtures including sinks, toilets, and associated accessories,
 - .2 Disconnect and reconnect domestic cold/hot water piping.
 - .3 Relocating existing mechanical equipment as indicated on Drawings.
 - .4 New installations of plumbing fixtures, and exhaust fans and associated ductwork.
 - .5 Connection to existing piping
 - .6 Testing and balancing
- .3 Electrical scope; including but not limited to the following:
 - .1 Removal of existing outlets, switches, fire alarm devices, lighting control, communication cabling, security devices, and lighting fixtures.
 - .2 Relocation of existing electrical equipment to suit the installation of new electrical equipment
 - .3 New Installation of outlets, switches, power supply to all mechanical and electrical equipment, fire alarm devices, lighting fixtures and controls

End of Section

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- 1 General
- 1.1 **GENERAL**
 - .1 Provide Work of this section in accordance with the Contract Documents.
 - .2 This section applies on projects where commissioning is performed by the General Contractor.
- 1.2 **DESCRIPTION**
 - .1 The commissioning process provides the Owner of the facility with a high level of assurance that the systems to be commissioned, including but not limited to the mechanical and electrical systems, have been installed in accordance with the Contract Documents, and operate within the design intent.
 - .2 The process does not take away or reduce the responsibility of the Design Consultants or Installing Contractors to Provide a finished Product. Commissioning is intended to enhance the quality of the system start-up and aid in the orderly transfer of beneficial use and knowledge from the Design Consultant and the Installation Contractor to the Owner.
 - .3 The General Contractor has primary responsibilities for coordinating all commissioning activities with the Consultant, Subcontractors, manufacturers and equipment Suppliers.
 - .4 The Consultant will witness and confirm that all startup commissioning and training are in general conformance with the Contract Documents.
- 1.3 **COMMISSIONING PROGRAM**
 - .1 The commissioning program is divided into four parts:
 - .1 Part 1: Verification Testing
 - .2 Part 2: Performance Testing
 - .3 Part 3: Systems Operating Manuals
 - .4 Part 4: Operator Training
- 1.4 **SUBSTANTIAL COMPLETION**
 - .1 Substantial Completion of the trades Work requires the following parts of the commissioning program to be completed and accepted by the Owner:
 - .1 Part 1: Verification Testing
 - .2 Part 4: Operator Training
 - .2 Part 2: Performance testing may begin before Substantial Completion and extend upwards of nine months minimum after Substantial Completion, based on seasonal conditions required to obtain test load conditions.
- 1.5 **ROLES AND RESPONSIBILITIES**
 - .1 Owner
 - .1 Assign maintenance and operations personnel and schedule them to participate in meetings, witnessing of demonstrations, and training.
 - .2 Designate a person(s) as an authorized acceptance authority, to sign-off and accept test reports.

- .3 Authorize the use of Owner's utilities for the commissioning process.
- .2 General Contractor
 - .1 Responsibility: primary point of responsibility to inform the Owner on the status, integration, and performance of the systems within the facility. Lead the coordination and scheduling of installation Work and commissioning Work. Ensure deficiencies are corrected.
 - .2 Scheduling: develop a coordinated commissioning schedule, including the scheduling requirements from the trade contractors conducting the commissioning. Coordinate Owner's commissioning personnel to be available at appropriate times for witnessing of tests.
 - .3 Information: collate and disseminate information to all construction team parties, including progress reports, meeting minutes, etc.
 - .4 Observation of tests: observe testing of installation and equipment and make recommendations for acceptance.
 - .5 Documentation of tests: document results of tests directly or ensure documentation is completed by trade contractors. Provide template format for tests to applicable trade contractors.
 - .6 Acceptance: determine and advise the Owner of the date of acceptance for each system and sub-system for start of the Warranty Period.
 - .7 Coordinate the Commissioning Plan with Consultant's Commissioning Agent.
- .3 Acceptance Authority
 - .1 Witness demonstration tests of equipment and systems, and have the authority to sign-off on the test forms to accept the test results.
 - .2 Coordinate and schedule additional operations and maintenance personnel to witness the test if required.
- .4 Consultant and Consultant's Commissioning Agent
 - .1 Conduct periodic construction site reviews to determine that the Work is in general conformance with the Contract Documents.
 - .2 Responsible for the system evaluation, adequacy of the system to meet design intent, capacity of the system, and review of Shop Drawings.
 - .3 Attend and participate in the systems training sessions. Provide hand-out literature to be reviewed by operations personnel as part of these sessions.
 - .4 Participate in operations staff orientation tours and final construction reviews.
 - .5 Attend initial meeting with TAB or similar testing contractor(s) to review testing methodology and acceptance criteria.
 - .6 Review verification and performance testing sheets and procedures prepared by the Installation Contractors.
 - .7 Review testing documentation for system conformance to Contract Documents. Issue a report noting deficiencies requiring corrective Work.
 - .8 Review as-built records as required to the Contract Documents.

- .9 Review and comment on the final commissioning report.
- .5 Installation Contractor
 - .1 Include requirements for submittal data, start-up and testing, O&M data, and training in each Purchase Order or Subcontract written.
 - .2 Ensure cooperation and participation of Subcontractors.
 - .3 Ensure participation of major equipment manufacturers in appropriate training and testing activities. Provide and pay for power, fuel, oil and all other necessities to perform testing and commissioning. Provide qualified personnel for video recording and editing of training sessions.
 - .4 Attend construction/commissioning coordination meetings scheduled by the General Contractor.
 - .5 Prepare schedules for systems orientation and review, O&M Manual submission, training sessions, systems testing, flushing and cleaning, equipment start-up, specialty testing, and completion of deficiency Work. Prepare schedule in MS Project. Submit schedule on agreed revision cycle, for integration into the master commissioning schedule prepared by the General Contractor.
 - .6 Provide detailed schedule and notification to the General Contractor for upcoming tests, a minimum of two weeks before the anticipated test date.
 - .7 Conduct system orientation and inspection at the equipment placement completion stage. Do not make connections to equipment until acceptance has been given by the Owner.
 - .8 Participate in, and schedule Vendors and Subcontractors to participate in the training sessions.
 - .9 Gather O&M Manuals and data on all equipment, and assemble in binders as specified.
 - .10 Shop Drawings which are to be included in the O&M Manuals, which are marked as "Reviewed" (or similar) by the Consultant or Owner, are to be marked on the front page as "ISSUED FOR MANUALS".
 - .11 Shop Drawings which are to be included in the O&M Manuals, which are marked as "Reviewed as Noted" (or similar) by the Consultant or Owner, are to be revised by the manufacturer to incorporate comments and marked on the front page as "REVISED FOR MANUALS".
 - .12 Shop Drawings which are marked as "Revised and Resubmit" (or similar) shall not be included in the O&M Manuals.
 - .13 Provide a final commissioning report as described below.
- .6 Equipment Suppliers and Miscellaneous Contractors
 - .1 Provide submittals and appropriate O&M Manuals.
 - .2 Attend initial commissioning coordination meetings scheduled by the General Contractor.
 - .3 Participate in training sessions as scheduled by the Installation Contractor.

- .4 Demonstrate performance of equipment as applicable. This includes in-season and out-of season testing depending on time of year of Substantial Completion.
- .5 Provide written and signed start-up reports and submit to the Installation Contractor.

2 Products

2.1 **GENERAL**

- .1 Refer to commissioning Specifications for affected division of the Work.

3 Execution

3.1 **COMMISSIONING PLAN AND SCHEDULE**

- .1 The General Contractor shall coordinate, develop and submit an integrated construction and commissioning schedule. Commissioning schedule and commissioning activities are to be coordinated with the Consultant and the Consultant's Commissioning Agent. Any additional site visits required by the Consultant and/or Consultant's Commissioning Agent resulting from incomplete work or corrections regarding commissioning shall be paid for by the General Contractor.
- .2 The Consultant and the Consultant's Commissioning Agent will provide a Commissioning Plan for the Contractor's use and coordination. Installation Contractors shall assist in the development and coordination of the overall commissioning schedule and plan.
 - .1 Commissioning Plan checklists and inputs for installers and sub-contractors may be hardcopy, software, app, or browser based.
 - .1 Login information for General Contractor and sub-contractors will be provided as needed.

3.2 **VERIFICATION AND PERFORMANCE TESTING**

.1 Personnel

- .1 Develop and document each commissioning test and procedure using personnel experienced in this type of Work.

.2 Test Reports

- .1 Provide a verification test report for each piece of equipment.
- .2 Provide a verification test report for each system.
- .3 Provide a performance test report for each system.
- .4 If template documents are used, modify document to suit the specific requirements of the system being tested.
- .5 Submit test reports for review to the Owner and Consultant. Each report is to be reviewed for technical depth, clarity of documentation and completeness.

.3 Safety Interlocks

- .1 Test safety or permissive interlocks in a real or closely simulated condition of failure.
- .2 Provide details of proposed method of testing each device.

- .4 As a result of initial testing results, testing plans and procedures may need to be adjusted to suit

3.3 **OPERATING AND MAINTENANCE MANUALS/SYSTEMS OPERATING MANUALS**

- .1 Provide Operating and Maintenance Manuals (O&M) in accordance with the specific requirements of each division of the Work, Section 01 10 00 General Requirements, and the General Contract requirements.
- .2 Submit the O&M Manuals for review at least two months prior to the start of operator training.

3.4 **TRAINING**

- .1 Assist in scheduling and coordinating training sessions for the operations and maintenance staff for each system.
 - .1 The General Contractor shall coordinate with the Owner and the Installation Contractor to schedule each training session.
 - .2 The Installation Contractor shall schedule training sessions with their Sub-contractors and equipment manufacturer service representatives.
- .2 Training is to be conducted in a classroom setting with the appropriate system schematics, handouts, and any audio/visual training aids on-site with the equipment. Video record the training sessions in full and submit two USB flash drives to the Design Consultant for turning over to the Owner.
- .3 The Consultant will assist the Installation Contractor with the development of training hand-outs, and in conducting training sessions with regards to system operation.
- .4 Equipment Vendors shall provide training on the specifics of each major equipment item including design intent, troubleshooting, and repair techniques.
- .5 Refer to the technical sections for specific commissioning requirements and Commissioning Plan for training details.

3.5 **RECORD DRAWINGS**

- .1 The Installation Contractor shall maintain and provide As-Built Drawings in accordance with the General Conditions of the Contract.
- .2 The General Contractor and Design Consultant shall review As-Built Contract Documents to verify incorporation of both design changes and As-Built construction details.

3.6 **ACCEPTANCE PROCEDURES**

- .1 The final acceptance procedures will be determined by the Commissioning Authority and the Owner, and will include but not be limited to the following:
 - .1 Demonstration and acceptance of systems in full automatic control.
 - .2 All I/O points individually verified for proper function, calibration, and operation. The General Contractor will audit report results and witness sufficient field tests to confirm all I/O have been tested.
 - .3 All control sequence of operation strategies have been tested, including alarm generation, graphics, remote reporting functions, and part load operation.
 - .4 All graphic display devices are operating correctly.

.5 Mass storage of retrieved data is functioning correctly.

.2 Witness Testing

.1 Request for witness testing only after already completing initial testing based on the accepted procedures and test sheet criteria. Where deficiencies are found by the Installation Contractor during these initial tests, these deficiencies will be corrected before scheduling a demonstration (witness) test.

.2 If during a witness test, a deficiency is discovered that in the opinion of the acceptance authority prevents the safe operation of the equipment or system, the test shall be abandoned. The Installation Contractor shall then correct the deficiency and reschedule the test(s).

3.7 **DEFICIENCY REVIEW AND REMEDIATION**

.1 The Consultant will conduct a deficiency review only after the Contractor submits an application for Substantial Performance. As part of this application, the Contractor shall submit their own comprehensive deficiency list of incomplete or incorrect work. Failure by the Contractor to list any deficiency does not relieve the Contractor from correcting or completing the Work.

.2 The Contractor shall correct, remedy, mitigate, or otherwise make good any and all deficient work immediately.

3.8 **FINAL COMMISSIONING REPORT**

.1 Upon completion of all four phases of the commissioning program, provide a final commissioning report for each division of the Work describing the following:

.1 General summary: a listing of each system and date of acceptance.

.2 System summary: a general description of the state of operation of each system, including any noted operating problems which were discovered and corrected during the commissioning process, as well as those problems which were discovered but were not resolved.

.3 Documentation index – document type: a table index listing all commissioning documents, arranged alphabetically by type of document (Verification Test, Performance Test, O&M, SOM, Training).

.4 Documentation index – alphabetic: a table index listing all commissioning documents, arranged alphabetically only by system name and/or equipment name.

3.9 **EXCLUSIONS**

.1 Responsibility for Construction Means and Methods

.1 The Installation Contractor is responsible for the safe operation of the equipment and systems until such time as the equipment and systems have been accepted by the Owner. Once accepted by the Owner, the Owner may require the Installation Contractor to maintain and operate the system until such time as the Owner is prepared to operate the facility, and such Work will be paid for by the Owner as a separate Contract.

.2 Hands-On Work

- .1 The Installation Contractor shall provide all services requiring tools or the use of tools to start-up, test, adjust, or otherwise bring equipment and systems into a fully operational state.
- .2 The General Contractor shall coordinate and observe these procedures (and may make minor adjustments as necessary).

End of Section

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- 1 General
 - .1 Items to be submitted for review
 - .1 Shop Drawings
 - .2 Samples
 - .3 Operating and Maintenance Manuals
 - .4 "As-Built" Drawings
 - .5 Certificates and transcripts
 - .6 Progress photographs
 - .2 Submittals MUST be accompanied by "Standard Submittal Form" with all blank spaces filled in. A copy of the form is bound into the Specifications following this section.
 - .3 Submit with reasonable promptness and in an orderly sequence so as not to cause delay in the Work. Failure to submit in adequate time is not considered sufficient reason for an extension of Contract Time and no claim for an extension by reason of such default will be allowed.
 - .4 Work affected by the submittal shall not proceed until review is complete.
 - .5 Contractor shall retain one reviewed and stamped copy of each submission on Site. Only the stamped copies shall be used on the Work.
- 2 Shop Drawings
 - 2.1 **GENERAL**
 - .1 The term "Shop Drawing" means Drawings, diagrams, illustrations, schedules, performance charts, brochures and other Work data which are to be provided by the Contractor to illustrate details of a portion of the Work.
 - .2 The Contractor shall arrange for the preparation of clearly identified Shop Drawings as called for by the Contract Documents or as the Consultant may reasonably request.
 - .3 Prior to submission to the Consultant, the Contractor shall review and stamp all Shop Drawings. By this review the Contractor represents that he has determined and verified all field measurements, field construction criteria, materials, catalogue numbers and similar data and that he has checked and coordinated each Shop Drawing with the requirements of the Work and of the Contract Documents. The Contractor's review of each Shop Drawing shall be indicated by stamp, date, and signature of a responsible person.
 - .4 Submittals not stamped, signed, dated and identified as to the specific Contract requirements may be returned without being examined and shall be considered rejected.
 - .5 The Contractor shall submit Shop Drawings to the Consultant for his review with reasonable promptness and in orderly sequence so as to cause no delay in the Work or in the work of other Contractors. If either the Contractor or the Consultant so requests they shall jointly prepare a schedule fixing the dates for submission and return of Shop Drawings. At the time of submission the Contractor shall notify the Consultant in writing of any deviations in the Shop Drawings from the requirements of the Contract Documents.

- .6 The Consultant will review and return Shop Drawings in accordance with schedule agreed upon, or otherwise with reasonable promptness so as to cause no delay. The Consultant's review will be for conformity to the design concept and for general arrangement only and such review shall not relieve the Contractor of responsibility for errors or omissions in the Shop Drawings or of responsibility for meeting all requirements of the Contract Documents unless a deviation on the Shop Drawings has been approved in writing by the Consultant.
- .7 The Contractor shall make any changes in Shop Drawings which the Consultant may require consistent with the Contract Documents and resubmit unless otherwise directed by the Consultant. When resubmitting, the Contractor shall notify the Consultant in writing of any revisions other than those requested by the Consultant.
- .8 The Contractor shall secure from all his Subcontractors and material Suppliers, uniform size Shop Drawings showing the construction materials, etc., or as required and upon which the respective Bids have been based.
- .9 Shop Drawings shall define the division of responsibility between the trades, and all items shown on the Shop Drawings shall be supplied as part of the Contract unless it is specifically noted that certain items are not part of the Contract.
- .10 Any work done before receiving the Consultant's final review of the Shop Drawings shall be at the Contractor's risk.

2.2 SHOP DRAWINGS IDENTIFICATION

- .1 An electronic stamp will be sized and placed to fit on each Shop Drawing:



<p>The review of this Shop Drawing is solely for the limited purpose of checking general conformance with the general design concept and general arrangement only. This review does not constitute approval or verification of the design inherent in the Shop Drawings, and any omissions or errors therein remain the responsibility of the Contractor. The Contractor remains entirely responsible for complying with the Contract Documents, confirming all field dimensions and site conditions, for information that pertains to fabrication, techniques of construction and installation, and coordination of the Work.</p>			
Reviewed	Reviewed As Noted	Revise & Resubmit	Not Reviewed
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Reviewed By:		Date:	

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2.3 REPRODUCTION OF ENGINEERING DRAWINGS

- .1 Reproduction of the engineering Drawings, to serve as background or reference for Shop Drawings, will be permitted. Cost of reproduction shall be based on the number of electronic Drawing files as indicated below, and shall be paid for by the Contractor in accordance with rates indicated below. Rates are exclusive of HST. The Consultant will prepare the files by removing logos, seals and other identification or reference to the Owner or Consultant, checking all reference files and removing unnecessary external references, and packaging files for release. Any identification or reference to the Owner or Consultant is to be removed from all Drawings that are used by the Contractor for this Contract. Costs incurred for the reproduction of engineering Drawings shall be paid by the Contractor directly to the Consultant.

- .1 One to ten files: \$1,000.00

- .2 Eleven to twenty files: \$1,900.00
 - .3 Twenty-one to fifty files: \$4,500.00
 - .4 Fifty-one to one hundred files: \$8,000.00
 - .5 More than one hundred files: \$75 rate per file, plus \$500.00 administration fee
 - .6 The submission of a copy of the Consultant's Drawings as a Shop Drawing without additional detailed installation, fabrication or Product information added is not an acceptable form of submittal and is grounds for automatic rejection.
- .2 Prior to the release of digital or electronic files, the Consultant will issue to the Contractor the Digital Transfer Agreement form attached to the end of this section.
- .1 The Contractor shall review and return to the Consultant an electronic copy of the agreement with the Contractor's signature.
 - .2 By this review and signing of the agreement, the Contractor has acknowledged and agreed to the terms contained within the Digital Transfer Agreement.
 - .3 The Consultant will not release digital files to the Contractor until the agreement is signed and executed. The Consultant will retain an executed copy of the Digital Transfer Agreement.

2.4 **SUBMITTAL SYSTEM - GENERAL**

- .1 Submit Portable Data Files (PDF's) of fully detailed and dimensioned Shop Drawings of the Work.
- .2 Shop Drawings will be returned to the Contractor stamped and marked "REVIEWED", or "REVIEWED AS NOTED", or "REVISE & RESUBMIT" or " NOT REVIEWED". These stamps are defined as follows:

Stamp	Meaning
REVIEWED	Drawings reviewed without comments. Proceed with construction
REVIEWED AS NOTED	Incorporate corrections or comments and proceed with construction. No other alterations are to be made to the Drawings by the Contractor subsequent to receipt of Drawings stamped and marked as above. If further changes are made in addition to the Consultant's notations, then the Drawings must be resubmitted for further review.
REVISE & RESUBMIT	Revise Drawing in accordance with corrections or comments and re-submit to the Engineer for further review
NOT REVIEWED	Drawing does not require Engineer's review

- .3 Shop Drawing numbering shall be in numerical sequence beginning with the specification Section number followed by "001". If a revision is submitted it shall be followed up in sequence beginning with ".R1". See below table for example:

Section 02 41 19	Selective Structure Demolition
02 41 19.001	Demolition Plan

02 41 19.001.R1	Demolition Plan
02 41 19.002	Conflict with Buried Fiber Cable

- .4 Coordinate Shop Drawing file sizes with Consultant in advance of submittal. Generally, submit up to 10 megabytes file size only.
- .5 Drawings shall be blackline as much as possible to obtain good resolution when printed.
- .6 Consultant may mark up the Shop Drawings electronically or may print and mark up manually.
- .7 A copy of Shop Drawings with Consultant's comments in colour and shall be emailed back to the Contractor or posted on a File Transfer Protocol (ftp) site or project website, if such site exists. The Consultant will retain on its electronic folder, a PDF copy of Shop Drawings returned to the Contractor. Original marked up hardcopy if applicable will also be retained by the Consultant.

2.5 **SUBMITTAL SYSTEM**

- .1 Shop Drawings shall be submitted in electronic format for obtaining reviews from the Consultant.
- .2 Electronic submittals shall be uploaded by the Contractor in PDF format. Any other format will result in delays in the review of submittals.
- .3 Contractor shall electronically notify various people of each submittal according to a communications plan determined at the beginning of the Work.
- .4 Consultant will apply the review stamp to the submittals and upload a PDF version of the reviewed Drawings complete with comments. Consultant will return submittals and will be named to align as closely as possible.
- .5 Consultant will electronically notify the various parties of a reviewed submittal as determined at the beginning of the Work in the communications plan.
- .6 Contractor shall download "Reviewed" submittal and print out the files in order to obtain the Consultant's review comments.
- .7 Contractor is responsible for opening and checking all documents and shall confirm the following and if there are any discrepancies, the Contractor shall contact the Consultant immediately.
 - .1 That the files contained have been correctly transmitted.
 - .2 That the transmittal sheet accurately lists the files that were sent.
 - .3 That the files match-up with files previously submitted by the Contractor to the Consultant.

2.6 **INFORMATION REQUIRED**

- .1 Indicate materials, methods of construction and attachment or anchorage, erection diagrams, connections, explanatory notes and other information requested in the individual Specification sections or as necessary for completion of Work. Where articles or equipment attach or connect to other articles or equipment, indicate that such items have been coordinated, regardless of the section under which the adjacent items will be supplied and installed. Indicate cross references to design Drawings and Specifications.

- .2 Where a submittal relates to door schedule(s), submittal MUST be cross referenced to the door schedule(s) indicating door number and type. Non-compliance will result in the rejection of Shop Drawing.

- .3 All submittals shall be clearly drawn with CAD or typewritten to be legible.

2.7 **ENGINEER'S STAMP AND SIGNATURE**

- .1 Shop Drawings of components, apparatus and equipment which are designed by the Contractor shall bear the stamp and signature of an Engineer licensed to practice in the Province of Ontario in accordance with the Ontario Building Code and the Professional Engineer's Act.

2.8 **CHANGES**

- .1 Adjustments made on Shop Drawings by the Consultant are not intended to change the Contract Price. If adjustments affect the value of Work, state such in writing to the Consultant prior to proceeding with the Work.
- .2 Make changes in Shop Drawings as the Consultant may require and which are consistent with Contract Documents. When resubmitting, notify the Consultant in writing of any revisions other than those requested by the latter.

2.9 **UNITS OF MEASUREMENT**

- .1 Shop Drawings shall show weights and dimensions in either metric (S.I. units) or Imperial units, consistent with the Consultant's Drawings and Specifications.

2.10 **MISCELLANEOUS**

- .1 Fabrication shall not proceed until Drawings have been reviewed, unless other authorization is granted in writing by the Consultant.
- .2 The Contractor and each Subcontractor is expected to operate as an expert in his respective field. The Contractor shall save Owner and Consultant harmless from any defect resulting from failure in this regard including cost of remedial action necessary before or after completion of the Work.
- .3 Drawings shall be prepared specifically for the Work.

2.11 **RECORD SUBMISSIONS**

- .1 Record purpose submissions for:
 - .1 Piping specialties.
 - .2 Valves.
 - .3 Any inspection certificate/report submitted by authorities shall be stamped "FOR RECORD PURPOSES ONLY".
 - .4 For each size or model as applicable for equipment, submit two copies or one copy on a USB drive, scanned file copies in Adobe Acrobat Version 9 or later.

2.12 **SUBMISSIONS TO AUTHORITIES HAVING JURISDICTION**

- .1 Contact authorities having jurisdiction over the Place of Work for required list of submissions for their review.

- .2 All detailed design Drawings or other submittals required to be submitted to the authority for approval shall be prepared, submitted, and paid for by the Contractor.

2.13 **BROCHURES**

- .1 Submit two copies of Product data sheets or brochures, or one copy on a USB drive, scanned file copies in Adobe Acrobat Version 9 or later. Data sheets or brochures are for requirements requested in Specification sections and as the Consultant may reasonably request where customized Shop Drawings will not be prepared due to standardized manufacture of Product.
- .2 Brochures or Drawings of standard production equipment shall be for one size or model and include all performance data and characteristic curves for such equipment.
- .3 Wiring diagrams and schematics shall accompany Shop Drawings for all equipment which have electrical controls furnished with the equipment.

3 Samples

3.1 **SAMPLES**

- .1 Submit for review all samples as requested in the respective Specification sections. Label samples as to origin and intended use in the Work.
- .2 Deliver samples prepaid to Consultant's business address, unless otherwise approved by Consultant. Large, heavy items such as concrete block samples may be reviewed on site if arranged in advance with the Consultant.
- .3 Notify the Consultant in writing at the time of submission, of deviations in samples from requirements of Contract Documents.
- .4 Adjustments made on samples by the Consultant are not intended to change the Contract Price. If such adjustments affect the value of Work, state such in writing to the Consultant prior to proceeding with the Work.
- .5 Make changes in samples which the Consultant may require consistent with the Contract Documents.

4 Building, Operating and Maintenance Manuals

4.1 **BINDERS**

- .1 Binders: Commercial quality, 260 mm x 295 mm; hard covered, jacketed, "D" ring style with 3 rings in size to suit binder thickness.
- .2 Covers: Identify each binder with typed or printed title "Building, Operating and Maintenance Manuals"; list title of Project, Owner, and date of manual submission.
- .3 Organize contents into applicable categories of Work, parallel to Specification sections. When only one volume is required, include a complete index. Where more than one volume is required, include a complete index of all volumes and each succeeding volume shall contain an index of its own contents.
 - .1 Provide tabbed fly leaf for each category of Work, with typed description of Product and major component parts of equipment.

- .2 Include names, addresses, telephone number and general email address of Contractor with names of responsible parties; schedule of Products and systems, indexed to content of the volume.
- .3 For each Product or system, list names, addresses, telephone numbers and general email address of Subcontractors and Suppliers who can effect repair or maintenance on equipment, including local source of supplies and replacement parts.
- .4 Product data: organize to parallel Project Manual breakdown. Mark each sheet to clearly identify specific Products and component parts and data applicable to installation; delete inapplicable information. Supplement Product data to illustrate relationships of component parts of equipment and systems to show control and flow diagrams
- .5 Typed text information: Provide as required to supplement Product data. Provide logical sequence of instructions for each procedure incorporating manufacturer's instructions.
- .6 For test information, manufacturer's printed data or typewritten data is required.
- .7 For Drawings, provide appropriate reinforced binder tabs and bind in with text; fold larger sheets.

4.2 **BUILDING MANUALS**

- .1 For building Products, applied materials and finishes include:
 - .1 Product data with catalogue number, size, composition and colour and texture designations.
 - .2 Maintenance instructions for finished surfaces and materials.
 - .3 Copy of finish hardware and paint schedules.
 - .4 Spare materials for maintenance purposes as listed in various technical sections.
 - .5 Provide information for reordering custom manufactured Products.
- .2 Include instructions for cleaning agents methods and recommended schedule for cleaning and maintenance, include precautionary information against detrimental agents and proper methods.
- .3 Additional requirements: Include as specified in individual Specification sections.

4.3 **OPERATING AND MAINTENANCE MANUALS**

- .1 Submit one (1) set of final hardcopy maintenance, operating and instruction manuals and two (2) sets in high quality indexed electronic PDF format (USB) to the Owner no later than thirty (30) business days after the certificate of completion is issued.
- .2 Manuals are to contain operational information on equipment, cleaning and lubrication schedules e.g. filters, overhaul and adjustment schedules and similar maintenance information. Give equipment function, normal operation characteristics and limiting conditions. Include performance curves, with engineering data and tests, and complete nomenclature and commercial number of replaceable parts.

- .3 Instructions shall be in such form and language so as to facilitate the Owner in the proper operation and maintenance of building systems.
- .4 In addition to information specified, include the following:
 - .1 Final Shop Drawings and Product data of equipment.
 - .2 Record Drawings of mechanical and electrical installations.
 - .3 Full description of building systems and operations.
 - .4 Operating procedure: include start up, break-in, and routing normal operating instructions and sequences. Include regulation, control, stopping, shut-down, and emergency instructions. Include summer, winter and any special operating instructions.
 - .5 Controls and operating sequences; wiring diagram of control panels.
 - .6 Schematic diagram of pneumatic, electrical, oil and/or gas systems.
 - .7 Non-dimensional layout showing locations of all electrical devices on mechanical equipment.
 - .8 Complete parts list of assemblies showing manufacturer's names, addresses, nearest replacement sources and telephone numbers.
 - .9 List of recommended spare parts and quantity of each item to be stocked.
 - .10 Maintenance requirements: include preventative requirements; routine procedures and guide for troubleshooting; disassembly, repair, and reassembly instructions and alignment, balancing and checking instructions.
 - .11 Manufacturer's warranties.
 - .12 Lubricating instructions, list of lubricants and recommended cycle of lubrication.
 - .13 Manufacturer's certified reports.
 - .14 Field testing and commissioning reports.
 - .15 Factory test reports.
 - .16 Sequence of controls operation and control diagrams.
 - .17 Contractor's coordination Drawings with installed colour coded piping diagrams.
 - .18 Original manufacturer's parts list, illustrations, assembly Drawings and diagrams required for maintenance.
 - .19 List of original manufacturer's spare parts, current prices and recommended quantities to be maintained in storage.
 - .20 Additional requirements: Provide as specified in individual Specifications sections.
- .5 Requirements specified apply to component parts of equipment whether they are manufactured by Supplier of equipment or are supplied as a component part of an item of equipment.

4.4 **SUBMITTAL OF MANUALS**

- .1 Two weeks prior to anticipated date of Substantial Performance, submit to Consultant one hardcopy and one USB drive of completed manuals in final form.
 - .1 Copy will be returned with Consultant's comments.
 - .2 Revise contents of manuals as required prior to final submittal.
 - .3 Submit two copies of revised manuals in final form within 14 days before Substantial Performance.
 - .4 USB shall contain PDF file copies in Adobe Acrobat Version 9 or later version, of all Building, Operating and Maintenance Manuals. Provide a file for each document, with bookmarking reference for each chapter or section in the document.

5 As-Builts

5.1 **AS-BUILT DRAWINGS**

- .1 Provide at own cost, additional sets of Drawing prints for use in maintaining "As-Built" information.
- .2 Be responsible for creating "As-Builts" from field data collected during the course of the Project. Neatly record complete with legible dimensions and notes.
- .3 "As-Built" Drawings are those prepared by the Contractor as it constructs the Project and upon which it documents the actual locations of the building components and changes to the original Contract Documents.
- .4 Field data is defined as information that is not available from the Contract Documents, addenda, Change Orders, or Site instructions. It is of importance that the Contractor record on the "As-Builts" all field information relating to concealed conditions.
- .5 "As-Built" information MUST have a high degree of accuracy in all respects.
- .6 Recording must be done on the same day that deviation is made to ensure that important information is not missed from the "As-Builts".
- .7 Hand-mark all recording using red ink. "Clouded" method is unacceptable and "As-Builts" showing such method will be returned to the Contractor.
- .8 Identify as "Project As-Built Copy". Maintain in good condition; clean, dry and legible, and make available for inspection on Site by Consultant at all times.
- .9 Upon completion of the Work and prior to final inspection, submit a clean and legible copy of "As-Built" Drawings to Consultant.

5.2 **PROGRESS PHOTOGRAPHS**

- .1 On commencement of the Work and at every two-week interval thereafter, supply the Consultant with minimum twelve digital colour photographs, taken from different views, indicating status and progress of the Work by each section of Work. Indicate date photograph was taken with appropriate description and email to the Consultant or upload to FTP site or project website, where the latter exists.
- .2 Maintain a binder on site with 4 x 6 photographs for easy reference.

End of Section

Digital Transfer Agreement

This Digital Transfer Agreement (the “**Agreement**”) is made as of **[Month, Day, Year]**, between **[Insert Client Name]** and **[Insert correct Arcadis entity legal name]** as provided below:

**[Insert Recipient Name
Office Address
City, Province/State, Country
Postal/ZIP Code]**

and

[Insert correct Arcadis entity name and address.]

the “**Recipient**”

the “**Consultant**”

The Consultant and the Recipient are providing services for the **[insert project name and brief description]** (the “**Project**”). The Recipient and Consultant wish to enter into this Agreement whereby the Consultant will provide digital documents to the Recipient to assist the Recipient in carrying out its Project-related services.

NOW THEREFORE, in consideration for being given access to information that is confidential and proprietary, and for other good and valuable consideration the receipt and sufficiency of which are hereby acknowledged, the parties hereby agree and covenant as follows:

Section 1 – Transfer of Files

- 1.01 The Consultant will, following execution of this Agreement **[and payment to Consultant by the Recipient of \$X]**, transfer to the Recipient the digital files listed at *Schedule 1 – Digital Files* (the “**Files**”). By separate amendment executed by both parties hereto, the parties may agree to transfer additional Files to be included in additional schedules in the form attached hereto at Schedule 2.
- 1.02 The Recipient acknowledges and agrees that it:
- (a) may use the Files, and any portion or component thereof, only for its own use in relation to the Project, and only for the following express purposes:
 - (i) **[background on which to prepare design, shop or other drawings and other submittals]**
 - (ii) **[3D coordination / clash detection / schedule simulation (4D)]**
 - (iii) **[take offs / quantity estimates of specific items (list)]**
 - (iv) **[fabrication / procurement of components]**
 - (v) **[integration with Geographic Information System (GIS) or Asset Management System]**
 - (vi) **[insert other]**
 - (b) may not transfer, forward, sell, trade, distribute, or permit access to, the Files, to any third party, including without limitation Project contractors, subcontractors, consultants and sub consultants, unless the Consultant has expressly agreed to such transfer in writing, it being understood that such agreement will not be forthcoming from the Consultant unless and until such proposed third party has executed a digital transfer agreement similar to the terms contained herein in favour of the Consultant; and
 - (c) may not alter, modify, amend or change in any manner the contents of Files, or separate any content, schedules, materials, wall types or legends which are included as elements within the Files, or in any portion of the Files.

Section 2 – Liability of Consultant and Recipient Indemnity

- 2.01 The parties agree that the Consultant is not responsible for, and does not warrant or guarantee the accuracy, correctness or completeness of, the Files or the data contained therein, including without limitation any reference notes to “as-built” or similar. The Consultant offers no assurances that the information in the Files is reflective of previous contract or as-built conditions, and disclaims all responsibility for the accuracy or use of the data contained within the Files.
- 2.02 The Recipient agrees to verify and check all information contained within the Files and acknowledges it is solely responsible for fully ascertaining all site conditions and measurements relevant to its Project deliverables..
- 2.03 The Recipient agrees to waive any and all actions, claims, demands, proceedings, charges, fines, sanctions, penalties, damages, losses, consequential losses, damages related to loss of use, loss of profit, loss of opportunity, loss income or diminution of property value and the like, and costs and expenses (including legal and other professional fees) of whatsoever nature or kind (together “Claims and Damages”), that the Recipient, the entity procuring the Project and any third party involved in the Project, and each of their respective employees and agents (together “Project Parties”) may suffer, on any theory of liability, whether in contract, strict liability, tort, negligence, or otherwise (as against the Consultant), which arise out of or result from the Recipient’s use of or reliance on the Files or use of or reliance of the Files by the Recipient’s third party recipient, whether or not authorized as permitted hereunder.
- 2.03 The Recipient agrees to indemnify, defend and hold harmless the Consultant, and each of its related and affiliated companies, their officers, directors, unit holders, partners, associates, and employees (together “Consultant Indemnified Parties”) from and against any and all Claims and Damages suffered by any Consultant Indemnified Party, arising out of, in connection with, or result from use of the Files by the Recipient or its representatives.

Section 3 – Consultant Retention of Rights

- 3.01 The Consultant retains all common law, statutory law and other intellectual property rights relating to the Files and the data contained therein, including, but not limited to, title, copyright, industrial design rights and moral rights.
- 3.02 The Recipient hereby assigns to the Consultant all copyrights in all materials produced from the Files and except with the Consultant prior written consent, the Recipient shall not use the Files or any part thereof to produce any materials not expressly required for the Project, including without limitation views, graphics, renderings, physical models or marketing materials, nor may the Recipient use those materials for any purpose other than the Project. If, in its sole discretion, Consultant does consent to any other use, such consent will be conditioned, at a minimum, to the Consultant receiving credit as the producer and (to the extent applicable) copyright holder.

Section 4 – Recipient Acknowledgments

- 4.01 While the Consultant has taken reasonable precaution to ensure that Files are “virus-free”, the Recipient takes full responsibility of assuring that this is the case, and that the Recipient shall have no entitlement to any Claims and Damages connected to damages to its computing systems and/or files in the transfer or use of the Files.
- 4.02 The Recipient acknowledges that:
- (a) the Files provide a representation of then dated design, are not construction documents, nor do the Files reflect construction or contract documents, and that there may be differences

- between the Files and any corresponding construction or contract documents, including but not limited to previously prepared construction or contract documents;
- (b) the Files do not represent or confirm specific Project elements, including without limitation those relating to fire and life safety, assembly details, systems, building envelope assemblies or details and the like; and
 - (c) data contained in the Files may change subsequent to the issue of Files to the Recipient due to changes or additions, however the Consultant is under no requirement to advise the Recipient of any such changes or additions and no liability accrues to the Consultant for not advising the Recipient of any changes or additions.
- 4.03 The Recipient shall, at its sole expense, remove all references to the name and logo of the Consultant, the name and logo of any other consultant, and all professional seals, in the use of the Files. Furthermore, the Consultant reserves the right to remove all references to the name and logo of the Consultant, the name and logo of any other consultant, and all professional seals, in the Files provided to the Recipient.
- 4.04 If the Files are provided as linked components, the Recipient takes full responsibility for any 'binding' which may be required by the Recipient. The Recipient acknowledges that in some cases Files are linked because of size constraints, and agrees that file corruption which may be a consequence thereof is at the Recipient's sole cost, risk and expense.

Section 5 – Term and Termination

- 5.01 Unless extended by mutual agreement of the Recipient and the Consultant, this Agreement will terminate on the earliest of: (a) [DATE]; and (b) the date of termination in accordance with this Section 5.
- 5.02 If the Recipient fails to comply with any of the terms or conditions of this Agreement, the Consultant may terminate this Agreement and all rights of the Recipient created herein.
- 5.03 Upon completion of the Project, or upon termination of this Agreement for whatever cause, all rights and privileges granted to the Recipient hereunder will immediately terminate and the Recipient shall immediately return to Consultant, or destroy, the Files and all related copies and materials. The Consultant reserves the right to require a certificate of a Director of the Recipient attesting to the return or destruction of the Files and all related copies and materials.

Section 6 – Confidentiality

- 6.01 Recipient shall not divulge any specific information identified as confidential, communicated to or acquired, or disclosed by the Consultant. No such information shall be used by Recipient on any other project without the written approval of the Consultant. These obligations of confidentiality shall not apply to information which is in the public domain; which is provided to Recipient by a third party without obligation of confidentiality; which is independently developed by Recipient without use of the Consultant's information; or which is required to be disclosed by law or by court order.

Section 7 – Miscellaneous

- 7.01 The express rights and remedies of the parties set out in this Agreement are in addition to and will not limit any other rights and remedies available to the Recipient or the Consultant at law or in equity. Any failure by either party to insist on strict performance and compliance by the other of any term, right or remedy under this Agreement will not be construed as a waiver by such party its right

- to require strict performance of any such term, right or remedy, and the duties of the party with respect to such contractual performance will continue in full force and effect.
- 7.02 Neither party will transfer, sublet or assign any rights or duties under, or interest in, this Agreement, without the prior written consent of the other party.
- 7.03 If any term, condition or obligation of this Agreement, or the application of any term, condition or obligation to the parties or to any other persons (including firms, partnerships, corporations or any combination), is to any extent held invalid or unenforceable under any applicable legislation or rule of law, such holding will be applied only to that provision(s), with the remainder of this Agreement remaining in full legal force and effect.
- 7.04 The parties agree that this Agreement and legal actions concerning its validity, interpretation and performance will be governed and interpreted in accordance with **[INSERT JURISDICTION OF CONSULTANT ENTITY]**; and it is further agreed by the parties that any legal action arising under this Agreement will be brought in a court of competent jurisdiction in that jurisdiction.
- 7.05 This Agreement constitutes the entire agreement between the Recipient and the Consultant regarding the transfer of Files and cancels and supersedes any prior understandings and agreements, whether written or oral in respect of the same. Except as expressly provided in this Agreement, no other terms, conditions or warranties, express or implied, form a part of this Agreement. Amendments to this Agreement must be in writing and signed by both parties.
- 7.06 Notwithstanding any amendment, completion or termination of this Agreement, all indemnifications in favour of the Consultant will survive and will remain in full legal force and effect.
- 7.07 The Recipient and the Consultant agree to be bound, as are their respective successors, executors, administrators and legal representatives, in respect of all terms, conditions and obligations pursuant to this Agreement.
- 7.08 This Agreement may be signed in counterparts and each such counterpart will constitute an original document and such counterparts, taken together, will constitute one and the same instrument. This Agreement may be executed and delivered by electronic transmission and the Recipient and the Consultant may rely on such electronic signature as though such were an original signature.

This Agreement is executed with effect as of the date set out on the first page of this Agreement.

[Recipient]

Name:	_____	Name:	_____
Title:	_____	Title:	_____

[insert correct Arcadis entity legal name]

Name:	_____	Name:	_____
Title:	_____	Title:	_____

Schedule 1 – DIGITAL FILES

[NTD: Insert Description of Digital Files including format (use a screen capture to include Name, Date and Size of the files. Extensions should be listed.)]

Schedule 2 – ADDITIONAL DIGITAL FILES

The defined terms used in Schedule 2 have the meaning ascribed to them in the Agreement.

For and in consideration of good and valuable consideration, the receipt and sufficiency of which is hereby acknowledged, the parties hereto agree that except for the addition of Files as described below, the provisions of Agreement shall remain in full force and effect and the Files described below shall be subject to the terms and conditions of the Agreement in full.

The Consultant will, following execution of this Agreement [**and payment to Consultant by recipient of \$X**], transfer to the Recipient the digital files listed at *Schedule 2 – Additional Digital Files* (the “Files”). By separate amendment executed by both parties hereto, the parties may agree to transfer additional Files to be included in additional schedules in the form attached hereto at Schedule 2.

[Recipient]

Name:	_____	Name:	_____
Title:	_____	Title:	_____

[insert correct Arcadis Entity legal name]

Name:	_____	Name:	_____
Title:	_____	Title:	_____

[NTD: Insert Description of Additional Digital Files including format (use a screen capture to include Name, Date and Size of the files. Extensions should be listed.)]

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**Attachment "A" to Specification Section 01 33 00
Standard Submittal Form**

Page 1

1. Submittal Title:											
2. To:		3. From:		4. Project Title & Location:		5. Submittal Date		6. New Resubmittal <input type="checkbox"/>			
ATTN:		ATTN:		8. Specification Section No:		7. Submittal No.		9. Partial Submittal No.			
						10. Resubmittal No.					
11. Contract				12. Project No:				Arcadis/Owner Use Contract No:			
13. Page No.	14. Mfr/Contractor		15. Item I.D. Description		16. Electronic Copy (Yes) (No)		17. No. of Hard Copies			Date: Received:	
							Print	Cat.	Samp	Other	Action Code # Dept. File
18. Contractor's Remarks:					The undersigned certifies that the above submitted items have been reviewed in detail and are correct and in strict conformance with all requirements of the Contract Documents, except as otherwise noted. Note: Approval of items submitted does not relieve Contractor from complying with all requirements of the Contract Documents.					Action Codes: Refer to Section 01 33 00 for full text of codes below	
Name of Contractor _____					Signature _____					1. Revise & Resubmit Revise and resubmit to the Consultant for further review <input type="checkbox"/>	
										2. Reviewed as Noted Incorporate corrections or comments and proceed with construction <input type="checkbox"/>	
										3. Reviewed Drawings reviewed without comments. Proceed with construction <input type="checkbox"/>	
										4. Not Reviewed Drawing does not require Consultant's review <input type="checkbox"/>	
Consultant Comment:			Route	Dept.	Ck'd by	Date	Action	Received			
				Civil							
				Arch.							
				Struc.							
				Mech.							
				Elect.							
				I & C							
				Process							
				PM							
Copies to:			Primary Dept. Checker				Review completed on				
			Control Administrator				Returned to Contractor on				
							By Date _____ Arcadis				

Attachment "A" to Specification Section 01 33 00
Standard Submittal Form

Page 2

Instructions for Use of Standard Submittal Form

1. Use an individual copy of this form for each and every required Project submittal.
2. Contractor shall fill in all blank spaces above the "Owner Comment" box and to the left of the "Action Codes", including the following:
 - Box 1 - Indicate generically what is being submitted i.e. "structural steel", "overhead doors", "plumbing fixtures", "wiring diagrams", etc.
 - Box 3 - Contractor's return address
 - Box 5 - Submittal date
 - Box 6 - Indicate "New" or "Resubmittal"
 - Box 7 - Submittal number
 - Box 8 - Specification section number submittal is in response to
 - Box 9 - Indicate if this is a partial submittal by using root number with part number (A5-00-01 – Part A, A5-00-01 – Part B, etc.)
 - Box 10 - Indicate if this is a resubmittal by using original root number with revision number
 - Box 11 - Indicate appropriate Contract name
 - Box 13 - Indicate Specification page number
 - Box 14 - Identify the manufacturer/Vendor/Subcontractor
 - Box 15 - Describe the submitted item
 - Box 16 - Indicate if electronic submittal
 - Box 17 - Indicate the quantity of submittal copies
 - Box 18 - Include appropriate remarks as required and sign the certification
3. The remainder of the submittal form will be completed by the Consultant, and returned to the Contractor with the submittal.

End of Attachment

- 1 Description
 - .1 This section covers Work for protection of environment as applicable to this Project.
 - .2 Provisions of this section supplement requirements of Contract Documents.
- 2 Environmental Practices
 - .1 Implement environmentally sound practices in this Project by incorporating Products that lessen burden on environment in production, use and final disposition. Support implementation of reduction, reuse and recycling strategies and use of environmentally sound Products. Promote use of environmentally responsible packaging practices by reducing and/or eliminating Products with excessive packaging in this Project where these practices do not negatively affect the proper protection of materials from inclement weather, especially water damage.
 - .2 Employ environmentally sound Products which are made, used and disposed of in a manner that significantly reduces harm to environment.
- 3 Surface Drainage and Watercourses
 - .1 Maintain ditches and watercourses for surface water drainage of Site and external properties during construction. Be responsible for damage due to negligence.
 - .2 Incorporate appropriate retention, detention and settling ponds, or similar methods, reviewed by Consultant, to control surface water run-off to adjacent ditches or other watercourses and to prevent oil, sediment or de-icing materials being carried into such ditches and/or watercourses. Tested quality of water discharged to ditches and/or watercourses shall not be of worse quality than that present in ditches and/or watercourses prior to any discharge of Site surface water. Monitor and test discharge water at least weekly and provide copies of test result to Consultant.
 - .3 Locate and protect stockpiles of semi-permanent nature to satisfaction of authorities having jurisdiction to ensure minimum environmental interference.
- 4 Noise Control
 - .1 Adhere to local noise bylaws.
 - .2 Equip vehicles and equipment with efficient noise attenuation devices (mufflers) to minimize noise levels in vicinity of Site.
 - .3 Where necessary place noise attenuation devices (barriers) around stationery pumps and compressors.
- 5 Dust Control
 - .1 Undertake control measures to prevent nuisances due to dust in any phase of construction.
 - .2 Application of calcium chloride shall be kept to a minimum and shall be restricted to vehicle right-of-way. In close proximity to watercourses, frequent application of water is preferred method. Obtain Consultant's approval before chemicals for dust control are used.
 - .3 Transport dusty materials in covered haulage vehicles.
 - .4 Transport wet materials in suitable watertight haulage vehicles.
- 6 Waste Management Practices

- .1 Refer to Section 01 74 19.
- 7 Equipment Fuelling, Maintenance and Storage
- .1 Obtain Consultant's acceptance of refueling areas.
 - .2 Procedures for interception and rapid clean-up and disposal of fuel spillages shall be submitted to Consultant for review prior to starting Work.
 - .3 Ensure that materials required for clean-up of fuel spillages are readily accessible on Site at all times.
 - .4 Carry out refueling of equipment at acceptable refueling areas.
 - .5 Ensure that water used for cleaning of equipment does not drain into streams, lakes or watercourses. Do not empty fuel, lubricants and/or pesticides into any watercourse, or on ground.
 - .6 Clean Construction Equipment prior to entering public roadways to prevent littering. Debris from cleaning equipment shall not be permitted into storm sewers or watercourses.
 - .7 Store equipment and materials in orderly manner and in location acceptable to Consultant.
- 8 Spills Reporting
- .1 In event of spill or other emission of pollutant into natural environment, notify:
 - .1 Local office of the Ministry of Environment and MOE Spill Action Centre (SAC).
 - .2 Municipality or regional municipality within boundaries of which spill occurred.
 - .3 Person having control of pollutant, if known, of spill, of circumstances surrounding the spill and of any action taken or intended to be taken.
- 9 Contingency Plan for Control and Clean-Up of Spill
- .1 Prior to commencing construction, prepare contingency plan for control and clean-up of spills. Contingency plan to include:
 - .1 Names and telephone numbers of persons in local municipalities and MOE to be notified forthwith of spill.
 - .2 Names and telephone numbers of representatives of fire, police and health departments of local municipalities who are responsible for responding to emergency situation.
 - .3 Names and telephone numbers of companies experienced in control and clean-up of hazardous materials that would be called upon in emergency involving spill.
 - .4 Contingency plan shall include provisions for spills of hazardous or unknown materials (i.e. puncturing on unmarked drain during excavation).
 - .5 Proposal for immediate containment and control of spill, clean up procedures to be initiated immediately and any other action to be taken to mitigate potential environmental damage while awaiting additional assistance.
 - .6 Be responsible for preparing, implementing, directing and supervision of contingency plan.

- .2 Ensure immediate availability of Products with which to effect temporary repair to broken pipelines and other services so spill or other emission of pollutant is immediately controlled and stopped and to mitigate damages.
- .3 Submit for Consultant's review copy of contingency plan and make appropriate changes as requested.

End Of Section

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1 **PROPOSED EQUIVALENT PRODUCTS**

- .1 Whenever a material or article is specified or described by using the name of a proprietary Product or the name of a particular manufacturer or Vendor, the specific item mentioned shall be understood as establishing type, function, dimension, appearance, and quality of Product desired.
- .2 The words "or accepted equal", "or accepted equivalent" and "or accepted alternative" as used in the Specifications are to be regarded as synonymous in meaning, and are applicable to all Specifications unless specifically stated otherwise. Any material, Product, or equipment which will fully perform or meet the service or function and/or aesthetics represented by a specified Product will be considered for acceptance as a "substitution", provided the Contractor submits proof that such material, Product or equipment is of acceptable equivalent substance and function and is accepted by the Owner. The burden of proof of acceptability rests with the Contractor.

2 **PROPOSED SUBSTITUTIONS**

- .1 Requests for substitutions must be submitted in writing using Section 01 62 01 Substitution Request Form.
- .2 The net cost of proposed substitution, weighed versus the cost of review, will be a factor in the Owner's final decision.
- .3 Contractor is responsible to determine suitability of accepted substitute Products for general construction purposes and scheduling requirements.
- .4 Acceptability of proposed substitutions is at the sole discretion of the Owner. The Owner however, is under no obligation to consider any or all proposed substitutions. Acceptance of substitutions shall in no way be interpreted as a waiver from full compliance with other Specification requirements.
- .5 Contractor shall declare that such substitution will fit within all constraints of the intended location and operating system in the Work without modification, or clearly described and defined modification, to allied specified systems, materials or assemblies.
- .6 Contractor shall save harmless the Owner, Consultant and their Subconsultants from any costs or third party action as a consequence of accepted substitution. Failure to comply with these requirements will result in rejection of the request.

3 **NOTIFICATION OF ACCEPTANCE**

- .1 Materials and equipment accepted as substitutions will be formally notified to the Contractor by a Change Order, Supplementary Instruction (SI) or Shop Drawings, as the case may be.

End of Section

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Substitution Request Form (SRF) No.: _____ Date: _____

Project: _____

General Contractor: _____ Subcontractor _____

Owner's Authorization: _____ Proceed (per _____)

1

General

- .1 This section applies to proposed substitutions submitted after Contract award.
- .2 Within four (two) weeks of Contract award, the Consultant will receive requests for substitutions from General Contractor for consideration. Proposed substitutions received after the expiration of the specified period will be marked "substitution review expired" and returned to Contractor.
- .3 Copy Owner on all substitution requests. The Owner will forward authorized substitution requests to Consultant by email. Consultant will not proceed with review without Owner's authorization.
- .4 For the Consultant's services in reviewing submittal, pay a fee of \$180.00/hour plus HST, minimum three hours or \$540.00, per proposed substitution.
- .5 Upon receipt of request, the Consultant will assess time required to review. If up to three hours is required, the Consultant will email Contractor and the Contractor will acknowledge by return email, authorizing the Consultant to proceed.
- .6 If the Consultant requires additional time above the three hours, Consultant will email Contractor with proposed additional hours with a proper breakdown for Contractor's consideration. Contractor shall send an email response accepting the proposed budget to authorize Consultant to do the review.
- .7 The Consultant will complete its review and submit a response back to Contractor in a timely manner.
 - .1 If accepted, a Change Order or Supplementary Instruction is issued.
- .8 Whether rejected or accepted, the Consultant will invoice Contractor for the cost of the review, with a copy of the Contractor's email confirmation attached to the invoice.
- .9 The Owner is under no obligation to consider any or all proposed substitutions.
- .10 For substitutions where cost savings are proposed the cost saving amount proposed by the Contractor will be reduced by the cost for the review.
- .11 Contractor shall declare that such substitution will fit within all constraints of the intended location and operating system in the Work without modification, or clearly described and defined modification, to allied specified systems, materials or assemblies. The proposed substitute shall be equal to or superior to the specified item as determined by Consultant.
- .12 Save harmless the Owner, Consultant and their Subconsultants from any costs or third party action as a consequence of accepted substitution. Failure to comply with these requirements will result in rejection of the request.
- .13 Any system, Product or material utilized without acceptance from the Consultant shall be removed from the Work, and replaced with complete installation of those specified without adjustment of Contract Price or Contract Time.

2 Details of Substitution Request

.1 Specified Product

.1 Section Number: _____

.2 Section Title: _____

.3 Paragraph Number: _____

.2 Proposed Substitution

.1 Manufacturer: _____

.2 Trade Name or Model Number: _____

.3 Manufacturer's Address: _____

.4 Contact Person: _____

.5 Phone No.: _____ Email: _____

.3 Product History

.1 New 2 to 5 yrs old 5 to 10 yrs old more than 10 yrs old

.2 Similar Installations:

.3 Project Name: _____

.4 Address: _____

.5 Consultant: _____

.6 Owner: _____

.7 General Contractor: _____

.4 Proposed Product Affects Other Parts of Work?

.1 No Yes

.2 If "Yes", explain:

.5 Differences between proposed substitution and specified Product:

.6 Reason for not providing specified Product (substitution requests are considered under any of the following conditions only. Indicate conditions with a check (√) mark):

- .1 Product(s) selected from those specified is/are unavailable.
- .2 Method(s) specified is/are too intricate.
- .3 Delivery date of Product(s), selected from those specified would unduly delay completion of Contract.
- .4 Method(s) specified would unduly delay completion of Contract.
- .5 Proposed substitute Product(s) or system(s) will result in a meaningful credit to the Contract Price.
- .7 Change to Contract Price
 - .1 Add/Deduct \$ _____ (_____)
- .8 Change to Contract Time
 - .1 Add/Deduct _____ days
- .9 Contractor's Declaration:
 - .1 Proposed substitution has been fully investigated and determined to be equivalent or superior in all respects to specified Product, and complies with requirements of authorities having jurisdiction.
 - .2 Same warranty will be furnished for proposed substitution as for specified Product.
 - .3 Cost data as stated above is complete. Claims for additional costs related to accepted substitution which may subsequently become apparent are to be waived.
 - .4 Proposed substitution does not affect dimensions and functional clearances.
 - .5 Proposed substitution is compatible with adjacent materials and assemblies.
 - .6 Coordination, installation, and changes in the Work as necessary for accepted substitution will be the responsibility of the Contractor.

Signed By Contractor: _____

Supporting Data Attached: Drawings Product Data Samples Reports Other

3 Consultant's Review

- .1 Substitution Accepted - Provide submittals per Specification requirements.
- .2 Substitution Not Accepted.
 - .1 Reason: _____

Signed By Consultant: _____ Date _____

End Of Form

- 1 General
- 1.1 **REQUIREMENTS INCLUDED**
 - .1 Product quality, availability, storage, handling, protection, handling on Site.
 - .2 Manufacturer's instructions.
 - .3 Workmanship, coordination, cutting, fastenings.
 - .4 Existing facilities.
- 2 Products
- 2.1 **QUALITY**
 - .1 Products, material, equipment and articles (referred to as Products throughout the Specifications) incorporated in the Work shall be new, not damaged or defective, and of the best quality, compatible with Specifications for the purpose intended.
 - .1 If requested, furnish evidence as to type, source and quality of Products provided.
 - .2 Defective Products, whenever identified prior to the completion of Work will be rejected, regardless of previous inspections. Inspection does not relieve responsibility, but is a precaution against oversight or error. Remove and replace defective Products at own expense and be responsible for delays and expense caused by rejection.
 - .3 Should any dispute arise as to the quality or fitness of Products, the decision rests strictly with the Consultant based upon the requirements of the Contract Documents.
 - .4 Unless otherwise indicated in the Specifications, maintain uniformity of manufacture for any particular or like item throughout the building.
 - .5 Permanent labels, trademarks and nameplates on Products are not acceptable in prominent locations, except where required for operating instructions, or when located in mechanical or electrical rooms as approved by the Consultant.
- 2.2 **AVAILABILITY**
 - .1 Immediately after award of Contract, review Product delivery requirements and anticipate foreseeable supply delays for any item. If delays in supply of Products are foreseeable, notify the Consultant of such, in order that substitutions or other remedial action may be authorized in sufficient time to prevent delay in performance of Work.
 - .2 In the event of failure to notify the Consultant at commencement of Work and should it subsequently appear that Work may be delayed for such reason, the Consultant reserves the right to substitute more readily available Products of similar character at no increase in Contract Price.
 - .3 Utilize Canadian materials and Products if available and equivalent in price and quality.
- 2.3 **STORAGE, HANDLING AND PROTECTION**
 - .1 Handle and store Products in a manner to prevent damage, deterioration and soiling and in accordance with manufacturer's instructions where applicable.
 - .2 Store packaged or bundled Products in original and undamaged condition with manufacturer's seals and labels intact. Do not remove from packaging, crating or bundling until required in the Work.

- .3 Store Products subject to damage from the elements, in weatherproof enclosures.
- .4 Store cementitious Products clear of earth or concrete floors, and away from walls.
- .5 Keep sand, when used for mortar or grout materials, clean and dry. Store sand on platforms and cover with waterproof tarpaulins during inclement weather.
- .6 Store sheet materials and lumber on flat solid supports and keep clear of ground. Slope to shed moisture.
- .7 Store and mix paints in a heated and ventilated room. Remove oily rags and other combustible debris from Site daily. Take every precaution necessary to prevent spontaneous combustion.
- .8 Remove and replace damaged Products at own expense and to the satisfaction of Consultant.

2.4 **RECEIVING MATERIAL FURNISHED BY OWNER**

- .1 Owner furnished material or equipment are listed in the Specifications.
 - .1 Contractor shall be responsible for unloading and handling material or equipment furnished by Owner to the Site.
- .2 Contractor receiving such items shall give receipts for the item delivered and thereafter will be held responsible for the care and storage of such items and shall pay for the cost of replacing or repairing any items damaged, misplaced or found to be missing while in Contractor's care and custody.

2.5 **TRANSPORTATION**

- .1 Pay costs of transportation of Products required in the performance of Work.
- .2 Transportation cost of Products supplied by the Owner and delivered to Site will be paid for by the Owner.
 - .1 Contractor shall unload, handle and store such Products.

2.6 **MANUFACTURER'S INSTRUCTIONS**

- .1 Unless otherwise indicated in the Specifications, install or erect Products in accordance with manufacturer's instructions. Do not rely solely on labels or enclosures provided with Products.
- .2 Obtain written instructions directly from manufacturers.

2.7 **ALTERNATIVE MATERIALS**

- .1 Purchased items or materials must meet the requirements of the Specifications. Be responsible for all costs for any modifications required for use of such items.
- .2 To receive approval of substitution, the proposed substitute shall be equal to or superior to the specified item. Requests for substitution shall be accompanied by documentary proof of equality and difference in price and delivery.
- .3 Submit request to the Consultant in writing and provide all technical data, samples and other information requested. No substitution shall be made without the written authority of the Consultant whose decision shall be final.

- .4 Products shall be applied, installed, connected, erected, cleaned and conditioned in accordance with the manufacturer's instructions or directions, unless specified to the contrary elsewhere in the Contract Documents.
- .5 Assume responsibility for any additional material or installation costs resulting from the approved use of equivalent materials or equipment.

2.8 **EXPEDITING**

- .1 The Contractor shall submit, when requested by Consultant, an updated material procurement/expediting record indicating clearly the status of material delivery and fabrication. Particulars to be covered by this record shall include the item identification, sub-vendor, order date, order number, Shop Drawing submission date(s) and review date(s), required delivery date, promised delivery date, date received, date checked and general remarks.
- .2 The Contractor shall accumulate and submit similar records from (assigned) Subcontractors and shall ensure that Subcontractors are properly and frequently expediting all equipment and material to meet delivery deadlines to suit installation schedule.
- .3 The Contractor shall allow the Owner, Consultant, or their representative free access to the Contractor's plant and to Subcontractor's plants for visual inspection of allotted material and/or progress of the Work.

3 Workmanship

3.1 **GENERAL**

- .1 Workmanship shall be of the best quality, executed by workers experienced and skilled in the respective duties for which they are employed. Immediately notify the Consultant if required Work is such as to make it impractical to produce required results.
- .2 Do not employ any unfit person or anyone unskilled in their required duties. The Consultant reserves the right to require the dismissal from the Site of workers deemed incompetent, careless, insubordinate or otherwise objectionable.
- .3 Decision as to the quality or fitness of workmanship in cases of dispute rests solely with the Consultant whose decision shall be final.
- .4 Whenever possible, give preference to the use of local labour. Establish rates of wages, and hours of work in accordance with provincial regulations and as generally recognized and accepted in the locality.

3.2 **CO-ORDINATION**

- .1 Ensure co-operation of workers in laying out Work. Maintain efficient and continuous supervision.
- .2 Be responsible for coordination and placement of openings, sleeves and accessories.

3.3 **CONCEALMENT**

- .1 In finished areas, conceal pipes, ducts and wiring in floors, walls and ceilings, except where indicated otherwise.
- .2 Before installation, inform Consultant if there is an existing contradictory situation. Install as directed by Consultant.

3.4 **CUTTING AND REMEDIAL WORK**

- .1 Perform cutting and remedial Work required to make the parts of the Work come together.
 - .1 Coordinate the Work to ensure this requirement is maintained.
- .2 Should Work performed outside this Contract necessitate cutting and/or remedial Work to be performed, the cost of such Work will be valued by the Consultant.
- .3 Perform cutting and remedial Work by specialists familiar with the materials affected. Perform in a manner to neither damage nor endanger any portion of Work.

3.5 **FASTENINGS**

- .1 Provide metal fastenings and accessories in same texture, colour and finish as adjacent material unless indicated otherwise.
- .2 Prevent electrolytic action between dissimilar metals and materials.
- .3 Use non-corrosive hot dipped galvanized steel fasteners and anchors for securing exterior Work, unless stainless steel or other material is specifically requested in the affected Specification section.
- .4 Space anchors within their load limit or shear capacity and ensure that they provide positive permanent anchorage. Wood or any other organic material plugs are not acceptable.
- .5 Keep exposed fastenings to a minimum, space evenly and install neatly.
- .6 Fastenings which cause spalling or cracking of material to which anchorage is made are not acceptable.

3.6 **PROTECTION OF WORK IN PROGRESS**

- .1 Adequately protect Work completed or in progress. Work damaged or defaced due to failure in providing such protection is to be removed and replaced, or repaired, as directed by the Consultant, at no increase in Contract Price.
- .2 Prevent overloading of any part of the Work or building. Do not cut, drill or sleeve any load bearing structural member, unless specifically indicated without written approval of the Consultant.

3.7 **EXISTING UTILITIES**

- .1 Connect to existing services or utilities at times directed by Owner or local governing authorities, with a minimum of disturbance to Work, building occupants, pedestrian and vehicular traffic.
- .2 Protect and maintain existing active services. When inactive services are encountered cap off in a manner approved by authority having jurisdiction and stake or otherwise record location of capped service.

End of Section

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- 1 General
 - 1.1 **DESCRIPTION**
 - .1 This section includes administrative and procedural requirements for construction waste management activities including the following:
 - .1 Salvaging nonhazardous construction waste.
 - .2 Recycling nonhazardous construction waste.
 - .3 Disposing of nonhazardous construction waste.
 - 1.2 **DEFINITIONS**
 - .1 CDL: Construction, Demolition and Landclearing.
 - .2 Construction Waste: Building and Site improvement materials and other solid waste resulting from construction operations. Construction waste includes packaging.
 - .3 Co-mingled CDL Recycling: The process of collecting mixed recyclable materials in one container on-site. The container is taken to a material recovery facility where materials are separated for recycling.
 - .4 Disposal: Removal off-site of construction waste and subsequent sale, recycling, reuse, or deposit in landfill or incinerator acceptable to authorities having jurisdiction.
 - .5 Recycling: The process of sorting, cleaning, treating, and reconstituting materials for the purpose of using the material in the manufacture of a new Product.
 - 1.3 **PERFORMANCE REQUIREMENTS**
 - .1 Materials to be recycled: The Contractor shall salvage and recycle as much nonhazardous construction waste as possible. At minimum, the Contractor shall designate the following materials to be recycled:
 - .1 Clean dimensional wood, palette wood.
 - .2 Masonry and CMU
 - .3 Metals.
 - .4 Insulation.
 - .5 Carpet and pad.
 - .6 Gypsum board (asbestos free).
 - .7 Piping.
 - .8 Electrical conduit.
 - .9 Packaging including paper, corrugated cardboard, boxes, plastic sheet and film, polystyrene packaging, plastic pails.
 - 1.4 **SUBMITTALS**
 - .1 Waste Management Plan: Submit Waste Management Plan for review by the Consultant prior to demolition and construction.
 - .2

- .3 Waste Management Tracking Form: Concurrent with each application for payment at 50% progress claim and at substantial completion and completion of demolition , if applicable.
- .4 Waste reduction progress reports: Include separate reports for construction waste. Include the following information:
 - .1 Material category.
 - .2 Generation point of waste.
 - .3 Total quantity of waste in tonnes.
 - .4 Quantity of waste salvaged, both estimated and actual in tonnes.
 - .5 Quantity of waste recycled, both estimated and actual in tonnes.
 - .6 Total quantity of waste recovered (salvaged plus recycled) in tonnes.
 - .7 Total quantity of waste recovered (salvaged plus recycled) as a percentage of total waste.
 - .8 Recycling and processing facility records: Indicate receipt and acceptance of recyclable waste by recycling and processing facilities licensed to accept them. If requested, provide manifests, weight tickets, receipts, and invoices.
 - .9 Landfill and incinerator disposal records: Indicate receipt and acceptance of waste by landfills and incinerator facilities licensed to accept them. Provide manifest, way-bills, invoices and other documentation if requested.

1.5 **QUALITY ASSURANCE**

- .1 Regulatory requirements: Comply with hauling and disposal regulations of authorities having jurisdiction.
- .2 Surplus materials, removals, grindings and other debris shall be disposed of offsite. No separate payment shall be made for the costs associated with this Work. The City will not make arrangements for the disposal of surplus materials or supply bills of lading. Stockpiling of excavated material is not permitted and shall immediately be disposed of upon removal.

2 Products

Not Used

3 Execution

3.1 **GENERAL**

- .1 General: Implement waste management plan as approved by City. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.
- .2 Waste management coordinator: Engage a waste management coordinator to be responsible for implementing, monitoring, and reporting status of waste management work plan. Coordinator shall be present at Project site for duration of Project.
- .3 Training: Train workers, Subcontractors, and Suppliers on proper waste management procedures, as appropriate for the Work occurring at Project site.

- .1 Distribute waste management plan to everyone concerned within three days of submittal return.
- .2 Distribute waste management plan to entities when they first begin Work on-site. Review plan procedures and locations established for salvage, recycling, and disposal.
- .4 Site access and temporary controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
 - .1 Designate and label specific areas on Project site necessary for separating materials that are to be recycled.
 - .2 Comply with Project requirements for controlling dust and dirt, environmental protection, and noise control.

3.2 **RECYCLING AND CONSTRUCTION WASTE, GENERAL**

- .1 Provide containers for CDL waste that is to be recycled clearly labeled as such with a list of acceptable and unacceptable materials. The list of acceptable materials must be the same as the materials recycled at the receiving material recovery facility or recycling processor.
- .2 Provide containers for CDL waste that is disposed in a landfill clearly labeled as such.
- .3 Use detailed material estimated to reduce risk of unplanned and potentially wasteful cuts.
- .4 Include in material purchasing agreements, a waste reduction provision requesting that materials and equipment be delivered in packaging made of recyclable material, that they reduce the amount of packaging, the packaging be taken back for reuse or recycling, and to take back all unused product. Ensure that Subcontractors require the same provisions in their purchase agreements.
- .5 Conduct regular visual inspections of dumpsters and recycling bins to remove contaminants.
- .6 Recycle paper and beverage containers used by on-site workers.
- .7 Procedures: Separate recyclable waste from other waste materials, trash, and debris. Separate recyclable waste by type at Project site to the maximum extent practical.
 - .1 Provide appropriately marked containers or bins for controlling recyclable waste until they are removed from Project site. Include list of acceptable and unacceptable materials at each container and bin. Inspect containers and bins for contamination and remove contaminated materials if found.
 - .2 Stockpile processed materials on-site without intermixing with other materials. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
 - .3 Stockpile materials away from construction area. Do not store within drip line of remaining trees.
 - .4 Store components off the ground and protect from the weather.
 - .5 Remove recyclable waste off Owner's property and transport to recycling receiver or processor.

3.3 **RECYCLING CONSTRUCTION WASTE**

.1 Packaging

- .1 Cardboard and boxes: Break down packaging into flat sheets. Bundle and store in a dry location.
- .2 Polystyrene packaging: Separate and bag materials.
- .3 Pallets: As much as possible, require deliveries using pallets to remove pallets from Project site. For pallets that remain on-site, break down pallets into component wood pieces and comply with requirements for recycling wood.
- .4 Crates: Break down crates into component wood pieces and comply with requirements for recycling wood.

.2 Wood Materials

- .1 Clean cut-offs of lumber: Grind or chip into small pieces.
- .2 Clean sawdust: Bag sawdust that does not contain painted or treated wood.
- .3 Gypsum board: Stack large clean pieces on wood pallets and store in a dry location.
 - .1 Clean gypsum board: Grind scraps of clean gypsum board using small mobile chipper or hammer mill. Screen out paper after grinding.

3.4 **SOURCE SEPARATION WASTE**

- .1 General: Separate recyclable materials by type from CDL waste.
- .2 Provide containers, clearly labeled, by type of separated materials or provide other storage method for managing recyclable materials until they are removed from Project site.
- .3 Stockpile processed materials on-site without intermixing with other materials. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
- .4 Stockpile materials away from demolition area. Do not store within drip line of remaining trees.
- .5 Store components off the ground and protect from weather.

3.5 **CO-MINGLED RECYCLING**

- .1 General: Do not put CDL waste that will be disposed in a landfill into a co-mingled CDL waste recycling container. Where matar

3.6 **DISPOSAL OF WASTE**

- .1 General: Except for items or materials to be recycled, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.
 - .1 Except as otherwise specified, do not allow waste materials that are to be disposed of to accumulate on-site.
 - .2 Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
- .2 Burning: Do not burn waste materials.

.3 Disposal: Transport waste materials off Owner's property and legally dispose of them.

End of Section

- 1 General
- 1.1 **SUMMARY**
 - .1 Section Includes
 - .1 Labour, Products, equipment and services necessary to complete the Work of this section.
 - .2 Restore damaged or disturbed Work.
 - .3 Be responsible for providing and performing items required and necessary other than specified, in order to complete the Work.
- 1.2 **REFERENCES**
 - .1 Conform to the latest edition of the following:
 - .1 AODA - Accessibility for Ontarians with Disabilities Act
- 1.3 **SUBMITTALS**
 - .1 Shop Drawings:
 - .1 Submit Shop drawings indicating proposed location and construction of hoarding, fencing, barriers, and dust-tight partitions, including plan for maintaining access during each stage of the Work.
 - .2 Submit a demolition plan for Consultant's review. Demolition plan shall be prepared by a qualified Professional Engineer licensed in the Province of Ontario.
 - .3 Submit copies of certified weigh bills receipts from authorized disposal sites and reuse and recycling facilities for all material removed from Site upon request of Consultant. Written authorization from the Consultant is required to deviate from the haulers facilities receiving organizations listed in waste reduction workplan.
- 1.4 **MAINTAINING ACCESS**
 - .1 Maintain and preserve Owner's access requirements to and from existing buildings in areas where demolition and removal Work is carried out and throughout the existing structures.
 - .2 Do not close, obstruct, place or store material in Owner's driveways and passageways. Conduct operations with minimum interference to roads, streets, driveways and passageways.
 - .3 Provide and erect barriers, maintain lights, and traffic control as required by the Owner, municipal traffic regulations or building by-laws.
 - .4 Maintain access to fire exits.
- 1.5 **HAULING OPERATIONS**
 - .1 Haul and move machines, vehicles and equipment over designated route and within Work areas as designated by Consultant.
 - .2 Maintain roadways and paving in the hauling areas clean on a daily basis and as required by municipal authorities.

- .3 Location of chutes, rubbish containers, hoisting equipment and the like shall be subject to approval by Owner and such that they will not unduly impede pedestrian or vehicular traffic and will not obstruct entrances and exits.

1.6 **INTERRUPTIONS TO OWNER'S OPERATIONS**

- .1 There will be absolutely no interruptions to Owner's operations permitted. Execute machine and equipment movements, deliveries and removals at time or times that will permit uninterrupted Owner's operations in and around buildings, including parking, deliveries and Site access and egress.
- .2 Carry out Work in such a manner to cause a minimum of noise or interference to adjoining operations and approval of Owner obtained before proceeding with any Work which may cause interference.
- .3 Service lines to be modified, if any, must be kept in service throughout the construction period except for brief change-over periods.
- .4 Maintain such services. Prepare sketches and detailed schedule of Work, and submit to Consultant for review.

1.7 **PROJECT/SITE CONDITIONS**

- .1 Existing Conditions
 - .1 The Demolition Drawings indicate the physical dimensions, existing levels and similar items being indicated where known and shall be read in conjunction with the new Drawings. Not all demolition Work may be shown in its entirety; the Contractor shall include for any demolition required to complete the new Work specified and on the Drawings.
 - .2 All information relative to existing conditions is offered to assist the Contractor in evaluation of the Work, but with no specific representation, either expressed or implied, as to completeness or accuracy. Be responsible for any deductions or conclusions made on the basis of this information and that of any additional Site inspections, if made.
- .2 Prior to beginning field construction Work, survey and record the condition of existing conditions to remain in place that might be affected by the demolition operations. After demolition operations are completed, survey the conditions again and restore existing facilities to their pre-demolition condition.
- .3 Protection
 - .1 Protect Work to remain against damage. Repair or replace damaged Work.
 - .2 Maintain in service and protect from damage, the existing utilities that are to remain.
 - .3 Conduct demolition operations to ensure safety of all persons and to prevent damage to existing structures and utilities, construction in progress, and other property.
 - .4 Conduct demolition operations and remove debris to disposal areas in a manner to ensure maximum safety and minimum interference with other operations.
 - .5 Protect building floor and roof against damage from operations under this section, including lifting, moving, rolling, etc., of materials. Use 13 mm thick plywood covers with ends mechanically joined, over floor for any such handling. Over roof, provide 19 mm thick plywood underlaid with 25 mm thick polystyrene

insulation board adhered to same. Provide same when working from, or over roof surfaces. Be responsible for repairs of any damage caused.

- .6 Provide temporary sheeting, shoring, bracing, underpinning and other protective measures, as required to prevent movement, collapse of, or damage to unsupported walls and other facilities as a result of demolition operations.
- .7 Support affected structures and, if safety of structure being demolished or adjacent structures or services appears to be endangered, take preventative measures and then cease operations and notify Consultant.
- .8 Remove and dispose of all temporary Work when no longer required.
- .9 Should material resembling spray or trowel applied asbestos or any other designated substance listed be encountered in the course of demolition, stop Work, take preventative measures, and notify Consultant immediately. Do not proceed until written instructions have been received.
- .10 Prevent extraneous materials from contaminating air beyond application area, by Providing temporary enclosures during demolition Work.
- .11 Cover or wet down dry materials and waste to prevent blowing dust and debris. Control dust on temporary roads.
- .12 Provide temporary means of exit as required for affected exits or entrances.
- .13 Protect existing air intakes for existing building ventilation system. Carry out all operations so as to prevent dust entering these intakes, using dampening abatement measures and protection.
- .14 Pay particular attention to prevention of fire and elimination of fire hazards which would endanger the Work or adjacent buildings and premises.
- .15 Keep and maintain fire extinguishers throughout the Work at all times to the approval of the fire marshal, and located at convenient and accessible points.

1.8 **UNEXPECTED CONDITIONS**

- .1 If existing active services are unexpectedly encountered, are not indicated on Drawings, or otherwise made known and interfere with permanent facilities under construction, notify Consultant and Owner in writing, requesting instructions on their disposition. Take immediate steps to ensure that services provided are not interrupted, and do not proceed with the Work until written instructions are received.

1.9 **COORDINATION**

- .1 Mechanical
 - .1 This clause is supplementary and complementary to demolition requirements specified in the mechanical divisions. Where there is conflict between this section and the mechanical divisions, the requirements of the mechanical divisions shall govern.
 - .2 Coordinate the Work to facilitate removal of walls and cutting of new openings. Disconnect, remove, cap off and relocate existing lines interfering with such Work. Remove and/or relocate equipment as required.
 - .3 Carry out alterations to existing mechanical systems as shown on Drawings and as required to interconnect new and existing systems.

- .4 Do all cutting, patching and making good of existing structure required to complete mechanical Work.
- .5 Refer to mechanical division for specific requirements.
- .2 Electrical
 - .1 This clause is supplementary and complementary to demolition requirements specified in the electrical divisions. Where there is conflict between this section and the electrical divisions, the requirements of the electrical divisions shall govern.
 - .2 Coordinate to facilitate demolition, removals, cutting of new openings, door widening and alteration in existing building, disconnecting, removing and/or relocating existing wiring, fixtures and devices interfering with such Work.
 - .3 Carry out all alterations to existing electrical, signal, and fire alarm systems as shown on Drawings and as required to interconnect new and existing systems.
 - .4 Disconnect and/or re-route electrical data, communication and telephone service lines entering structures to be demolished. Remove abandoned lines as indicated on Drawings. Post warning signs on electrical lines and equipment which is required to remain energized.
 - .5 Remove or relocate existing equipment and services unexpectedly encountered, not indicated on Drawings, and interferes with such Work.
 - .6 Do all cutting, patching, and making good of existing structure and finishes as required to complete electrical Work. Remove and replace existing acoustic tile ceilings where required. Be responsible for replacement of any tile soiled or marred as a result.
- 2 Products
 - 2.1 **MATERIALS**
 - .1 Temporary wood studs: Construction grade spruce.
 - .2 Polyethylene sheet: 0.152 mm, thick, clear, stapled in place.
 - .3 Plywood: Douglas fir plywood.
 - 3 Execution
 - 3.1 **TEMPORARY PARTITIONS OR DUST PROOF SCREENS**
 - .1 Dust proof partitions or screens: Before any Work proceeds in any particular area in the existing building, temporarily enclose the area and access thereto, with light stud and plywood, clean polyethylene sheet material or, clean polyethylene sheet screen overlapped 100 mm and taped at floor, ceiling and doors, walls or intersecting members, in a manner to prevent dust and dirt infiltration into the adjoining areas.
 - .2 Where access is required through partition, provide a solid core wood door or hollow steel door, in steel frame, equipped with self-closing and latching hardware.
 - .3 Where an exit is closed off due to construction activities, provide alternate exit acceptable to both the Owner and to Authorities Having Jurisdiction. Temporary exits shall be clearly identified with appropriate signage.

- .4 Take every possible precaution to prevent dust and dirt resulting from the Contract operations from entering Owner's operational areas. Adjust and relocate such partitions or screens as required for the various operations under the Contract.
- .5 As Work progresses, Contractor shall remove and relocate, reconfigure or adjust the dust proof partitions and/or construction hoarding as required to accommodate the construction progress and to ensure that the construction areas remain secure at all times.
- .6 Weather Protection
 - .1 Provide weather protection screens similar to above in areas where existing building interior is exposed to the elements.
 - .2 Provide protection in the form of tarpaulins, plywood or polyethylene for temporary roof and wall openings and other exposed areas, before final construction is in place.

3.2 **DEMOLITION AND REMOVALS**

- .1 Carry out demolition Work, removal of existing materials and equipment, and disposal of resultant debris. Proceed with demolition of or alteration to any portion of existing building ONLY after thorough protection of existing building has been achieved.
- .2 During demolition operations, keep Work wetted down with fog sprays to prevent dust and dirt rising. Provide temporary water for this purpose. Use covered chutes, watered down.
- .3 Demolition shall proceed safely in systematic manner from roof to grade and as necessary to accommodate remedial Work indicated. Work on each floor level shall be complete before commencing Work on supporting structure and safety of its supports are impaired. Parts of building which would otherwise collapse prematurely shall be securely shored. Walls and piers shall not be undermined.
- .4 Do not overload floor or wall with accumulations of material or debris or by other loads.
- .5 Remove existing equipment, services, and obstacles where required for refinishing or making good of existing surfaces, and replace as Work progresses.
- .6 During demolition operations, keep Work wetted down with fog sprays to prevent dust and dirt rising. Provide heavy duty water hose for this purpose; connect to Owner's existing water source where directed by Consultant.
- .7 Where Work includes cutting of roof openings, Provide a plywood catchboard immediately under the areas to be cut so as to protect the building interior from falling debris. Provide catchboard in combination with weather screens previously specified.
- .8 Confine operations and workmen to those parts of the building which are defined on Drawings, and exercise great care not to damage existing construction beyond that necessary for carrying out new Work and make good any such damage in every respect.
- .9 Concrete:
 - .1 Demolish concrete by methods which avoid impact loads on items which are not to be demolished.
 - .2 Where only part or parts of a concrete floor, wall, roof, foundation or other items are to be demolished, use saw cuts to isolate areas which are to be demolished except where existing reinforcing steel is to be left in place. Prior to such isolating, install suitable support to prevent premature movement of area(s) being

- isolated and undesirable transfer of loads as cutting progresses. If necessary remove area(s) to be demolished by successively isolating small sections.
- .3 Where reinforcing steel is to be left in place, use saw cuts from surface of concrete reinforcing steel around perimeter(s) of area(s) to be demolished, chip concrete without damaging reinforcing steel. Retouch damaged epoxy coating of existing reinforcing steel.
 - .10 Masonry: Demolish block or brick walls in small sections of not more than 2 m². Where only part(s) of a wall is to be demolished, install adequate support for adjacent part(s). Do not permit masonry to fall in mass from one level to another
 - .11 Sheet metal flashings: Remove sheet metal flashings indicated on Drawings and recycle.
 - .12 Where doors are scheduled to be removed for disposal, include removal of door frames and door hardware.
 - .13 Remove interior partitions, fittings, fixtures and accessories as indicated on Drawings. Partitions and walls shall be removed full height to structure above.
 - .14 Ceiling
 - .1 Removal of existing ceilings shall include complete removal including bulkheads and suspension system.
 - .2 Where ceilings are to be removed to accommodate Work, and later reinstalled, carefully disassemble ceilings to the extent required.
 - .3 Where ceilings are to remain after wall or bulkheads are demolished, remove ceiling components as required to complete demolition work. Coordinate with trades doing new ceiling work, and confirm what components are to be retained for reuse. Cut tiles may not be used; new full or appropriately cut tiles will be required.
 - .15 At end of each day's Work:
 - .1 Leave Work in safe and stable condition. Protect interiors of parts not to be demolished from exterior elements at all times.
 - .2 Leave Work in safe condition so that no part is in danger of toppling or falling.
 - .3 Prevent debris from blocking surface drainage system, elevators, mechanical and electrical systems which must remain in operation.
 - .4 Ensure that demolition Work does not adversely affect adjacent watercourses, groundwater and wildlife, or contribute to excess air and noise pollution.
 - .5 Do not dispose of waste or volatile materials such as: mineral spirits, oil, petroleum based lubricants, or toxic cleaning solutions into watercourses, storm or sanitary sewers. Ensure proper disposal procedures are maintained throughout Project.
 - .16 Materials to be reused: Where designated on Drawings to be removed and stored for future use, remove, handle and transport such items to point of storage. Perform such Work carefully and with diligence to prevent any damage to the items during removal and in storage.

.17 Cutting

- .1 Cut openings through existing walls, partitions, roofs and floors. Establish exact location of steel reinforcing in existing concrete slabs or walls before cutting. Be responsible for damage to existing steel reinforcing and be liable for structural failure. Make good surfaces disturbed with materials to match existing.
- .2 Use power operated cutting devices. Chipping will not be allowed. Commence breaking out operations only after sawcutting of the cut-off points has been performed in order to prevent damage to remainder of structure and to obtain straight and clean junctions of new and existing works.
- .3 Use a saw blade which will achieve superior sawing performance. Spalling of remaining concrete at sawcut points will be judged as defective and shall be rectified at no increase in Contract Price. Do not overcut corners (i.e. avoid "intersecting" sawcuts).
- .4 Demolish masonry and concrete in small sections.
- .5 Coordinate with mechanical trade and sawcut and breakout existing floor or wall to accommodate new mechanical piping. Have mechanical trade lay out and supervise Work.

3.3 **DISPOSAL OF MATERIALS, RUBBLE AND DEBRIS**

- .1 Surplus materials: Take ownership of surplus materials and remove from Site daily, unless such materials are designated to be reused (or turned over to Owner).
- .2 Rubble and debris: Clean up rubble and debris as they are generated. Dispose of same at end of each day's Work or place in waste disposal bins and empty on a regular basis.
- .3 Stockpiling of surplus materials, rubble and debris on Site will not be permitted.
- .4 Do not burn material on Site.

3.4 **CLEAN-UP**

- .1 Upon completion, clean site(s) in areas disturbed by construction activities, including landscaped areas. Remove and dispose of rubbish, surplus materials, waste materials, tools and other equipment. Leave site(s) in a neat clean and safe condition acceptable to Consultant.
- .2 Vacuum clean and wet mop floors and wipe clean wall surfaces free of dust on completion of Work.

End of Section

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1 General

1.1 **SUMMARY**

.1 Section Includes

- .1 Labour, Products, equipment and services necessary to complete the Work of this section, including but not limited to, the following:
- .1 Decorative metal trim
 - .2 Corner Guards
 - .3 Miscellaneous metals

1.2 **REFERENCES**

.1 Conform to the latest edition of the following:

- .1 ASTM A123 - Zinc (Hot Galvanizing) Coatings on Iron and Steel Products
- .2 ASTM A153 - Zinc Coating (Hot-Dip) on Iron and Steel Hardware
- .3 ASTM A240 - Standard Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels
- .4 ASTM A269 - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
- .5 ASTM A276 - Specification for Stainless Steel Bars and Shapes
- .6 ASTM A653/A653M - Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
- .7 CSA-G40.20/G40.21-M - General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steels
- .8 CAN/CSA G164-M - Hot-Dip Galvanizing of Irregularly Shaped Articles
- .9 CSA W47.1 - Certification of Companies for Fusion Welding of Steel Structures
- .10 CSA W59-M - Welded Steel Construction (Metal Arc Welding)
- .11 CAN/CSA-W117.2 - Safety in Welding, Cutting and Allied Processes
- .12 AODA - Accessibility for Ontarians with Disabilities Act

1.3 **SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00.
- .2 Show fabrication and installation of details of decorative metal. Include plans, elevation, profiles and attachments to other work.
- .3 Submit representative samples of each type of exposed finished required.

1.4 **QUALITY ASSURANCE**

- .1 Work of this section requires specialized high quality metal Work and shall be done by a company with a record of minimum five years of continuous and successful experience in the fabrication and installation of commercial ornamental metal Work, and thoroughly conversant with governing laws, by-laws and regulations. Submit proof of this requirement to the Engineer on request.
- .2 Have a full time, senior, qualified representative at the Site to direct the Work.

1.5 **PROJECT CONDITIONS**

- .1 Protection: Provide strippable protective film to stainless steel surfaces.

2 Products

2.1 **MATERIALS - GENERAL**

- .1 Specialty metals: Of best commercial quality, with various forms straight and true without scratches, scars, creases, buckles, ripples, or chatter marks. Finished surfaces must be suitable for polishing.
- .2 Select materials for surface flatness, smoothness, and freedom from surface blemishes when exposed to view in finished unit. Exposed-to-view surfaces which exhibit pitting, seam marks, roller marks, "oil-canning", stains, discolourations, dents or other imperfections on finished units will not be acceptable.
- .3 Stainless steel sheet, plate and strip: ASTM A240, Type 304 in Excelsior "XL-Blend-S" on exposed surfaces.
- .4 Stainless steel shapes: Conforming to ASTM A276, type 304 with X-L Blend S finish.
- .5 Stainless steel pipe: Conforming to ASTM A312, type 304, (316) 180-grit finish.
- .6 Stainless steel fasteners: Sizes and type shown, stainless steel type 304, unless otherwise specified.
- .7 Stainless steel bars: Conforming to ASTM A276.
- .8 Structural shapes and plates: New material conforming to CSA-G40.20-M and CSA-G40.21-M, Grade 300W.
- .9 Galvanizing of ferrous metal: Hot-dip with minimum zinc coating of 600 g/m² to CAN/CSA G164-M.
- .10 Galvanized touch up: W.R. Meadows of Canada Ltd. "Galvafruid" zinc rich coating.
- .11 Fastenings: Furnish stainless steel fasteners and adhesives as required by various substrates and details; supply drilled inserts where required in accordance with Section 05 50 00.

2.2 **SCHEDULE**

- .1 Corner Guard (CG-1): 16 gauge, type 304 stainless steel, brush finish, pre-drilled for countersunk screws. Refer to Finishes Schedule for supplier, finish and locations
- .2 Edge trim (MT-1): To be applied at tackboard. Refer to Finishes Schedule for tackboard type, supplier, finish and locations

2.3 FABRICATION

- .1 Design components to allow for expansion and contraction without causing buckling, excessive opening of joints or overstressing of welds and fasteners.
- .2 Form metalwork to required shapes and sizes with true curves, lines and angles. Provide necessary rebates, lugs and brackets for assembly of units.
- .3 Shop fabricate items so far as practicable. Flush rivet joints to conceal reinforcement, or weld where thickness of section permits. Where cutting, welding, and grinding are required for proper shop fitting and jointing of Work, restore finish to eliminate any evidence of such corrective Work.
- .4 Grind contact surfaces of connected members true. Assemble parts so that joints are tight and practically unnoticeable, without use of filling compound.
- .5 Stainless steel shall be refinished as required after fabrication to a polished finish specified, to eliminate markings, scratches or other surface imperfections.
- .6 Furnish assemblies with matching fascia and floor flanges factory welded to posts and rails, of sizes shown. Provide countersunk holes in flanges for flush fasteners.
- .7 Protect tubing and plate with strippable sheet protection, remaining in place through installation.

2.4 WELDING

- .1 Welding shall conform to CSA W59-M and done by a firm fully certified in accordance with CSA W47.1. All welders employed in the field shall be qualified as Class "O" as defined in CSA W47.1.
- .2 Conform to safety requirements of CSA W117.2 for all welding operations.

2.5 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 Atlas Stainless Steels' "Technical Data" handbook on stainless steel.
- .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, and as follows:
 - .1 In fabrication of stainless steel do not use tools and dies which have been used on carbon steels.
 - .2 Ensure tools and dies used for forming and cutting stainless steel are free of nicks and other damage.
 - .3 Do not use carbon grits and grinding wheels which will imbed foreign particles into stainless steel surfaces. Use only stainless steel wool when wool polishing is required.
 - .4 Stainless steel items on which rust stains appear, shall be replaced with new fabricated material.

2.6 **CLEANING AND POLISHING STAINLESS STEEL**

- .1 Thoroughly clean welds and surrounding substrate area of weld spatter, flux or scale by wire brushing, grinding and polishing. When wire brushing and grinding, use shield over adjacent mill finished surfaces to protect same, or provide limiting stops on grinder to avoid canting of grinding wheel.
- .2 Remove excess weld by grinding to provide for continuous weld line. Grinding, polishing, and passivating of welds exposed to view in finished construction to match finish of parent material.

2.7 **CLEANING AND GALVANIZING - FERROUS METALS**

- .1 Clean ferrous steel to SSPC SP6 and remove loose mill scale, weld flux and spatter. After fabrication, hot-dip galvanize miscellaneous steel items specified herein. Plug relief vents air tight. After galvanizing, remove plugs, ream holes to proper size and re-tap threads. Straighten shapes and assemblies true to line and plane after galvanizing. Repair damaged galvanized surfaces with galvanize primer in accordance with manufacturer's printed directions.
- .2 Hot-dip galvanize members in accordance with CAN/CSA G164-M and requirements of the following ASTM standards, with minimum coating weights or thicknesses as follows:
 - .1 Rolled, pressed and forged steel shapes, plates, bars and strips: ASTM A123; average weight of zinc coating per square/foot of actual surface, for 4.8 mm and less thickness members 2.0 ounces, for 6 mm and heavier members 2.3 ounces.
 - .2 Iron and steel hardware: ASTM A153; minimum weight of zinc coating, in ounces per square foot of surface shall be in accordance with Table 1 of ASTM A153, for the various classes of materials used in the Work.
 - .3 Steel sheet: ASTM A653/A653M; weight of zinc coating, total per area for both sides of sheet. Coating designation Z275, minimized spangle and chemically treated.
- .3 Drill holes for bolts and screws. Conceal fasteners where possible. Mill exposed ends and edges smooth, with corners slightly rounded. Form joints exposed to weather to exclude water.

3 Execution

3.1 **INSTALLATION**

- .1 Install Work to a secure and rigid installation.
- .2 Fastening to in-place construction: Provide anchorage devices and fasteners where necessary for securing metal items to in-place construction including threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws, and other connectors as required.
- .3 Cutting, Fitting and Placement
 - .1 Perform all cutting, drilling, and fitting required for installation of the Work.
 - .2 Set Work accurately in location, alignment and elevation, plumb, level and true, measured from established lines and levels.
 - .3 Provide temporary bracing or anchors in framework for items which are to be built into concrete, masonry or similar construction.

- .4 Form tight joints with exposed connections accurately fitted with uniform reveals and spaces for sealants and joint fillers.
- .5 Do not cut or abrade finishes which cannot be completely restored in field.
- .6 Refinish items rejected by the Engineer or alternatively, replace with new materials without cost to the Owner.

3.2 **PROTECTION**

- .1 Remove protective coverings when there is no longer danger of damage to specialty metal Work.

End of Section

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- 1 General
- 1.1 **SUMMARY**
 - .1 Section Includes
 - .1 Labour, Products, equipment and services necessary to complete the Work of this section.
- 1.2 **REFERENCES**
 - .1 Conform to the latest edition of the following:
 - .1 AWI/AWMAC - American Woodwork Institute/Architectural Woodwork Manufacturers Association of Canada
 - .2 CAN3-O188.1-M - Interior Mat-Formed Wood Particleboard
 - .3 CSA O80 Series - Wood Preservation
 - .4 CSA O115-M - Hardwood and Decorative Plywood
 - .5 CSA O121-M - Douglas Fir Plywood
 - .6 CAN/ULC-S102 - Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies
 - .7 NEMA LD3 - National Electrical Manufacturers Association, High Pressure Decorative Laminates
 - .8 AODA - Accessibility for Ontarians with Disabilities Act
- 1.3 **SUBMITTALS**
 - .1 Shop Drawings
 - .1 Submit in accordance with Section 01 33 00. Show on Shop Drawings, vanities, counters, cupboards, and other casework.
 - .2 Show fabrication details, including exact sizes and description of anchorage and hardware, nature of the materials which are to be used as component parts, and installation and interface conditions.
- 1.4 **QUALITY ASSURANCE**
 - .1 Special Experience Requirements
 - .1 Manufacturer/fabricator: Architectural woodwork shall be manufactured by a current member firm of AWI/AWMAC, and having a minimum of five years experience on Work of similar size and quality to that indicated and specified.
 - .2 Installer qualifications: Engage an installer who is a current member firm of AWI/AWMAC, and who has successfully completed two architectural woodwork projects similar in scope, materials and design to that indicated and specified within the last five years.
 - .2 Execute plastic laminate Work to CAN3-A172-M, except as specified otherwise.
- 1.5 **PRODUCT DELIVERY, STORAGE AND HANDLING**

- .1 Deliver units to meet installation schedule. Arrange for strategic, off-the-ground, covered storage locations with constant minimum temperature of 16°C (61°F) and maximum moisture content of 12% when measured with moisture meter.
- .2 Cover plastic laminate faced surfaces and varnished surfaces at the factory with 480 kg/m³ kraft paper. Protect all surfaces with corrugated cardboard.
- .3 Provide adequate protection until finally accepted.

1.6 **WARRANTY**

- .1 Warrant Work of this section against defects and deficiencies for a period of two years from date Work is certified as substantially performed in accordance with the general conditions of the Contract.
- .2 Promptly make good defects and deficiencies which become apparent within the Warranty Period by replacing defective plastic laminate Work satisfactory to the Consultant and at no expense to the Owner.
- .3 Defects shall include, but not be limited to, warping and delamination.

1.7 **COORDINATION**

- .1 Coordinate with the frame Suppliers as to the time at which such items will be required for installation. Receive and store such items.

2 Products

2.1 **MATERIALS**

.1 Wood Materials

- .1 Restriction of source of supply: 50% of wood Products used in Work of this section must be Forest Stewardship Council (FSC) Certified, with chain of custody verification.
- .2 Provide materials that comply with requirements of the AWI/AWMAC Manual for each type of woodwork and quality grade indicated and, where Products are part of woodwork, with requirements of the referenced Product standards that apply to Product characteristics indicated.
- .3 Lumber: To AWI/AWMAC manual with the following requirements:
 - .1 Hardwood for concealed blocking and framing: Economy grade, any species that, when painted, will not show any defects.
 - .2 Moisture content: Provide kiln-dried (KD) lumber with an average moisture content range of 6% to 11% for interior Work. Maintain temperature and relative humidity during fabrication, storage and finishing operations so that moisture content values for woodwork at time of installation do not exceed 5% to 10%.
 - .3 Solid hardwood for transparent finish grade: to Architectural Woodwork Standards, Edition 1-2009, Grade I. Wood species and cut: To later selection by Consultant.
 - .4 Architectural lumber: Clear, straight, kiln dried, select yellow birch for urethane or varnish finished fitments and door jambs. Lumber shall be kiln dried to 5% moisture content and free from blemishes that would be apparent after finish is applied.

- .1 Stainless Steel Trim / Edge:
 - .1 Fabricate stainless steel trim to sizes, shapes and profiles as indicated on Drawings.
 - .2 Standard commercial tempers and hardness, as required for fabrication, strength and durability from Type 304 alloy. Miter exposed corner joints and machine fit to hairline joint. Stainless steel finish: No. 4 (bright directional polish); No. 8 (non-directional mirror polish).
- .2 Plastic laminate face sheets: Refer to Section 06 47 00 Plastic Laminates.
- .3 Countertops: Refer to Section 12 36 00 Countertops.

2.2 SHEET MATERIALS

- .1 Melamine surfaced boards: 720 kg/m³ density particleboard core with thermally fused low pressure laminate finish by Domtar, Arborite or Uniboard. Colour as selected by the Consultant.
- .2 Plywood: Douglas fir conforming to CSA O121-M, G2S, sanded, and stain grade birch conforming to CSA O115-M, G1S and G2S, depending on exposure.
- .3 Softwood Plywood: CSA-O121; Graded to NAAWS; Custom installation; veneer core; Douglas Fir face species, rotary cut.
- .4 Medium Density Fibreboard (MDF): NPA A208.2 moisture resistant; composed of wood particles reduced to fibres, made with high waterproof resin binders; of grade to suit application; sanded faces.
- .5 Hardboard: CAN/CGSB-11.3 AHA A135.4; Pressed wood fibre with resin binder, standard tempered grade, 6 mm (1/4 inch) thick, smooth one sides.
- .6 Casework hardware: As follows:
 - .1 Adjustable shelf hardware (janitors' shelves): Extra heavy duty; Knappe and Vogt No. 87 ANO standards, No. 187LL ANO shelf brackets and matching shelf rests or Richelieu equivalent, all in anochrome finish. Locate standards at 600 mm o.c. maximum.
 - .2 Adjustable shelf hardware (cupboard shelves): Knappe & Vogt No. 255 standards and No. 256 shelf brackets, or Richelieu equivalent, nickel plated (brass) (epoxy coated white) (epoxy coated almond), mortised into cabinet sides.
 - .3 Door and drawer pulls: Canadian Builders Hardware CBH 220, 88 mm long aluminum (bronze) (brass) (stainless steel) or Hafele 116.05.922.
 - .4 Hinges: Blum "Clip 170" or Hettich "Euromat Topsafe 4955", 170 degree opening angle, concealed, self-closing, nickel plated.
 - .5 Drawer slides: Full extension, rated 100 lb. load, Knappe & Vogt 1400 or Accuride 3832.
 - .6 Cabinet door and drawer lock: Knappe & Vogt 986, nickel plated.
 - .7 Vanity brackets: Hebcos table brackets.
- .7 Rough hardware: Supply all rough hardware to frame and fix finish carpentry. This includes bolts, anchors, nails, expansion shields and other fastenings required. Ensure

bolts and screws are galvanized or non-ferrous material. Wood screws shall be full thread screws.

- .8 Wood veneer for natural finish: Species: Straight grain, to match approved sample, minimum 0.8 mm thick, architectural quality, premium grade selected for uniformity of colour, figure and grain. Piece veneers shall be parallel chipped, jointed by tapeless splicer and edge glued. Face veneers shall not contain open joints, face depressions, glue stain, patches, plastic repair or any other manufacturing irregularities or defects.
- .9 Fire retardant treated plywood: Pressure-impregnated fire retardant treated plywood conforming to CSA O80.27, to provide a flame spread rating of 25 or less, in accordance with CAN/ULC-S102.

2.3 **FABRICATION**

- .1 Obtain and verify dimensions at the building before fabrication of casework takes place, and in ample time to prevent unnecessary delays in the Work.
- .2 Make Work plumb, level and true, in as long lengths as practicable with joints arranged to be as inconspicuous as possible, and with proper provision for shrinkage.
- .3 Machine sand wood surfaces to an even, smooth surface, ready for finish. Hand clean Work and securely fix. Accurately fit joints of shop assembled Work. Dovetail and glue drawer slides to fronts and backs. Groove drawer bottoms 6 mm deep into drawer fronts, sides and back. Connect other joints by means of mortise and tenons, dowels, stub tenons, dovetails, dadoes or lock joints, as applicable for the jointing condition. Ensure end grain on finished surfaces, unless part of the design, are not exposed. Nails shall have concealed heads and with all screw and bolt heads countersunk and covered with matching wood plugs in exposed surfaces.
- .4 Tool marks on exposed surfaces is deemed sufficient cause for rejection.
- .5 Neatly and accurately scribe, mitre and joint Work. Carefully mitre all exposed corners. Neatly cope intersecting moulds at inside corners; do not mitre.
- .6 Rout or groove back of flat trim; kerf backs of wide flat members, except for members with backs exposed in finished Work.
- .7 Assemble Work at the shop, unless impractical, and deliver ready for installation, with ample allowance for cutting, fitting and scribing.
- .8 Ensure that mill assembled units are of sizes that can be transported through the building to their final location.
- .9 Construct Work as shown or noted on the Drawings and Shop Drawings. Adequately frame as required to provide a firm and rigid installation complete with all gables, divisions and other members. Conceal all fastenings.

3 Execution

3.1 **EXAMINATION**

- .1 Inspect existing conditions upon which Work of this section is dependent. Report to the Consultant in writing any defects or discrepancies. Commencement of Work implies acceptance of existing conditions.

3.2 **INSTALLATION**

- .1 Set and secure materials and components in place, rigid, plumb and square, and in accordance with reviewed Shop Drawings. Be responsible for a rigid and secure attachment.
- .2 Casework: Install level plumb and true and complete in all respects. Rigidly and securely fasten to retaining structures using heavy duty hardware. Fit and scribe as required to achieve neat junctures with retaining structure and to conceal voids at such points. Install finish hardware for casework in accordance with manufacturers' directions. Adjust as required for a perfect fit and for ease of operation.
- .3 Custom Moulding
 - .1 Protect adjacent surfaces from damage prior to undertaking dismantling, in-situ repairs and refinishing.
 - .2 Fill surface voids with compounds formulated for wood.
 - .3 Avoid damaging materials and finishes adjacent to the surface being dismantled.
 - .4 Avoid marring, crushing or splitting components.
 - .5 Protect dismantled historic components from weather.
 - .6 Splice in new materials with same wood species as existing wood component, if possible. Grain orientation shall match existing wood component and match profile of existing wood section.
- .4 Wood Handrails
 - .1 Secure wood stair handrails, level, square and true to the required lines, slopes or curves.
 - .2 Bolt balcony handrails to retaining angle welded atop balcony edge steel framing. Likewise, secure handrail to retaining angle at stairs and landings. Let bolt heads in finished Work and cap with edge grain wood caps, dress and finish flush.
 - .3 Finish woodwork in maximum possible lengths. Scarf, glue and properly fasten joints between lengths. Match material being jointed reasonably well for grain and colour.
 - .4 Accurately cut, mitre, fit and joint Work together to produce tight hairline joints, rigidly secured together in a permanent manner using glue or blind screw fixing.
 - .5 Hand sand after installation to remove roughness, planer marks, etc. Sanding shall be done with the grain of the wood and finished with fine grit paper to leave a smooth scratch-free surface suitable to receive finish.

End of Section

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- 1 General
- 1.1 **SUMMARY**
 - .1 Section Includes
 - .1 Labour, Products, equipment and services necessary to complete the Work of this section.
 - .2 By definition, "casework" means cabinets, vanities, counters, countertops, cupboards, wardrobes, lockers, closets, shelving, desks, tables, benches, showcases, door jambs.
- 1.2 **REFERENCES**
 - .1 Conform to the latest edition of the following:
 - .1 AWMAC - Architectural Woodwork Manufacturers Association of Canada
 - .2 ANSI A208.1 - Particleboard
 - .3 CAN3-A172-M - High Pressure, Paper Base, Decorative Laminates
 - .4 CAN3-O188.1-M - Interior Mat-Formed Wood Particleboard
 - .5 CSA O115-M - Hardwood and Decorative Plywood
 - .6 CSA O121-M - Douglas Fir Plywood
 - .7 NEMA LD-3 - High Pressure Decorative Laminates
 - .8 AODA - Accessibility for Ontarians with Disabilities Act
- 1.3 **SUBMITTALS**
 - .1 Submit Shop Drawings to illustrate fully all details of Work and conditions adjoining the Work, in accordance with Section 01 33 00.
 - .2 Show fabrication details including exact sizes and description of anchorage and hardware, the nature of the materials which are to be used as component parts.
 - .3 Clearly cross reference components on the Shop Drawings to the Contract Working Drawings indicating location, number required and name of unit.
 - .4 Certification: Submit a certificate from the National Hardwood Lumber Association stating compliance of supplied hardwood lumber to the Specification.
 - .5 Samples: Submit samples of casework sections in accordance with Section 01 33 00. Sample units for submission shall be as follows:
 - .1 150 x 150 mm plastic laminate applied on 19 mm core showing finish for countertops.
 - .2 150 x 150 mm plastic laminate applied on 19 mm core showing finish for cupboard doors and adjustable shelves.
 - .3 or
 - .4 One drawer unit (except hardware) constructed and finished as specified.

- .6 Apply plastic laminate on sample materials on both faces and on three sides only of core, in thicknesses specified.
- .7 Samples shall depict exactly, the Work required to be provided with regards to finish and material on which finish is applied. Finish all casework equal in quality and finish to those approved.
- .8 Identify samples with Project name and number, date of submission, material name and Subcontractor's name.

1.1 **QUALITY ASSURANCE**

- .1 Special Experience Requirements
 - .1 Manufacturer/fabricator: Architectural woodwork shall be manufactured by a current member firm of AWI/AWMAC, and having a minimum of five years experience on Work of similar size and quality to that indicated and specified.
 - .2 Installer qualifications: Engage an installer who is a current member firm of AWI/AWMAC, and who has successfully completed two architectural woodwork projects similar in scope, materials and design to that indicated and specified within the last five years.
- .2 Quality standard: Comply with AWI/AWMAC Architectural Woodwork Standards Edition 1-2009 ("AWI/AWMAC Manual"), "Custom Grade".
- .3 Execute plastic laminate Work to CAN3-A172-M, except as specified otherwise.

1.2 **PRODUCT DELIVERY, STORAGE AND HANDLING**

- .1 Deliver units to meet installation schedule. Arrange for strategic, off-the-ground, covered storage locations with constant minimum temperature of 16°C (61°F) and maximum moisture content of 12% when measured with moisture meter.
- .2 Cover plastic laminate faced surfaces and varnished surfaces at the factory with 480 kg/m³ kraft paper. Protect all surfaces with corrugated cardboard.
- .3 Provide adequate protection until finally accepted.

1.3 **WARRANTY**

- .1 Warrant Work of this section against defects and deficiencies for a period of two years from date Work is certified as substantially performed in accordance with the general conditions of the Contract.
- .2 Promptly make good defects and deficiencies which become apparent within the Warranty Period by replacing defective plastic laminate Work satisfactory to the Consultant and at no expense to the Owner.
- .3 Defects shall include, but not be limited to, warping and delamination.

1.4 **EXAMINATION**

- .1 Examine the Drawings and Specifications and previously constructed Work which is to receive this Work. Notify the Consultant in writing of any conditions beyond acceptable tolerances which may prejudice the proper completion of this Work.
- .2 Obtain and verify all dimensions at the building before any fabrication of casework takes place, and in ample time to prevent unnecessary delays in the Work.

- .3 Commencement of Work on the Site shall constitute acceptance of existing conditions.
- 2 Products
- 2.1 **MATERIALS**
- .1 Plastic Laminate Cabinets
 - .1 Grades:
 - .1 General Purpose Standard Grade (GP)
 - .2 Postforming Standard Grade (PF)
 - .3 Plastic laminate backing sheet: Backing Grade (BK) 0.511 mm, Product of manufacturer of face sheet used.
 - .2 Lower Cabinets (PLAM-1):
 - .1 Laminate face sheets. Refer to Section 06 47 00.
 - .2 Thickness as indicated on Drawings
 - .3 Colour: Alabaster D431 by Wilsonart or accepted equal
 - .3 Upper Cabinets (PLAM-2):
 - .1 Laminate face sheets. Refer to Section 06 47 00.
 - .2 Thickness as indicated on Drawings
 - .3 Colour: North Sea D90 by Wilsonart or accepted equal
 - .4 Adhesive: Thermosetting to suit laminate application without failure and as recommended by manufacturer.
- .2 Hardboard: confirming to CGSB 11-GP-3M.
- .3 Rough hardware: Supply all bolts, anchors, nails, expansion shields and other fastenings required for this Work. All bolts and screws shall be non-ferrous materials.
- .4 Casework Hardware: As follows:
 - .1 Provide cabinet hardware and accessory materials for complete installation, except for items in accordance with Section 08 71 00 Door hardware
 - .1 Hinges: Blum "Clip 170" or Hettich "Euromat Topsafe 4955", 170 degree opening angle, concealed, self-closing, nickel plated.
 - .2 Adjustable shelf hardware (cupboard shelves): Knappe & Vogt No. 255 standards and No. 256 shelf brackets, or Richelieu equivalent, nickel plated (brass) (epoxy coated white) (epoxy coated almond), mortised into cabinet sides.
 - .3 Adjustable Shelf for Cabinets: recessed pilaster strips and rests.
 - .4 Door and drawer pulls: Canadian Builders Hardware CBH 220, 88 mm long aluminum (bronze) (brass) (stainless steel) or Hafele 116.05.922.
 - .5 Drawer slides: Full extension, rated 100 lb. load, Knappe & Vogt 1400 or Accuride 3832.

- .6 Cabinet door and drawer lock: Knappe & Vogt 986, nickel plated.
- .7 Refuse Cabinets: full extension carburized steel ball bearing, bottom mounting, 79 kg capacity heavy duty load rating, cold rolled steel slide members and ball retainers, cushioned in and out stops, progressive action, positive stop, bright electro zinc plate finish.

2.2 **SHOP FABRICATION AND WORKMANSHIP**

- .1 Carry out all finish joinery Work in accordance with first quality cabinet making practice, by skilled mechanics, under the supervision of a competent supervisor. Erect casework plumb, level and true, in lengths as long as practicable with joints arranged to be as inconspicuous as possible, and with proper provision for shrinkage.
- .2 Machine sand wood surfaces to an even, smooth surface, ready for finish. Hand clean and securely fix all joints accurately fitted, no end grain exposed on finished surfaces, unless part of the design; and concealing nail heads with all screw and bolt heads countersunk and covered with matching wood plugs in finished Work.
- .3 Tool marks on exposed surfaces is deemed sufficient cause for rejection.
- .4 Do all scribing, mitres and jointing accurately and neatly. Carefully mitre all exposed corners. Neatly cope intersecting moulds at inside corners and do not mitre.
- .5 Assemble and finish Work completely at the shop, unless impractical, and deliver ready for installation. Where Work is to be built in, construct casework with ample allowance for cutting and fitting.
- .6 Ensure that mill assembled units are of sizes that can be transported through the building to their final location.
- .7 Construct Work adequately framed, and complete with gables, divisions, blocking and other members as required to provide a firm and rigid installation. Cover all exposed braces and brackets of wood with plastic laminate covered on all exposed edges and faces. Conceal all fastenings.
 - .1 Doors: Cupboard doors, unless otherwise detailed, of 19 mm thick five-ply construction and installed with edging strips on sides, top and bottom, rebated into the core so as to conceal the joint as much as possible. Provide hardwood core.
 - .2 Adjustable shelves: Shelves in cabinets of 19 mm thick plywood, unless detailed otherwise on the Drawings, edge lipped with solid wood and adjustable at 13 mm intervals on pilaster track and brackets.
 - .3 Drawers: All drawers shall have 25 mm solid birch front (cut for lock hardware). Drawer sides shall be 13 mm thick solid birch with top edges rounded and attached to drawer front with carefully fitted glued dovetail joints. Mortised or nailed construction will not be accepted. Drawer backs shall be 13 mm solid birch attached to drawer sides with carefully fitted lock corner joints. Drawer bottoms shall be 6 mm plywood grooved into drawer sides, back and front making box construction. Install all hardware to drawers, doors and fitments.
 - .4 Pipe frames: Construct pipe frames and metal bracing to tables and benches where indicated. Pipe shall be standard 32 mm diameter, Schedule 40 pipe with rails and braces fitted and welded and ground smooth. Form channel braces of 38 x 38 mm sections bolted to framing. Feet shall be standard flange type, welded to legs.

- .8 Coordinate with mechanical trades and cut fitments for sinks, services and wastes.
- .9 Plastic Laminate Application
 - .1 Veneer plastic laminate to core material in accordance with manufacturer's printed directions. Apply laminate face sheet to exposed surfaces of casework. Apply backing grade to underside of shelves and counters. Use melamine finished core for interior surfaces of drawers and cabinets only.
 - .2 Neatly butt plastic laminate, with self edging applied before face veneers. Seal core at joints and edges and where sink cut-outs are provided, with water-resistant material to retard movement of moisture to, or from, the assembly. Mechanically shop fasten backsplash core material to the top core with 1.5 mm (16 gauge) concealed brackets at 300 mm centres. Carry counter laminate material up at back edges to form integral coved backsplash.
 - .3 Joints in plastic laminate Work are not permitted except in pieces exceeding 2400 mm in length.
 - .4 Splashbacks, unless otherwise shown on the Drawings, to be 100 mm high, but where installed over a counter and below an overhead cupboard, the splashback shall be for the full height between the two fitments. Butt joints in all surfaces to be spliced and drawn together with "draw-bolts" of type recommended by manufacturer of laminate material. All such butt joints to be located not nearer than 600 mm from any sink. Splashbacks to be mechanically shop fastened at the counter top with 1.5 mm (16 gauge) brackets at 300 mm centres.

2.3 **FINISHES**

- .1 Prime paint all metal Work (except galvanized iron) with one coat primer conforming to CISC/CPMA 2.75, finished with two coats alkyd enamel in colours selected later by the Consultant.
 - .2 Finish all oak veneer or solid stock oak with sealer and two-coat hand rubbed lacquer treatment.
 - .3 Finish all birch, solid and veneered material, including interiors of cabinets, drawers, counters and trim as specified for oak material.
 - .4 Cover all exteriors of fitments, braces, shelves, countertops, aprons and backsplash, and the interior faces of doors, with plastic laminate finish as hereinbefore specified. Exterior shall mean all faces, edges and ends not concealed behind doors. All door edges shall be similarly faced.
- OR
- .5 All painted wood to receive one coat of interior wood primer and two coats interior alkyd enamel, low gloss, colours as later selected by the Consultant. Prime all concealed wood surfaces such as cupboard backs against walls, cupboard supports under bottom shelves, etc; before installation.

3 Execution

3.1 **EXAMINATION**

- .1 Inspect existing conditions upon which Work of this section is dependent. Report to the Consultant in writing any defects or discrepancies. Commencement of Work implies acceptance of existing conditions.

3.2 **INSTALLATION**

- .1 Set and secure materials and components in place, rigid, plumb and square, and in accordance with reviewed Shop Drawings. Be responsible for a rigid and secure attachment.
- .2 Rigidly and securely fasten to retaining structures using heavy duty hardware. Fit and scribe as required to achieve neat junctures with retaining structure and to conceal voids at such points. Install finish hardware for casework in accordance with manufacturers' directions. Adjust as required for a perfect fit and for ease of operation.
- .3 Hardwood face veneers: Tightly and smoothly cut, selected for uniformity of colour. Knots, open defects, wood inlays, excessive stain or discolouration of plastic fillers are not acceptable. Match face veneers for grain or colour.
- .4 Install all finish hardware supplied by the finishing hardware Supplier.

3.3

CLEAN-UP

- .1 Clean-up and remove from the Owner's premises on a daily basis all rubbish and surplus materials resulting from this Work.
- .2 Immediately prior to final acceptance of finished Work, thoroughly clean and polish all Work of this trade to an acceptable finish.

End of Section

- 1 General
 - 1.1 **SUMMARY**
 - .1 Section Includes
 - .1 Labour, Products, equipment and services necessary to complete the Work of this section.
 - 1.2 **REFERENCES**
 - .1 Conform to the latest edition of the following:
 - .1 AWI/AWMAC - American Woodwork Institute/Architectural Woodwork Manufacturers Association of Canada
 - .2 CAN3-A172-M - High Pressure Paper Base, Decorative Laminates
 - .3 CSA O80 Series - Wood Preservation
 - .4 CSA O115-M - Hardwood and Decorative Plywood
 - .5 CSA O121-M - Douglas Fir Plywood
 - .6 NEMA LD 3-2005 - High Pressure Decorative Laminates (HPDL).
 - .7 AODA - Accessibility for Ontarians with Disabilities Act
 - 1.3 **SUBMITTALS**
 - .1 Shop Drawings
 - .1 Submit in accordance with Section 01 33 00. Show on Shop Drawings, vanities, counters, cupboards, and other casework.
 - .1 Submit fully dimensioned Shop Drawings showing layouts and components, including edge conditions, joinery, terminating conditions, substrate construction, and cutouts and holes. Include elevations, section details, and large scale details. Indicate color, pattern, and finish selections.
 - .2 Show fabrication details, including exact sizes and description of anchorage and hardware, nature of the materials which are to be used as component parts, and installation and interface conditions.
 - .2 Samples: Submit duplicate samples of plastic laminate for colour and sheen verification.
 - 1.4 **QUALITY ASSURANCE**
 - .1 Special Experience Requirements
 - .1 Manufacturer/fabricator: Architectural woodwork shall be manufactured by a current member firm of AWI/AWMAC, and having a minimum of five years experience on Work of similar size and quality to that indicated and specified.
 - .2 Installer qualifications: Engage an installer who is a current member firm of AWI/AWMAC, and who has successfully completed two architectural woodwork projects similar in scope, materials and design to that indicated and specified within the last five years.
 - .2 Execute plastic laminate Work to CAN3-A172-M, except as specified otherwise.

1.5 **PRODUCT DELIVERY, STORAGE AND HANDLING**

- .1 Deliver units to meet installation schedule. Arrange for strategic, off-the-ground, covered storage locations with constant minimum temperature of 16°C (61°F) and maximum moisture content of 12% when measured with moisture meter.
- .2 Cover plastic laminate faced surfaces and varnished surfaces at the factory with 480 kg/m³ kraft paper. Protect all surfaces with corrugated cardboard.
- .3 Provide adequate protection until finally accepted.

1.6 **WARRANTY**

- .1 Warrant Work of this section against defects and deficiencies for a period of two years from date Work is certified as substantially performed in accordance with the general conditions of the Contract.
- .2 Promptly make good defects and deficiencies which become apparent within the Warranty Period by replacing defective plastic laminate Work satisfactory to the Consultant and at no expense to the Owner.
- .3 Defects shall include, but not be limited to, warping and delamination.

1.7 **COORDINATION**

- .1 Coordinate with other work having a direct bearing on work of this section.
- .2 Coordinate the work with electrical rough-in, installation of associated and adjacent components, systems and finishes.

1.8 **FIELD MEASUREMENTS:**

- .1 Verify actual measurements and openings by field measurements before fabrication; show recorded measurements on Shop Drawings.
- .2 Coordinate field measurements and fabrication schedule with construction progress to avoid construction delays.

2 Products

2.1 **MATERIALS**

- .1 Composition: Decorative surface papers impregnated with melamine resins and pressed over kraft paper core sheets impregnated with phenolic resin and bonded together under pressures. Finished sheets trimmed and backs sanded to facilitate bonding to substrate.
- .2 Plastic Laminate Types: Conform to NEMA LD3.
 - .1 General purpose type:
 - .1 Horizontal (HGS) sheet thickness: Minimum 1.2 mm.
 - .2 Vertical (VGS) sheet thickness: Minimum 0.7 mm.
 - .2 Post-formed type:
 - .1 Horizontal (HGP) sheet thickness: Minimum 1 mm.
 - .2 Vertical (VGP) sheet thickness: Minimum 0.7 mm.

- .3 Backing Sheets: Non-decorative, high pressure laminate, NEMA LD3, Grade, types and thickness to match face sheets and equalize pull. Sanded one face and manufactured by same manufacturer as facing sheet.
- .4 Particleboard core of minimum 720 kg/m³ density conforming to CAN3-O188.1-M, sanded face, or Douglas Fir plywood conforming to CSA O121-M, G2S. Conforming to NEMA LD3. Provide waterproof cores in countertops with sinks and in all other areas where moisture is possible.
- .5 Adhesives: Conforming to CSA 0112, formulated for use in decorative laminate fabrication and to suit the conditions of application without failure. Adhesive for countertops where sinks will be installed is to be water resistant.
- .6 Rough hardware: Supply all rough hardware to frame and fix finish carpentry. This includes bolts, anchors, nails, expansion shields and other fastenings required. Ensure bolts and screws are galvanized or non-ferrous material. Wood screws shall be full thread screws.

2.2 **FINISH SCHEDULE**

- .1 Refer to Section 09 06 00 Product and Finish Schedule and Drawings for details of Work.

2.3 **FABRICATION**

- .1 Obtain and verify dimensions at the building before fabrication takes place, and in ample time to prevent unnecessary delays in the Work.
- .2 Make Work plumb, level and true, in as long lengths as practicable with joints arranged to be as inconspicuous as possible, and with proper provision for shrinkage.
- .3 Plastic laminate shall be applied to an approved underlayment with a thermosetting adhesive.
- .4 Veneering of plastic laminate to core material shall be done according to the laminate manufacturer's directions. All veneered work shall be backed with a balancing sheet except where exposed in the finished work, then face veneer to be applied to all exposed surfaces. Apply backing grade to underside of shelves and counters.
- .5 Assemble Work at the shop, unless impractical, and deliver ready for installation, with ample allowance for cutting, fitting and scribing.
- .6 Where fabrication is done at the site, laminate and core materials shall be stored in the work area for not less than 48 hours for preconditioning before bonding together.
- .7 Neatly butt plastic laminate, with self edging applied before face veneers. Seal core at joints and edges and where sink cut-outs are provided, with water-resistant material to retard movement of moisture to, or from, the assembly. Mechanically shop fasten backsplash core material to the top core with 1.5 mm (16 gauge) concealed brackets at 300 mm centres. Carry counter laminate material up at back edges to form integral covered backsplash.
- .8 Joints in plastic laminate Work are not permitted except in pieces exceeding 2400 mm in length.
- .9 Ensure that mill assembled units are of sizes that can be transported through the building to their final location.
- .10 Construct Work as shown or noted on the Drawings and Shop Drawings. Adequately frame as required to provide a firm and rigid installation complete with all gables, divisions and other members. Conceal all fastenings.

3 Execution

3.1 **EXAMINATION**

- .1 Inspect existing conditions upon which Work of this section is dependent. Report to the Consultant in writing any defects or discrepancies. Commencement of Work implies acceptance of existing conditions.

3.2 **INSTALLATION**

- .1 Substrate Repairs: Restore damaged substrates with specified repair materials. Sand and clean all repaired areas prior to applying resurfacing laminate.
- .2 Set and secure materials and components in place, rigid, plumb and square, and in accordance with reviewed Shop Drawings. Be responsible for a rigid and secure attachment.
- .3 Make allowances around perimeter where fixed objects pass through or project into laminated plastic work to permit normal movement without restriction.
- .4 Provide cutouts for inserts, grills and appliances and other penetrations. Round internal corners, chamfer edges and seal exposed core.

End of Section

- 1 General
- 1.1 **SUMMARY**
 - .1 Section Includes
 - .1 Labour, Products, equipment and services necessary to complete the Work of this section.
- 1.2 **REFERENCES**
 - .1 Conform to the latest edition of the following:
 - .1 CAN/ULC-S701 - Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering
 - .2 CAN/ULC-S702 - Standard for Thermal Insulation, Mineral Fibre, for Buildings
 - .3 ULC CAN4-S101-M - Standard Methods of Fire Endurance Tests of Building Construction and Materials
 - .4 AODA - Accessibility for Ontarians with Disabilities Act
- 1.3 **DELIVERY, STORAGE AND HANDLING**
 - .1 Deliver materials to Site, clean and undamaged, and in manufacturer's distinctly identified cartons or wrappings. Remove unsatisfactory materials from Site and replace at no cost to the Owner.
 - .2 Take precautionary measures to avoid fires and abide by fire protection regulations.
 - .3 Place suitable forms or skids under the insulation upon delivery to protect the insulation from absorbing dampness from the surrounding terrain or floor. Cover material with approved tarpaulins and secure. Do not store insulation in direct contact with the earth, road surface, or floors.
 - .4 Store materials indoors at Site, in an area at a temperature of not less than 4°C (39°F) for a minimum of twelve hours prior to use.
- 1.4 **PROTECTION**
 - .1 Place protective covers, boards, tapes and take other measures to protect all surfaces, and in particular the building cladding, from being marred or contaminated.
 - .2 Supervise the Work of other trades where such Work is closely associated with the Work of this section and report any damage.
- 1.5 **SUBMITTALS**
 - .1 Submit the following in accordance with Section 01 33 00.
 - .1 Samples: Submit representative samples of each specified insulation material, insulation clips, adhesives, fasteners, and other material for review.
 - .2 Manufacturer's Product data:
 - .1 Submit manufacturer's Product data sheets for Products proposed for use in the Work of this section.

- .2 Submit data and installation instructions for materials and prefabricated devices, providing descriptions sufficient for identification at the place of the Works.
 - .3 Submit data from manufacturer's or independent laboratory indicating compatibility and adhesive results of proposed materials.
- 2 Products
- 2.1 **MATERIALS - INSULATION**
- .1 Mineral Wool: Exterior Thermal Batt Insulation for exterior steel frame wall, floor and ceiling construction
 - .1 Performance characteristics: Mineral fibre, non-combustible, semi-rigid mineral wool batt insulation, manufactured from basalt rock and slag, in accordance with CAN/ULC S702 Type 1 or ASTM C665, Type I. Non-combustible in accordance with CAN/ULC S114
 - .2 Facing options: Unfaced or foil faced.
 - .3 Thickness: as indicated on Drawings
 - .4 Acceptable Manufacturers:
 - .1 Rockwool ComfortBatt by Rockwool Inc.
 - .2 Thermafiber UltraBatt by Owens Corning
 - .3 Or accepted equal
 - .2 Mineral Wool: Exterior Insulation for exterior wall continuous insulation and Rainscreen cavity wall
 - .1 Performance characteristic: Mineral fibre, semi-rigid or rigid board, manufactured from basalt rock and slag, Conforming to CAN/ULC 702 Type 1 or ASTM C612, Type IVB.
 - .2 Thermal Resistance: RSI-value 0.74/25 mm (R-value 4.3/inch) in accordance with ASTM C518.
 - .3 Density: to ASTM C303
 - .1 Thicknesses below 50 mm Density: 70 kg/m³.
 - .2 Thicknesses 65 mm and above Density: Outer layer: 100 kg/m³; Inner layer: 60 kg/m³
 - .4 Non-combustible in accordance with CAN/ULC S114.
 - .5 Acoustic: 1.00/51 mm NRC in accordance with ASTM C423.
 - .6 Thickness as indicated on Contract Drawings.
 - .7 Acceptable Manufacturer:
 - .1 Cavityrock by Rockwool Inc.
 - .2 Thermafiber RainBarrier 45 by Owens Corning
 - .3 Thermafiber RainBarrier HD by Owens Corning

- .4 Or accepted equal
- .3 Mineral Wool: For Continuous Insulation Systems
 - .1 Performance characteristic: Conforming to ASTM C612, Type IVB and CAN/ULC S702, Type 1, Non-combustible, rigid, water repellent, mineral wool insulation board for exterior non-structural commercial and industrial high performance insulation sheathing applications and or "screws through insulation assembly" where the dense board is sandwiched with strapping, furring or hat track. It can also be used below slabs, on exterior insulated below grade walls, and in other continuous insulation board application.
 - .2 Thickness: as indicated on Drawings
 - .3 Acceptable Manufacturer:
 - .1 Density: 8lb/ft³
 - .1 Comfortboard 110 by Rockwool Inc.
 - .2 or accepted equal
 - .2 Density 11lb/ft³
 - .1 Comfortboard 110 by Rockwool Inc.
 - .2 or accepted equal
- .4 Mineral Wool: Multipurpose Board Insulation for Thermal and Acoustic Applications
 - .1 Performance characteristic: Semi-rigid or rigid board, manufactured from basalt rock and slag, and having the following properties:
 - .2 Density: Nominal 64, 96, 80 kg/m³ in accordance with ASTM C303.
 - .3 Non-combustible in accordance with CAN/ULC S114.
 - .4 Thermal Resistance: RSI-value 0.71-0.74/25 mm (R-value 4.1-4.2/inch)
 - .5 Thickness as indicated on Drawings
 - .6 Acoustic: Coefficients at frequencies in accordance with ASTM C423.
 - .7 Acceptable Manufacturer:
 - .1 Density: 64 kg/m³ = 1.00/51 mm NRC
 - .1 Acceptable Manufacturer:
 - .1 RockBoard 40 by Rockwool Inc.
 - .2 Thermafiber VersaBoard 40 by Owens Corning
 - .3 Or accepted equal
 - .2 Density: 96 kg/m³ = 0.95/51 mm NRC
 - .1 Acceptable Manufacturer:
 - .1 RockBoard 60 by Rockwool Inc.
 - .2 Thermafiber VersaBoard 60 by Owens Corning

- .3 Or accepted equal
 - .3 Density: $128 \text{ kg/m}^3 = 0.80/51 \text{ mm NRC}$.
 - .1 Acceptable Manufacturer:
 - .1 RockBoard 80 By Rockwool Inc.
 - .2 Thermafiber VersaBoard 80 by Owens
 - .3 Or accepted equal
- .5 Mineral Wool: Firestopping Insulation for firestop applications at perimeter floor and wall penetrations
 - .1 Performance Criteria: Mineral fibre, semi-rigid board, manufactured from basalt rock and slag, in accordance with ASTM C612 Types IA, IB, II, III, or IVA
 - .2 Thermal Resistance: RSI-value 0.74/25 mm (R-value 4.2/inch) in accordance with ASTM C518.
 - .3 Non-combustible in accordance with CAN/ULC S114.
 - .4 Acceptable Manufacturer:
 - .1 Roxul Safe by Rockwool Inc.
 - .2 Thermafiber Safing by Owens Corning Canada LP.
 - .3 Or accepted equal
- .6 Mineral Wool: Exterior Fire Containment Insulation for aluminum spandrel curtain wall, steel stud framed gypsum sheathing curtain wall, glass spandrel curtain wall, or precast concrete spandrel panel applications
 - .1 Performance Criteria: Mineral fibre, rigid board, manufactured from basalt rock and slag, in accordance with CAN/ULC S702 Type 1, Type 3 (foil), or ASTM C612, Type IA, IB, III, or IVB.
 - .2 Facing options: Unfaced or foil faced.
 - .3 Thermal resistance: RSI-value: 0.74/25 mm (R-value 4.2/inch) in accordance with ASTM C518.
 - .4 Density: In accordance with ASTM C303.
 - .5 Non-combustible in accordance with CAN/ULC S114.
 - .6 Fire-resistance rating of the system tested in accordance with ASTM E2307.
 - .7 Acceptable Manufacturers:
 - .1 Density 64 kg/m³:
 - .1 CurtainRock 40 by Rockwool Inc.
 - .2 Thermafiber FireSpan 40 or Therma fiber FireSpan FF 40 by Owens Corning
 - .3 Or accepted equal
 - .2 Density 128 kg/m³:

- .1 CurtainRock 80 by Rockwool Inc.
 - .2 Thermafiber FireSpan 90 or Thermafiber FireSpan FF 90 by Owens Corning
 - .3 Or accepted equal
- .7 Rigid Insulation - XPS (Perimeter Foundation Insulation)
- .1 Extruded polystyrene (XPS), closed-cell foam, rigid insulation board, smooth skin, to CAN/ULC S701-01, Type 4 or ASTM C578, Type IV.
 - .2 Thermal resistance: RSI-value 0.88/25 mm (R-value 5.0/inch) in accordance with ASTM C518.
 - .3 Compressive strength, ASTM D1621, 207 kPa
 - .4 Combustible in accordance with CAN/ULC S114.
 - .5 Thickness: as indicated on Drawings
 - .6 Acceptable Manufacturers:
 - .1 Styrofoam brand SM by DuPont
 - .2 Foamular C-300 by Owens Corning
 - .3 Or accepted equal
- .8 Rigid Insulation - XPS (under slab Insulation)
- .1 Extruded polystyrene (XPS), closed-cell foam rigid insulation board, to CAN/ULC S701-05, Type 4.
 - .2 Compressive strength, ASTM D1621-04a, 275 kPa (40 psi) minimum (measured at 5% deformation or at yield, whichever occurs first).
 - .3 Thickness: as indicated on Drawings
 - .4 Acceptable Manufacturers:
 - .1 Styrofoam brand Highload 40 by DuPont
 - .2 Foamular 400 by Owens Corning
 - .3 Or accepted equal

- .9 Loose insulation: Loose glass fibre by Owens Corning Canada, basalt wool by Fibrex Insulations Inc. or mineral wool by Roxul Inc.
 - .10 Foamed-in-place air seals: One component polyurethane foam for installation within closures and fillers; "Enerfoam" by Abisko Manufacturing Inc. or "Foam Sealant" by Zerodraft Products Inc.
 - .11 Adhesives
 - .1 Polystyrene foam insulation adhesive: Canadian Adhesive "Lepage PL Premium" or approved equivalent.
 - .2 Glass fibre or mineral wool insulation adhesive: Henry "200-02".
 - .3 For installing insulation clips direct to masonry, concrete or metal: High strength, resilient adhesive having a drying time of zero to thirty minutes (rapid initial set), and twenty-four hours final set. Adhesive shall be compatible with insulation and air/vapour barrier and shall be non-corrosive to galvanized steel and membrane air/vapour barrier.
 - .4 Mechanical fasteners to concrete: Galvanized "Gripcon" screws with plastic plates. For use with vinyl faced insulation, use white head screws and white plastic plates to match vinyl.
 - .5 Insulation clips: Insul-Anchors, adhered to substrate with Tactoo adhesive and with self locking washers by Continental Stud Welding. Clip size and type to suit application and insulation thickness. Alternative adhesive at obstructions: Air-Bloc 21 by Henry.
- 3 Execution
- 3.1 **MECHANICAL FASTENERS**
- .1 Install rigid insulation on masonry, concrete, metal, behind precast panels and where use of wedges is not possible using stick clips.
 - .2 Use five stick clips per 600 mm x 1200 mm x up to 75 mm thick. Use six stick clips per 600 mm x 1200 mm x 100 mm thick or thicker.
 - .3 Apply clips with mastic adhesive, allowing it to "ooze" out through the perforations and/or around the clip base.
 - .4 Install clips to liquid membrane by softening membrane with torch and installing fasteners into softened areas. Supplement with a small power activated pin fastener applied through fastener base to structure.
 - .5 Support adhesive-installed clips in place until adhesive has set.
- 3.2 **RIGID MINERAL FIBRE INSULATION**
- .1 Clean surfaces to receive rigid insulation free of moisture, grease and oil. Ensure surfaces are reasonably smooth and free of mortar projections.
 - .2 Knife cut and fit boards neatly around beams, pipes, ducts, openings and corners, reinforcing and bonding ties, and other obstructions.
 - .3 Butt insulation boards together and stagger joints to ensure thermal tight construction. Apply firm hand pressure to level insulation boards.

- .4 Where cutting is necessary, use the largest module of insulation possible to reduce the number of joints. Patch holes and tears with the same material.
- .5 Do not install insulation in any part of the building where protection against inclement weather has not yet been provided, and where the insulation could thereby be exposed to damage.
- .6 Insulation on liquid membrane air/vapour barrier: Apply board in 100% bond to 3.2 mm thick liquid air/vapour barrier.
- .7 Insulation on sheet membrane air/vapour barrier: Apply board using daubs of adhesive at 300 mm o.c.
- .8 Air/vapour barrier covered by insulation: Install "stick clips" to concrete or masonry substrate. After clip adhesive has cured, apply liquid air/vapour barrier to serve as insulation adhesive over the entire area to receive insulation. Apply to a uniform thickness of 3 mm. Press insulation against adhesive and stick clips. Install washers in stick clips to lock insulation in place.
- .9 Insulation covered by air/vapour barrier (and no gypsum board is subsequently applied): Apply daubs of adhesive to substrate at 300 mm o.c. into which, press insulation board. To ensure positive adhesion of insulation, mechanically fasten insulation at the middle and at each end with galvanized fasteners with smooth plastic washer buttons, at the rate of 4 per 600 mm x 1200 mm board. Depress fastener heads slightly from surface of insulation. Double tape all fastener points with vapour barrier tape.
- .10 Where more than one layer of insulation is required, stagger successive layer joints with the joints of the preceding layer and bed in adhesive trowelled solidly over the preceding layer.

3.3 **HIGH DENSITY INSULATION**

- .1 Place high density insulation under or within poured-in-place concrete in accordance with the Drawings.
- .2 Foamed-In-Place Insulation
 - .1 Install foam insulation at jambs of all doors and windows in pool in accordance with manufacturer's recommendations.
 - .2 Insulation will be inspected by the Consultant prior to the installation of the internal caulking seal.

3.4 **LOOSE INSULATION**

- .1 Install in exterior hollow metal frames, wall voids formed by metal closures, and at locations where loose insulation packing is shown on Drawings.

3.5 **WALL VOID INSULATION**

- .1 Fill exterior wall voids, such as within and around beams, under metal closures at sills of openings, and other miscellaneous locations as shown, using specified glass fibre material.

3.6 **BATT INSULATION**

- .1 Install batt insulation between steel studs; at metal closures and where shown elsewhere. Extend nailing flanges over stud faces and secure with adhesive or sheet metal screws. Install batts with vapour barrier face on warm side. Tape at top and bottom of stud spaces and at junctions with other materials, provide a complete vapour seal.

3.7 **PATCHING**

- .1 Perform cutting and patching necessary to accommodate irregularities in the Work including piping, ductwork and electrical conduit projecting through the insulation.
- .2 Ensure the continuity of the insulation where such above items project through the insulation. Allow for expansion and contraction and linear movement of these items.
- .3 Where there is a possibility of heat loss through ductwork or conduit which passes through the insulation, extend insulation around the duct or conduit a distance of 300 mm minimum on both sides of the barrier.
- .4 After installation under other sections of heating equipment and other construction adjacent to the Work of this section, conduct an inspection and replace insulation as necessitated by unavoidable minor damage caused in the course of the Work of the other sections.

3.8 **FIELD QUALITY CONTROL**

- .1 Insulation installations will be inspected and approved by the Consultant prior to the installation of ceiling and wall finishing materials. Notify Consultant forty-eight hours in advance of inspection.

End of Section

1 General

1.1 **SUMMARY**

.1 Section Includes

.1 Labour, Products, equipment and services necessary to complete the Work of this section.

1.2 **REFERENCES**

.1 Conform to the latest edition of the following:

- .1 ANSI/NAAMM HMMA-84, Tolerances and Clearances for Commercial Hollow Metal Doors and Frames
- .2 ANSI/NAAMM HMMA-867, Guide Specifications for Commercial Laminated Core Hollow Metal Doors and Frames
- .3 ASTM A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process
- .4 ASTM A924/A924M, Standard Specification for Steel Sheet, Zinc-Coated Galvanized or Zinc Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
- .5 ASTM D4726, Standard Specification for Rigid PVC Exterior Profile Extrusions Used for Assembled Windows and Doors
- .6 CAN4-S104-M, Standard Method for Fire Tests of Door Assemblies
- .7 CAN4-S105-M, Standard Specification for Fire Door Frames Meeting the Performance Required by CAN4-S104
- .8 CSA W47.1, Certification of Companies for Fusion Welding of Steel
- .9 CSA W59-M, Welded Steel Construction (Metal Arc Welding)
- .10 NFPA 80, Standard for Fire Doors and Other Opening Protective
- .11 AODA, Accessibility for Ontarians with Disabilities Act
- .12 NECB, "National Energy Code of Canada for Buildings"
- .13 ASHRAE 90.1, "Energy Standard for Sites and Buildings Except Low-Rise Residential"
- .14 OBC SB-10, "Energy Efficiency Requirements"
- .15 GANA Publications: GANA's "Laminated Glazing Reference Manual" and GANA's Glazing Manual."
- .16 AAMA Publications: AAMA GDSG-1, "Glass Design for Sloped Glazing," and AAMA TIR-A7, "Sloped Glazing Guidelines."
- .17 IGMA Publication for Sloped Glazing: IGMA TB-3001, "Guidelines for Sloped Glazing."

- .18 IGMA Publication for Insulating Glass: IGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."
- .19 NFRC 100, "Procedure for Determining Fenestration Product U-Factors"
- .20 NFRC 200, "Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and VLT"

1.3 **SUBMITTALS**

- .1 Shop Drawings
 - .1 Submit in accordance with Section 01 33 00. Clearly show in detail, gauges of metal Work, assemblies, large screen frame sections and assembly details, fastenings, hardware cutouts and reinforcing, anchorage and finish.
 - .2 Indicate doors and frames which are fire rated.
 - .3 Submit manufacturer's Product data brochure as part of Shop Drawing submittal, including hardware Product data
- .2 Product Test Reports: Based on evaluation of comprehensive fire tests performed by a qualified testing agency, for each type of standard steel door and frame.
- .3 Manufacturer not to proceed with fabrication without receipt of approved submittal drawings and approved hardware schedule, including electrical door elevations and conduit diagrams within doors and frames.
- .4 Samples:
 - .1 Glas sample: submit 305 mm x 305 mm sample of glass for verification. Glass to show all coatings, frit patterns and interlayers from manufacturers able to meet the Project's design intent and performance requirements.
 - .2 Samples shall indicate product, characteristics, and locations in the work.

1.4 **COORDINATION**

- .1 Coordinate with finish hardware Supplier to ensure proper preparation of hollow metal doors and frames for finish hardware.
- .2 Coordinate with electrical division for doors requiring conduits.

1.5 **DELIVERY, STORAGE AND HANDLING**

- .1 Protect Work against rust and damage during manufacture and delivery. Handle carefully to prevent distortion and wracking.
- .2 Protect hollow metal Work from damage. Replace damaged Work which cannot be satisfactorily repaired, restored or cleaned. Store materials on site in a manner to prevent damage.

1.6 **WARRANTY**

- .1 Warrant the Work of this section from defects in materials and workmanship and weather tight for a minimum period of Ten (10) years,
 - .1 Finish: warrant for a period of twenty (20) years

- .2 Manufacturer's warranty: Twenty-five (25) manufacturer warranty for framing, gaskets, seals and assembly components) from the date of acceptance of the Contract Work by the Owner.
- .3 Hardware: Twenty (20) years against breakage, premature wear and/or operational difficulties such as inability or increased difficulty to operate products, including an increase in operating force beyond the values in AAMA/WDMA/CSA 101/I.S.2/A440 Table 6.

2 Products

2.1 **MANUFACTURERS**

.1 Source doors and frames from one of the following:

- .1 Fleming Door Products Limited
- .2 Artek Door
- .3 Baron Metal Industries
- .4 Daybar Industries Limited
- .5 Or accepted equal

2.2 **MATERIALS**

- .1 Sheet steel: Commercial grade sheet steel conforming to ASTM A653/A653M. Sheet steel thicknesses specified are base metal thicknesses prior to galvanizing.
 - .1 Exterior Doors: coating designation Z275 (G90)
 - .2 Interior Doors: coating designation ZF75.
- .2 Frame Anchors: Commercial grade steel conforming to ASTM A653/A653M, Type B with minimum G90 (Z275).

2.3 **HOLLOW METAL DOORS (AND TRANSOM PANELS)**

.1 General:

- .1 Doors in general use areas (except high security or sensitive facilities):
 - .1 Interior: 18 gauge skin thickness, polystyrene insulated, tack welded and filled edges.
 - .2 Exterior doors: 16 gauge skin thickness, steel stiffened, insulated.
- .2 Provide 1-3/4" doors of design indicated, not less than thickness indicated; fabricated with smooth surfaces without visible joints or seams on exposed faces unless otherwise indicated.

.2 Exterior Doors:

- .1 Medium duty: Insulated, polystyrene core. Minimum R-Value 2.6 in accordance with ASTM C1363 in thermally broken frame. Thermal performance maximum U-factor 0.39. Maximum 3-hour fire rating.

- .2 Heavy duty: Insulated, stiffened hollow steel core with polyurethane insulation in accordance with ASTM C1029. Minimum R-value 3.4 in accordance with ASTM C1363 in thermally broken frame. Thermal performance maximum U-factor 0.29. Maximum 3-hour fire rating.
- .3 Interior Doors:
 - .1 Medium duty: Manufacturer's standard kraft-paper honeycomb or one-piece polystyrene core, securely bonded to both faces.
 - .2 Heavy duty: Stiffened hollow steel core with mineral fibre semi-rigid blanket and batt insulation in accordance with ASTM C592 or ASTM C553, Type 1.
- .4 Adhesive:
 - .1 Honeycomb core and steel components: Heat-resistant, spray grade resin reinforced neoprene/rubber based, low viscosity, contact cement meeting manufacturer's requirements and testing in accordance with UL/ULC certification requirements.
 - .2 Interlocking edge seams for honeycomb cores: Resin reinforced polychloroprene (RRPC), fire resistance, high viscosity, sealant/adhesive meeting manufacturer's requirements and tested in accordance with UL/ULC certification requirements.
- .5 Interior stiffeners: 0.91 mm thick (20 ga) steel.
- .6 Sound deadening and insulating material: Semi-rigid fibreglass, 24 kg/m³ minimum density, to fill core space.
- .7 Top caps: Rigid PVC extrusions conforming to CGSB 41-GP-19Ma. Fire labelled exterior doors to have factory installed flush steel top caps.
- .8 Glazing stops: 1.5 mm thick (16 ga) steel, formed, drilled and countersunk for fastenings.

2.4 **DOOR ACCESSORIES**

- .1 Door louvres: Vee shaped sight tight, with double flat frames, with 40% minimum free area, of W25 galvanized steel sheet with manufacturer's standard shop primer finish in grey colour; Airvector "T20F", Kreuger "600A", K.N. Crowder "SDL-V90", or M.W. McGill "DG 2000".
- .2 Fusible link door louvres: 1.6 mm (16 ga) cold rolled steel, fire actuated fusible link closure mechanism, minimum 25% free louvre area, baked enamel finish in colour selected by Consultant, listed and bearing the mark of ULC or Warnock Hersey. Accepted manufacturers: E. H. Price, Airflow, or K.N. Crowder.
- .3 Screws: Tamperproof stainless steel screws with countersunk flat head.
- .4 Door bumpers: In accordance with ANSI/BHMA A156.16, Type 6-180, grey neoprene.
- .5 Hardware reinforcement: 3.4 mm thick (10 ga) steel.

2.5 **HOLLOW METAL DOOR FRAMES**

- .1 Exterior Frames: Fabricated or hot-dip zinc coated steel that complies with ASTM A653/A653M, coating designation G90.
 - .1 Minimum 16-gauge thick steel sheet.

- .2 Thermal break frames: Tested for thermal performance in accordance with NFRC 100 and resistance to air infiltration in accordance with ASTM E283. Where indicated provide thermally broken frame profiles for use in both masonry and drywall construction. Fabricate with 1/16" positive thermal break and integral vinyl weatherstripping.
- .2 Interior Frames: Fabricated from cold-rolled steel sheet complying with ASTM A1008/1008M.
 - .1 Minimum 16-gauge thick steel sheet.
 - .2 Fire rated frames: Fabricate frames in accordance with NFPA 80 listed and labeled by a qualified testing agency for fire protection ratings indicated.
 - .3 Frame jambs shall extend to surface of finish floor only. Provide frame jambs with 2-piece adjustable floor anchors.
 - .4 Hardware reinforcement: Fabricate with reinforcement plates from same material as frames.
 - .5 Conduit in hollow metal frames: To CSA C22.2 No. 83-M. EMT galvanized cold rolled steel tubing.
- .3 Frame Anchors
 - .1 Frames in masonry: Adjustable "T-strap" anchors and base anchor.
 - .2 Frames in precast (concrete): Countersunk galvanized expansion bolts complete with base anchors, and spacers behind hollow metal frame.
 - .3 Frames in steel channel sub-frames: Countersunk fluorocarbon coated self drilling screws complete with spacers behind hollow metal frame.
 - .4 Labeled frames: To conform to ULC or Warnock Hersey requirements.
 - .5 Frames in gypsum board partitions: Steel anchor clips and adjustable base anchors of suitable design securely welded inside each jamb.
 - .6 Floor anchors: Minimum 3.5 mm thick adjustable hot dip galvanized base anchors with two holes for bolting to floor.

2.6 **LIGHT OPENINGS AND GLAZING**

- .1 Refer to Section 08 80 00 for glazing types and applications.
- .2 Stops and mouldings: Provide stops and mouldings around glazed lites where indicated. Form corners of stops and mouldings with butted or mitered hairline joints at fabricator's shop. Fixed and removable stops to allow multiple glazed lites each to be removed independently. Coordinate frame rabbet widths between fixed and removable stops with the type of glazing and installation indicated.
- .3 Mouldings for glazed lites in doors and loose stops for glazed lites in frames: Minimum 20 gauge, fabricated from same material as door face sheet in which they are installed.
- .4 Fixed frame mouldings: Formed integral with hollow metal frames, minimum 16 mm high unless otherwise indicated. Provide fixed frame mouldings and stops on outside of exterior and on secure side of interior doors and frames.

- .5 Preformed metal frames for light openings: Manufacturer's standard frame formed of cold rolled steel sheet with baked enamel or powder coated finish. Approved for use in doors of fire protection rating indicated. Match pre-finished door paint colour where applicable.

2.7 FABRICATION

- .1 Finish Work free from warp, open seams, buckles, weld and grind marks and other surface defects detrimental to attainment of a good paint finish in field. Form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer's plant. When shipping limitations dictate, frames for large openings are to be fabricated in sections for splicing or splining in the field by others.
- .2 Arc weld joints in accordance with CSA W59-M to produce a finished unit, square, true and free of distortion. Continuous weld joints unless specified otherwise. Execute welding by a firm fully approved by Canadian Welding Bureau to requirements of CSA W47.1.
- .3 Ream and remove burrs from cutouts and from drilled and punched holes.
- .4 Doors that do not require labels shall have label holes properly filled at the factory prior to shipping to Site.
- .5 Hollow Metal Doors and Transoms
 - .1 Doors: Flush swing type of sizes to details, schedules and reviewed Shop Drawings with cutouts for glass and grilles and reinforced to receive hardware fastenings.
 - .1 Blank, reinforce, drill and tap doors for mortised, template hardware. Where required, reinforce doors for surface-mounted hardware and door closers.
 - .2 Provide inverted, recessed, spot welded channels at top and bottom of doors. Provide PVC top caps on exterior doors.
 - .3 Provide cutouts with framing, glass stop mouldings and division bars where openings are required.
 - .4 Glass stops: Drill and countersink glass stops, secure with stainless steel tamper-proof flat head screws spaced at maximum 150 mm o.c. Provide stainless steel stops for stainless steel doors.
 - .5 Door seams:
 - .1 Laminated doors: Adhesive assisted lock seam.
 - .2 Steel stiffened doors: Continuous welded edges.
 - .2 Exterior Insulated Doors:
 - .1 Vertical edges:
 - .1 Vertical edges to be mechanically interlocked with hairline seam, continuously welded, filled and ground smooth full height of door.
 - .2 Top and bottom edges:

- .1 Reinforced tops and bottoms of doors with continuous steel channel minimum 16 gauge, extending full width of door and welded to face sheet.
- .2 Doors with inverted top channel to include steel top cap welded in place with web of channel flush with face sheets of door.
- .3 Plastic or composite fillers shall not be used.
- .3 Transoms: Fabricate from same materials and construction and finish in same manner as doors.
- .6 Frames and Screens
 - .1 Welded frames: Weld flush face joints continuously. Grind, fill, dress and make smooth, flush and invisible.
 - .1 Welded frames are to be provided with two steel spreaders temporarily attached to the bottom of both jambs to serve as a brace during shipping. Spreader bars are for bracing only and are not to be used to size the frame opening.
 - .2 Furnish exterior door frames with continuously welded integral steel weather drip at head of frame.
 - .2 Sidelight and Transom Bar Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by butt welding.
 - .3 Floor anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.
 - .4 Where frames are set in masonry or concrete, supply adjustable anchors to trade installing frame.
 - .5 Fabricate frames for installation in gypsum board partitions with steel anchors. Minimum number of anchors for each jamb is as follows:
 - .1 4 anchors for frames up to 2285 mm.
 - .2 5 anchors for frames from 2285 mm to 2440 mm.
 - .3 5 anchors, plus one additional for each 600 mm over in height for frames over 2440 mm.
 - .6 Frames in previously placed concrete, masonry, precast or structural steel: Anchors located at maximum 150 mm from top and bottom of each jamb, and intermediate anchors at maximum 660 mm o.c.
 - .7 Prepare each door opening for single stud rubber door silencers. Three for single door openings located in strike jamb and two for double door openings located in head.
- .7 Thermally broken door frames:
 - .1 For conditions where extreme temperature differences occur, use thermally broken commercial knocked-down or welded steel frames to decrease thermal conductivity.

- .2 Manufactured from 16 gauge paintable galvaneal steel.
 - .3 171.4 mm jamb depth.
 - .4 Where thermally broken welded frame is required, ensure welds do not cause thermal transfers between interior and exterior surfaces of frame sections.
 - .5 Fabricate interior and exterior sections of thermally broken frames with continuous PVC thermal break separation.
 - .6 Thermally broken sections shall not be assembled with screws, grommets or other fasteners.
 - .7 Closed sections (mullions and centre rails) of thermally broken frames to be factory insulated with 24 kg/m³ of loose batt type fiberglass material.
 - .8 Fire Rated Doors and Frames
 - .1 Fabricate doors and frames for hourly rating noted on door schedules in conformance with CAN4 S104-M and CAN4 S105-M. Furnish door and frames with the appropriate label of a testing organization accredited by Standard Council of Canada in conformance with the foregoing standards.
 - .2 Label the entire assembly of fire rated screens containing doors.
 - .3 Locate fire rating label on doors on hinged edge midway between top hinge and head of door. Locate fire rating label on frames in door rebate.
 - .4 Mortise, reinforce, drill and tap doors to receive template hardware and reinforce for surface mounted hardware, all as per requirements of foregoing standards.
 - .9 Temperature Rise Limit
 - .1 Where located in a firewall, fabricate doors to achieve the Temperature Rise Limit (TRL) indicated in the Ontario Building Code.
 - .2 Provide such doors with a combined fire rating/temperature rise limit label. Locate as previously specified.
 - .10 Insulated hollow metal transom panels: Same as for hollow metal door construction complete with drip flashings on exterior panels.
 - .11 Preparation for security system: Hollow metal doors will be monitored to a central security system as indicated on Drawings. Provide frame with metal mortar guard at back side of hinge and with a 19 mm diameter rigid galvanized steel conduit from top of mortar guard to 300 mm above door head.
- 3 Execution
- 3.1 **INSTALLATION**
- .1 Setting of hollow metal frames:
 - .1 Erect door frames, (glazed screen and borrowed light frames) plumb, square and level, maintaining widths and heights.

- .2 Brace frames solidly in position while being built into masonry. Install temporary wood spreaders at mid-height of door frames, full width, until adjacent masonry Work is complete.
 - .3 Pack the door jamb and head voids which occur in exterior walls with specified insulation.
 - .4 Tap structural steel to coincide with fastener spacing on hollow metal door frame. Place spacer at each fastener location and install fastener.
 - .5 Tighten fastener, with head flush to frame. Apply metal filler to fastener head. Sand filler flush to frame and prepare for paint finish.
- .2 Installation of doors and finish hardware is specified in Section 08 71 05 - Installation of Doors and Finish Hardware.
- .3 Door Hardware and Painting
- .1 Install door hardware supplied by Section 08 71 00 - Finish Hardware.
 - .2 Install door hardware in accordance with hardware templates and manufacturer's written instructions.
 - .3 Install louvres, glazing and silencers.
 - .4 Finish paint in accordance with Section 09 91 00 Painting.
- End of Section

1 General

1.1 **SUMMARY**

.1 Section Includes

- .1 Labour, Products, equipment and services necessary to complete the Work of this section.
- .2 This section shall be read in conjunction with Appendix A City of Toronto Corporate Building System Design Requirements. Appendix A shall take precedence where there is a conflict in this Section.

1.2 **REFERENCES**

.1 Conform to the latest edition of the following:

- .1 CAN/CGSB-12.1-M, Tempered or Laminated Safety Glass
- .2 CAN/CGSB-12.10-M, Glass, Light and Heat Reflecting
- .3 CAN/CGSB-1.108-M, Bituminous Solvent Type Paint
- .4 CAN/CSA G40.20/ G40.21-M, Welded Structural Quality Steel/Structural Quality Steels
- .5 CAN/CGSB 19.24-M, Multi-Component, Chemical-Curing Sealing Compound
- .6 ASTM A446/A446M, Specification for Steel Sheet, Zinc Coated (Galvanized) by the Hop Dip Process, Structural (Physical) Quality
- .7 NAAMM AMP-505, The National Association of Architectural Metal Manufacturers, Applied Coatings
- .8 NAAMM AMP-501, The National Association of Architectural Metal Manufacturers, Finishes for Aluminum
- .9 AODA - Accessibility for Ontarians with Disabilities Act
- .10 NECB, "National Energy Code of Canada for Buildings"
- .11 ASHRAE 90.1, "Energy Standard for Sites and Buildings Except Low-Rise Residential"
- .12 OBC SB-10, "Energy Efficiency Requirements"
- .13 GANA Publications: GANA's "Laminated Glazing Reference Manual" and GANA's Glazing Manual."
- .14 AAMA Publications: AAMA GD5G-1, "Glass Design for Sloped Glazing," and AAMA TIR-A7, "Sloped Glazing Guidelines."
- .15 IGMA Publication for Sloped Glazing: IGMA TB-3001, "Guidelines for Sloped Glazing."
- .16 IGMA Publication for Insulating Glass: IGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."
- .17 NFRC 100, "Procedure for Determining Fenestration Product U-Factors"

- .18 NFRC 200, "Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and VLT

1.3 **SUBMITTALS**

.1 Samples

- .1 Submit in accordance with Section 01 33 00.
- .2 Submit duplicate sample sections of all component parts of entrances, curtain wall, windows, glass and spandrel panels, finished in specified colours. Sizes of samples as follows:
 - .1 Extruded shapes: 300 mm
 - .2 Each type of glass: 300 mm square

.2 Shop Drawings

- .1 Submit in accordance with Section 01 33 00.
- .2 Show fabrication and erection details of all components and accessories. (Prior to review by the Consultant, submit Shop Drawings and calculations to structural silicone sealant manufacturer for review and approval.) Show the following on the Shop Drawings:
 - .1 Interface conditions with adjoining works.
 - .2 Sealant locations and joint detail including joint back-up.
 - .3 Interior structure and/or reinforcements.
 - .4 Extruded framing system for all members (plans and sections, in half full size, if not of the manufacture specified and drawn). Show thermal breaks and what material.
 - .5 Glazing and glass stop details, vinyl or neoprene mouldings (in half full size), and all anchorage and assembly fixings.
 - .6 Ventilator details showing hardware locations and a note confirming that operating hardware is accessible for unobstructed hand operation.
 - .7 List of materials used for every component.
- .3 Indicate how thermal expansion and contraction are to be accommodated and to what degree. Show connections to adjacent construction and provision made for structural deflections, contractions, expansion and other normal movement..

1.4 **GENERAL DESIGN**

- .1 Make thorough examination of all Drawings and details, check interfacing with Work of other Contracts and other factors influencing the engineering design and performance of the Work and be fully cognizant of requirements.
- .2 Drawings and Specifications do not intend to identify or solve the requirements of thermal, structural, vapour and air movement, methods of anchorage, flatness and other requirements. Be responsible for all of these aspects. Base design on the "rainscreen principle" as advocated by National Research Council of Canada (NRC).
- .3 Design to withstand without failure, the positive and negative forces imposed by wind, earthquake, temperature and shrinkage stress, deflections of the supporting or adjacent

structures, all within deflection limitations governed by the design of the supporting structure. Calculate external pressure of suction due to wind on part or all of the surface of the units in accordance with the Ontario Building Code.

- .4 Design in such a way that completed installation is free from rattles, wind whistles and noise due to thermal and structural movement and air pressure.

1.5 **DESIGN REQUIREMENTS**

- .1 Be responsible for the design of components and accessories thereof and connections in accordance with the requirements of the Ontario Building Code.
- .2 Design to prevent accumulation of condensate on interior side of window frame under the following service conditions:
 - .1 Interior temperature: 25°C (77°F).
 - .2 Exterior temperature: -20°C (-4°F).
 - .3 Interior RH: 40%.
- .3 Restrict air infiltration/exfiltration, through window assembly to 0.25 m³/h/m⁻¹ and doors to 2.79 m³/h/m⁻¹ at reference pressure differential of 75 Pa, when measured in accordance with ASTM E283.
- .4 No water infiltration when tested to ASTM E331 with pressure differential of 720 Pa (15.0 psf).
- .5 Design glass in accordance with CAN/CGSB-12.20-M. Perform stress analysis. Design units to accommodate live, dead, lateral, wind, seismic, handling, transportation, and erection loads.
- .6 Prevent deflection and permanent or progressive glazing displacement. Restrict horizontal and vertical mullion deflection to less than L/175 (under uniformly distributed positive design wind load), and 10 mm maximum regardless of span.
- .7 Design anchorage inserts for installation as part of other sections of Work. Design anchorage assemblies to accommodate construction and installation tolerances.

1.6 **DELIVERY, HANDLING AND STORAGE**

- .1 Transport materials to the job site storage compound in such a manner as to prevent in-transit damage. These measures shall include, but not limited to, crating, polyethylene wrapping system, etc.
- .2 Store in a dry, protected area on site, in original undamaged containers with manufacturers labels and seals intact.
- .3 Provide interleaving protection between glass. Keep glass and interleaving dry and store cases in clean, cool, dry areas with temperatures above the dewpoint. Circulation of cool, dry air in storage areas is essential. Open cases and inspect units periodically for moisture accumulation. Do not store glass in direct sunlight without an opaque protective covering over same.
- .4 Remove damaged or unsatisfactory materials from the site and replace with new materials to the satisfaction of the Consultant at no cost to the Owner.

1.7 **QUALITY ASSURANCE**

- .1 Have a senior, qualified representative of the silicone sealant manufacturer present at the job site to supervise the butt glazing Work at all times.

1.8 **TESTING AND INSPECTION**

- .1 The Owner may retain an independent inspection company approved by the Consultant to inspect Work of this section and to perform additional shop and field inspection as required. Inspections and tests will be paid for by the Owner except that the Contractor will be required to pay for inspection tests which show results not meeting the requirements of the Specifications or Drawings and for subsequent inspections made necessarily thereby.
- .2 The inspection company will verify that Shop Drawings show that the Work of this section has been designed in accordance with established building envelope design principles.

1.9 **PROTECTION**

- .1 Protect the Work of this trade from damage. Protect Work of other trades resulting from the Work of this section.
- .2 Install at the factory, strippable coatings on all exposed surfaces of aluminum. Leave coating and protective wrappings on the surfaces through the period that other trades work proceeds on the building. Remove on completion of the Work.
- .3 Comply with unpacking procedures as recommended by framing and glass manufacturers.
- .4 Make good all damaged Work caused by failure to provide adequate protection. Remove unsatisfactory Work and replace at no expense to the Owner.

1.10 **WARRANTY**

- .1 Warrant Work of this section against defects and deficiencies for the periods specified below from date Work is certified as substantially performed in accordance with the general conditions of the Contract.
- .2 Promptly make good defects and deficiencies which become apparent within the Warranty Period by replacing defective Work satisfactory to the Consultant and at no expense to the Owner.
- .3 Warrant the Work as follows:
 - .1 Work in general: Ten (10) year warranty against defects and failure of system, and to remain completely weathertight and air and water leakproof within the tolerances and limits specified.
 - .2 Warrant the Work of this section from defects in materials and workmanship and weather tight for a minimum period of Ten (10) years,
 - .3 Finish: warrant for a period of twenty (20) years
 - .4 Manufacturer's warranty: Twenty-five (25) manufacturer warranty for framing, gaskets, seals and assembly components) from the date of acceptance of the Contract Work by the Owner.
 - .5 Hardware: Twenty (20) years against breakage, premature wear and/or operational difficulties such as inability or increased difficulty to operate products,

including an increase in operating force beyond the values in AAMA/WDMA/CSA 101/I.S.2/A440 Table 6.

2 Products

2.1 **MATERIALS**

.1 Aluminum Extrusions: Alloy and temper recommended by aluminum-framed entrance door manufacturer for strength, corrosion resistance, and application of required finish and not less than 0.090" wall thickness at any location for the main frame and door leaf members.

.2 Aluminum

- .1 Extrusions: AA6063-T5 alloy, anodizing quality, conforming to ASTM B221.
- .2 Plate and sheet: AA1100-H14 alloy, anodizing quality unless otherwise indicated minimum 3 mm thick, conforming to ASTM B209.
- .3 Exposed surfaces of aluminum shall be free of die marks, scratches, blisters, "leave-off marks", or other blemishes, whether left unfinished or finished.

2.2 **SYSTEM DESCRIPTION:**

- .1 Exterior Entrance: Thermally broken aluminum extrusions, factory anodized finish, with related flashings, hardware, anchorage, weatherstripping and attachment devices. To match existing conditions.
- .2 Interior Vestibules: aluminum extrusions, factory anodized finish, sealed single pane tempered safety glass with related hardware, anchorage, and attachment devices. Extend vertical framing to underside of structural framing and provide required support.

2.3 **ALUMINUM ENTRANCE FRAMES**

.1 Non-thermally Broken, Single Glazed Systems

- .1 Extruded aluminum frame: conforming to ASTM B221, 6063 alloy, flush glazing stops, anodizing quality for exposed surfaces.
- .2 Refer to Section 08 80 00 Glazing.

.2 Thermally Broken, Double Glazed Systems

- .1 Extruded aluminum sections, dimension to match existing condition, thermally broken. Provide complete with flush glazing stops, internal drainage system where required.
- .2 Refer to Section 08 80 00 Glazing.

2.4 **DOORS**

.1 Extruded aluminum sections, flush glazing stops, top rail and stiles, bottom and mid-rail or as indicated on Drawings. Door to match existing conditions.

.2 Door thickness: 44 mm

.3 Door size as indicated on Drawings

.4 Door Hardware. Provide manufacturer's standard and recommended hardware as required for door system applications. Provide complete sets including rails, hangers,

supports, bumpers, floor guides, and accessories indicated. Refer to Hardware schedules.

2.5 **ACCESSORIES**

- .1 Perimeter sealant: One part silicone neutral cure low modulus sealant. Colour as selected by the Consultant from standard colour selection.
- .2 Screws, bolts and fasteners: Self tapping electrozinc plated or cadmium plated steel for aluminum to aluminum contact and stainless steel for aluminum to steel contact.
- .3 Steel reinforcements and anchors: Conforming to CAN/CSA-G40.20/G40.21-M, Grade 300W hot-dip galvanized to CSA G164-M requirements.
- .4 Isolation coating: Henry "410-02" bituminous paint or zinc chromate paint.
- .5 Thermal break material: Polyvinylchloride, of semi-rigid durometer hardness of 80, plus or minus 5, located on the external side of the glass pane.
- .6 Door weatherstripping: Heavy duty mohair pile material designed for easy removal and replacement when worn, complete with adjustable fixing to ensure a full "wipe" of the threshold below.
- .7 Compressible filler: Ceramar by W.R. Meadows or CPD Closed Cell Foam.
- .8 Loose insulation: Loose fibreglass or mineral wool.
- .9 Temporary strips: 25 mm wide, light reflecting, easily removable, pressure sensitive tape applied over all glass. Doors shall have two cross stripes at eye level, windows and curtain wall shall have corner to corner cross stripes from aluminum frames.
- .10 Door track:
 - .1 Top and Bottom Track: Surface mounted, extruded aluminum single track profile.
 - .2 Side Track: Single Surface mounted, extruded aluminum track reinforced to take locking hardware.

2.6 **FABRICATION**

- .1 General
 - .1 Form all sections true to detail, free from defects impairing appearance, strength and durability.
 - .2 Fabricate frames with thermal breaks.
 - .3 Mullions and frames shall be tubular extruded shapes with sharp, well defined corners.
 - .4 Overall assembled profiles shall be as detailed on the Drawings. Curtain wall glazing shall be replaceable from the exterior while window glazing shall be replaceable from the interior.
 - .5 Make provision at all sealed horizontals to lead moisture accumulation to the exterior. Provide drainage leads in the pressure plates and horizontal snap-on covers for this purpose.
 - .6 Pressure plates shall be of extruded aluminum with integrally aligned sockets to receive and hold the latch bulbs of the snap-on face caps.

- .7 Form continuous sills, stools and flashings with intermediate clips, anchorages and reinforcing and as much as possible, be shop assembled. Furnish all filler and closure pieces as required.
 - .8 Locate thermal break on the exterior side of the glazing and secure by snap-in methods without the use of any metallic fasteners which could reduce the effectiveness of the thermal barrier.
 - .9 Make provision in the Work for vertical and horizontal expansion and contraction and structural deflections.
 - .10 Mitre and closely fit all corners of formed Work. Apply back-up sealants on the inside of joints. Provide drainage towards the exterior at the bottom of all glazing rebates.
 - .11 Attach all anchorages to the warm side.
 - .12 Carry out all welding with argon shielded electric arcs to ensure complete fusion of the metal.
 - .13 Fabrication Tolerance: to be in accordance with Appendix A, City of Toronto Corporate Building System Design Requirements.
- .2 Doors
- .1 Aluminum doors shall have square snap-on glazing beads designed for EPDM glazing gaskets.
 - .2 Equip doors with full weatherstripping at perimeter. Install weatherstripping throughout the full length and width of the doors at jambs and heads.
 - .3 Fabricate doors and frames complete with all necessary internal reinforcements, cutouts, recesses, mortising or milling operations required for a rigid assembly and to accommodate finish hardware. All connections shall ensure adequate strength.
 - .4 Fabricate frames with joints accurately fitted and securely jointed together in a manner to ensure tightly fitting joints. Internally seal corners of frames and all joints exposed to water penetration using a material compatible to resist flow at the high surface summer temperatures to be experienced by the metal.
- .3 Doors - Barrier Free Access
- .1 Prepare doors where indicated to accommodate power operators and pushbutton controls to allow barrier-free access. Provide a barrier-free logo above pushbutton.
 - .2 Coordinate as required for the satisfactory installation of finish hardware by Section 08 71 05.
- .4 Insulated Spandrel Panel Back-Up
- .1 Form panels with offset edge flange to provide flush surface at edge of pan. Bond insulation to panel back-up with daubs of mastic adhesive.
 - .2 Provide integral reinforcing and stiffeners as required.
 - .3 Weld corners of panels and grind smooth or butter corner joints with butyl sealant.

2.7 **PROTECTION OF METALS**

- .1 Provide protection against galvanic action wherever dissimilar metals are in contact, either by painting the contact surfaces with a heavy coat of zinc chromate primer, or by the application of an appropriate sealant or tape.
- .2 Protect aluminum which is to be in contact with cured concrete with zinc chromate primer or bituminous paint, and wherever crevices between the contact surfaces may entrap moisture or other corrosive elements.

3 Execution

3.1 **INSPECTION OF JOB CONDITIONS**

- .1 Inspect existing conditions upon which Work of this section is dependent. Report to the Consultant in writing any defects or discrepancies. Commencement of Work implies acceptance of existing conditions.

3.2 **INSTALLATION**

.1 Windows

- .1 Set units in their correct location, level, square and plumb and at proper elevations, with the nominal face of the framing aligned in a single vertical plane. Fasten and anchor framing in place.
- .2 Accurately measure glass openings and calculate glass size based on manufacturer's installation tables allowing for proper edge engagement, rabbet width, rabbet depth and expansion.

.2 Assembly and Anchorage

- .1 Anchor component parts securely in place by bolting, welding or other permanent mechanical attachment system, which will comply with performance requirements and permit movement as intended or necessary. Install slip-joint linings where required to ensure movement as per design.
- .2 Allow for complete adjustment in anchorage for levelling and positioning of units during installation.

.3 Erection Tolerances

- .1 Limit variations from plumb, level or dimensioned angle to the following:
 - .1 Plumb: 3.2 mm in 3 m; non-cumulative.
 - .2 Level: 3.2 mm in 6 m; non-cumulative.
 - .3 Alignment: End to end or edge to edge offset of adjoining consecutive element to 1.6 mm.
 - .4 Location and Plane: Limit variation from plane to 1 3.2 mm in 3.6 m; 12.7 mm over total length.
 - .5 Diagonal Measurements: Limit difference between diagonal measurements to 3.2 mm
 - .6 Tolerances shall not be cumulative.

.4 Doors

- .1 Install doors plumb, square, level, free from warp, twist and superimposed loads.
- .2 Secure Work adequately and accurately to structure in the required position, in a manner not to restrict thermal movement.
- .3 Provide compressible filler over aluminum work at locations shown on Drawings.
- .4 Use aluminum or long-life coated steel screws, nuts, bolts, washers, rivets and all other fastening devices, colour to match doors and frames where exposed to view.

3.3 **GLAZING**

- .1 Use extruded gaskets for door and sidelight glazing. Extruded gaskets shall comply with ASTM C509.
- .2 Thoroughly wipe all surfaces receiving glazing materials with a cloth dampened in xylol to assure a clean surface.
- .3 Use glazing tape for glass and aluminum spandrel panels except at butt glazing, use structural silicone sealant and spacer blocks. Provide temporary pinning at butt glazed joints.
- .4 At horizontal mullions and frames secure lites with screw applied pressure plates into the main grid members. Mitre glazing tape at all end joints, corners and at junctions. Screw fasteners shall be 1/4-20 machine screws. Contain glazing tape on pressure plates with a rigid polyvinyl chloride spacer. Internal seal shall be bulb type silicone extrusions.
- .5 Place setting blocks at quarter points from each corner of glass. Centre glass in opening and press firmly against tape. Roll-in inside resilient extrusion.

3.4 **JOINT SEALANT AND SEALS**

.1 Joint Sealant

- .1 At interior and exterior joints between aluminum framing and adjacent Work of others execute the following Work:
 - .1 Install backer rod as required to provide sealant joints of proper form, thickness-to-width ratios, and to provide bond break at back side of sealant. Where backer rod cannot be used, use bond breaker tape to back side of sealant joint substrate.
 - .2 Clean substrate surfaces to which sealant is to bond and apply sealant primers as recommended by sealant manufacturer.
 - .3 Seal joints continuous to produce weatherproof and visually acceptable joint installation.
- .2 Install backer rod between butt glazed insulating and spandrel glass units, and between units to adjacent structures as shown. Seal joints continuous to produce weatherproof and visually acceptable joint installation.
- .3 Seal all joints required for a weatherproof installation and against air/vapour leakage. Use materials in strict accordance with the manufacturer's printed instructions, and applied only by tradesmen specially trained or experienced in their use. Before applying sealants, completely remove all mortar, dirt, dust, moisture and other foreign matter from surfaces it will contact. Mask adjoining

surfaces when required, to maintain a clean and neat appearance. Total sealing compounds to fill the joint and provide a smooth finished surface.

.4 Refer to and comply with workmanship requirements of Section 07 92 00.

.2 Foamed-In-Place Air Seals

.1 Prior to application, remove mortar, dirt, dust, moisture and other foreign matter from joints to be sealed.

.2 Apply seal in accordance with manufacturer's directions. Fill all joints. Trim off excess seal.

.3 Airseal Transition Membrane

.1 Apply primer and airseal transition membrane in accordance with membrane manufacturer's instructions. Use primer in conjunction with adhesive if part of system.

.2 Re-prime surfaces not covered with transition membrane during the same working day.

.3 Overlap airseal transition membrane 75 mm minimum. Lap in the direction of waterflow. Coordinate the airseal transition with adjacent parts of the Work.

3.5 **FIELD QUALITY CONTROL**

.1 Field Testing in the field by independent inspection agency retained by the City. Testing shall be performed after completing the installation of the Work and before the installation of interior finishes has begun.

.2 Testing and inspecting a representative areas of the Work as installation proceeds to determine compliance of installed assemblies with specified requirements.

.3 Repair or remove and replace Work that is considered defective, does not meet requirements or that is damaged by testing.

3.6 **CLEAN UP**

.1 Maintain the units in a clean condition throughout construction period, so that they will be without deterioration or damage at time of Owner's acceptance. Select methods of cleaning which will promote achievement of uniform appearance and stabilized colours and textures for materials that weather or age with exposure.

.2 Immediately before time of Substantial Performance, wash glass thoroughly, inside and out.

.3 Do not use steel wool, wire brushes or steel scrapers on finished surfaces.

.4 Daily during this Work, and on completion, remove from the job site, all rubbish, debris, broken glass, temporary safety markings and excess materials resulting from this Work.

.5 Remove protective covering and coating from aluminum surfaces, inside and out, and clean all surfaces, remove all labels, temporary stripes and protective devices and polish all glass surfaces, immediately prior to final acceptance of the Work by the Consultant.

End of Section

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- 1 General
- 1.1 **FINISH HARDWARE**
- .1 Supply door hardware for this Project, complete with templates, installation instructions, screws, expansion shields, anchors and other related accessories, and schedule delivery to avoid delaying the progress of the Work. Deliver hardware to the job site packaged, labelled and cross-referenced to the hardware schedule in such a manner that all items may be readily located to their scheduled location on the Work.
- 1.2 **REQUIREMENTS OF REGULATORY AGENCIES**
- .1 Use ULC listed and/or Warnock Hersey International labelled hardware for doors in fire separations and exit doors.
- 1.3 **QUALITY ASSURANCE**
- .1 Standards: Comply with standards specified in this section.
- .2 Qualifications of manufacturers: Products supplied under this section shall be from manufacturers regularly engaged in manufacture of similar items and with history of successful production acceptable to the Consultant.
- 1.4 **SUBMITTALS**
- .1 Submit in accordance with Section 01 33 00.
- .2 Product Data of Manufacturer's specifications, catalogue cuts and other data required to demonstrate compliance with specified requirements.
- .3 Identify each hardware item by manufacturer, manufacturer's catalogue number, material, function, finish and location of item in Work.
- .4 Review of hardware list by Consultant shall not relieve Contractor from responsibility for furnishing all required finish hardware.
- 1.5 **SAMPLES**
- .1 Deliver physical samples of approved finish hardware items to Consultant within fifteen Calendar Days.
- .2 Identify each sample by label indicating applicable Specification paragraph or line number, brand name and number, finish and hardware package number.
- .3 Substitute new samples for those rejected by Consultant.
- .4 Consultant will retain samples until completion of Project, at which time, samples will be returned to Supplier.
- .5 Do not deliver any hardware to Site until all samples have been approved.
- 1.6 **PRODUCT HANDLING**
- .1 Packaging and marking: Individually package each unit of finish hardware, complete with proper fastenings and appurtenances, clearly marked on outside to indicate contents and specific locations in the Work.
- .2 Replacements: In the event of damage, immediately make all repairs and replacements necessary to approval of Consultant and at no additional cost to Owner.

1.7 **MAINTENANCE**

- .1 Maintenance data: Submit maintenance data, parts list and manufacturer's instructions for each type of door closer, lockset, latchset, door holders and fire exit hardware for incorporation into maintenance manual specified in Section 01 33 00.
- .2 Brief maintenance staff regarding proper care, cleaning and general maintenance.
- .3 Supply special wrenches and tools for door closers, locksets and fire exit hardware.

1.8 **DELIVERY AND STORAGE**

- .1 Store finish hardware in locked, clean and dry area on site.
- .2 Package each item of hardware including fastenings, separately or in like groups of hardware, label each package as to item definition and location.
- .3 Maintain inventory list with hardware schedule.

1.9 **HARDWARE LIST**

- .1 The Supplier shall thoroughly check the hardware list forming part of this section and shall bring to the attention of the Consultant any errors or omissions therein.
- .2 Confirm degrees of swing for door holders and closers.

1.10 **DOOR SCHEDULES**

- .1 The Supplier shall thoroughly check the door schedules and Working Drawings to ensure that hardware listed can be used as specified in accordance with building codes and function. Bring to attention of the Consultant any errors or omissions therein.
- .2 Doors shown on Drawings and omitted from the schedules shall be included on the detailed finish hardware list.

1.11 **WARRANTY**

- .1 Warrant the Work of this Section for a period of 20 years against defects and deficiencies in accordance with the Contract.
- .2 Defects shall include but not limited to premature wear, operational difficulties such as inability or increased difficulties to operate product, increased or increase in operating force beyond values in AAMA/WDMA/CSA 101/I.S.2/A440 Table 6.
- .3 Promptly correct any defects or deficiencies which become apparent within the warranty period, to the satisfaction of the Consultant at no expense to the Owner.

2 Products

2.1 **GENERAL**

- .1 Manufacturers: Products listed in the hardware schedule are from the manufacturers listed in the door hardware schedule. Alternative Suppliers other than those listed will not be considered.
- .2 Fasteners: Furnish all finish hardware with all screws, bolts and other fasteners of suitable size and type necessary to anchor hardware in position for trouble-free service under heavy duty usage.

- .1 Furnish fastenings where necessary with expansion shields, toggle bolts and other anchors acceptable to Consultant, depending on material to which hardware is to be applied and recommendations of hardware manufacturer.
- .2 Fastenings shall harmonize with hardware as to material and finish.
- .3 Exposed screws for installing hardware shall have Phillips or Robertson heads.
- .4 Finishes: Hardware shall match finish of locksets. Take special care to coordinate all various manufactured items furnished under this section, to ensure an acceptable uniform finish.

2.2 **MANUFACTURERS**

- .1 As indicated in Hardware Schedule.

2.3 **MATERIALS**

- .1 Provide all products as indicated to Hardware Schedule.

2.4 **KEYING**

- .1 All locksets, panic hardware and key switches will be supplied complete with Medeco high security, removable core cylinders, master keyed to a grand master key system.
- .2 Supply the following:
 - .1 Three keys for each permanent cylinder core
 - .2 Two keys for each construction (temporary core)
 - .3 Three construction master keys
 - .4 Twelve grand master keys

2.5 **KEY CONTROL AND KEY CABINET**

- .1 Finishes – to BHMA A156.18
- .2 Description
 - .1 600 Primed for paint
 - .2 605 Polished Brass
 - .3 606 Satin Brass
 - .4 612 Satin Bronze
 - .5 613 Oil Rubbed Bronze
 - .6 618 Polished Nickel (on brass or bronze base metal)
 - .7 619 Satin Nickel (on brass or bronze base metal)
 - .8 622 Flat Black (on brass or bronze base metal))
 - .9 625 Polished Chrome (on brass or bronze base metal)
 - .10 626 Satin Chrome (on brass or bronze base metal)

.11	628	Satin Aluminum (anodized)
.12	628/B	Extruded Satin Aluminum/Brush
.13	628/P	Extruded Satin Aluminum/Pile
.14	629	Polished Stainless Steel
.15	630	Satin Stainless Steel
.16	631	Flat Black Steel
.17	632	Polished Brass Steel
.18	633	Satin Brass Steel
.19	640	Oil Rubbed Bronze Steel
.20	645	Polished Nickel Steel
.21	646	Satin Nickel Steel
.22	651	Polished Chrome Steel
.23	652	Satin Chrome (on steel base metal)
.24	671	Flat Black Aluminum
.25	689	Satin Aluminum Paint
.26	693	Flat Black (painted/powder coat)
.27	695	Oil Rubbed Bronze (painted/powder coat)
.28	702	Satin Chrome Aluminum
.29	703	Oil Rubbed Bronze Aluminum
.30	ALUM	Extruded Aluminum Mill Finish (thresholds)

3 Execution

3.1 **DELIVERY**

- .1 Stockpile all items sufficiently in advance to ensure their delivery to the site in a timely manner to ensure orderly progress of Work.

3.2 **INSTALLATION INSTRUCTIONS**

- .1 Furnish metal door and frame manufacturers with complete instructions and templates for preparation of their Work to receive hardware.
- .2 Furnish manufacturer's instructions for proper installation of each hardware component.
- .3 Fully adjust all non-sized or universal door closers in strict accordance with the manufacturer's printed instructions for spring power closing speed, latching speed and backcheck at the time of installation.

3.3 **EXAMINATION**

- .1 Prior to commencing verify site conditions and previously constructed Work which is to receive this Work. Notify the Consultant if areas are not acceptable for installation. Do not begin installation until acceptable conditions have been met.

3.4 **KEY SECURITY**

- .1 Deliver to, and install all cylinders at the jobsite.
- .2 Key all doors to receive locks according to an approved key schedule.

3.5 **INSTALLATION**

- .1 Hardware installation is specified in Section 08 71 05 - Installation of Doors and Finish Hardware.

3.6 **ADJUSTMENT**

- .1 Coordinate with hardware installer and adjust all items of hardware to operate smoothly. If a manufacturer's representative has done this Work, forward written confirmation of same.
- .2 Prepare or replace any hardware found defective.

3.7 **HARDWARE SCHEDULE**

- .1 As per list following this section. Hardware schedule was prepared by Spyder SC.

End of Section

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DOOR HARDWARE

08 71 00

PROJECT: 
CITY OF TORONTO
Modern TO Office
95 The Esplanade,
Toronto, Ontario

ARCHITECT: 
175 Galaxy Blvd, Unit 100
Toronto, Ontario

Prepared By: Alex Bekmansourov
Date: December 20, 2024
Revised: January 17, 2025
Revised: February 1, 2025

Architectural Hardware Finishes

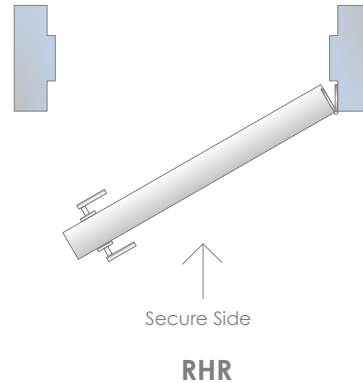
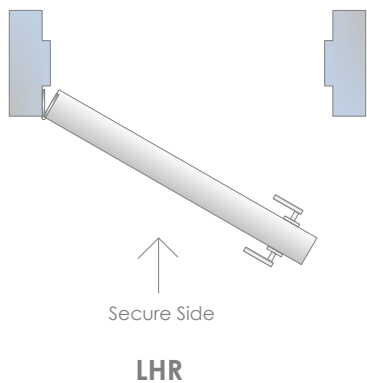
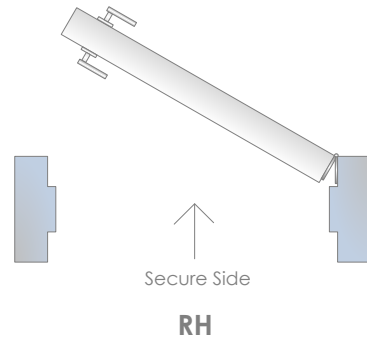
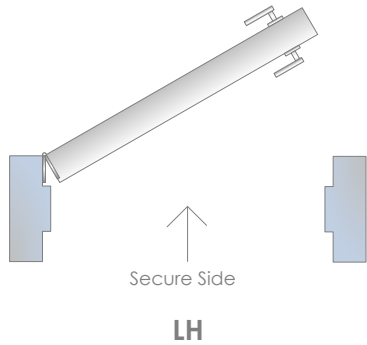
Steel	Stainless Steel	Brass/Bronze	Aluminum	Painted/Powder Coat	US/CAN#
Clear Anodized / Painted Aluminum					
			628	689	US28
Satin Nickel					
646		619	670		US15
Polished Nickel					
645		618	669		US14
Satin Stainless Steel					
	630				US32D
Polished Stainless Steel					
	629				US32
Satin Chrome					
652		626	702		US26D
Polished Chrome					
651		625	672		US26
Satin Brass					
633		606	667	678	US4
Polished Brass					
632		605	666	677	US5
Satin Bronze					
639		612	668	680	US10
Oil Rubbed Bronze					
640		613	703	695	US10B
Flat Black / Anodized Black					
631		622	671	693	US19

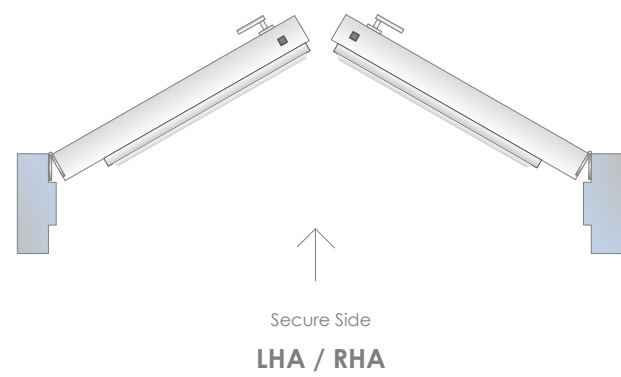
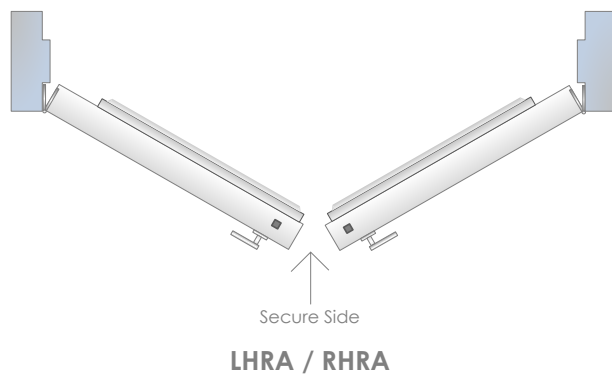
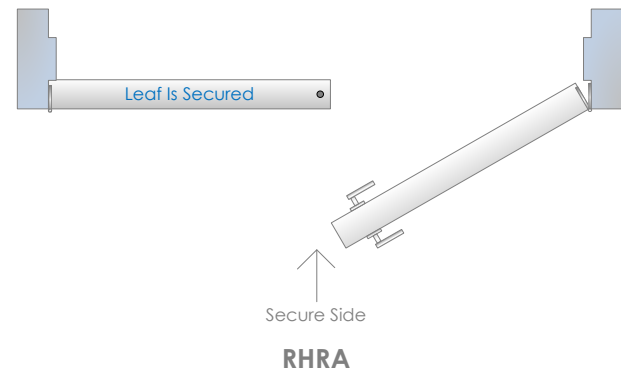
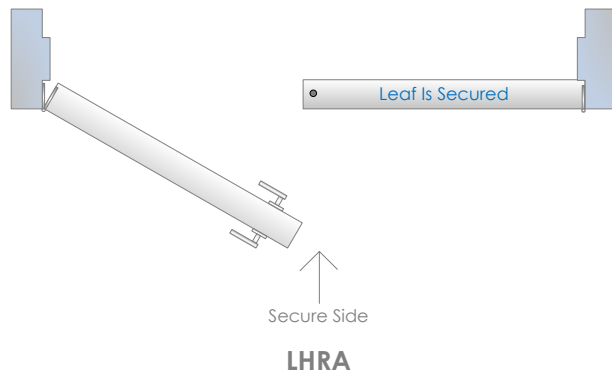
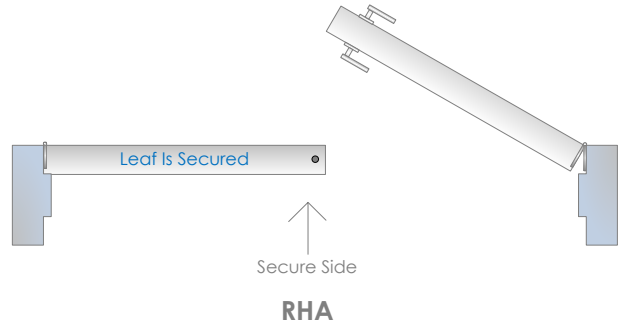
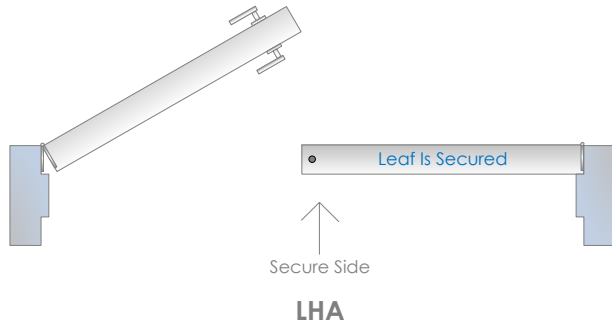
Door Types & Handing

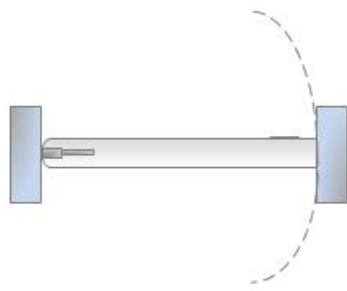
Abbreviations

RH – Right Hand	RHA – Right Hand Active	SS- Single Slider
LH – Left Hand	LHA – Left Hand Active	BP – Bi-Parting Slider
RHR – Right Hand Reverse	RHRA/LHRA – Right & Left Hand Reverse Active	BP – Bi-Passing Slider
LHR – Left Hand Reverse	RHA/LHA – Right & Left Hand Active	BF – Bi-Folding Slider
RHRA – Right Hand Reverse Active	DA- Double Acting	TS – Telescopic Slider
LHRA – Left Hand Reverse Active	DE – Double Egress	PKT – Pocket Slider

Note: The handing on a swing door is determined by placing yourself on the secure side or keyed side of the door.







DA-DOUBLE ACTING



DE-DOUBLE EGRESS



PKT - POCKET SLIDER



SS - SINGLE SLIDER or BARN SLIDER



BP - BI-PARTING



BPS - BI-PASSING

Symbols



- Door has a fire rating and all associated hardware must have a fire label to suit. Must comply with local requirements.



- Door is automatic and is equipped with an auto operator. Door must meet local barrier free codes



- Door has an electrical requirement and requires power to be brought to the appropriate location above the door or to the latch, for either security or barrier free applications. Refer to security & electrical drawings for further information.



- Door requires security card access. Refer to security / electrical drawings for further information.

Abbreviations

Door:

HMD = Hollow Metal Door
 IHMD = Insulated Hollow Metal Door
 ALD = Aluminum Door
 SCWD = Solid Core Wood Door
 HCWD = Hollow Core Wood Door
 FGD = Frameless Glass Door
 FRP = Fiberglass Reinforced Plastic Door

Frame:

HMF = Hollow Metal Frame
 ALF = Aluminum Frame
 Cased Open HMF = Cased Open Hollow Metal Frame
 WDF = Wood Frame
 Cased Open WDF = Cased Open Wood Frame
 Cased Open Drywall = Cased Open Drywall

Fire Ratings:

0 HR – Zero Hour Fire Rating / Smoke Barrier
 20 MIN – 20 Minute Fire Rating
 ¼ HR – 45 Minute Fire rating
 1 ½ HR – 90 Minute Fire Rating
 2 HR – 120 Minute Fire Rating
 3 HR – 180 Minute Fire Rating

Disclaimer

Installation Instructions:

Installation instructions have been provided for convenience only. Although we do our best to ensure these documents are accurate and up to date, it is ultimately the responsibility of the installer to ensure they are using the correct instructions for the product they are installing. Use of the installation instructions provided is done so at one's own risk and Spyder SC takes no responsibility to their accuracy.

Weblinks:

Weblinks do change from time to time as manufacturers move around their websites, please inform us if you have a none functioning weblink.

HARDWARE SCHEDULE



Heading# 1

Opening Information					
Opening Type:	Single	Opening Size:	1088 x 2135 x 45	STC Rating	None
Door Material:	ALD	Frame Material:	ALF	Fire Rating	None

1 Total Openings						Web Link	Install Instructions	Site Verified
1	Door#	100a	Location:	Exterior from Vestibule 100	Handing:			

By Hardware Supplier

1	Continuous Hinge	112XY x 2108 x EPT	628	Ives	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
1	Power Transfer	EPT-10	689	Von Duprin	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
1	Exit Device	RX-LX-QEL-35A-NL-OP x 388NL x 4'0	626	Von Duprin	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
1	Rim Cylinder	80-116	626	Schlage	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1	Medeco Cylinder	Permanent Medeco High Security Cylinder	626	Schlage	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1	Door Pull	GSH 165F x 1830 x #2 MTG *Confirm based on door height	630	Gallery	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1	Overhead Stop	105S	630	Glynn Johnson	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
1	Weatherstrip	By Aluminum Door Supplier	628		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1	Door Sweep	By Aluminum Door Supplier	628		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1	Threshold	By Aluminum Door Supplier	628		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

By Automatics Supplier – PACKAGE #1A – PUSH BUTTONS UPGRADED TO TOUCHLESS WAVE (UPGRADE EXTRA)

1	Auto Operator (SNG)	BESAM SW200i – Push Side Mount - RH	628		<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1	Push Button	CM60/4-WT	630	Camden	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1	Surface Mount Box	CM-79	630	Camden	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1	Wave Buttons	CM-331/42SW-SGLR, Double Gang, SS Face Plate with LED Ring	630	Camden	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1	Surface Mount Box	CM-43CBLA	630	Camden	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1	Logic Relay	CX-33		Camden	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

By Security Supplier

1	Card Reader	To Suit Building System (12V)	BLK		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1	Door Contact	To Suit Building System			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1	Rex Sensor	To Suit Building System			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1	Access Controller	To Suit Building System			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

1	Power Supply	Located in nearest IT Closet – By Security Provider			<input type="checkbox"/>
By Locksmith					
1	Permanent Core/Cylinder	Permanent Medeco Core/Cylinder Provided by City Locksmith Listed Below.	626	Medeco	<input type="checkbox"/>

Notes:

- 120VAC is required at the head of the door for all handicap door operators, 15A dedicated circuit. Wall/Frame must be reinforced for automatic operator mounting, all conduit and back boxes with pull cords are to be provided by the electrical contractor.
- Electrician to confirm wire locations with auto door operator supplier prior to pulling wires.
- Final commissioning of all access control items, such as but not limited to electric strikes, Rex sensors, Door contacts, Electrified Panics, Relays & Maglocks is the responsibility of the security provider
- Permanent Cores & Cylinders to be Provided by Approved City Locksmiths: Reillys Lock & Security Systems and/or ABC Security Access Systems and/or Gunnebo.

.....End of Heading.....



Heading# 2

Opening Information

Opening Type:	Single	Opening Size:	1067 x 2153 x 45	STC Rating	None
Door Material:	HMD	Frame Material:	HMF	Fire Rating	None

1 Total Openings

1	Door#	100b	Location:	Vestibule 100 from Client In-Take	Handing:	LHR
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Web Link	Install Instructions	Site Verified
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By Hardware Supplier

3	Heavy Weight Hinge	BB1168 – 4 ½" x 4" NRP	630	Hager	X			<input type="checkbox"/>
1	Exit Device	CD-35A-NL-OP x 388NL x 4'0	626	Von Duprin	X	X		<input type="checkbox"/>
1	Rim Cylinder	80-116	626	Schlage				<input type="checkbox"/>
1	Mortise Cylinder	80-110	626	Schlage	X			<input type="checkbox"/>
2	Medeco Cylinder	Permanent Medeco High Security Cylinder	626	Schlage	X			<input type="checkbox"/>
1	Electric Strike	6300 x 12/24VCD	630	Von Duprin	X	X		<input type="checkbox"/>
1	Door Pull	GSH 165F x 1830 x #2 MTG	630	Gallery	X			<input type="checkbox"/>
1	Overhead Stop	105S	630	Glynn Johnson	X	X		<input type="checkbox"/>
1	Kickplate	GSH 80A – 203 x 1029 (Rounded Corners) – 3M TAPE	630	Gallery	X			<input type="checkbox"/>
1	Smoke / Sound Seal	W-66 x 5600	BLK	KN Crowder	X			<input type="checkbox"/>
1	Auto Door Bottom	434APKL x 1067	MIL	Pemko	X	X		<input type="checkbox"/>

By Automatics Supplier – **PACKAGE #3 – PUSH BUTTONS UPGRADED TO TOUCHLESS WAVE (UPGRADE EXTRA)**

2	Auto Operator (SNG)	BESAM SW200 – Push Side Mount - RH	628		X			<input type="checkbox"/>
2	Wave Buttons	CM-331/42SW-SGLR, Double Gang, SS Face Plate with LED Ring	630	Camden	X			<input type="checkbox"/>
2	Surface Mount Box	CM-43CBLA	630	Camden	X			<input type="checkbox"/>
1	Logic Relay	CX-33		Camden	X			<input type="checkbox"/>

By Security Supplier

1	Card Reader	To Suit Building System (12V)	BLK					<input type="checkbox"/>
1	Door Contact	To Suit Building System						<input type="checkbox"/>
1	Rex Sensor	To Suit Building System						<input type="checkbox"/>
1	Access Controller	To Suit Building System						<input type="checkbox"/>
1	Power Supply	Located in nearest IT Closet – By Security Provider						<input type="checkbox"/>

By Locksmith

1	Permanent Core/Cylinder	Permanent Medeco Core/Cylinder Provided by City Locksmith Listed Below.	626	Medeco				<input type="checkbox"/>
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Notes:

- 120VAC is required at the head of the door for all handicap door operators, 15A dedicated circuit. Wall/Frame must be reinforced for automatic operator mounting, all conduit and back boxes with pull cords are to be provided by the electrical contractor.
- Electrician to confirm wire locations with auto door operator supplier prior to pulling wires.
- Final commissioning of all access control items, such as but not limited to electric strikes, Rex sensors, Door contacts, Electrified Panics, Relays & Maglocks is the responsibility of the security provider
- Permanent Cores & Cylinders to be Provided by Approved City Locksmiths: Reillys Lock & Security Systems and/or ABC Security Access Systems and/or Gunnebo.

.....End of Heading.....



Heading# 3

Opening Information

Opening Type:	Single	Opening Size:	1067 x 2135 x 45	STC Rating	None
Door Material:	HMD	Frame Material:	HMF	Fire Rating	None

1 Total Openings

1	Door#	101	Location:	Client In-Take from Lower LVL Open Workstations 104	Handing:	LHR
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Web Link	Install Instructions	Site Verified
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By Hardware Supplier

3	Heavy Weight Hinge	BB1168 – 4 1/2" x 4" NRP	630	Hager	X			<input type="checkbox"/>
1	Exit Device	CD-35A-NL-OP x 388NL x 4'0	626	Von Duprin	X	X		<input type="checkbox"/>
1	Rim Cylinder	80-116	626	Schlage				<input type="checkbox"/>
1	Mortise Cylinder	80-110	626	Schlage	X			<input type="checkbox"/>
2	Medeco Cylinder	Permanent Medeco High Security Cylinder	626	Schlage	X			<input type="checkbox"/>
1	Electric Strike	6300 x 12/24VCD	630	Von Duprin	X	X		<input type="checkbox"/>
1	Door Pull	GSH 165F x 1830 x #2 MTG	630	Gallery	X			<input type="checkbox"/>
1	Overhead Stop	105S	630	Glynn Johnson	X	X		<input type="checkbox"/>
1	Kickplate	GSH 80A – 203 x 1029 (Rounded Corners) – 3M TAPE	630	Gallery	X			<input type="checkbox"/>
1	Smoke / Sound Seal	W-66 x 5600	BLK	KN Crowder	X			<input type="checkbox"/>
1	Auto Door Bottom	434APKL x 1067	MIL	Pemko	X	X		<input type="checkbox"/>

By Automatics Supplier – PACKAGE #3 – PUSH BUTTONS UPGRADED TO TOUCHLESS WAVE (UPGRADE EXTRA)

2	Auto Operator (SNG)	BESAM SW200 – Push Side Mount - RH	628		X			<input type="checkbox"/>
2	Wave Buttons	CM-331/42SW-SGLR, Double Gang, SS Face Plate with LED Ring	630	Camden	X			<input type="checkbox"/>
2	Surface Mount Box	CM-43CBLA	630	Camden	X			<input type="checkbox"/>
1	Logic Relay	CX-33		Camden	X			<input type="checkbox"/>

By Security Supplier

1	Card Reader	To Suit Building System (12V)	BLK					<input type="checkbox"/>
1	Door Contact	To Suit Building System						<input type="checkbox"/>
1	Rex Sensor	To Suit Building System						<input type="checkbox"/>
1	Access Controller	To Suit Building System						<input type="checkbox"/>
1	Power Supply	Located in nearest IT Closet – By Security Provider						<input type="checkbox"/>

By Locksmith

1	Permanent Core/Cylinder	Permanent Medeco Core/Cylinder Provided by City Locksmith Listed Below.	626	Medeco	<input type="checkbox"/>
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Notes:

- 120VAC is required at the head of the door for all handicap door operators, 15A dedicated circuit. Wall/Frame must be reinforced for automatic operator mounting, all conduit and back boxes with pull cords are to be provided by the electrical contractor.
- Electrician to confirm wire locations with auto door operator supplier prior to pulling wires.
- Final commissioning of all access control items, such as but not limited to electric strikes, Rex sensors, Door contacts, Electrified Panics, Relays & Maglocks is the responsibility of the security provider
- Permanent Cores & Cylinders to be Provided by Approved City Locksmiths: Reillys Lock & Security Systems and/or ABC Security Access Systems and/or Gunnebo.

-----End of Heading-----



Heading# 4

Opening Information

Opening Type:	Single	Opening Size:	1067 x 2135 x 45	STC Rating	None
Door Material:	HMD	Frame Material:	HMF	Fire Rating	None

1 Total Openings

1 Door#	103	Location:	Client In-Take to B/F Universal WR 103	Handing:	RH
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Web Link	Install Instructions	Site Verified
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By Hardware Supplier

3	Heavy Weight Hinge	BB1168 – 4 ½" x 4"	630	Hager	X		<input type="checkbox"/>
1	Storeroom Lockset	L9080BDC x 03B x 630	630	Schlage	X	X	<input type="checkbox"/>
1	Medeco Cylinder	Permanent Medeco High Security Cylinder	626	Schlage	X		<input type="checkbox"/>
1	Electric Strike	1500C	630	HES	X	X	<input type="checkbox"/>
2	Kickplate	GSH 80A – 203 x 1029 (Rounded Corners) – 3M TAPE	630	Gallery	X		<input type="checkbox"/>
2	Coat Hook	GSH 390	626	Gallery	X		<input type="checkbox"/>
1	Floor Stop	GSH 87	626	Gallery	X		<input type="checkbox"/>
1	Smoke / Sound Seal	W-66 x 5600	BLK	KN Crowder	X		<input type="checkbox"/>
1	Auto Door Bottom	434APKL x 1067	MIL	Pemko	X	X	<input type="checkbox"/>
1	Emergency Key Cabinet	EB-02	RD	Canropa	X		<input type="checkbox"/>

By Automatics Supplier – **PACKAGE #5 – PUSH TO LOCK KIT UPGRADED TO TOUCHLESS WAVE (UPGRADE EXTRA)**

1	Auto Operator (SNG)	BESAM SW100 – Pull Side Mount - RH	628		X		<input type="checkbox"/>
1	Wave to Lock Kit	CX-WC16	630	Camden	X	X	<input type="checkbox"/>
1	Emergency Call Kit	CX-WEC10K2	630	Camden	X	X	<input type="checkbox"/>

By Locksmith

1	Permanent Core/Cylinder	Permanent Medeco Core/Cylinder Provided by City Locksmith Listed Below.	626	Medeco	<input type="checkbox"/>
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Notes:

- 120VAC is required at the head of the door for all handicap door operators, 15A dedicated circuit. Wall/Frame must be reinforced for automatic operator mounting, all conduit and back boxes with pull cords are to be provided by the electrical contractor.
- Electrician to confirm wire locations with auto door operator supplier prior to pulling wires.
- Permanent Cores & Cylinders to be Provided by Approved City Locksmiths: Reillys Lock & Security Systems and/or ABC Security Access Systems and/or Gunnebo.

.....End of Heading.....



Heading# 6

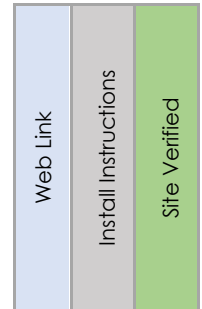
Opening Information

Opening Type:	Single	Opening Size:	EXISTING TO REMAIN	STC Rating	None
Door Material:	ALD	Frame Material:	ALF	Fire Rating	None

0 Total Openings

1	Door#	E104	Location:	Exterior from Lower LVL Open Workstations 104	Handing:	LHR
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***EXISTING DOOR, FRAME & HARDWARE TO REMAIN.**



.....End of Heading.....



Heading# 7

Opening Information

Opening Type:	Single	Opening Size:	1067 x 2135 x 45	STC Rating	None
Door Material:	HMD	Frame Material:	HMF	Fire Rating	3/4 HR

1 Total Openings

1	Door#	106	Location:	Upper LVL Open Workstations 118 to Server 106	Handing:	RH
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Web Link	Install Instructions	Site Verified
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By Hardware Supplier

3	Heavy Weight Hinge	BB1168 – 4 1/2" x 4"	652	Hager	<input checked="" type="checkbox"/>			<input type="checkbox"/>
1	Storeroom Lockset	L9080BDC x 03B x 630	630	Schlage	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input type="checkbox"/>
1	Medeco Cylinder	Permanent Medeco High Security Cylinder	626	Schlage	<input checked="" type="checkbox"/>			<input type="checkbox"/>
1	Electric Strike	1500C	630	HES	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input type="checkbox"/>
1	Closer	4011	689	LCN	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input type="checkbox"/>
1	Floor Stop	GSH 87	626	Gallery	<input checked="" type="checkbox"/>			<input type="checkbox"/>
1	Kickplate	GSH 80A – 203 x 1029 (Rounded Corners) – 3M TAPE	630	Gallery	<input checked="" type="checkbox"/>			<input type="checkbox"/>
1	Smoke / Sound Seal	W-66 x 6800	BLK	KN Crowder	<input checked="" type="checkbox"/>			<input type="checkbox"/>
1	Auto Door Bottom	434APKL x 1067	MIL	Pemko	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input type="checkbox"/>

By Security Supplier

1	Card Reader/Keypad	To Suit Building System (12V)	BLK					<input type="checkbox"/>
1	Door Contact	To Suit Building System						<input type="checkbox"/>
1	Rex Sensor	To Suit Building System						<input type="checkbox"/>
1	Access Controller	To Suit Building System						<input type="checkbox"/>
1	Power Supply	Located in nearest IT Closet – By Security Provider						<input type="checkbox"/>

By Locksmith

1	Permanent Core/Cylinder	Permanent Medeco Core/Cylinder Provided by City Locksmith Listed Below.	626	Medeco				<input type="checkbox"/>
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Notes:

- Final commissioning of all access control items, such as but not limited to electric strikes, Rex sensors, Door contacts, Electrified Panics, Relays & Maglocks is the responsibility of the security provider
- Permanent Cores & Cylinders to be Provided by Approved City Locksmiths: Reillys Lock & Security Systems and/or ABC Security Access Systems and/or Gunnebo.

.....End of Heading.....



Heading# 8

Opening Information

Opening Type:	Single	Opening Size:	1067 x 2135 x 45	STC Rating	None
Door Material:	HMD	Frame Material:	HMF	Fire Rating	3/4 HR

1 Total Openings

1 Door#	107	Location:	Upper LVL Open Workstations 118 to Server 107	Handing:	RH
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Web Link	Install Instructions	Site Verified
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By Hardware Supplier

3	Heavy Weight Hinge	BB1168 – 4 1/2" x 4"	652	Hager	<input checked="" type="checkbox"/>			<input type="checkbox"/>
1	Storeroom Lockset	L9080BDC x 03B x 630	630	Schlage	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input type="checkbox"/>
1	Medeco Cylinder	Permanent Medeco High Security Cylinder	626	Schlage	<input checked="" type="checkbox"/>			<input type="checkbox"/>
1	Electric Strike	1500C	630	HES	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input type="checkbox"/>
1	Closer	4011	689	LCN	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input type="checkbox"/>
1	Floor Stop	GSH 87	626	Gallery	<input checked="" type="checkbox"/>			<input type="checkbox"/>
1	Kickplate	GSH 80A – 203 x 1029 (Rounded Corners) – 3M TAPE	630	Gallery	<input checked="" type="checkbox"/>			<input type="checkbox"/>
1	Smoke / Sound Seal	W-66 x 6800	BLK	KN Crowder	<input checked="" type="checkbox"/>			<input type="checkbox"/>
1	Auto Door Bottom	434APKL x 1067	MIL	Pemko	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input type="checkbox"/>

By Security Supplier

1	Card Reader/Keypad	To Suit Building System (12V)	BLK					<input type="checkbox"/>
1	Door Contact	To Suit Building System						<input type="checkbox"/>
1	Rex Sensor	To Suit Building System						<input type="checkbox"/>
1	Access Controller	To Suit Building System						<input type="checkbox"/>
1	Power Supply	Located in nearest IT Closet – By Security Provider						<input type="checkbox"/>

By Locksmith

1	Permanent Core/Cylinder	Permanent Medeco Core/Cylinder Provided by City Locksmith Listed Below.	626	Medeco				<input type="checkbox"/>
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Notes:

- Final commissioning of all access control items, such as but not limited to electric strikes, Rex sensors, Door contacts, Electrified Panics, Relays & Maglocks is the responsibility of the security provider
- Permanent Cores & Cylinders to be Provided by Approved City Locksmiths: Reillys Lock & Security Systems and/or ABC Security Access Systems and/or Gunnebo.

.....End of Heading.....



Heading# 9

Opening Information

Opening Type:	Single	Opening Size:	1067 x 2613 x 45	STC Rating	None
Door Material:	HMD	Frame Material:	HMF	Fire Rating	None

1 Total Openings

1	Door#	116	Location:	Upper LVL Open Workstations 118 to Breakout Room 116	Handing:	RH
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Web Link	Install Instructions	Site Verified
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By Hardware Supplier

4	Heavy Weight Hinge	BB1168 – 4 ½" x 4"	652	Hager	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1	Classroom Lockset	L9070BDC x 03B x 630	630	Schlage	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1	Medeco Cylinder	Permanent Medeco High Security Cylinder	626	Schlage	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1	Electric Strike	1500C	630	HES	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1	Closer	4011	689	LCN	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1	Floor Stop	GSH 87	626	Gallery	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1	Kickplate	GSH 80A – 203 x 1029 (Rounded Corners) – 3M TAPE	630	Gallery	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1	Smoke / Sound Seal	W-66 x 6800	BLK	KN Crowder	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1	Auto Door Bottom	434APKL x 1067	MIL	Pemko	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

By Automatics Supplier – **PACKAGE #3 – PUSH BUTTONS UPGRADED TO TOUCHLESS WAVE (UPGRADE EXTRA)**

1	Auto Operator (SNG)	BESAM SW200i – Pull Side Mount - RH	628		<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2	Wave Buttons	CM-331/42SW-SGLR, Double Gang, SS Face Plate with LED Ring	630	Camden	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2	Surface Mount Box	CM-43CBLA	630	Camden	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1	Key Switch	CM-2210 x 7224 LED	630	Camden	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1	Cylinder	CM-CYL60-KA	630	Camden	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1	Logic Relay	CX-33		Camden	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1	Keypad	CV-110SPK	630	Camden	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

By Locksmith

2	Permanent Core/Cylinder	Permanent Medeco Core/Cylinder Provided by City Locksmith Listed Below.	626	Medeco	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
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Notes:

- Final commissioning of all access control items, such as but not limited to electric strikes, Rex sensors, Door contacts, Electrified Panics, Relays & Maglocks is the responsibility of the security provider
- Permanent Cores & Cylinders to be Provided by Approved City Locksmiths: Reillys Lock & Security Systems and/or ABC Security Access Systems and/or Gunnebo.

End of Heading



Heading# 10

Opening Information

Opening Type:	Single	Opening Size:	1067 x 2135 x 45	STC Rating	None
Door Material:	HMD	Frame Material:	HMF	Fire Rating	None

1 Total Openings

1	Door#	119f	Location:	Kitchen/Lunch Room 120 from WC Corridor	Handing:	LH
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Web Link	Install Instructions	Site Verified
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By Hardware Supplier

3	Heavy Weight Hinge	BB1168 – 4 1/2" x 4"	630	Hager	X			<input type="checkbox"/>
1	Door Pull	GSH 167F x 610 x #5-2 MTL MTG	630	Gallery	X			<input type="checkbox"/>
1	Push Plate	GSH 80A – 150 x 610 (Rounded Corners) – 3M TAPE	630	Gallery	X			<input type="checkbox"/>
2	Kickplate	GSH 80A – 203 x 1029(Rounded Corners) – 3M TAPE	630	Gallery	X			<input type="checkbox"/>
1	Overhead Stop	105S	630	Glynn Johnson	X	X		<input type="checkbox"/>
1	Smoke / Sound Seal	W-66 x 5600	BLK	KN Crowder	X			<input type="checkbox"/>
1	Door Sweep	W-24S x 1067	CA	KN Crowder	X			<input type="checkbox"/>

By Automatics Supplier – **PACKAGE #4 – PUSH BUTTONS UPGRADED TO TOUCHLESS WAVE (UPGRADE EXTRA)**

1	Auto Operator (SNG)	BESAM SW200i – Push Side Mount	628		X			<input type="checkbox"/>
2	Wave Buttons	CM-331/42SW-SGLR, Double Gang, SS Face Plate with LED Ring	630	Camden	X			<input type="checkbox"/>
2	Surface Mount Box	CM-43CBLA	630	Camden	X			<input type="checkbox"/>

Notes:

- 120VAC is required at the head of the door for all handicap door operators, 15A dedicated circuit. Wall/Frame must be reinforced for automatic operator mounting, all conduit and back boxes with pull cords are to be provided by the electrical contractor.
- Electrician to confirm wire locations with auto door operator supplier prior to pulling wires.

End of Heading

Heading# 11

Opening Information

Opening Type:	Single	Opening Size:	Existing	STC Rating	None
Door Material:	Existing	Frame Material:	Existing	Fire Rating	3/4 HR

1 Total Openings

1	Door#	E108	Location: Upper LVL Open Workstations 118 to Server/Electrical	Handing:	RH
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Web Link	Install Instructions	Site Verified
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***EXISTING DOOR TO REMAIN.PATCH AND REPAIR. NEW PAINT WHEN SIGN ON DOOR IS REMOVED**

.....End of Heading.....

Heading# 12

Opening Information

Opening Type:	Single	Opening Size:	Existing	STC Rating	None
Door Material:	Existing	Frame Material:	Existing	Fire Rating	None

1 Total Openings

1	Door#	E109	Location: Upper LVL Open Workstations 118 from Pump Room	Handing:	LHR
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Web Link	Install Instructions	Site Verified
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***EXISTING DOOR TO REMAIN.PATCH AND REPAIR. NEW PAINT WHEN SIGN ON DOOR IS REMOVED**

.....End of Heading.....

Heading# 13

Opening Information

Opening Type:	Pair	Opening Size:	Existing Doors and Frame	STC Rating	None
Door Material:	Existing	Frame Material:	Existing	Fire Rating	None

3 Total Openings

1	Door#	E119a	Location:	Corridor from Closet	Handing:	LHRA/RHRA
1	Door#	E119b	Location:	Corridor from Closet	Handing:	LHRA/RHRA
1	Door#	E119c	Location:	Corridor from Closet	Handing:	LHRA/RHRA

* REPAINTEXISTING (2) 680 DOOR PANELS TO REMAIN – NEW PAINT

Web Link	Install Instructions	Site Verified
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.....End of Heading.....

Heading# 14

Opening Information

Opening Type:	Existing	Opening Size:	Existing	STC Rating	None
Door Material:	Existing	Frame Material:	Existing	Fire Rating	None

3 Total Openings

1	Door#	E121	Location:	WC Corridor to Male Washroom	Handing:	LH
1	Door#	E122	Location:	WC Corridor to Female Washroom	Handing:	LH
1	Door#	E123	Location:	WC Corridor from Janitor	Handing:	RHR

*EXISTING DOOR & HARDWARE TO REMAIN – NEW PAINT WHEN SIGN ON DOOR IS REMOVED

Web Link	Install Instructions	Site Verified
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.....End of Heading.....

Heading# 15

Opening Information

Opening Type:	Single	Opening Size:	SEE DEMOUNTABLE PARTITION DETAILS	STC Rating	None
Door Material:	FGD	Frame Material:	ALF	Fire Rating	None

6 Total Openings

1	Door#	112	Location:	Upper LVL Open Workstations 118 to Meeting RM #1 112	Handing:	SS
1	Door#	113	Location:	Upper LVL Open Workstations 118 to Meeting RM #2 113	Handing:	SS
1	Door#	114	Location:	Upper LVL Open Workstations 118 to Focus RM #2 114	Handing:	SS
1	Door#	115	Location:	Upper LVL Open Workstations 118 to Meeting RM #3 115	Handing:	SS
1	Door#	117	Location:	Upper LVL Open Workstations 118 to Large Meeting RM 117	Handing:	SS
1	Door#	105	Location:	Lower LVL Open Workstations 104 to Focus Room 105	Handing:	RH

Web Link	Install Instructions	Site Verified
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***ALL HARDWARE PROVIDED BY DEMOUNTABLE PARTITION SYSTEM PROVIDER.**

.....End of Heading.....

END OF SCHEDULE

1 General

1.1 **SUMMARY**

.1 Section Includes

.1 Labour, Products, equipment and services necessary to complete the Work of this section, including but is not limited to the following:

.1 Glazing for interior and exterior applications including glazed partition, and glass door vision panel.

.2 This section shall be read in conjunction with Appendix A City of Toronto Corporate Building System Design Requirements. Appendix A shall take precedence where there is a conflict in this Section.

1.2 **REFERENCES**

.1 Conform to the latest edition of the following:

.1 ASTM C1503, Standard Specification for Silvered Flat Glass Mirror

.2 CAN/CGSB-12.1-M, Tempered or Laminated Safety Glass

.3 CAN/CGSB-12.3-M, Flat, Clear Float Glass

.4 CAN/CGSB-12.8-M, Insulating Glass Units

.5 CAN/CGSB-19.2-M, Glazing Compound, Non-Hardening, Modified Oil Type

1.3 **SUBMITTALS**

.1 Shop Drawings:

.1 Submit Shop Drawings in accordance with Section 01 33 00 Submittals, for fabrication and erection of glazing elements indicating materials, thicknesses, finishes, connections, joints, method of anchorage, number of anchors, supports, reinforcement, details and accessories.

.2 Samples:

.1 Submit one 300 x 300 mm sample of each type of glass in accordance with Section 01 33 00. Samples shall show tints, surface treatments, thickness and details of edge finishing.

.3 Certificates: Submit manufacturer's certification that glass and glazing materials are compatible.

.1 Submit compatibility and adhesion test reports from sealant manufacturer indicating that glazing materials were tested for compatibility and adhesion with glazing sealants. Include sealant manufacturer's interpretation of test results relative to sealant performance and recommendations for primers and substrate preparation needed for adhesion.

.2 Compatibility test report from manufacturer of insulating glass edge sealant, indicating that glass edge sealants were tested for compatibility with other glazing materials including sealants, setting blocks, edge blocks and any other material that contacts or can affect the edge seal.

1.4 **DELIVERY, HANDLING AND STORAGE**

- .1 Deliver materials to the site in original crates and containers with the maker's name and brand distinctly marked thereon and with glass labeled as to types. Do not remove labels on glass until after Work is accepted by the Consultant.
- .2 Store materials within the building, in a clean, dry location. Fully protect materials from damage until ready for use.

2 Products

2.1 **MATERIALS**

- .1 Tempered Glass (GL-1 & GL-2): conforming to CAN/CGSB-12.1-M, Type 2, Class B, clear float glass. Free from roller and tong marks.
 - .1 Refer to Section 09 06 00 Product and Finishes Schedule for type, thickness, colour and location.
 - .2 Basis of Design: Agardy Glass or accepted equivalent.

2.2 **ACCESSORIES**

- .1 Glazing compound (fire doors): Putty.
- .2 Spacer shims and setting blocks: Neoprene, Shore "A" Durometer hardness 70-90, 100 mm long, wide enough to extend from fixed stop to opposite face of glass and of height suitable to provide adequate glazing "bite" for setting blocks. Neoprene, Shore "A" 40 to 50 Durometer hardness, of adequate thickness to provide correct glass to face clearance of at least 3 mm for spacer shims. For glass in fire rated doors (screens) use ULC approved fire resistant setting blocks and spacer shims.
- .3 Glazing channel (for interior glazing): Black extruded neoprene or PVC channel gaskets, of size to suit glazing.
- .4 Glazing compound: One-part clear silicone. GE Canada "Silpruf SCS 2000", Dow Corning "795" or Tremco "Spectrum 2".
- .5 Window Films/Vision Barriers: Refer to Section 08 87 00 Glazing Surface Films.

3 Execution

3.1 **INSPECTION OF JOB CONDITIONS**

- .1 Inspect openings and frames prepared by other trades into which glass is to be installed. Notify the Consultant in writing, of any conditions which will preclude proper installation. Do not glaze unsatisfactory locations until such conditions have been made good. Commencement of Work implies acceptance of existing conditions.
- .2 Obtain glass dimensions on the job site. Glass shall be 4 mm less than the rebate size in either dimension, with allowance for edge spacers, shims and setting blocks.
- .3 Free rabbets, stops and glass edges of dirt, moisture, oil and other foreign matter detrimental to or obstructing glazing material.

3.2 **GLASS INSTALLATION**

- .1 Check that all openings and stops to be painted are primed before commencing Work.

- .2 At completion of the Work, replace at own expense, glass provided under this section which is broken due to loose setting, binding in the frame, pinched by glazing clips, inadequate or improper use of setting blocks, improper workmanship or other causes.

3.3 **INTERIOR GLAZING**

- .1 Standard wood doors: Install glass with continuous glazing channels on glass edges. Set glass and secure in place with stops butted tight to glazing channels. Secure stops to door with screws provided, with heads slightly below glass stop surface.
- .2 Standard hollow metal frames for screens and borrowed lights: Place setting blocks and spacers as required to support glass. Use a minimum of two setting blocks, locate at one-quarter points. Locate spacers at jamb edges of glass, uniformly spaced at 600 mm o.c. maximum, and 300 mm maximum from top and bottom.
- .3 Fire rated hollow metal doors: Set glass on continuous setting block with 6 mm gap between glazing stops and embed in putty in accordance with NFPA 80 requirements. All exposed joints between the metal and glass shall be struck and pointed.

3.4 **EXTERIOR GLAZING**

- .1 Apply setting blocks at quarter points on all four sides of openings.
- .2 Cut glazing tape to proper length and set against permanent stops approximately 0.8 mm below sightline. Install horizontal strips first, extend over entire width of opening before applying vertical strips. Weld corners together by butting tape and dabbling with sealant.
- .3 Remove backing paper from tape prior to setting glass.
- .4 Apply continuous heel bead between glass and sash.
- .5 Place glass in opening, press tightly and evenly against glazing tape.
- .6 Apply continuous glazing tape on removable stop. Place and screw stop in place with fluorocarbon coated oval head screws. Apply elastomeric sealant cap bead over top between glass and removable stop.

3.5 **IDENTIFICATION OF GLAZING**

- .1 Provide on one side of all glass lites, temporary, easily removable, large safety decals, immediately after glass installation. Maintain safety markings until final clean-up. Remove all markings at time of final clean-up.

End of Section

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- 1 General
- 1.1 **SUMMARY**
 - .1 Section Includes
 - .1 Labour, Products, equipment and services necessary to complete the Work of this section.
- 1.2 **SUBMITTALS**
 - .1 Samples: Submit one 500 x 500 mm sample of each type of film specified.
 - .2 Product Data: Submit Manufacturer's data sheets on each type of film including:
 - .1 Adhesive
 - .2 Typical installation methods, maintenance data, storage and handling.
 - .3 Technical characteristics and criteria.
- 1.3 **WARRANTY**
 - .1 Warrant the work of this Section for a period of 10 years commencing date of Substantial Performance.
- 1.4 **DELIVERY, HANDLING AND STORAGE**
 - .1 Store materials within the building, in a clean, dry location. Fully protect materials from damage until ready for use.
 - .2 Store materials protected from exposure to harmful environmental conditions and at temperature and humidity conditions recommended by the manufacturer.
- 2 Products
 - .1 Components and materials specified in this Sections shall be from single manufacturer.
 - .2 Frosted Window Film (GF-1)
 - .1 Polyester film with pressure sensitive adhesive. Film to provide "Etched/Frosted" appearance.
 - .2 Visible light transmittance: 30%
 - .3 Refer to Section 09 06 00n Product and Finishes Schedule for type, manufacturer, and location.
 - .4 Basis of design: 3M or accepted equal
 - .3 Decorative Films (GF-2 to GF-4)
 - .1 Refer to Section 09 06 00n Product and Finishes Schedule for type, manufacturer, colour, and location.
- 3 Execution
- 3.1 **EXAMINATION**

- .1 Verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for product installation in accordance with manufacturer's written recommendations.
 - .1 Examine glass surfaces to receive the new film and verify that they are free from defects and imperfections that will affect the final appearance.
 - .2 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Consultant.
- .2 Start of glazing surface film installation indicates installer's acceptance of substrate conditions.

3.2 **PREPARATION**

- .1 Comply with manufacturers recommendations for surface preparation.
- .2 Clean glass of dust, dirt, paint, oil, grease, mildew, mold, and other contaminants that would inhibit adhesion.
- .3 Immediately prior to applying film, thoroughly wash glass with neutral cleaning solution.
- .4 Protect adjacent surfaces.

3.3 **INSTALATION**

- .1 Apply glazing surface films in accordance with manufacturer's written recommendations.
- .2 General Film Installation:
 - .1 Accurately cut film with straight edges to required sizes
 - .2 Remove release liner immediately prior to adhering film to glass.
 - .3 Apply mounting solution to film and glass.
 - .4 Apply film to glass and removed air bubbles, wrinkles, and other defects using a squeegee. Three to five complete passes are required to completely remove mounting solution from between film and glass.

3.4 **FIELD QUALITY CONTROL**

- .1 After installation, view film from a distance of 10 feet (3 meters) against a light colored background. Ensure appearance is uniform without streaks, bands, thin spots, and pinholes in accordance with the IWFA Visual Quality Standard for Applied Window Film.
- .2 If installed film does not meet these requirements removed and replaced with new film.

3.5 **CLEANING AND PROTECTION**

- .1 Clean glass following installation.
- .2 Remove excess sealants and other glazing materials from adjacent finished surfaces.
- .3 Remove labels and protective covers.
- .4 Protect films for damage during construction. Repair damaged to adjacent materials caused by glazing surface film installation.

End of Section

- 1 General
- 1.1 **SUMMARY**
 - .1 This section contains a coordinated system in which requirements for materials and equipment specified in other sections shown are identified by abbreviated material names
- 1.2 **SUBMITTALS**
 - .1 Submittals shall be in accordance with Section 01 33 00.
- 2 Products
- 2.1 **MANUFACTURERS**
 - .1 Manufacturer's trade names and model numbers identified on the attached Schedules are to identify colors, finishes, textures and patterns. Products of other manufacturer's equivalent to colors, finishes, textures and patterns of manufacturers listed that meet requirements of technical specifications will be acceptable upon approval in writing by the Consultant's and/or Owner's approval for finish requirements.
- 2.2 **OWNER-SUPPLIED PRODUCTS**
 - .1 Owner may furnish products indicated on Drawings and Schedule. The Work includes but not limited to checking order, receiving, unloading, storing, protecting and installing Owner supplied products and making building service connections.
- 2.3 **PRODUCT**
 - .1 Refer to Schedules attached at the end of this section.
- 3 Execution
- 3.1 **GENERAL**
 - .1 Inspect existing conditions upon which Work of this section is dependent. Report to the Consultant in writing any defects or discrepancies. Commencement of Work implies acceptance of existing conditions.
 - .2 Match adjoining or existing similar surfaces colors, textures or patterns where disturbed or damaged by alterations or new work when not scheduled.

End of Section

Finishes Schedule

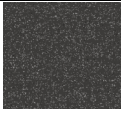
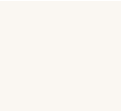



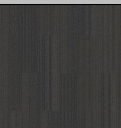


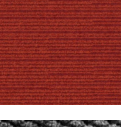

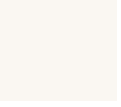
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Finishes Schedule

Project Name: Office Modernization for Toronto Water Office

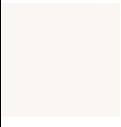






Project Number: 1418121

Date: 2025-02-03

Symbol	Description	Notes	Image	
Plastic Laminate				
PLAM-1	Manufacturer: Product Number: Colour: Finish: Location:	Formica (Or approved alternate) General Purpose Grade Laminate (HGP) Graphite Matte - Lowers Copy Print or Café	Contact: Maria Bannon-Turvey (O) 416.592.0664 maria.bannon-turvey@formica.com	
PLAM-2	Manufacturer: Product Number: Colour: Finish: Location:	Formica (Or approved alternate) Colour Core 2 New White Gloss - Uppers Copy Print or Café	Contact: Maria Bannon-Turvey (O) 416.592.0664 maria.bannon-turvey@formica.com	
PLAM-3	Manufacturer: Product Number: Colour: Finish: Location:	Formica (Or approved alternate) Colour Core 2 New White Matte - Copy Print Countertop	Contact: Maria Bannon-Turvey (O) 416.592.0664 maria.bannon-turvey@formica.com	
Resilient Tile Flooring				
LVT-1	Type: Manufacturer: Product Name: Color: Size: Thickness: Location:	Vinyl Tile Flooring Mohawk (Or approved alternate) Secoya Kew Gardens 142 9" x 59" (nominal) 20mm -See Finish Plans for exact location and extent		
Static Dissipative Tile				
SDT-1	Type: Manufacturer: Product Name: Color: Size: Thickness: Recycled Content: Location:	Vinyl Tile Flooring Johnsonite Aria 2.0 Urban Legend - 673 24" x 24" nominal .080" (2mm) nominal 25% pre-consumer recycled material 0.5% post-consumer recycled material -See Finish Plans for exact location and extent -BOH LAN ROOM		
Carpet				
CPT-1	Manufacturer: Product Name: Color: Size: Installation: Location:	Interface (Or approved alternate) Silver Linings Collection SL910 Charcoal - 104500 25cm x 1m Ashlar -See Finish Plans for exact location and extent	Contact: Bailey Johnston +1 416 768 8096 bailey.johnston@interface.com	
CPT-2	Manufacturer: Product Name: Color: Size: Installation: Location:	Interface (Or approved alternate) On Line Collection Azure - 103797 25cm x 1m Ashlar -See Finish Plans for exact location and extent	Contact: Bailey Johnston +1 416 768 8096 bailey.johnston@interface.com	
CPT-3	Manufacturer: Product Name: Color: Size: Installation: Location:	Interface (Or approved alternate) On Line Collection Grass - 105264 25cm x 1m Ashlar -See Finish Plans for exact location and extent	Contact: Bailey Johnston +1 416 768 8096 bailey.johnston@interface.com	
CPT-4	Manufacturer: Product Name: Color: Size: Installation: Location:	Interface (Or approved alternate) On Line Collection Orange - 105270 25cm x 1m Ashlar -See Finish Plans for exact location and extent	Contact: Bailey Johnston +1 416 768 8096 bailey.johnston@interface.com	
CPT-5	Manufacturer: Product Name: Color: Size: Location:	Uline (Or approved alternate) Waterhog Carpet Mat - H-3142GR Charcoal Cut-to fit (site verify) Entry Vestibule		
Paint				
PT-1	Manufacturer: Type: Colour: Finish: Location	Benjamin Moore (or approved alternate) Latex Interior Standard, Low VOC Ice Mist OC-67 Eggshell -General Paint Walls	General Paint	

Finishes Schedule

Project Name: Office Modernization for Toronto Water Office
 Project Number: 1418121
 Date: 2025-02-03

Symbol	Description	Notes	Image
PT-1a	Manufacturer: Type: Colour: Finish: Location	Benjamin Moore (Or approved alternate) Latex Interior Standard, Low VOC Chantilly Lace OC-67 Flat -Paint all GWB bulkheads. In areas of no finished ceilings are to be painted PT-1a.	Drywall Ceilings 
PT-2	Manufacturer: Type: Color Number: Color Name: Finish: Location	Dulux (Or approved alternate) Latex Interior Standard, Low VOC 90BG 29/267 Spirited Flight Eggshell -Accent Paint - Walls	Open Focus 
PT-3	Manufacturer: Type: Color Number: Color Name: Finish: Location	Dulux (Or approved alternate) Type Latex Interior Standard, Low VOC 10BB 17/269 Sapphire Glow Eggshell Accent Paint - Walls	Enclosed Focus 
PT-4 (RESERVE)			
PT-5	Manufacturer: Type: Color Number: Color Name: Finish: Location	Dulux (Or approved alternate) Latex Interior Standard, Low VOC 10GY 21/375 Calypso Green Eggshell Accent Paint - Walls	Meeting Rooms 
PT-6	Manufacturer: Type: Color Number: Color Name: Finish: Location	Sherwin Williams (Or approved alternate) Latex Interior Standard, Low VOC SW 6643 Yam Eggshell Accent Paint - Walls	Open Lockers 
PT-7	Manufacturer: Type: Color Number: Color Name: Finish: Location	Sherwin Williams (Or approved alternate) Latex Interior Standard, Low VOC SW 6629 Jalapeno Eggshell Location Accent Paint - Walls	Servery 
PT-8	Manufacturer: Type: Color Number: Color Name: Finish: Location Notes:	Dulux (Or approved alternate) Latex Interior Standard, Low VOC 00NN 13/000 Obsidian Glass Eggshell on walls, Semi-Gloss on frames Door Panels Refer to Wall Finish Plan & Door Schedule for extent and locations	Doors 

Finishes Schedule

Project Name: Office Modernization for Toronto Water Office
 Project Number: 1418121
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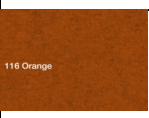
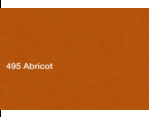
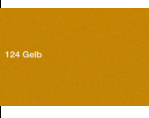
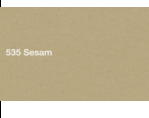
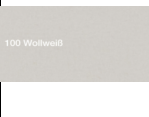

Symbol	Description	Notes	Image
Acoustical Felt Board			
AWP-1	Manufacturer: Symbol: Type: Colour: Location:	FilzFelt AF01 - Acoustic Wall Paneling Rectangle Block - Standard Edge 113 Immergrün *or equivalent Focus Areas	
	Manufacturer: Symbol: Type: Colour: Location:	FilzFelt AF02 - Acoustic Wall Paneling Rectangle Block - Standard Edge 551 Eis *or equivalent Focus Areas	
	Manufacturer: Symbol: Type: Colour: Location:	FilzFelt AF03 - Acoustic Wall Paneling Rectangle Block - Standard Edge 284 Himmel *or equivalent Focus Areas	
	Manufacturer: Symbol: Type: Colour: Location:	FilzFelt AF04 - Acoustic Wall Paneling Rectangle Block - Standard Edge 995 Wasser *or equivalent Focus Areas	
	Manufacturer: Symbol: Type: Colour: Location:	FilzFelt AF05 - Acoustic Wall Paneling Rectangle Block - Standard Edge 686 Enzian *or equivalent Focus Areas	
	Manufacturer: Symbol: Type: Colour: Location:	FilzFelt AF06 - Acoustic Wall Paneling Rectangle Block - Standard Edge 626 Azur *or equivalent Focus Areas	
	Manufacturer: Symbol: Type: Colour: Location:	FilzFelt AF07 - Acoustic Wall Paneling Rectangle Block - Standard Edge 150 Weiß *or equivalent Enclosed Collaboration - Meeting Rooms	
	Manufacturer: Symbol: Type: Colour: Location:	FilzFelt AF08 - Acoustic Wall Paneling Rectangle Block - Standard Edge 170 Asche *or equivalent Enclosed Collaboration - Meeting Rooms	
AWP-2	Manufacturer: Symbol: Type: Colour: Location:	FilzFelt AF07 - Acoustic Wall Paneling Rectangle Block - Standard Edge 150 Weiß *or equivalent Enclosed Collaboration - Meeting Rooms	
	Manufacturer: Symbol: Type: Colour: Location:	FilzFelt AF08 - Acoustic Wall Paneling Rectangle Block - Standard Edge 170 Asche *or equivalent Enclosed Collaboration - Meeting Rooms	
	Manufacturer: Symbol: Type: Colour: Location:	FilzFelt AF09 - Acoustic Wall Paneling Rectangle Block - Standard Edge 575 Salbei *or equivalent Enclosed Collaboration - Meeting Rooms	
	Manufacturer: Symbol: Type: Colour: Location:	FilzFelt AF10 - Acoustic Wall Paneling Rectangle Block - Standard Edge 260 Sprießen *or equivalent Enclosed Collaboration - Meeting Rooms	

Finishes Schedule

Project Name: Office Modernization for Toronto Water Office

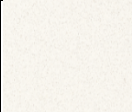
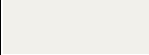



Project Number: 1418121

Date: 2025-02-03

Symbol	Description	Notes	Image
	Manufacturer: FilzFelt Symbol: AF11 - Acoustic Wall Paneling Type: Rectangle Block - Standard Edge Colour: 625 Pinie *or equivalent Location: Enclosed Collaboration - Meeting Rooms		
	Manufacturer: FilzFelt Symbol: AF12 - Acoustic Wall Paneling Type: Rectangle Block - Standard Edge Colour: 378 Oliv *or equivalent Location: Enclosed Collaboration - Meeting Rooms		
AWP-3	Manufacturer: FilzFelt Symbol: AF13 - Acoustic Wall Paneling Type: Rectangle Block - Standard Edge Colour: 116 Orange *or equivalent Location: Open Collaboration		
	Manufacturer: FilzFelt Symbol: AF14 - Acoustic Wall Paneling Type: Rectangle Block - Standard Edge Colour: 495 Abricot *or equivalent Location: Open Collaboration		
	Manufacturer: FilzFelt Symbol: AF15 - Acoustic Wall Paneling Type: Rectangle Block - Standard Edge Colour: 124 Gelb *or equivalent Location: Open Collaboration		
	Manufacturer: FilzFelt Symbol: AF16 - Acoustic Wall Paneling Type: Rectangle Block - Standard Edge Colour: 535 Sesam *or equivalent Location: Open Collaboration		
	Manufacturer: FilzFelt Symbol: AF17 - Acoustic Wall Paneling Type: Rectangle Block - Standard Edge Colour: 100 Wollweib *or equivalent Location: Open Collaboration		
Bases			
B-1	Type: Resilient Wall Base Supplier: Johnsonite (Or approved alternate) Color: Product Name: TightLock Resilient Base Size: 3.25" Manufacturer's standard thickness Finish: Notes: -Use B-1 unless otherwise noted		
B-2	Type: Wall Base Product Name: Millwork Base -To be provided by millworker -Refer to detail 4/D1004		
B-3	Type: Wall Base Product Name: Tile Base with cove -To match TL-4 -Refer to detail 5/D1004		
Grout			
GT-1	Manufacturer: Colour: Product Name:		

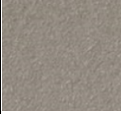

Finishes Schedule

Project Name: Office Modernization for Toronto Water Office
 Project Number: 1418121
 Date: 2025-02-03

Symbol	Description	Notes	Image
Glazing			
GL-1	Type: Colour: Thickness: Location Notes:	Tempered Clear 1/4" -Wood door vision panel (Access Doors Client In-Take) -Provided by System Manufacturer	
GL-2	Type: Colour: Thickness: Location Notes:	Tempered Clear 3/8" -Glass partition with aluminum frame -Provided by System Manufacturer	
Glazing Film			
GF-1	Manufacturer: Product Type/Colour: Notes:	3M (Or approved alternate) Translucent Dusted Crystal 7725SE-314 vinyl Refer to Finishes Plan / Door Schedule for locations	
Metal			
MT-1	Material / Alloy: Supplier: Type: Product: Finish: Location:	Clear Adonized Aluminum GC Edge Trim "L" Profile Breakform Satin -Continuous frame @ TK-1 (Tackable Finish)	
Solid Surface			
SS-1	Manufacturer: Product Name: Color: Color Number: Location: Notes:	Caesarstone (Or approved alternate) Classico Blizzard 2141 Refer to elevations for extent and locations.	
Tile			
TL-1	Manufacturer: Product Name: Color: Size: Finish: Location: Notes:	Stone Tile (Or approved alternate) Nova Architectura White 5500 10cm x 20cm Matte -Kitchen Wall Tile -See Finish Plans for exact locations and extent	
TL-2	Manufacturer: Product Name: Color: Size: Finish: Location: Notes:	Olympia (Or approved alternate) Colour & Dimension Artic White Matte 10cm x 40cm Matte -Washroom Wall Tile -See Finish Plans for exact locations and extent	
TL-3	Manufacturer: Product Name: Color: Size: Finish: Location: Notes:	Olympia (Or approved alternate) Colour & Dimension Dark Grey Matte 10cm x 40cm Matte -Washroom Wall Tile -See Finish Plans for exact locations and extent	
TL-4	Manufacturer: Product Name: Color: Size: Finish: Location: Notes:	Olympia (Or approved alternate) Colour & Dimension Dark Grey Matte 12"x24" Matte -Washroom Floor Tile -See Finish Plans for exact locations and extent	

Finishes Schedule

Project Name: Office Modernization for Toronto Water Office
 Project Number: 1418121
 Date: 2025-02-03







Symbol	Description	Notes	Image
Wallcovering			
TK-1	Item: Manufacturer: Color: Location: Notes:	Tackable Board Forbo (Or approved alternate) Potato Skin -Business Centre -Refer to elevations for extent and locations. -Provide continuous metal trim at all edges.	
WC-1	Item: Manufacturer: Location: Notes:	Custom Printed Wallcovering BGM Imaging -TBD -Refer to Plan and Elevations for locations and extent	
Acoustical Panel Ceiling			
ACT-1	Manufacturer : Product Name: Color: Size: Location : Notes:	Armstrong (Or approved alternate) Fine Fissured Square Lay-in Humiguard Plus 1736 with Prelude XL 15/16" Exposed Tee White 24"x48"x5/8" *or equivalent As indicated on Reflected Ceiling Plans	
Miscellaneous			
CG-1	Type: Material/Alloy: Supplier: Type: Size: Finish: Location	Corner Guard Stainless Steel GC Corner Guard 3" x 3" x 48" H Brushed Refer to Wall Finish Plan for extent and locations	
TS-1	Type: Material / Alloy Supplier: Product Name: Location: Notes:	Transition Strip Stainless Steel Schuler Systems Inc. (Or approved alternate) Schiene, E Refer to Floor Finishes Plan for extent and locations. Used at transition from carpet to tile.	
TS-2	Type: Supplier: Product Name: Colour: Location: Notes:	Transition Strip Johnsonite (Or approved alternate) Slim Line Transition SLTC-20-A Neutral -Refer to Finish Plan for extent and locations. -Used at transition from resilient/vinyl to carpet	

Furniture Schedule

New

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Furniture Schedule - New
Project Name: Office Modernization for Toronto Water Office
Project Number: 1418121
Date: 2025-02-03

Symbol	Description	Inventory Quantity	Qty Required & Location	Dimensions LxWxH	Finishes	Notes	Image
Chairs							
CH-07	New - JumpSeat 90, Sedia Systems	N/A	1pc - Client In-take (Waiting Area)		TBD	JumpSeat 90. Moveable Seat, non fixed base.	
CH-08	New - Kitchen Counter Height Stool	N/A	3pcs - Kitchen/Lunch Room	18"W, 29"H seat height	TBD	Polypropylene stackable chair; seat and perforated back, chrome frame, c/w glides on resilient flooring. No arms. No seat pad. For use at counter-height tables. Neutral colour to be specified.	
Workstations							
WS-01	New - Workstations	N/A	22 - Main Level Workstations 27 - Mezzanine Level Workstations TOTAL: 49	5' - 6" x 2' - 6" (ModernTO suggests 6', space can not accommodate)	TBD	Equipped With: - Sit-Stand Desk (independent from Spine) - Seated Height Privacy Screen secured to spine @ 51" AFF - Height Adjustable 27" - 43"H - Low electronic mechanism. Height Adjustable controls to have Colour/Brightness Contrast - Under surface Cable Management - Single Pole Dual Monitor Arm c/w integrated cable management (any size application) - Min Range: 6"-27" Vertically, 16"-25" Horizontally, 80 Deg Tilt, 360 Deg. rotation, 40lb support, quick install/release, white with polished aluminum trim - Desk Mount power/usb Module (2) Power, (2) USB and (1) Blank. - Universal Docking Station (by others) - Side Gallery Panel at Corridor Side of workstation Pods. Grade A or 1 whiteHPL. -6 outlet Power Bar, fixed to underside of desk. - T Leg - Grade A or 1 White HPL c/w square vinyl Edge.	
WS-02	New - Workstations	N/A	4-Mezzanine TouchDown Workstations	4' - 0" x 2' - 6" (As Per ModernTO) -Surface height capable of between 30" - 34" AFF;	TBD	- Colour/brightness contrast from surrounding environment; and -Feet/legs that do not protrude outside of the workstation. -Power Bar, fixed to underside of desk.	
WS-03	New - Workstations	N/A	3- Client In-Take	4' - 10" x 2' - 6" -Surface height capable of between 30" - 34" AFF;	TBD	- Sit-Stand Desk (independent from Spine) -Modesty Panel between user and guest. - Height Adjustable 27" - 43"H - Low electronic mechanism. - Height Adjustable controls to have Colour/Brightness Contrast -Gallery Panel between users and at end of run @72" H - Desk Mount power/usb Module (2) Power, (2) USB and (1) Blank. - Colour/brightness contrast from surrounding environment - Universal Docking Station (by others) -Monitor arm 2qty - Min Range: 6"-27" Vertically, 16"-25" Horizontally, 80 Deg Tilt, 360 Deg. rotation, 40lb support, quick install/release, white with polished aluminum trim -6 outlet Power Bar, fixed to underside of desk.	
Credenza							
CR-01	New - Credenza	N/A	1- Large Meeting Room	6'-0" x 1'-8" x 29"	TBD	-Credenza/counter for serving with trash and recycling bins stored below.	Z J X B Boardroom Credenza, 1/2" Top, 29H with Doors & Drawers 





Furniture Schedule Relocated

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Furniture Schedule - Relocated
Project Name: Office Modernization for Toronto Water Office
Project Number: 1418121
Date: 2025-02-03

Symbol	Description	Inventory Quantity	Qty Required & Location	Dimensions LxWxH	Finishes	Notes	Image
Chairs							
CH-01	Relocated - Black Task Chair	65	22- Main Level Workstations 34- Mezzanine Level Workstations 3 - Client In-take Employee Workstations 2 - Focus Rooms TOTAL: 61				
CH-02	Relocated - Boardroom Chair	28	16 - Large Meeting Room 4 - Meeting Room #1 4 - Meeting Room #2 4 - Meeting Room #3 TOTAL: 28				
CH-03	Relocated - Black Guest Chair	15	3 - Client In-Take (Client Chair) 3 - Client In-Take (Waiting Area) TOTAL: 6				
CH-04	Relocated - Black Lunchroom Chair	14	2- Kitchen Lunch Room (Black Chair)				
CH-05	Relocated - Collaboration Stools	6	6 - Collaboration Stool				
CH-06	Relocated - Blue chair on wheels	8	1 - Breakout Room				
Tables							
TB-01	Relocated - Boardroom Table with Wheels 30x60	8	8- Large Meeting Room			Can be retrofitted with power modules for each table.	
TB-02	Relocated - Round Table 36"	4	1- Kitchen/Lunch Room				
TB-03	Relocated - meeting room tables	3 - 54x51 round	3pcs - Meeting Room #3 (3 person meeting room)				
TB-05	Relocated - White rectangular table	1	1 - Collaboration Area			Collaboration table has power mod on top with wire connecting to base power	 
TB-06	Relocated - Sit Stand Desks	2	2- Focus Rooms	8x30 sit stands for focus rooms are available.		Only one desk has dual monitor arms, no power cube. The other has a power mod built into the desk, no monitor arms.	 
TB-07	Relocated - White fixed height table	1	1- Client In-Take Sample Drop Off	48x20x29 Table			

Furniture Schedule - Relocated
Project Name: Office Modernization for Toronto Water Office
Project Number: 1418121
Date: 2025-02-03

Symbol	Description	Inventory Quantity	Qty Required & Location	Dimensions LxWxH	Finishes	Notes	Image
Tables							
WS-02A		3	3- Mezzanine Touchdown Workstations	(3) 46x29 sit stands for touchdown workstations			
Storage							
LKR-01	Relocated - Bank of 6 Lockers 24x18x72	4	4 - Locker area on Mezzanine			To be relocated as discussed previously	
	Relocated - Bank of 9 Lockers 36x18x72	2	2 - Locker area on Mezzanine			To be relocated as discussed previously	
Bed/Cot							
CT-01	Relocated - Cot	4	1 - Breakout Room				

Equipment Schedule

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Arcadis
 9th Floor 55 St Clair
 West
 Toronto ON
 M4V 2Y7
 Canada



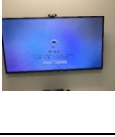


Issued For: 95% Design Submission
 Issued For: 100% / Permit

Equipment Schedule

Project Name: Office Modernization for Toronto Water Office

Project Number: 1418121

Date: 2025-02-03

Symbol	Description	Inventory Quantity	Qty Required & Location	Notes	Image
Tech Equipment					
EQ-01	Samsung TV - QM98T-B Crystal UHD 4K Signage 96in. TV	None - NEW	1- Large Boardroom		
EQ-02	Cisco Camera	2	1- Large Boardroom		
EQ-03	65" Television Samsung	1	1 - Meeting Rm #1	Only 3 required for the 4-5 person meeting rooms	
	65" Screen	2 From TW IT	2 - Meeting Rm #2 & #3		
EQ-04	55" Television Sony	1	1 - Mezzanine Meeting Room Hallway		
EQ-05	55" Television Sharp	1	1- Kitchen/Lunch Room		
EQ-06	Photo Copier mipe87660	2	1- Business Centre 1- Adjacent Large Meeting room		
Kitchen Equipment					
EQ-07	LG Fridge	1	1-Kitchen	D: 34", W: 33", H:~68"	
	Stainless Steel Fridge	1	1-Kitchen	Only 1 stainless steel fridge required Client to provide specs	
EQ-08	Range	1	1-Kitchen	L: 30 1/4", W: 27 1/2", H: 35 1/2" top of stove Stove only - range not required	



Arcadis
 9th Floor 55 St Clair
 West
 Toronto ON
 M4V 2Y7
 Canada









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 Issued For: 100% / Permit

Equipment Schedule

Project Name: Office Modernization for Toronto Water Office

Project Number: 1418121

Date: 2025-02-03

Symbol	Description	Inventory Quantity	Qty Required & Location	Notes	Image
EQ-09	Microwave	2	1-Kitchen	Client to provide spec	
EQ-10	Toaster Oven	1	1-Kitchen	One toaster required.	
	Toaster Oven	1			
	Toaster	1			
EQ-11	Dish Washer	1	1-Kitchen	D: 25 1/2", W: 24", H: 34 1/2"	
EQ-12	Coffee Maker	1	1-Kitchen	Client to provide spec	
Kitchen Plumbing Fixtures					
EQ-13	Kitchen Sink	None - NEW	1-Kitchen	24" Undermount single bowl kitchen sink. Approx. 24"W x 18 1/4"D Finish: Stainless steel.	
EQ-14	Faucet	None - NEW	1-Kitchen	Faucet with Touchless Technology. Approx. 9.5"W x 16 3/16"H Finish: Chrome.	
EQ-15	Bottle Filling Station with Drinking Fountain.	None - NEW	Washroom Hallway	Approx. 19"W x 18 3/8"L x 39 1/16"H Finish: Stainless steel.	

- 1 General
- 1.1 **SUMMARY**
 - .1 Section Includes
 - .1 Labour, Products, equipment and services necessary to complete the Work of this section.
- 1.2 **REFERENCES**
 - .1 Conform to the latest edition of the following:
 - .1 ASTM A653/653M - Standard Specification for Sheet Steel, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot Dip Process
 - .2 ASTM A568/A568M - Standard Specification for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for
 - .3 ASTM C1396/C1396M - Standard Specification for Gypsum Board
 - .4 ASTM C475/C475M - Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board
 - .5 ASTM C645 - Standard Specification for Nonstructural Steel Framing Members
 - .6 ASTM C1002 - Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs
 - .7 CAN/CSA-G40.20/ G40.21-M - General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steels
 - .8 SSPC - The Society for Protective Coatings, "Steel Structures Painting Manual, Vol. 2"
 - .9 AODA - Accessibility for Ontarians with Disabilities Act
- 1.3 **QUALITY ASSURANCE**
 - .1 Retain workmen skilled in gypsum board work to perform Work of this section in accordance with this Specification and the latest printed directions of the manufacturer.
- 1.4 **DELIVERY, STORAGE AND HANDLING**
 - .1 Deliver materials in original packages, containers and bundles bearing brand and manufacturer's name. Handle materials with care to prevent damage thereto. Store in a covered area off the ground, on flat, smooth, dry surfaces.
 - .2 Protect this Work against damage at all times. Protect from moisture until ready for use.

1.5 **PROJECT/SITE CONDITIONS**

- .1 In cold weather and during period of gypsum board application and joint finishing, maintain temperatures within the building uniformly within the range of 13°C to 21°C (55°F to 70°F). Also provide adequate ventilation to eliminate excessive moisture within the building during this same period.

2 Products

2.1 **STEEL FRAMING SYSTEM**

.1 Manufacturer:

- .1 Bailey Metal Products Limited
- .2 Canadian Gypsum Co. Limited (CGC)
- .3 Or accepted equal

- .2 Main runner channels: 38 mm x 19 mm, cold rolled galvanized steel channels, weighing not less than 0.8 kg/m conforming to ASTM A568/568M and ASTM A653/653M.

- .3 Metal furring channels: 22 mm winged flange type, cold rolled galvanized steel channels conforming to ASTM A568/568M and ASTM A653/653M.

- .4 Metal studs: Standard gypsum board screw-on stud system complete with floor and ceiling runners conforming to ASTM A568/568M, ASTM C645 and ASTM A653/653M. Size: 32 mm wide x depths shown on Drawings. Use 20 gauge for abuse-resistant board.

- .5 Shaftwall framing: "C-H" studs complete with "J" runners and "E" studs as required, all hot-dip galvanized.

- .6 Hangers: 5 mm diameter pencil rods or 32 mm x 3 mm galvanized steel flat bars to CSA A82.30-M.

- .7 Tie wire: Not less than No. 18 gauge galvanized wire.

- .8 Screw fasteners: in accordance with ASTM C1002, Type S, corrosion resistant.

.9 Wall Reinforcement:

- .1 Provide fire retardant treated wood blocking and minimum 18 gauge sheet steel secured between studs for additional reinforcement and supports for wall mounted fixtures, equipment and accessories. The same requirements shall be applied to ceiling mounted items. Coordinate with General Contractor for weight of items to be supported and revise steel gauge accordingly to ensure proper support.

- .2 Provide additional wall reinforcement to support future adult change table designed for a minimum load of 1.33 kN and baby change table designed to support a 0.22 KN load applied to it

2.2 **GYPSUM BOARD**

.1 Standard Gypsum board:

- .1 12.9 mm and 15.9 mm thick, or as indicated on Drawings, with tapered and rounded edge for joint filling, and in 1200 mm wide sheets of maximum practical lengths to minimize end joints, in accordance with ASTM C1396/C1396M:

- .2 Acceptable Manufacturer
 - .1 "ToughRock" by Georgia Pacific Canada (GP)
 - .2 "Sheetrock" by CGC
 - .3 "ProRoc Regular Gypsum Board" by CertainTeed
 - .4 Or accepted equal
- .2 Fire Rated Gypsum Board
 - .1 Gypsum board shall conform to the flame spread rating requirements of the Ontario Building Code.
 - .2 For fire rated assemblies, conforming to ASTM C1396/C1396M
 - .3 Size: 12.7 mm, 15.9 mm, 19.1 mm or 25.4 mm thick, unless indicated otherwise, Type "X" or "C"
 - .4 Acceptable Manufacturer
 - .1 Sheetrock Firecode Core Type C by CGC Inc
 - .2 ToughRock Fireguard Type X or C by Georgia Pacific Canada
 - .3 AirRenew Essential Type X LAQ Gypsum Board by CertainTeed Gypsum Inc.
 - .4 Or accepted equal
- .3 Soundproof Gypsum Panels
 - .1 Mould-resistant type, impact resistant, STC 52 - 74, Type X
 - .2 Size: 15.9 mm thick, 1220 x 2440 mm sheets, unless indicated otherwise
 - .3 Acceptable Manufacturer
 - .1 QuietRock 530 by CertainTeed
 - .2 Or accepted equal
- .4 Interior Ceiling Board
 - .1 In accordance with ASTM C1396 and CAN/CSA-A82.27
 - .2 Size: 12.7 mm thick, 1220 x 2440 mm sheets, unless indicated otherwise
 - .3 Acceptable Manufacturer
 - .1 "Easi-Lit Lightweight Drywall" by CertainTeed Gypsum Inc.
 - .2 "Sheetrock Interior Ceiling Board" by CGC Inc.
 - .3 "ToughRock CD Ceiling Board" by Georgia Pacific Canada
 - .4 Or accepted equal
- .5 Moisture and Mould-Resistant Gypsum Board

- .1 To ASTM C1396M, score of 10 with moisture and mould resistant core and paper surfaces.
- .2 12.7 mm or 15.9 mm thick and of maximum practical lengths to minimize end joints, unless indicated otherwise.
- .3 Acceptable Manufacturer
 - .1 M2Tech Moisture and Mold Resistant Type X Gypsum Board by CertainTeed
 - .2 Sheetrock Mould Tough Type X Interior Panel by CGC Inc.
 - .3 DensArmor Plus High Performance Interior Panel or ToughRock Mold-Guard by Georgia Pacific Canada.
 - .4 ProRock Moisture Resistant Gypsum Board by CertainTeed
 - .5 Or accepted equal
- .6 Tile Backer Gypsum Board for Showers
 - .1 In accordance with ASTM C1178/C1178M and ASTM C1658/C1658M
 - .2 Size: 12.7 mm thick, or as indicated on Drawings
 - .3 Acceptable Manufacturer
 - .1 "Diamondback Tile Backer" or "Diamondback Type X Tile Backer" by CertainTeed
 - .2 "Sheetrock Mould Tough Fibreglass Interior Panel" or "Sheetrock Mould Tough Fibreglass Type X Interior Panel" by CGC Inc.
 - .3 "DensShield Tile Backer" or "DensShield Tile Backer Type X" by Georgia Pacific (GP)
 - .4 Or accepted equal
- .7 Cement Board
 - .1 In accordance with ASTM C1396/C1396M
 - .2 Size: 12.7 mm thick, or as indicated on Drawings
 - .3 Acceptable Manufacturer
 - .1 "Durock Cement Board" by CGC Inc
 - .2 "Permabase" by Unifix Inc distributed by CertainTeed Gypsum Inc or National Gypsum.
 - .3 Or accepted equal
- .8 Exterior Soffit Board
 - .1 Sag resistant, conforming to ASTM C1396.
 - .2 Acceptable Manufacturer
 - .1 "Exterior Ceiling Panel" by CGC Inc.

- .2 "ToughRock Soffit Board" by Georgia Pacific Canada (GP)
- .3 CertainTeed Soffit Board
- .4 Or accepted equal
- .9 Exterior Sheathing
 - .1 In accordance with ASTM C79, Type X
 - .2 Size: 12.7 mm thick or as indicated on Drawings
 - .1 "Dens Deck" or "ToughRock Sheathing" by Georgia Pacific Canada (GP)
 - .2 "ProRoc Sheathing Treated Core" by CertainTeed
 - .3 "Gyplap Sheathing" by CGC
 - .4 Or accepted equal
- .10 Abuse Resistant Gypsum Fibre Panels
 - .1 Size: 16 mm thick or as indicated on Drawings
 - .2 Acceptable Manufacturer
 - .1 "Abuse-Resistant Gypsum Board Panels" with tapered edges by CGC
 - .2 "ToughRock Abuse-Resistant Gypsum Board", by Georgia Pacific Canada (GP)
 - .3 Extreme Impact by CertainTeed
 - .4 Or accepted equal
- .11 Shaft Liner
 - .1 Mould and moisture resistant panels, double bevelled edge, conforming to ASTM C1396.
 - .2 Size: 25.4 mm thick or as indicated on Drawings
 - .3 Acceptable Manufacturer
 - .1 "Shaftwall Linerpanel" by CGC
 - .2 "Toughwall Fireguard Shaftliner" by Georgia Pacific (GP)
 - .3 M2Tech Shaft Liner by CertainTeed
 - .4 Or accepted equal
- .12 Accessories
 - .1 External corner reinforcement: Domtar "Metal Corner Bead", CGC "Dur-A-Bead", CertainTeed "AquaBead Corner Reinforcement" or GP equal.
 - .2 Casing beads: 0.56 mm (25 gauge) galvanized steel designed to accept the specified thickness of gypsum board.
 - .3 Joint reinforcement tape (gypsum board): Domtar "Joint Tape" CGC "Perf-A-Tape", CertainTeed "FibaTape" or GP equal, conforming to ASTM C475.

- .4 Joint reinforcement tape (backer board): Glass mesh.
- .5 Joint filler, topping cement: For gypsum board, use manufacturer's high grade premixed compound. For composite and cementitious backer board, use board manufacturer's high grade premixed compound for waterproof exposure.
- .6 Control joint strip: Roll formed zinc coated metal with a tape protected void, 6 mm wide throat x 11 mm deep with flanges for embedding in joint compound.
- .13 Floor Underlayments: "Levelrock 25000 by CGC or accepted equal.
- .14 Acoustic insulation: QuietZone Acoustic Batt by Owens Corning, "Sustainable Insulation Noise Reducer" by Certainteed, "Thermafiber Sound Attenuation Fire Blanket" by Thermafiber Inc., "SAFB" by Fibrex Insulations, Inc. or "AFB" by Rockwool. Size as indicated on Drawings.
- .15 Acoustic sealant and spray: Tremco "Acoustical Sealant", PRC "PR181", U.S.E.-Hickson "Kop●R●100" or Wilrep "SilenSeal" (water based), "CP 506 Smoke and Acoustic Sealant" or "CP 572 Smoke and Acoustic Spray" by Hilti Canada, or accepted equal. Covering bead at exposed applications shall be a material compatible with acoustic sealant, suitable for painting, as supplied by acoustic sealant manufacturer.
- .16 Shower Waterproofing Membrane
 - .1 Refer and coordinate requirements with Section 09 30 00 Tiling.
 - .2 Shower Waterproofing membrane is to be provided on shower walls and to transition to shower pan.
- .17 Column covers: Non-combustible glass fibre-reinforced high density gypsum (GRG) conforming to ASTM E-84, fabricated in two vertically divided sections attached with screws and with field finished joint. All fasteners are to be concealed. Provide all support structures. Formglas Inc. or DecoForm Inc. or accepted equal.
- .18 Screws and Nails:
 - .1 Backer board screws: "Hi-Lo" bugle head Type S point concrete backer board screws, corrosion resistant.
 - .2 Gypsum board screws: 5 mm x 25 mm (No. 6 gauge) x 1" long for metal furring application and 5 mm x 32 mm (No. 6 gauge) x 1-1/4" long for metal stud application. Screws shall be self-drilling, case hardened, with socket countersunk heads to ASTM C1002, Type S.
 - .3 Screws for gypsum board on wood studs: 5 mm (No. 6 gauge) x length to penetrate minimum 16 mm into wood. Screws shall conform to ASTM C1002, Type W.
 - .4 Nails for exterior gypsum board sheathing on wood framing: Roofing type, galvanized.
- .19 Inserts for concrete slabs
 - .1 Ceiling Wire X-CW or Ceiling Clip X-CC by Hilti Canada, Tie wire anchors, Red Head TW-1614 by ITW Canada Inc., Parabol Wire Hanger distributed by Acrow-Richmond Ltd., T-14 Eyebolt by Ramset Ltd. or Tie Wire Drive TW-932 by Isometric Ltd or accepted equal.
- .20 Adhesive

- .1 Adhesive for gypsum board on rigid insulation: 3M No. 2166 or ICI Devoe D.W.24.
- .2 Adhesive for gypsum board on masonry or concrete walls: Joint filler mixed with water in accordance with manufacturer's directions.
- .21 Supplementary steel supports: Steel conforming to Section 05 50 00 of this Specification.
- .22 Metal deck flute closure: Moulded to deck profile; moulded cellular neoprene or rubber closure pieces at non-rated locations and fire rated closed cell neoprene conforming to ASTM D1056 or D2056 at fire rated locations.
- .23 Access doors: Refer to Section 08 31 00 Access Doors and Panels

2.3

FRAMING SYSTEMS

- .1 Acceptable products: Model CFS-TTS "Firestop Top Track Seal" by Hilti Canada or accepted equal.
- .2 Slip-type head joints: Deflection track.
- .3 Firestop top track seal: One-piece, pre-formed, polyurethane foam based, firestop seal for use with standard head-joint top tracks and bottom-joint tracks, and slip-type head joints in fire-rated construction at top of bottom of partition to maintain continuity of the fire resistance rated assembly. Provide in width and configuration required to accommodate depth and installation of studs and designed to saddle over the top track or under the bottom track.
 - .1 Track seal shall be UL 2079 tested for specific fire rated construction conditions conforming to construction assembly type, space requirements and fire-rating required for each application.
 - .2 Performance Requirements:
 - .1 Movement: +/- 50%
 - .2 Surface burning characteristics in accordance with CAN/ULC S102-10:
 - .1 Flame spread: 15
 - .2 Smoke developed: 35
 - .3 Mold-mildew performance in accordance with ASTM G21-96, Class 0.
 - .4 VOC content: 0.16 lb/gallon

3

Execution

3.1

SUSPENSION SYSTEM

- .1 Locate anchorage points in reinforced concrete floor slab underside (35 MPa compressive strength) in accordance with gypsum board manufacturers' suspension requirements. Drill holes with carbide-tipped drill bits conforming to ANSI B94.12-M. Install anchors; minimum installation depth and method of expansion as recommended by anchor manufacturer.
- .2 DO NOT secure hangers to metal deck or mechanical ducts. Hang grillage for suspended gypsum board ceilings independent of walls, pipes, ducts. Securely anchor to the building structural framing or slab.

- .1 Space hangers at 1200 mm maximum centres along the carrying channels, and not more than 150 mm from ends.
- .2 Place supplementary steel supports as required to maintain hanger spacing and to keep metal deck and mechanical ducts free from hangers being secured to.
- .3 Space carrying channels at maximum 1200 mm centres and not less than 25 mm nor more than 150 mm from boundary walls.
 - .1 Run the channels transverse to structural framing members.
 - .2 Where splices are necessary, lap members at least 200 mm and wire each end with two loops.
 - .3 Avoid clustering or lining up splices. Attach to rod hangers by bending hanger sharply under bottom flange of runner and securely wire in place with a saddle tie.
- .4 All stems on precast concrete double tee deck have 13 mm diameter holes, at 1200 mm o.c. and are available to ALL trades for attachments and hangers. Not all holes will therefore be used for gypsum board suspension alone. Provide supplementary steel as required and attach to holes that are available.
- .5 Install furring channels transverse across carrying channels or other supports.
 - .1 Space at 400 mm centres and not less than 25 mm nor more than 150 mm from boundary walls, openings, interruptions in ceiling continuity and change in direction.
 - .2 Secure to each support with clips or equivalent attachment.
 - .3 Splice joints by nesting and tying channels together or with custom splicers.
 - .4 Level to a maximum tolerance of 3 mm over 3600 mm.
 - .5 Reinforce wherever necessary for the proper support of luminaires, access hatches, ceiling grilles, outlet boxes, ventilating outlets and all other openings.
 - .6 Provide special furring as required at recessed lights.
- .6 Provide expansion/control joints in ceilings, furring and panelling where stresses are likely to develop, such as at the following locations:
 - .1 At abutting structural elements
 - .2 At dissimilar walls and ceilings
 - .3 At dissimilar backup interface at structural expansion and control joints
 - .4 At wings of "L", "U" and "T" shaped ceiling areas
 - .5 At 9000 mm maximum spacing in continuous runs
- .7 Form control joints using continuous furring channels along each side of joint locations, and filling control joint space with specified joint strip, secured in place, making straight joints. Temporarily tape control joint "V" grooves in preparation for joint filling.

3.2 **STEEL STUDS AND FURRING**

- .1 Install tracks at floors, ceilings and underside of deck over, align accurately and secure to structure at 600 mm centres maximum. Avoid piercing metal deck.

- .2 Close opening between top track and steel deck flutes on all full height partitions and bulkheads with specified deck flute closure. Install carefully and compress into place to close flute openings.
- .3 Close opening between track and concrete deck on all full height partitions. Where partitions are at right angles to stems on precast concrete double tee deck, extend studs above bottom of stems as required to support gypsum board. Cut and fit top track between stems.
- .4 On full height partitions at coffered ceilings, stop studs at ceiling level, install studs from top of ceilings to concrete deck. Cut and fit top track between stems as required.
- .5 Place studs vertically at 400 mm o.c. and not more than 50 mm from abutting walls, openings and each side of corners. Install studs and secure to tracks.
- .6 Arrange for mechanical and electrical horizontal runs within walls to be installed simultaneously with partitions.
- .7 Provide freedom for deflection under beams and deck to prevent transmission of structural loads to studs, or install 50 mm deep telescoping top tracks.
- .8 At openings, install horizontal track to accommodate intermediate studs. Cut out flanges at each end of track, turn up webs and screw to studs. Install intermediate studs above and below openings at same spacing as wall studs.
- .9 Provide double studs at all hollow metal door jambs. Secure at top and bottom and brace back to adjacent studs at mid-point.
- .10 Provide control joints in gypsum board partitions where stresses are likely to develop, such as at the following locations:
 - .1 At abutting structural elements
 - .2 At dissimilar backup interface
 - .3 At dissimilar walls and ceilings
 - .4 At structural expansion and control joints
 - .5 At door and other openings
 - .6 At 9000 mm maximum spacing in continuous runs
- .11 Form control joints using double studs back to back on each side of joint locations, and filling control joint space with specified joint strip secured in place, making straight joints. Temporarily tape control joint "V" grooves in preparation for joint filling.

3.3 **WALL REINFORCEMENT:**

- .1 Provide and install backing and/or reinforcing within steel stud gypsum partitions for items being hung from or anchored to such partitions or furring.
- .2 Verify location of supports within gypsum board and provide information in ample time to ensure supports are provided in the correct locations. Do not install gypsum board until wood blocking or other reinforcements are installed. Remove and reinstall gypsum board at no extra cost to the Owner where this requirement is not complied with.
- .3 Provide galvanize stud reinforcements in moist areas. Do not use wood blocking for this purpose. Mount additional reinforcement horizontally or at an angle and secure between

studs to support the load of and shear forces imposed by items installed upon the Work of this Section. Such items include, but not limited to the following:

- .1 Washroom accessories
- .2 Miscellaneous specialties
- .3 Manufactured components
- .4 Fitments and fixtures
- .5 Architectural woodwork and other millwork components
- .6 Minor mechanical and electrical work; heavy mechanical and electrical equipment shall be self-supporting.
- .7 Adult and baby change table
- .8 Fire hose cabinets
- .9 Access panels
- .10 Handrails
- .11 Coat hooks
- .12 Wall hung cabinets
- .13 Shelving
- .14 Owner supplied equipment

.4

3.4

GYPSUM BOARD ON METAL SUSPENSION, STEEL STUDS AND FURRING

- .1 Erect gypsum boards vertically or horizontally, whichever results in fewer end joints. Locate edge or end joints over supporting members. Stagger vertical joints over different studs on opposite sides of partitions.
- .2 Locate vertical joints at least 300 mm from the jamb lines of openings.
- .3 Do not install imperfect, damaged or damp boards. Butt boards together for a light contact at edges and ends with not more than 1.6 mm open space between boards. Do not force into place.
- .4 Position boards so that both tapered edge joints abut, and mill-cut or field-cut where end joints abut. Do not place tapered edges against cut edges or ends.
- .5 Attach gypsum board to framing (and blocking) as required for additional support at openings and cutouts.
- .6 Do not locate joints within 200 mm of corners or openings, except where control joints are shown at jamb lines or where openings occur adjacent to corners in the partition/wall layout. Where necessary, place a single vertical joint over the centre of wide openings.
- .7 Where feasible, and where recommended by manufacturer, install gypsum board with "floating" corner construction, unless isolation of the intersecting boards is indicated or unless control or expansion joints are indicated.

- .8 Drive screws with a power screw-gun and set with the countersunk head slightly below the surface of the board.
- .9 In the case of double layers of gypsum board, screw first layer to studs and furring, laminate second layer to first using joint filler as an adhesive. Stagger joints between first and second layers. Brace face layer until adhesive has dried.
- .10 Install fire rated gypsum board to provide the fire ratings shown. Conform to applicable ULC/Warnock-Hersey designs and to manufacturer's specifications. Provide corner beads on all external corners.
- .11 Receive access panels from mechanical division and install in gypsum board assemblies. Coordinate locations with mechanical division.

3.5 **ACOUSTIC INSULATION**

- .1 Install sound attenuation blankets to full height and full width of partitions where indicated. Fit carefully behind electrical outlets and other Work which penetrates partitions.

3.6 **INSTALLATION OF SHAFTWALL**

- .1 Install runners at floors and underside of deck over, align accurately and secure to structure at 600 mm centres maximum with short leg toward finish side of wall.
- .2 Close opening between top track and steel deck flutes on all full height partitions and bulkheads with specified deck flute closure. Install carefully and compress into place to close flute openings.
- .3 Cut liner panel 25 mm less than floor to ceiling height and erect vertically between J-runners. If wall exceeds maximum panel length, position panel and joints within upper and lower third points of wall. Stagger joints top and bottom in adjacent panels and reinforce joints with horizontal C-H studs. Screw-attach studs or runners on walls over 4800 mm high.
- .4 Install studs to within 10 mm of floor to ceiling height, between liner panel, with panel edge inserted into stud groove. Install full length steel E-studs or J-runners vertically at intersections, corners, and columns. Frame openings to maintain structural support for wall.
- .5 Install gypsum panels on finish side to studs with 25 mm type S screws at 300 mm maximum.
- .6 Provide freedom for deflection under deck to prevent transmission of structural loads to studs.
- .7 Install horizontal shaftwall using C-H studs at 600 mm o.c. unless shown otherwise. Use J-runner to connect system to wall studs. Screw fasten gypsum board to J-runners.
- .8 Provide control joints where stresses are likely to develop, such as at the following locations:
 - .1 At abutting structural elements
 - .2 At dissimilar backup interface
 - .3 At dissimilar walls and ceilings
 - .4 At structural expansion and control joints, openings

- .5 At 9200 mm maximum spacing in continuous runs
 - .9 Form control joints using J-runners or E-studs back to back on each side of joint locations, and filling control joint space with specified joint strip secured in place, making straight joints.
 - .10 Install firestopping and sealant along perimeter edge, top and penetrations in fire rated assembly.
- 3.7 **GYPSON BOARD ON RIGID INSULATION**
- .1 Apply gypsum board by mechanical screwing and adhesive to insulation and to channels impaled in insulation. Channels are vertical, at 400 mm 600 mm o.c.
 - .2 Apply adhesive to foil face of insulation or back of wallboard with 3 mm continuous beads at 200 mm o.c.
 - .3 Erect gypsum board vertically or horizontally, whichever results in fewer end joints. Press to firm contact with adhesive.
 - .4 Screw to all channels at 300 mm o.c. using power screw-gun. Set screws with countersunk heads slightly below board surface.
- 3.8 **ACCESSORIES**
- .1 Erect plumb, or level, with minimum joints.
 - .2 Corner reinforcing bead: Install along all external angles. Secure with screws at 225 mm o.c. Apply filler over flanges flush with nose of the bead and extending at least 75 mm onto surface of board each side of corner. When filler dries, apply a thin coat of topping cement and blend onto adjoining surfaces.
 - .3 Casing beads: Install where wallboard butts against a surface having no trim concealing the juncture. Secure with screws at 300 mm o.c. Apply filler over flange flush with nose of the bead and extending at least 75 mm onto surface of board. When dry, apply a thin coat of topping cement and blend onto adjoining surfaces.
 - .4 Recess channels and trim: Secure recess channels and special metal trim to substrate. Provide casing beads full height on wallboard edges at recess channels and metal trim.
- 3.9 **JOINT TAPING, FINISHING**
- .1 Apply a coat of joint filler over board each side of joint and embed reinforcing tape. Cover edges of embedded tape with a thin coat of joint filler and complete joint with a final coat of topping cement feathered at least 200 mm each side of joint and cambered to a maximum thickness of 1.6 mm.
 - .2 Fill any gaps between boards at internal corners with joint filler, allow to dry. Apply thin coat of joint filler over board 50 mm on each side of corner. Embed angularly creased reinforcing tape and cover edges of tape with a thin coat. Apply second coat over tape on one side of corner and allow to dry before covering tape on other side. Apply finish coat of topping cement.
 - .3 Fill screw holes and depressions over each screw and nail head with joint filler/topping cement.
 - .4 After topping cement has dried, sand surface lightly with No. 00 sandpaper and leave smooth, ready for painting. Apply second coat of filler if required.
 - .5 Finish work smooth, seamless, plumb, true, flush and with square, plumb, neat corners.

- .6 Remove control joint "V" groove tape.

3.10 **JOINT TREATMENT OF BACKER BOARD - TILED AREAS**

- .1 Pre-fill joints of board with thin-set mortar and embed glassfibre tape. Press to a smooth finish. Allow to cure.
- .2 Provide control joint around ceiling perimeter, in addition to locations outlined earlier in this section.

3.11 **JOINT TREATMENT AND FINISHING OF BACKER BOARD - UNTILED**

- .1 Apply 50 mm glassfibre tape uniformly over joints and corners in a bed of joint compound. Cover fasteners with joint compound. Apply in accordance with manufacturer's directions.
- .2 Apply board manufacturer-recommended base coat uniformly on surface of board.
- .3 Apply 2.4 mm thick uniform water resistant skim coat as recommended by board manufacturer, finish smooth similar to that of gypsum board, ready to receive coating.
- .4 Provide control joint around ceiling perimeter, in addition to locations outlined earlier in this section.

3.12 **FINISHING**

- .1 Finishing shall conform to the following ASTM C840 finish levels:
 - .1 Level 0: For temporary construction.
 - .1 No taping, finishing or corner beads required.
 - .2 Level 1: Gypsum board in areas above ceilings, concealed spaces, service corridors and other areas not open to public view, and in areas where sound and smoke control is required.
 - .1 All joints and angles shall have tape embedded in joint compound. Surface shall be free of excess joint compound. Tool marks and ridges are acceptable.
 - .3 Level 2: Where water resistant gypsum backing board (ASTM C630) is used as tile substrate, in warehouse storage or similar areas where surface appearance is not a primary concern.
 - .1 All joints and angles shall have tape embedded in joint compound and have one separate coat of joint compound wiped with joint knife and leaving a thin coating over the tape and fastener heads. Cover accessories by one coat of joint compound. Surface shall be free of excess joint compound. Tool marks and ridges shall be acceptable.
 - .4 Level 3: Gypsum board in areas to receive heavy or medium texture finishes before final painting or where heavy grade wall coverings are to be applied as the final decoration. Do not use where smooth painted surfaces or light to medium wall coverings are specified.
 - .1 All joints and angles shall have tape embedded in joint compound and two separate applications of joint compound over all joints, angles and fastener heads. Cove accessories with two separate coats of joint compound. Joint compounds shall be smooth and free of tool marks and

ridges. Cover the prepared surface with a drywall primer prior to the application of the final decoration.

- .5 Level 4: Gypsum board in areas where flat paints, light textures (or backed wall coverings) are to be applied. Adequately conceal joints and fasteners if wall covering material is lightweight, contains limited pattern, has a gloss finish or combination of these finishes.
 - .1 All joints and angles shall have tape embedded in joint compound and have three separate coats of joint compound over all joints, angles and fastener heads. Cover accessories with three separate coats of joint compound. All joint compounds shall be free of tool marks and ridges. Cover the prepared surface with a drywall primer prior to the application of the final decoration, and repair if required.
- .6 Level 5: Where gloss, semi-gloss or non-textured flat paints are specified.
 - .1 Equal to level 4 and, in addition, apply a skim coat. Immediately shear off excess material leaving a film covering the paper. Cover the prepared surface with a drywall primer prior to the application of the final decoration.

3.13 **ACOUSTICAL CAULKING**

- .1 Refer to Section 07 92 00 Joint Sealant.

3.14 **CUTTING, DRILLING AND PATCHING**

- .1 Cut, drill and patch gypsum board as may be necessary to accommodate the work of other trades.

3.15 **PROTECTION BOARD**

- .1 Neatly cut boards in straight line. Position in place and butt together in moderate contact with 3 mm gap between boards.
- .2 Predrill and screw in place keeping a fastener distance of 19 mm from edge of board, and in accordance with manufacturer's directions.

End of Section

- 1 General
- 1.1 **SUMMARY**
 - .1 Section Includes
 - .1 Labour, Products, equipment and services necessary to complete the Work of this section.
- 1.2 **REFERENCES**
 - .1 Conform to the latest edition of the following:
 - .1 ASTM C920 - Standard Specification for Elastomeric Joint Sealants
 - .2 TTMAC - Terrazzo, Tile and Marble Association of Canada
 - .3 AODA - Accessibility for Ontarians with Disabilities Act
- 1.3 **QUALITY ASSURANCE**
 - .1 Retain a Subcontractor regularly engaged in installing ceramic tile for a minimum of five years, and whom has had a minimum of three successful installations of the type called for in this section, each at least three years old. Likewise Subcontractor shall be a member in good standing of the Terrazzo, Tile and Marble Association of Canada (TTMAC).
 - .2 Submit upon Consultant's request, documented evidence of compliance with the foregoing.
- 1.4 **SUBMITTALS**
 - .1 Submit in accordance with Section 01 33 00.
 - .2 Samples
 - .1 Submit full size sample of each type, colour, size and pattern of tile specified.
 - .2 Submit grout samples for approval by Consultant. Grout samples to match each tile colour, unless otherwise specified.
 - .3 Approved samples shall be used as minimum standard for all Work under this section and installed Work must match samples in every respect.
 - .3 Certification: Submit certification for each type of floor tile as follows:
 - .1 Provide tile products manufactured and tested in accordance with ANSI A137.1 as appropriate to the Basis-of-Design Materials listed in this Section and on the Drawings.
 - .2 Slip Resistance: Provide materials having a minimum Dynamic Coefficient of Friction (DCOF) of 0.42 dry and, wet in accordance with ANSI A137.1 when tested using BOT 3000 Digital Tribometer or minimum 0.45 dry and wet in accordance with DIN 51130 with minimum R9 Class Slip Resistance.
- 1.5 **DELIVERY, STORAGE AND HANDLING**
 - .1 Deliver materials in adequate crates or containers with manufacturer's name and Product description clearly marked thereon.

- .2 Handle and store tiles in a manner to avoid chipping, breakage or the intrusion of foreign matter. Take precautions to protect the mortar and grout admixtures from freezing or from excessive heat.

1.6 **EXTRA STOCK**

- .1 Upon completion of Work, deliver tiles in quantities equivalent to 5% (to nearest full carton) of each tiled area (wall and floor), including fittings, as required for Owner's future maintenance purposes.
- .2 Obtain maintenance tiles and fittings from the same production run as tiles and fittings installed. Put in heavy duty boxes and clearly label.

1.7 **WARRANTY**

- .1 Warrant Work of this section against defects and deficiencies for a period of two (2) years from date Work is certified as substantially performed in accordance with the general conditions of the Contract.
- .2 Promptly make good defects and deficiencies which become apparent within the Warranty Period by replacing defective Work satisfactory to the Consultant and at no expense to the Owner.
- .3 Defects shall include but not limited to loss of bond, loosening, cracking, splitting, warping and deformations.

2 **Products**

2.1 **GENERAL**

- .1 For Tile flooring, refer to Finishes Schedule.
- .2 It must be noted that the Finishes Schedule is for the purpose of establishing minimum standards for material types and/or colours for this Project.
- .3 Except where specified otherwise, other Products are acceptable provided that the quality and/or colour represented in the schedule are fully matched to the approval of the Consultant.

2.2 **MATERIALS**

- .1 Porcelain Tiles (TL-XX):
 - .1 Complete with trim fittings including bullnosed tiles for floors at doors where tile meets other finishes thinner than the porcelain tile.
 - .2 Refer to Finishes Schedule for type, manufacturer, colour, size, installation method and location.
- .2 Floor and Wall Transition Strips: Refer to Finishes Schedule for type.

2.3 **GROUT**

- .1 Polymer modified portland cement grout: Field mixed, high strength polymer modified portland cement/sand for floors; unsanded for wall applications. Colour to match tiles.
 - .1 Grout line width greater than 5 mm
 - .1 Mapei "Ultracolor Plus"
 - .2 Laticrete "Floor grout with 1776 additive"

- .3 Flextile "PM 600 Grout"
- .4 Kiesel equal
- .2 Grout line width between 1.5 mm to 3 mm
 - .1 Mapei "Ultracolor Plus"
 - .2 Laticrete "Wall grout with 1776 additive"
 - .3 Flextile "PM 500 Grout"
 - .4 Kiesel equal
- .3 Grout line - Walls over 3 mm grout line width:
 - .1 Mapei "KERACOLOR S" (sanded)
 - .2 Laticrete "Floor grout with 1776 additive"
 - .3 Flextile "PM 600 Grout"
 - .4 Kiesel equal
- .2 Epoxy grout: Meeting ANSI 118.3 requirements:
 - .1 Mapei "Kerapoxy"
 - .2 Daltile "Laticrete Latapoxy SP-100"
 - .3 Flextile "Flex-Epoxy 100"
 - .4 Kiesel equal
- 2.4 **SETTING BED AND THIN-SET**
 - .1 Thin set liquid latex-portland cement mortar: Field mixed, high strength thin bed mixture of latex-additive portland cement-filler powder.
 - .1 For tiles 200 mm x 200 mm or less in size:
 - .1 Mapei "Kerabond/Keralastic"
 - .2 Laticrete "4237/211"
 - .3 Flextile "41/silica sand and cement"
 - .4 Kiesel equal
 - .2 For tiles over 200 mm x 200 mm up to 300 mm x 300 mm in size:
 - .1 Mapei "Kerabond / Keralastic"
 - .2 Laticrete "4237 / 211"
 - .3 Flextile "53 / 44"
 - .4 Kiesel equal
 - .3 For 330 mm x 330 mm tiles, use a full contact thin set mortar:
 - .1 Mapei "Ultracontact"

.2 Kiesel equal

2.5 **WATERPROOFING AND CRACK ISOLATION**

.1 Waterproof membrane: Meeting ANSI 118.10 Specification for load bearing, bonded, waterproof membranes for thin-set ceramic tile and dimension stone installation.

.1 Mapei "Mapelastic" with Mapei reinforcing mesh

.2 Laticrete "9235"

.3 Kiesel equal

.2 Crack suppressant membrane: Fabric or mesh reinforced, meeting TTMAC requirements.

.1 Mapei "Mapelastic"

.2 Laticrete "9235"

.3 Kiesel equal

.3 Uncoupling Membrane

.1 3 mm thick, orange, high-density polyethylene membrane incorporating a grid structure of 12 mm x 12 mm square cavities cut back in dovetail configuration. Polypropylene fleece laminated to its underside of HDPE layer. Provide waterproofing seaming membrane for seams and corners: 0.1 mm thick, orange polyethylene membrane, with polypropylene fleece laminated on both sides.

.1 Accepted manufacturer: Schluter "Ditra" or accepted equal.

2.6 **SEALER**

.1 Sealant

.1 Tile control joints: Tremco "THC 900" or "Vulkem 245/255".

.2 For internal tile to tile corners: Mapei "Keracaulk", Laticrete "Flexible Sealant" or one-part polyurethane specified in Sub-paragraph .3 herein, colour to match wall grout.

.3 For other sealant associated with tile work: 1 part polyurethane conforming to ASTM C920, Type S, Grade NS, Class 25; Sika "RC-1", Tremco "Dymonic" or Sonneborn "NP-1", colour to match grout colour.

.2 Floor sealer and protective coating: Compatible with tiles installed as recommended by tile manufacturer, to protect tile from yellowing, powdering, scuffing, acid, alkalis, calcium chloride and detergent dulling.

2.7 **CONTROL AND EXPANSION JOINTS**

.1 Prefabricated control and expansion joints: Provide "Movement Joint Profiles" by Schluter or approved alternative in styles and sizes to suit application and as approved by Consultant.

3 Execution

3.1 **PREPARATION OF SURFACES**

.1 Ensure surfaces are thoroughly clean, dry and sound. Remove oil, wax, grease, dirt, paint, form release agent, and other foreign material that may impair proper tile bond to

wall and floor surfaces. Use mechanical methods such as sanding for walls or bead blasting for floors.

- .2 On surfaces to be waterproofed, prepare concrete substrate in accordance with waterproofing manufacturer's preparation standards.
- .3 Ensure substrates are structurally sound, level and plumb, within a maximum tolerance of 3 mm in 2.4 m for vertical surfaces, and horizontal surfaces within a maximum tolerance of 6 mm in 3 m from finished levels of the surface, or better.
- .4 Trowel apply a levelling coat on uneven surfaces, or surfaces which do not guarantee a plumb or level finish to the tile, at a minimum of 6 mm thick.
- .5 Do not set tile on surfaces containing frost. Maintain temperature to a minimum of 10°C (50°F) during installation. Maintain temperature above freezing until mortar and grout have properly cured. The lower the temperature, the longer tile curing will take.

3.2 **FLOOR CONTROL JOINTS**

- .1 Clean control joints occurring in slab areas to receive tile and blow clean with compressed air. Use a vacuum to avoid spreading dust in areas to be tiled. Grout flush to slab with cement compound using same materials as specified for levelling coat.
- .2 If possible, use uncut tiles at structural floor control joints.

3.3 **TILE LAYOUT**

- .1 Lay out Work to produce a symmetrical pattern with minimum amount of cutting. Ensure cut tile at room perimeter is not less than one-half full size.

3.4 **WATERPROOFING MEMBRANE**

- .1 Prepare substrate for waterproofing in accordance with waterproofing manufacturer's directions.
- .2 Apply with a trowel on prepared substrate to a total dry film thickness of 635 microns (25 mils) in accordance with manufacturer's directions. Extend system over curbs and minimum 150 mm up walls.
- .3 Ensure full, complete, and permanent bond. Build up system where necessary to ensure positive slope to drain.
- .4 Reinforce intersections, projections, openings, and other locations as required, with fine glass fibre mesh reinforcing.
- .5 Terminate membrane in reglets wherever possible, except for control joints and grout joints.
- .6 In the case of reinforcing mesh or fabric, embed mesh or fabric while the first coat is fresh and apply a second coat on the mesh or fabric in accordance with manufacturer's written directions

3.5 **INSTALLATION**

- .1 Mix thin set mortar and grout components to proportions and methods specified by mortar and grout manufacturer, to achieve maximum bond strength within the capacity of the mortar or grout.
- .2 Use mortar and grout within their pot life as specified by manufacturer.

- .3 For Tiles Less Than 200 x 200 mm In Size
 - .1 Apply mortar with a notched trowel using a scraping motion to work the material into good contact with surface to be covered. A trowel having notches approximately 4 x 4 x 4 mm is recommended. Back of tiles must have 95% mortar coverage.
 - .2 Apply only as much thin set mortar that can be covered within twenty minutes or while surface of thin set mortar is still fresh. Discard thin set mortar that has skinned over and apply fresh thin set mortar. Set tiles in place and beat with a small beating block as necessary to ensure a proper contact of the thin set mortar to the back of the tile and also to level the tiled surface. Align tile to show uniform joints and then allow to set until firm, refer to thin set mortar manufacturer's written instructions. Clean excess thin set mortar from surface of tile with a damp cloth or sponge while the thin set mortar is fresh.
- .4 For Tiles 200 mm x 200 mm or Larger
 - .1 Apply thin set mortar with the flat side of a notched trowel using a scraping motion to key in the mortar into good contact with surface to be covered. A trowel notches approximately 8 mm x 8 mm x 8 mm is recommended, comb in one direction. Back of tiles must have 95% mortar coverage.
 - .2 Install with back-buttering to achieve good adhesion.
- .5 Lay out Work so that fields are centred on areas, with no tiles of less than half-size used at room perimeter.
- .6 Maintain heights of panels in full courses to nearest indicated dimension.
- .7 Align joints of wall tile with floor tile.
- .8 Make joints between tile uniform, plumb, straight, true, even and with adjacent tile flush.
- .9 Provide fittings (base, wall caps and wall corner units) to complement tile system. Install edge protection at external vertical corners.
- .10 Installation Methods
 - .1 Tile on concrete floor slab: Install tile floor, base fittings with thin set mortar in accordance with TTMAC Installation Manual, Detail 311F, latest edition.
 - .2 Tile on cementitious board ceilings in dry areas: Install tile with thin set mortar in accordance with TTMAC Installation Manual, Detail 315C, latest edition.
 - .3 Tile on cementitious board walls in wet areas: Install tile and fittings with thin set mortar in accordance with TTMAC Installation Manual, Detail 305W, latest edition.
 - .4 Tile on concrete or masonry walls: Install tile and fittings with thin set mortar in accordance with TTMAC Installation Manual, Detail 303W, latest edition. Install wall tile full height unless shown otherwise.
 - .5 Tile on gypsum board walls in dry areas: Install tile and fittings with thin set mortar in accordance with TTMAC Installation Manual, Detail 304W, latest edition.
 - .6 Tile on stairs: Install tile, fittings, and risers with thin set mortar in accordance with TTMAC Installation Manual, Detail 318S, latest edition.

- .7 Tile on wood subfloor in dry area: Install tile, fittings, and risers with thin set mortar in accordance with TTMAC Installation Manual, Detail 313F, latest edition.
- .11 Tile control joints: Provide 6 mm wide control joints in tiled floors where shown and directly over control joints in floor slab or masonry walls, in accordance with TTMAC Installation Manual, Detail 301MJ, latest edition. Apply sealant as specified.
- .12 Cut and fit tile neatly to piping, fittings, projections and around recesses for recessed washroom accessories. Where surface mounted equipment and accessories are to be installed on tiled surfaces, extend tile over surfaces. Make cut edges smooth, even and free from chipping. Chipped and broken edges are not acceptable.
- .13 Cut circular cutouts for pipe and drain penetrations by core drilling only.
- .14 If existing tiles, those to remain, are damaged during demolition and removal Work, provide new tiles to match existing tiles. Prepare substrate and install new tiles as specified for new Work of this Section.

3.6 **GROUTING**

- .1 Do not proceed with grouting until at least forty-eight hours after tile has set to prevent displacement of tiles.
- .2 Ensure grout is applied to the full thickness of the tile.
- .3 Force grout into joints in accordance with grout manufacturer's directions to produce watertight, filled joints without voids, cracks and excess grout. Finish flush to edge thickness of tile.
- .4 Do not grout internal corner intersections of wall tile.
- .5 Protect grouted work from traffic for minimum forty-eight hours. Epoxy grout will achieve chemical and stain resistance after ten days therefore protect Work against spills until curing period has lapsed.

3.7 **SEALANT**

- .1 Apply sealant around piping and fittings extending through tiled surfaces.
- .2 Apply sealant in tile control joints and in internal tile to tile joints.
- .3 Tool to a smooth, flush surface, free from air bubbles and contamination. Provide backer rod only where required to control depth of sealant.

3.8 **UNCOUPLING MEMBRANE**

- .1 Leveling of the subfloor must be done prior to installing uncoupling membrane.
- .2 Install uncoupling membrane to wood subfloor, concrete or vinyl floor in accordance with manufacturer's written instructions.
 - .1 For wood substrates, verify that subfloor panels are properly fastened to framing members
 - .2 For vinyl substrates, ensure that the structure is sound and adequate and well adhered. Remove wax and clean surface. For vinyl over wood structures, nail off floor with ring shank flooring nails every 4" (102 mm) o.c. Fasteners must pass through entire thickness of assembly with minimal penetration into joists.

- .3 For concrete substrates, mechanically remove any waxy or oily films and curing compounds if present.
 - .3 Install membrane in full bedding of thin set mortar. Roll membrane to ensure full and continuous adhesion to structure.
 - .4 Movement Joints: construct expansion joints and control joints in accordance with TTMAC Detail 301MJ.
- 3.9 **CLEANING**
- .1 Clean off excess grout with soft burlap or sponge moistened with clean water.
 - .2 After grouting has cured, clean floor and wall tile. Clean in accordance with TTMAC recommendations for treating new work as specified in its "Maintenance Guide". Do not use acid for cleaning.
 - .3 Apply two coats of sealer to unglazed floor in accordance with sealer manufacturer's printed directions.
 - .4 Re-point joints after cleaning as required to eliminate imperfections. Avoid scratching tile surfaces.
- 3.10 **PROTECTION ON COMPLETION**
- .1 After completion, close tiled areas to traffic for a minimum period of seventy-two hours.
 - .2 Cover Work temporarily with building paper properly lapped and taped at joints, or other protection, until the Work is accepted by Consultant.
- End of Section

- 1 General
- 1.1 **SUMMARY**
 - .1 Section Includes
 - .1 Labour, Products, equipment and services necessary to complete the Work of this section.
- 1.2 **REFERENCES**
 - .1 Conform to the latest edition of the following:
 - .1 CAN/ULC-S102 - Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies
 - .2 ASTM E84 - Standard Testing Method for Surface Burning Characteristics of Building Materials
 - .3 ASTM E580 - Standard Practice for Installation of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Subject to Earthquake Ground Motions (for Seismic)
 - .4 ASTM E1264 - Standard Classification for Acoustical Ceiling Products – acoustical testing (classification of tile)
 - .5 Indoor Air Quality - GreenGuard
 - .6 ASTM C635/C635M - Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings
 - .7 ASTM C636/C636M - Standard Practice for Installation on Metal Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels
 - .8 AODA - Accessibility for Ontarians with Disabilities Act
- 1.3 **SUBMITTALS**
 - .1 Submit in accordance with Section 01 33 00.
 - .2 Shop Drawings: Show/include the following:
 - .1 Suspension system layout; conditions at abutting, intersecting and penetrating construction; dimensional locations of lighting fixtures, diffusers, sprinkler heads, other items that pierce the ceiling plane, and suspension hangers.
 - .2 Locations of accessible openings in acoustic tile ceilings.
 - .3 Product data on ceiling grid system, acoustic units, clearly indicating the specific items proposed for use if manufacturer's catalogs are submitted.
 - .3 Samples: Submit the following:
 - .1 300 mm long samples of suspension system parts, including trim.
 - .2 300 mm x 300 mm samples of acoustic units.

- .4 Certificates: Submit certificate attesting that installed acoustical ceiling systems meet the fire-resistance ratings required for this Project.
- .5 Maintenance data: Submit maintenance instructions for recommended cleaning materials and methods for acoustic units and trim. Include precautions for use of and composition of cleaning materials detrimental to acoustic units and trim.

1.4 **DELIVERY, STORAGE AND HANDLING**

- .1 Deliver materials in original packages, containers and bundles, bearing brand and manufacturer's name and ULC/Warnock Hersey labels.
- .2 Store materials in a covered area, off-ground, on flat, smooth, dry surfaces. Protect from moisture. Remove damaged or deteriorated materials from site.
- .3 Comply with acoustic unit manufacturer's recommendations regarding temperature and humidity conditions before, during and after ceiling installation.

1.5 **PROJECT CONDITIONS**

- .1 Environmental requirements: Continuously maintain rooms or areas scheduled to receive acoustical treatment at not less than 21°C (70°F), and at occupancy humidity, at least three days prior to installation and three days after this Work is completed. Schedule the Work to eliminate the risk of damage to these materials due to adverse environmental conditions in rooms or areas when and after this Work is installed.

1.6 **MAINTENANCE**

- .1 Extra stock: Leave spare acoustic units and full-size plenum barrier boards in quantity equivalent to 2% (to nearest box) of each type of acoustic ceiling. Obtain spare units from same production run as installed units. Product to be packaged with protective covering for storage and identified with labels describing contents.

2 Products

2.1 **MATERIALS**

- .1 Acoustic Panel Ceiling (CL-XX):
 - .1 Incombustible mineral fiber, square [reveal] edge, white factory-painted exposed surface. Minimum NRC rating of 0.70.
 - .2 Refer to Finishes Schedules for manufacturer, colour, size and location.
- .2 Hangers: Soft-annealed, zinc coated steel wire minimum 2.64 mm (12 gauge), meeting "heavy-duty" classification of ASTM C635.
- .3 Edge mouldings: to complement ceiling grid, and installed around ceiling perimeters, in factory finished satin white on zinc coated cold rolled steel. Conform to manufacturer's requirements.
- .4 Metal closures and trim: Bonderized and with factory-applied baked enamel finish in white. If coloured, coordinate with ceiling tile colour and manufacturer's colour selection. Use anchors standard with manufacturer. Corrosion-resistant factory finished units. Provide anchors as standard with manufacturer.
- .5 Panel hold-down clips: Standard of grid manufacturer.
- .6 Supplementary splines: Hard fiber or steel splines as standard with grid manufacturer.

3 Execution

3.1 **EXAMINATION**

- .1 Inspect substrates and previously placed Work to determine suitability and completeness. Start of this Work constitutes an acceptance of existing conditions. Correct failure of this Work due to unsatisfactory existing conditions at no increase in Contract Price. Similarly, if the Work needs to be removed to correct defects in substrates or previously placed Work, perform both removal and replacement at no increase in Contract Price.

3.2 **EXPOSED GRID LAY-IN PANEL CEILINGS**

- .1 Install main tees, cross tees, and wall moldings so bottom flanges are in flat, level plane at finish ceiling elevations. Arrange grid so opposite wall edge panels are of equal width but not less than one-half panel width, and lay out and erect grid system to provide panel pattern shown.
- .2 Install exposed ceiling grid per ASTM C636, reviewed Shop Drawings, and specified herein. Place secondary steel framing to span structural steel as required.
- .3 Erect main beams parallel to main wall and to each other; space uniformly at centres specified.
- .4 In ceilings having recessed lighting fixtures, modify grid framing to provide main beams along and parallel to both long sides of lighting fixtures.
- .5 Support main beams with hangers along each run, spaced at not more than 1200 mm centers; except in areas of steel framing, Provide hangers at each intersection of main beam and framing.
- .6 If ductwork or equipment located in ceiling plenum area interferes with hanger spacing, Provide a trapeze or other arrangement reviewed by Consultant to support main beams at proper spacing.
- .7 Do not secure hangers to metal roof deck, ductwork, conduit, piping, equipment, or support system for any of these. Provide additional hangers at each diffuser, grille and other points of extra loading.
- .8 Secure hangers to main beams to develop full strength of hangers and per manufacturer's published directions. Secure hangers to construction above per ASTM C636 and following requirements:
 - .1 Exposed concrete slab: Use anchors, cast-in hanger wires or inserts, specifically designed for hanger use.
 - .2 Steel beams: Use beam clips.
 - .3 Steel joists: Wrap hanger wire around lower chord member.
 - .4 Permanent metal forms and cellular floor deck: Tabs, holes or slots specifically provided for hanger attachment; prevent hanger twisting or turning by cross tying.
- .9 Install primary cross tees at right angles to main beam tees and space uniformly at centers specified. Join ends of cross tees to web of main beams with a positive interlock; except at light fixtures, secure members together with concealed steel clips and bolts. Install tees to produce fine-line joints between flanges of abutting members.
- .10 Install secondary cross tees at right angles to primary tees and space uniformly at centers specified, and secure in a manner similar to primary tees.

- .11 At locations where ceilings abut walls, columns and other vertical surfaces, install continuous wall molding to trim ceiling edges.
 - .1 Install molding with bottom horizontal leg at elevation required to support acoustic panel and to be flush with bottom flange of grid members [for concealed, flush with the bottom of tile, and with vertical leg concealed, as per manufacturer's instructions.
 - .2 Bolt moldings to supporting construction at 600 mm on centre and within 150 mm of end of each molding piece.
 - .3 Butt joints in moulding inconspicuously if several pieces are required in any one run.
- .12 At recessed-grid system for reveal-edge lay-in panels, install "W" shaped wall molding, of profile specified, to retain recessed detail at ceiling perimeters.
- .13 Install acoustic lay-in panels in grid system openings supported by bottom flanges of members in accordance with manufacturer's instructions.
- .14 Where within 6000 mm of exterior doors, secure each lay-in panel into grid opening with concealed hold-down clips.
- .15 Install reveal-edge panels with angled or square edges resting on bottom flanges of members, with panel surface extending below bottom flanges.

3.3 **FIRE-RESISTANCE RATED CEILINGS**

- .1 Provide fire-resistance rated ceilings where required, including proper construction of framing and furring and proper thickness and weight of acoustic units, to produce hourly fire-resistance ratings called for.
- .2 Requirements for materials, methods of erection and application specified under appropriate headings of this section apply except where more stringent requirements are defined for particular fire-resistance rating by Underwriters' Laboratories of Canada or Warnock-Hersey.

3.4 **ADJUSTING AND CLEANING**

- .1 After interior finishing Work has been substantially completed, or when directed by Consultant, inspect acoustical treatment Work. Replace broken, chipped or damaged Work, reset loose units or units out of place, and touch up marred surfaces with matching paint. Upon completion of the Project, clean acoustical surfaces free from dirt and other markings and in good condition acceptable to Consultant.

End of Section

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- 1 General
- 1.1 **SUMMARY**
 - .1 Section Includes
 - .1 Labour, Products, equipment and services necessary to complete the Work of this section.
 - .2 The work of this section shall include, but not necessarily be limited to, the supply and installation of the following:
 - .1 Vinyl Tile Flooring
 - .2 Static dissipative floor tile
 - .3 Rubber base
 - .4 Transition strip
 - .5 Adhesive, primers and related accessories for the above installations.
- 1.2 **SUBMITTALS**
 - .1 Samples
 - .1 Submit in accordance with Section 01 33 00.
 - .2 Submit duplicate full size samples of each type and colour of resilient tile flooring and base.
 - .3 Identify samples with Project name, job number, date, colour, manufacturer's name and Contractor's name.
 - .2 Product Data: Submit manufacturer's special installation requirements and adhesive Product data confirming specified requirement. Data shall also give specific warning of maintenance practice or materials which may damage or disfigure resilient flooring.
- 1.3 **DELIVERY, STORAGE AND HANDLING**
 - .1 Deliver and store materials undamaged in original wrappings or containers, with manufacturer's labels and seals intact. Store materials in a warm, dry area.
 - .2 Prevent damage to materials during handling and storage. Stack material not over two cartons in height, nor in excess of allowable floor loading. Store materials on smooth surfaces only, in an area designated by Consultant.
 - .3 Protect this Work and the work of other trades at all times.
- 1.4 **QUALITY CONTROL**
 - .1 Work shall be performed by a skilled installer with a minimum of 5 years' experience with work of this Section.
- 1.5 **EXTRA STOCK**
 - .1 Leave in quantity equivalent to 5% (to nearest full carton) of each colour of vinyl tile flooring and 3 lineal yards of rubber base installed, with Owner for replacement purposes. Label cartons as to contents and indicate areas where tiles were used.. Material shall be from same production run as the material installed. Obtain receipt for maintenance materials.

.1 Include sufficient amount of adhesive.

2 Products

2.1 **GENERAL**

- .1 For resilient flooring and base refer to Finish Schedule.
- .2 It must be noted that the finish schedule is for the purpose of establishing minimum standards for material types and/or colours for this Project.
- .3 Except where specified otherwise, other Products are acceptable provided that the quality and/or colour represented in the schedule are fully matched to the approval of the Consultant.

2.2 **MATERIALS**

- .1 Vinyl Composition Tile (LVT-01): Refer to Finishes Schedule for approved floor type, manufacturer, colour, size, thickness, and locations.
- .2 Static Dissipative Tile (SDT-01): Conforming to ASTM F 1700, Class 1, Type A, resistance higher than the average of 1,000,000 ohms and less than the average of 100,000,000 ohms as tested in accordance with NFPA 99 2 6.3.8, ASTM F 150, UL 779, and ANSI/ESD S7.1. Refer to Finishes Schedule for approved floor type, manufacturer, colour, size, thickness, recycled content, and locations.
- .3 Resilient Wall Base (RB-1 and RB-2): Conforming to ASTM F1861. Refer to Finishes Schedule for approved type, supplier, size, and thickness.
- .4 Transition Strips (TS-2): Refer to Finishes Schedule for approved type, supplier, colour, and locations.
- .5 Epoxy adhesive and caulking compound: As required for surfaces involved recommended and supplied by rubber tile and tread manufacturer.

2.3 **ACCESSORIES**

- .1 Adhesive: solvent-free, non-toxic, odorless, as recommended by flooring manufacturer for the substrate.
- .2 Sealer and Wax: As recommended by flooring manufacturer.
- .3 Sub-floor filler: Non-shrink latex-cement compound, as recommended by flooring manufacturer.

3 Execution

3.1 **PREPARATION**

- .1 Inspect substrate surfaces floor substrate is suitable to receive the floor finish material. Report any unsatisfactory conditions to the Consultant. Starting work shall imply acceptance of surfaces.
- .2 Remove dirt, dust and other stances from the existing subfloor as recommended by the manufacturer of the flooring used.
- .3 Fill cracks, crevices and holes in concrete sub-floors. Finish smooth and level. Grind bumps and ridges level.
- .4 Grout sawcut and control joints to be covered with resilient tile flooring.

3.2 **FLOORING INSTALLATION**

- .1 Install flooring in accordance with manufacturer's written instructions and recommendations.
- .2 Apply adhesive evenly over floor surfaces. Allow adhesive to become tacky before laying flooring.
- .3 Lay tile with joints straight, in true plane, butted to moderate contact, symmetrical with and parallel to axes of rooms to provide equal size perimeter tile on each side. Distribute variations in shade or pattern to obtain a uniform effect. Abrupt variations will not be acceptable. Lay in pattern as directed by Consultant.
- .4 Roll after laying with a polished, clean roller weighing at least 45 kg/100 lbs.
- .5 Cut and fit neatly around fixed objects. Fit tightly to electrical and mechanical fittings, piping and equipment. Scribe and fit to abutting surfaces.
- .6 Continue flooring through areas to receive movable type partitions without interrupting floor pattern.
- .7 Install metal edge strip where flooring terminates.

3.3 **INSTALLATION - STATIC DISSIPATIVE TILE**

- .1 Install in accordance with manufacturer's instructions.
- .2 If the adhesive is bleeding or oozing at the seams, immediately remove the excess adhesive with a clean cloth dampened with warm soapy water or denatured alcohol before the adhesive cures. After cleaning with denatured alcohol, rinse with a clean soft cloth dampened with clean water. Do not allow adhesive to cure on the surface of the tile.
- .3 Borders and other specialty cut tiles must be scribed and cut fit snugly, not tightly, against the wall, threshold, transition strip, fixtures, or other obstacles.
- .4 Roll and cross roll each section of tile laid with a 45 kg three-section roller within thirty minutes after the tile section has been installed. Conduct a visual inspection during the rolling process to ensure there has been no shifting of the tiles and that there is no adhesive on the surface of the tile. Inspect each section laid after rolling to check for raised edges. Roll and cross roll a second time approximately thirty minutes after the initial rolling.
- .5 Testing for electrical resistance: Test static dissipative floor for electrical resistance approximately seven days after the installation. The adhesive must be allowed to properly cure and the flooring system to stabilize to the ambient conditions. T

3.4 **BASE INSTALLATION**

- .1 Before installing base, fill cracks and irregularities with a filler recommended by base manufacturer.
 - .1 Install base in longest possible lengths with joints vertical and tight. Accumulated short lengths not permitted.
 - .2 Scribe and fit to abutting surfaces.
 - .3 Bend and apply base continuous on radius corners.
 - .4 Butt joints and keep flush without gaps.

3.5 **FIELD QUALITY CONTROL**

- .1 Promptly remove and replace flooring showing bumps from underlying dirt, discolouration, excessive wear, shrinkage or adhesion failure. Remove and replace base showing shrinkage or adhesion failure or uneven adjoining surfaces.

3.6 **CLEANING AND WAXING**

- .1 Comply with flooring manufacturer's recommendations.
- .2 Remove adhesive from surfaces as work progresses. Clean surfaces with a mild soap solution. Rinse clean, dry and apply two coats of wax. Polish thoroughly.
- .3 Cover waxed and polished surfaces with fibre reinforced, non-staining kraft paper, secure in position with gummed tape to prevent drifting. Remove covering prior to substantial performance.

End of Section

- 1 General
- 1.1 **SUMMARY**
 - .1 Section Includes
 - .1 Labour, Products, equipment and services necessary to complete the Work of this section.
 - .2 Work of this section includes but not limited to the following:
 - .1 Supply and Install Carpet tiles.
 - .2 Supply and Install accessories to complete installation
- 1.2 **REFERENCES**
 - .1 Conform to the latest edition of the following:
 - .1 ASTM E648 - Test Method for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source
 - .2 CAN/ULC S102.2-M - Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies
 - .3 CGSB 4-GP-129 - Carpets, Commercial
 - .4 NFPA-99 - National Fire Protection Association, Health Care Facilities
- 1.3 **SUBMITTALS**
 - .1 Samples
 - .1 Submit in accordance with Section 01 33 00.
 - .2 Submit two 300 mm x 300 mm samples of each type carpet specified.
 - .2 Shop Drawings
 - .1 Submit in accordance with Section 01 33 00.
 - .2 Illustrate carpeted floor pile direction, patten of installation and seaming diagram (location and length).
 - .3 Product Data:
 - .1 Submit manufacturer's literature for flooring describing performance, sizes, pattern and compliance with requirements in this specifications.
 - .2 Submit adhesive product data confirming specified requirement.
- 1.4 **DELIVERY, STORAGE AND HANDLING**
 - .1 Deliver materials in original, factory sealed rolls, containers and wrappers. Handle and store and prevent damage, contamination and deterioration to Work of this section.
 - .2 Clearly mark carpet with register number and dye lot on each bale.

1.5 **PROJECT/SITE ENVIRONMENTAL REQUIREMENTS**

- .1 Moisture: Ensure substrate is within moisture limits prescribed by manufacturer.
- .2 Temperature: Maintain ambient temperature of not less than 18°C (64.4°F) from seventy-two hours before installation to at least seventy-two hours after completion of work.
- .3 Relative humidity: Maintain relative humidity between 10% and 65% RH for forty-eight hours before, during and forty-eight hours after installation.
- .4 Safety: Comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage, and disposal of hazardous materials.
- .5 Ventilation: Provide continuous ventilation during and after carpet application. Run ventilation system twenty-four hours per day during installation; provide continuous ventilation for seven days after completion of carpet installation.

1.6 **EXTRA STOCK**

- .1 Upon completion of the Work, deliver a minimum of 10% (to the nearest full carton) of total amount of each type of tile as required for Owner's future maintenance purpose.
- .2 Ensure such tiles are from same production run as tiles installed, and boxes are clearly labelled.

1.7 **WARRANTY**

- .1 Warrant Work of this section against defects and deficiencies for the periods stated below from date Work is certified as substantially performed in accordance with the Contract.
 - .1 Manufacturer's Warranty: Ten years against unravelling, wear, colour fading and deterioration of backing materials, including materials and workmanship detrimental to appearance or performance.
 - .2 Installer's Warranty: Two years against loose fitting, breaking of seams or breaking away from sub-base.
- .2 Promptly make good defects and deficiencies which become apparent within the Warranty Period by replacing defective Work satisfactory to the Consultant and at no expense to the Owner.

2 Products

2.1 **MATERIALS**

- .1 Carpet Tile (CPT-1 to CPT-4):
 - .1 Dual tone with pressure sensitive adhesive with releasable bonding properties to allow for easy carpet tile removal or replacement.
 - .2 Refer to Schedule 09 06 00 Finishes Schedule for manufacturer, colour, size, installation method and location.

2.2 **ACCESSORIES**

- .1 Sub-floor filler: White premix latex floor leveller by Projex.
- .2 Adhesive: Solvent-free, of type as recommended by carpet manufacturer.
- .3 Base gripper: Type as recommended by carpet manufacturer.

- .4 Multi-purpose latex sealer: for sealing carpet edge as recommended by carpet manufacturer.
- .5 Transition Strips (TS-1 and TS-2): Refer to Finishes Schedule for approved type, supplier, colour, and locations.

2.3 TESTS

- .1 Carpet shall have been tested to, and passed the following test requirements:
 - .1 Flooring radiant panel test (ASTM E-648): mean average critical radiant flux of 0.45 w/sq.cm or higher.
 - .2 Flammability: The following aspect shall comply with requirements of CGSB 4-GP-129 and requirements of authorities having jurisdiction, when tested to CAN/ULC S102.2:
 - .1 Flame spread
 - .2 Fuel contribution
 - .3 Smoke developed
 - .3 Electrostatic propensity (AATCC 134): Not more than 2 kV.
 - .4 Surface resistivity (NFPA 99): Not more than $2 \text{ kV} \times 10^{10} \text{ ohms}$.
 - .5 Seconds (NFPA 99): 5000 - 500 V not more than 0.5; 5000 - 0 V not more than 2.0 V.

3 Execution

3.1 PREPARATION

- .1 Inspect substrate surfaces floor substrate is suitable to receive the floor finish material. Report any unsatisfactory conditions to the Consultant. Starting work shall imply acceptance of surfaces.
- .2 Ensure floors are dry and free from dust, dirt, oil, paint, grease, sealers and other contaminants.
- .3 Repair depressions and cracks with latex base compound. Sweep and vacuum surfaces before laying carpet.
- .4 Grind ridges and high spots smooth and level.

3.2 INSTALLATION - GENERAL

- .1 Install carpet tiles in accordance with manufacturer's written directions.
- .2 Apply adhesive by brush or roller. Do not spray.
- .3 Anchor securely around projections and contours.

3.3 INSTALLATION

- .1 Install in accordance with manufacturer's printed directions.
- .2 Commence installation after other trades have completed their work in areas to receive carpet Work.

- .3 Lay carpet with pile in same direction throughout a given floor area. A change in direction of pile will only be permitted in visually isolated areas which cannot be viewed simultaneously with other carpeted areas of same selection.
- .4 Lay carpet by direct glue-down system according to printed instruction procedures of manufacturer of carpet being installed. Lay carpet tile without evidence of seams.
- .5 Lay carpet with adhesive. Wait for glue to set before stretching carpet.
- .6 Where carpet meets ceramic tile, double glue carpet 600 mm from the tile.
- .7 Cut carpet to fit accurately around perimeter of room, into all recesses, and around fixtures.
- .8 Keep seams to a minimum. When making seams, overlap the carpet by at least one row of tufts. Position seams so that where possible:
 - .1 The seams run the length of the area.
 - .2 Main traffic runs along rather than across the seam.
 - .3 Incident light does not strike across the seam.
 - .4 Avoid seams perpendicular to doorway openings.
 - .5 Seams are away from areas subject to pivoting traffic.
- .9 Position edges of carpet in door reveals directly under door bottom.
- .10 Extend floor carpet up at walls to specified height and into cap strip to form a coved carpet base.
- .11 Roll down carpet into adhesive bed using 45 kg roller. Roll in both directions. Do not over-roll.
- .12 Make cut-outs for all floor mounted items where they occur on carpet. Keep holes to an absolute minimum diameter to allow services involved to pass through, and diameter of holes shall be such that trim will completely hide hole when installed. Cooperate and coordinate with electrical trade to ensure correct location of outlets is obtained.
- .13 Glue carpet to access box covers. Use glue recommended by carpet manufacturer.
- .14 Install transition strip at exposed carpet edges and where carpet terminates flush with other surfaces, or where transition is made to another material. Where carpet meets tile, leave carpet maximum 1.6 mm higher than the tile.
- .15 Ensure entire carpet installation is level, flush across seams, continuous in texture, patterns and colour. Ensure joints are invisible and surface is free of wrinkles, bubbles and other defects.

3.4 **CLEANING**

- .1 On completion, remove dirt, carpet scraps, etc., from surfaces of carpet.
- .2 Clean carpet with beater-type vacuum cleaner.
- .3 Remove any soiled spots or excessive adhesive with spot remover as recommended by carpet manufacturer.
- .4 Remove loose pieces of face yarn by cutting with sharp scissors.

- .5 Protect carpet areas with 6 mil polyethylene sheets. Tape joints to prevent shifting.
- .6 On completion, permit Owner's Representative to inspect waste carpet scraps for possible retention for future repairs before removal from site. This is in addition to maintenance materials specified herein.

3.5

PROTECTION

- .1 Protect carpet from traffic for 48 hours minimum after installation and from damage
- .2 Protec from damage for the during construction.
- .3 Repair damage to materials cause by carpet installation.

End of Section

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- 1 General
- 1.1 **SUMMARY**
 - .1 Section Includes
 - .1 Labour, Products, equipment and services necessary to complete the Work of this section.
 - .2 The work of this section shall include, but not necessarily be limited to, the supply and installation of the following:
 - .1 Custom printed wall covering
- 1.2 **SAMPLES**
 - .1 Submit in accordance with Section 01 33 00.
 - .2 Samples:
 - .1 Submit two samples of each wall covering in sizes of 300 mm x full width of roll samples of each material.
 - .3 Product Data:
 - .1 Submit printed maintenance instructions giving specific warnings of maintenance practices of substances which may stain or otherwise damage the wall coverings.
- 1.3 **JOBSITE MOCK-UP**
 - .1 Install three panels of full usable width, including one corner, in area designated by Consultant. Sample areas shall be full height, and shall include one outside corner and one covering material joint.
 - .2 Promptly revise or replace coverings on sample areas at no additional cost to the Owner until approval of the Consultant is obtained. The approved sample area installations shall be the standard for acceptance of the remaining work.
- 1.4 **EXTRA STOCK**
 - .1 Provide extra wall covering materials and adhesive to be stored by the Owner. Quantity of extra stock shall be 2% of total coverage area or to nearest full roll of each colour, pattern and type of wall covering material required for maintenance use.
- 1.5 **QUALITY ASSURANCE**
 - .1 Applicator: A firm specializing in wallcovering Work with not less than five years of satisfactory experience in installing wallcoverings similar to those required for this Project.
 - .2 Product data: Submit manufacturer's technical data and installation instructions for each type of wall covering and installation materials.
 - .3 Certification: Submit manufacturer's certification that materials furnished comply with requirements specified.
 - .4 Maintenance instructions: Submit manufacturer's printed instructions for maintenance of installed Work, including precautions for use of cleaning materials which could damage wall covering.

- .5 Replacement materials: After completion of Work, deliver to Project site not less than 6 m of each type, colour, and pattern of wall covering installed. Furnish replacement materials from same production run as materials installed.
- 2 Products
- 2.1 **MATERIALS**
- .1 Wallcovering (WC-1):
 - .1 Refer to Finishes Schedule for approved floor type, manufacturer, colour, size, thickness, and locations.
 - .2 Material shall have ULC rating for fuel contributed, flame spread and smoke development factors, comply with the Ontario Building Code. Provide ULC Certificate of rating for approval. Provide manufacturer's standard backing on fabrics which are adhesive applied.
- .2 Adhesive: Of the type recommended by the wallcovering manufacturer, mildew resistant and non-staining to wallcovering.
- 3 Execution
- 3.1 **EXAMINATION**
- .1 Ensure that surfaces are dry, clean, free from dust, dirt, mortar, loose crystals, and any extraneous matter before commencing Work.
- .2 Verify that satisfactory environmental conditions as required by wallcovering manufacturer will prevail while Work proceeds.
- .3 Verify by test that moisture and alkali content of walls are within limits for satisfactory installation before commencing Work.
- 3.2 **PREPARATION**
- .1 Acclimatize wallcovering materials by removing from packaging in area of installation not less than twenty-four hours before application.
- .2 Remove switchplates, wall plates, and surface-mounted fixtures in areas where wallcovering is to be applied.
- .3 Spackle wall imperfections.
- 3.3 **INSTALLATION**
- .1 Scrape or sand surfaces smooth before installation of materials.
- .2 Neutralize and seal surfaces according to manufacturer's instructions for each material.
- .3 Apply materials in strict accordance with the manufacturer's prepared instructions to the trade and under his supervision.
- .4 Provide controlled ventilation during application.
- .5 Take special care that no mortar particles, grit, or any such extraneous matter is imbedded beneath the wallcovering.
- .6 Apply material vertically. Horizontal joints will not be accepted.
- .7 Trim around fixtures, door frames, etc., in a neat and careful manner.

- .8 Seams on non-matched patterns may be table trimmed, or overlapped and double-cut during installation, exercising care not to cut too deeply into the wall substrate. Geometric and matched designs may require table trimming for match perfection.
- .9 Install seams plumb and away from corners minimum 150 mm.
- .10 Install so that the material will not cove or pull away from outside corners, or so that air is not trapped on either side of outside corners.
- .11 Installation shall be free from air pockets, wrinkles, pimples, or other defects detrimental to the appearance or performance of the wallcovering.
- .12 Trim selvages as required to assure colour uniformity and pattern match.
- .13 Remove excess adhesive along finished seams while it is still wet using warm water and clean sponge, and wipe dry.
- .14 Re-install removed plates and fixtures; verify cut edges of wall coverings are completely concealed.

3.4 **CLEANING**

- .1 Clean off excess adhesive from floor, base and wall surfaces as the work progresses.
- .2 Remove surplus materials, rubbish, tools and equipment after installation is completed.

3.5 **PROTECTION ON COMPLETION**

- .1 After completion, protect wall covering from damage for the duration of construction period.
- .2 Repair damage to adjacent materials caused by wall covering installation.

End of Section

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- 1 General
 - 1.1 **SUMMARY**
 - .1 Section Includes
 - .1 Labour, Products, equipment and services necessary to complete the Work of this section.
 - .2 Work includes but is not limited to the following:
 - .1 Acoustical Wall Panel
 - .2 Installation components
 - 1.2 **REFERENCES**
 - .1 Conform to the latest edition of the following:
 - .1 ASTM C423, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
 - .2 CAN/ULC S102, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
 - 1.3 **SUBMITTALS**
 - .1 Product Data:
 - .1 Submit manufacturer's technical data for each type of acoustical wall panel to be provided.
 - .2 Shop Drawings:
 - .1 Submit shop drawings showing how panels are to be laid out on the walls, details of trim members and width of panels. Width of panels and location of vertical seams are critical.
 - .3 Samples:
 - .1 Submit minimum 150 mm x 150 mm samples of specified acoustical wall panel; minimum 100 mm long samples of attachment method including trim and decorative accents for review by Consultant before commencing work. Samples to be clearly labelled with manufacturer's name and type.
 - .4 Test Reports.
 - .1 Submit complete, unedited test reports for acoustical wall panel prepared by an independent testing laboratory indicating full compliance with both acoustical and fire resistance performance requirements.
 - .2 Test systems in accordance with CAN/ULC-S102-M, "Test for Surface Burning Characteristics of Building Materials and Assemblies" and ASTM C423, "Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method".
 - 1.4 **QUALITY ASSURANCE**
 - .1 Contractor executing Work, must have a minimum of three (3) years continuous Canadian experience in successful installation of work of type and quality shown and

specified. Contractor must have adequate equipment and skilled tradesmen to perform it expeditiously and to the highest quality standards for this type of Work. Submit proof of experience upon Consultant's request.

.2 Coordination of Work:

.1 Coordinate acoustical wall panel work with installers of related work including, but not limited to building insulation, gypsum board, light fixtures, mechanical systems, electrical systems, and sprinklers.

1.5 **DELIVERY, STORAGE AND HANDLING**

.1 Deliver acoustical wall panels to project site in original, unopened packages and store them in a fully enclosed space where they will be protected against damage from moisture, direct sunlight, surface contamination, and other causes.

.2 Before installing acoustical wall panels, permit them to reach room temperature and a stabilized moisture content.

.3 Handle acoustical wall panels carefully to avoid chipping edges or damaged units in any way.

1.6 **PROJECT/SITE CONDITIONS**

.1 Environment

.1 All wet work must be complete and dry prior to installation. Installation shall be carried out where the temperature is between 6 degrees C and 49 degrees C. These temperature conditions must be maintained throughout the life of the warranty.

.2 Field Measurements.

.1 Verify field dimensions prior to fabrication. Installer is responsible for details and dimensions not controlled by job conditions and indicate, on shop drawings, field measurements beyond his control. Contractor and installer cooperates to establish and maintain these field dimensions.

.2 Measure each wall area and establish layout of panels to balance borders at opposite edges of each wall.

.3 Locate electrical receptacles, switch-boxes, elevator call buttons, and other similar devices which are exposed in finished work.

1.7 **WARRANTY**

.1 Warrant Work against defects in materials and workmanship in accordance with the General Conditions, for a period of one (1) years from date of Substantial Performance and agrees to repair or replace faulty materials or Work which appears during the warranty period, without cost to the Owner.

1.8 **MAINTENANCE**

.1 Extra Materials:

.1 Provide additional stock of 5% of acoustical wall panels to Owner for storage upon completion of installation. Include cost of extra materials in the Contract price.

- 2 Products
- 2.1 **MATERIALS**
 - .1 Acoustical wall panel: Refer to Interior Design Drawings and Schedules for material, Finishes, type and location.
 - .2 Mounting Components: Refer to Interior Design Drawings and Schedules for material, Finishes, type and location.
- 3 Execution
- 3.1 **EXAMINATION**
 - .1 Examine substrates to receive the Work and ensure that work of other sections is complete and that there are no conditions which adversely affect the Work.
 - .2 Do not begin installation until.
 - .1 Space has been enclosed and is weather-tight.
 - .2 Wet work has been completed and is dry.
 - .3 Painting is completed and wall base and floor covering is installed.
 - .4 Adjacent work of other trades such as woodwork, ceilings, wall coverings, etc. have been completed.
 - .3 Drywall surfaces to be taped, bedded, sanded, and primed. Penetrations to be sealed against air and moisture leakage through wall.
 - .4 Notify the Construction Manager immediately of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected.
 - .5 Commencement of the Work implies acceptance of surfaces and conditions.
- 3.2 **PREPARATION**
 - .1 Measure each wall area and establish layout of acoustical units to balance border widths at opposite edges of each wall. Coordinate panel layout with mechanical and electrical fixtures.
- 3.3 **INSTALLATION**
 - .1 Install acoustical wall panels by attaching the panels to an existing wall in accordance with reviewed shop drawings, manufacturer's written instructions, and authorities having jurisdiction.
 - .2 Attachment of acoustical wall panels to the wall will include the use of internal splines (included) and J molding as required for top and bottom edges.
- 3.4 **ADJUSTING AND CLEANING**
 - .1 Replace damaged and broken panels.
 - .2 Routine maintenance of acoustical wall panels should consist of:
 - .1 Remove excess spills from material quickly.
 - .2 Wipe with a damp cloth. If stain persists, apply small quantities of carpet or upholstery shampoo solution with a damp cloth.

- .3 Remove well with a clean cloth after each application of the solution.
- .4 Avoid excessive amounts of water.
- .5 Ensure adequate ventilation if the product is likely to be subject to excessive moisture

3.5 **PROTECTION**

- .1 Protect finished work from damage due to subsequent construction activity on the site.

End of Section

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- 1 General
- 1.1 **SECTION INCLUDES**
 - .1 Labour, Products, equipment and services necessary to complete the Work of this section.
 - .2 Work of this section includes but is not necessarily limited to, the following:
 - .1 Surface preparation and application of paint system on interior substrates as indicated on Finish Schedule and on Drawings
 - .3 Examine the Project Manual and Drawings for the Work of other Sections regarding the provisions for primer and finish coats. Paint or finish materials installed throughout the project which are required to be painted and which are left unfinished or unpainted by other Sections. The only exception to this requirement is where the Drawings, Project Manual or schedules explicitly state that a surface is not to be finish painted.
- 1.2 **REFERENCES**
 - .1 Department of Justice Canada
 - .1 Canadian Environmental Protection Act (CEPA).
 - .2 Environmental Protection Agency (EPA)
 - .1 EPA Test Method for Measuring Total Volatile Organic Compound Content of Consumer Products, Method 24, (for Surface Coatings).
 - .3 Health Canada / Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
 - .4 Master Painters Institute (MPI)
 - .1 MPI Architectural Painting Specifications Manual.
 - .5 National Fire Code of Canada
 - .6 Society for Protective Coatings (SSPC)
 - .1 SSPC Painting Manual, Volume Two, 8th Edition, Systems and Specifications Manual.
 - .7 Transport Canada (TC)
 - .1 Transportation of Dangerous Goods Act (TDGA).
 - .8 Accessibility for Ontarians with Disabilities Act (AODA), latest edition
- 1.3 **QUALITY ASSURANCE**
 - .1 Qualifications
 - .1 Contractor: Minimum of five years proven satisfactory experience. Provide list of last three comparable jobs including, job name and location, specifying authority, and project manager.
 - .2 Journeymen: Qualified journeymen who have "Tradesman Qualification Certificate of Proficiency" engaged in painting work.

- .3 Apprentices: Working under direct supervision of qualified tradesperson in accordance with trade regulations.
- .2 Conform to the standards contained in the Master Painters Institute Architectural Painting Specification Manual, latest edition (hereafter referred to a MPI Painting Specification) for all painting procedures including preparation and application of materials. MPI Painting Specification Manual as issued by the local MPI Accredited Quality Assurance Association having jurisdiction.
- .3 All paint manufacturers and Products used shall be as listed under the “Approved Products” section of the MPI Architectural Painting Specification Manual.

1.4

SUBMITTALS

- .1 Product Data
 - .1 Submit Product data and instructions for each paint and coating Product to be used.
 - .2 Submit Product data for the use and application of paint thinner.
 - .3 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS). Indicate VOCs during application and curing.
- .2 Samples
 - .1 Submit 200 x 300 mm draw-downs of each colour and gloss/sheen as indicated on the Finish Schedule before painting is required.
 - .1 Colours shall match those specified in the Finish Schedules as indicated on Drawings and in this section.
 - .2 Where colour availability is restricted, submit full range colour sample chips for Consultant selection.
 - .3 Retain reviewed samples on-site to demonstrate acceptable standard of quality for appropriate on-site surface.
- .3 Certificates: Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .4 Manufacturer's Instructions
 - .1 Submit manufacturer's installation and application instructions.
- .5 Closeout submittals: Submit maintenance data for incorporation into maintenance manual. Include following:
 - .1 Product name, type and use.
 - .2 Itemized list complete with manufacturer, Product number, paint type and colour coding for all colours used for Owner's later use in maintenance.
 - .3 MPI Environmentally Friendly classification system rating.

1.5 **DELIVERY, STORAGE AND HANDLING**

.1 Packing, Shipping, Handling and Unloading

.1 Pack, ship, handle and unload materials to jobsite with containers and labels intact.

.2 Acceptance at Site

.1 Identify Products and materials with labels indicating:

.1 Manufacturer's name and address.

.2 Type of paint or coating.

.3 Compliance with applicable standard.

.4 Colour number in accordance with established colour schedule.

.3 Remove damaged, opened and rejected materials from site.

.4 Storage and Protection

.1 Provide and maintain dry, temperature controlled, secure storage.

.2 Store materials and supplies away from heat generating devices.

.3 Store materials and equipment in well ventilated area with temperature range 7°C to 30°C (45°C to 86°F).

.5 Store temperature sensitive Products above minimum temperature as recommended by manufacturer.

.6 Keep areas used for storage, cleaning and preparation clean and orderly. After completion of operations, return areas to clean condition.

.7 Remove paint materials from storage only in quantities required for same day use.

.8 Fire Safety Requirements

.1 Handle, store, use and dispose of flammable and combustible materials in accordance with National Fire Code of Canada requirements.

1.6 **SITE CONDITIONS**

.1 Surface and Environmental Conditions

.1 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.

.2 Apply paint to adequately prepared surfaces and to surfaces within moisture limits.

.3 Apply paint when previous coat of paint is dry or adequately cured.

1.7 **EXTRA STOCK MATERIALS**

.1 Two drawdowns and one 4L can with complete product code, formula, date used, clearly marked for each paint product, in each finish and colour of paint, used in the Work for use in maintenance.

2 Products

2.1 **MATERIALS**

- .1 Paint materials (primers, paints, coatings, varnishes, stains, lacquers, fillers, thinners, solvents, etc.):
 - .1 As listed in the MPI Approved Products List (APL) are acceptable for use on this Project.
 - .2 Provide paint materials for paint systems from one manufacturer.
- .2 Only qualified Products with E2 or E3 "Environmentally Friendly" rating are acceptable for use on this Project.
- .3 Conform to latest MPI requirements for exterior and interior painting Work including preparation and priming.
- .4 Shellac and turpentine: Highest quality Product from approved manufacturer listed in MPI Architectural Painting Specification Manual, compatible with other coating materials as required.
- .5 Provide paint Products meeting MPI "Environmentally Friendly" ratings based on VOC (EPA Method 24) content levels.
- .6 Use MPI listed materials having minimum E2 or E3 rating where indoor air quality (odour) requirements exist.
- .7 Paints, coatings, adhesives, solvents, cleaners, lubricants, and other fluids:
 - .1 Water-based for concrete, concrete block and gypsum board
 - .2 Manufactured without compounds which contribute to ozone depletion in the upper atmosphere.
 - .3 Manufactured without compounds which contribute to smog in the lower atmosphere.
- .8 Formulate and manufacture water-borne surface coatings with no aromatic solvents, formaldehyde, halogenated solvents, mercury, lead, cadmium, hexavalent chromium or their compounds.
- .9 All materials and paints shall be lead and mercury free and shall have low VOC content where possible.
- .10 All paint materials shall have good flowing and brushing properties and shall dry or cure free of blemishes or sags.
- .11 Where required, paints and coatings shall meet flame spread and smoke developed ratings designated by local code requirements and/or authorities having jurisdiction.

2.2 **COLOURS**

- .1 General: Colours for some elements to be painted are based on certain Product brands
- .2 Other Products may be used on the condition that colours selected by the Consultant must be matched at no extra cost even if it requires custom matching. Refer to Finish Schedule for complete list of colours.
- .3 Refer to Finishes Schedule for manufacturer, type, colour, finish and location.

2.3 **PAINT MIXES**

- .1 Perform colour tinting operations prior to delivery of paint to site.
- .2 Mix paste, powder or catalyzed paint mixes in accordance with manufacturer's written instructions.
- .3 Use and add thinner in accordance with paint manufacturer's recommendations. Do not use kerosene or similar organic solvents to thin water-based paints.
- .4 Thin paint for spraying in accordance with paint manufacturer's instructions.
- .5 Re-mix paint in containers prior to and during application to ensure break-up of lumps, complete dispersion of settled pigment, and colour and gloss uniformity.

2.4 **GLOSS/SHEEN RATINGS**

- .1 Paint gloss is defined as sheen rating of applied paint, in accordance with following values:

	Gloss @ 60 degrees	Sheen @ 85 degrees
Gloss Level 1 - Matte Finish (flat)	Maximum 5	Maximum 10
Gloss Level 2 - Velvet-Like Finish	Maximum 10	10 to 35
Gloss Level 3 - Eggshell Finish	10 to 25	10 to 35
Gloss Level 4 - Satin-Like Finish	20 to 35	min. 35
Gloss Level 5 - Traditional Semi-Gloss Finish	35 to 70	
Gloss Level 6 - Traditional Gloss	70 to 85	
Gloss Level 7 - High Gloss Finish	More than 85	

2.5 **INTERIOR PAINTING SYSTEMS**

- .1 Concrete Vertical Surfaces
 - .1 INT 3.1C - Latex, semi-gloss finish.
- .2 Concrete masonry units: Concrete block:
 - .1 INT 4.2D - High performance architectural latex, semi-gloss finish.
- .3 Structural steel and metal fabrications: Exposed structural and miscellaneous metals
 - .1 INT 5.1C-DD - dry fall, water based acrylic, semi-gloss finish.
- .4 Galvanized metal (not chrome passivated): Doors, frames, ferrous metal pickets/railings, miscellaneous steel, pipes, exposed decking underside, and ducts
 - .1 INT 5.3K - water based acrylic, semi-gloss finish (over water based primer).
 - .2 For hot-dip galvanized surfaces, apply polyamine epoxy tie-coat in lieu of cementitious primer and apply alkyd topcoat.
- .5 Galvanized metal (not chrome passivated): Exposed decking underside, and ducts
 - .1 INT 5.3H- dry fall, water based acrylic, flat finish.
- .6 Gypsum board: Gypsum wallboard:
 - .1 INT 9.2B - High performance architectural latex, flat for ceilings; semi-gloss for walls.
- .7 Canvas and Cotton Coverings

- .1 INT 10.1A - Latex, flat finish.
- .8 Interior of all Pipe Spaces and Ducts Visible Through Grilles, and all Surfaces Visible Through Louvres Occurring in Ceilings
 - .1 INT 10.1A - Latex, flat finish, black colour unless indicated otherwise.
Note: Prepare surfaces as required by applying proper primers on the surface to which paint is applied. For surfaces above ceilings, paint surfaces after all services have been installed and prior to ceiling installation.
- .9 Piping and Conduit (except gas piping)
 - .1 INT 5.1C-G5 - dry fall, water based acrylic, semi-gloss finish.
- .10 Natural Gas Piping
 - .1 INT 5.1C-G5 - INT 5.1C-G5 - dry fall, water based acrylic, semi-gloss finish, yellow colour
- .11 Fire Protection Piping
 - .1 INT 5.1C-G5 - dry fall, water based acrylic, semi-gloss finish, red colour.
- .12 Wood Substrates: Wood trim, door trim, and window trim.
 - .1 High-Performance Architectural Latex System MPI INT 6.3A:
 - .1 Prime Coat: Primer, latex for exterior wood, MPI #39.
 - .2 Intermediate Coat: Latex, exterior, matching topcoat.
 - .3 Topcoat: Latex, exterior, low sheen (MPI Gloss Level 3-4), MPI #139.
- 3 Execution
- 3.1 **MANUFACTURER'S INSTRUCTIONS**
 - .1 Compliance: Comply with manufacturer's written recommendations or specifications, including Product technical bulletins, handling, storage and installation instructions, and data sheet.
- 3.2 **GENERAL**
 - .1 Perform preparation and operations for interior painting in accordance with MPI Architectural Painting Specifications Manual except where specified otherwise.
 - .2 Apply paint materials in accordance with paint manufacturer's written application instructions.
- 3.3 **EXAMINATION**
 - .1 Examine substrates for problems related to proper and complete preparation of surfaces to be painted. Report to Consultant damages, defects, and unsatisfactory or unfavourable conditions before proceeding with Work.
 - .2 Conduct moisture testing of surfaces to be painted using properly calibrated electronic moisture meter, except test concrete floors for moisture using simple "cover patch test". Do not proceed with Work until conditions fall within acceptable range as recommended by manufacturer.

3.4 **PREPARATION**

- .1 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 surfaces as directed Consultant
 - .2 Protect items that are permanently attached such as fire labels on doors and frames.
 - .3 Protect factory finished Products and equipment.
- .2 Surface Preparation
 - .1 Remove electrical cover plates, light fixtures, surface hardware on doors, bath accessories and other surface mounted equipment, fittings and fastenings prior to undertaking painting operations. Identify and store items in secure location and re-installed after painting is completed.
 - .2 Move and cover furniture and portable equipment as necessary to carry out painting operations. Replace as painting operations progress.
 - .3 Place "WET PAINT" signs in occupied areas as painting operations progress. Signs to approval of Consultant.
- .3 Clean and prepare surfaces in accordance with MPI Architectural 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 or compressed air, as appropriate for the given condition.
 - .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. Minimize use of mineral spirits or organic solvents to clean up water-based paints.
- .4 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.
- .5 Where possible, prime non-exposed 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.
- .6 Sand and dust between coats as required to provide adequate adhesion for next coat and to remove defects visible from a distance up to 1 m.
- .7 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. Remove traces of blast Products from surfaces, pockets and corners to be painted by brushing with clean brushes or other suitable means.
- .8 Touch up of shop primers with primer as specified.

3.5

APPLICATION

- .1 Conform to manufacturer's application instructions unless specified otherwise.
- .2 Brush and Roller Application
 - .1 Apply paint in uniform layer using brush and/or roller type suitable for application.
 - .2 Work paint into cracks, crevices and corners.
 - .3 Paint surfaces and corners not accessible to brush using spray, daubers and/or sheepskins. Paint surfaces and corners not accessible to roller using brush, daubers or sheepskins.
 - .4 Brush and/or roll out runs and sags, and over-lap marks. Rolled surfaces free of roller tracking and heavy stipple.
 - .5 Remove runs, sags and brush marks from finished work and repaint.
- .3 Anti-slip Floor Coating
 - .1 Install product in accordance with manufacturer instructions.
 - .2 Apply product to clean, dry surface free from dirt, grease, waxes, chalking, soap build up, and loose paint.
 - .3 New concrete shall be cured for minimum one month prior to painting.
 - .4 Bare metal shall be correctly primed. Glossy surface shall be scuffed sanded to promote adhesion.
- .4 Spray Application
 - .1 Provide and maintain equipment that is suitable for intended purpose, capable of atomizing paint to be applied, and equipped with suitable pressure regulators and gauges.
 - .2 Keep paint ingredients properly mixed in containers during paint application either by continuous mechanical agitation or by intermittent agitation as frequently as necessary.
 - .3 Apply paint in uniform layer, with overlapping at edges of spray pattern. Back roll first coat application.
 - .4 Brush out immediately all runs and sags.
 - .5 Use brushes and rollers to work paint into cracks, crevices and places which are not adequately painted by spray.

- .5 Use dipping, sheepskins or daubers only when no other method is practical in places of difficult access.
- .6 Apply coats of paint 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 closets and alcoves as specified for adjoining rooms.
- .10 Finish top, bottom, edges and cutouts of doors after fitting as specified for door surfaces.

3.6 **MECHANICAL/ELECTRICAL EQUIPMENT**

- .1 Paint finished area exposed conduits, piping, hangers, ductwork and other mechanical and electrical equipment with colour and finish to match adjacent surfaces, except as indicated.
- .2 Boiler room, mechanical and electrical rooms: Paint exposed conduits, piping, hangers, ductwork and other mechanical and electrical equipment.
- .3 Other unfinished areas: Leave exposed conduits, piping, hangers, ductwork and other mechanical and electrical equipment in original finish and touch up scratches and marks.
- .4 Touch up scratches and marks on factory painted finishes and equipment with paint as supplied by manufacturer of equipment.
- .5 Do not paint over nameplates.
- .6 Keep sprinkler heads free of paint.
- .7 Paint inside of ductwork where visible behind grilles, registers and diffusers with primer and one coat of matt black paint.
- .8 Paint fire protection piping red.
- .9 Paint disconnect switches for fire alarm system and exit light systems in red enamel.
- .10 Paint natural gas piping yellow.
- .11 Paint both sides and edges of backboards for telephone and electrical equipment before installation. Leave equipment in original finish except for touch-up as required, and paint conduits, mounting accessories and other unfinished items.
- .12 Do not paint interior transformers and substation equipment.

3.7 **SITE TOLERANCES**

- .1 Walls: No defects visible from a distance of 1 m at ninety degrees to surface.
- .2 Ceilings: No defects visible from floor at forty-five 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.

3.8 **RESTORATION**

- .1 Clean and re-install 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 Protect freshly completed surfaces from paint droppings and dust to approval of Consultant. Avoid scuffing newly applied paint.
- .5 Restore areas used for storage, cleaning, mixing and handling of paint to clean condition as approved by Consultant.

3.9 **FIELD QUALITY CONTROL**

- .1 All surfaces, preparation and paint application shall be inspected by the paint inspection agency.
- .2 Painted surfaces shall be considered to lack uniformity and soundness if any of the following defects are apparent to the painting inspection agency inspector.
 - .1 Runs, sags, hiding or shadowing by inefficient application methods.
 - .2 Evidence of poor coverage at rivet heads, plate edges, lap joints, crevices, pockets, corners and re-entrant angles.
 - .3 Damage due to touching before paint is sufficiently dry or any other contributory cause.
 - .4 Damage due to application on moist surfaces or caused by inadequate protection from the weather.
 - .5 Damage and/or contamination of paint due to wind-blown contaminants (dust, sand blast materials, salt spray, etc.).
- .3 Painted surfaces rejected by the inspector shall be made good at the expense of the Contractor. Small affected areas may be touched up; large affected areas or areas without sufficient dry film thickness of paint shall be repainted. Runs, sags of damaged paint shall be removed by scraper or by sanding prior to application of paint.

End of Section

- 1 General
 - 1.1 **SUMMARY**
 - .1 Section Includes
 - .1 Products, equipment and services necessary to complete the Work of this section.
 - 1.2 **REFERENCES**
 - .1 Conform to the latest edition of the following:
 - .1 AODA - Accessibility for Ontarians with Disabilities Act
 - .2 TADG - Toronto Accessibility Design Guidelines
 - 1.3 **SUBMITTALS**
 - .1 Shop Drawings shall contain detailed description, and bear item numbers, marked to show quantity, colour, model numbers, fabrication details, and installation instructions. Submit in bound volumes.
 - 1.4 **DELIVERY, STORAGE AND HANDLING**
 - .1 Deliver packaged materials in original, undamaged containers with manufacturer's labels and seals intact. Handle and store materials in accordance with manufacturer's and Supplier's recommendations to prevent damage thereto.
 - 1.5 **PROTECTION**
 - .1 Protect the Work of this section from damage of any kind. Protect other work from damage resulting from Work of this section. Replace damaged work which cannot be repaired, cleaned or restored.
- 2 Products
 - 2.1 **ACCESSIBLE PUSH BUTTON MOUNTING POST/ BOLLARD (PEDESTAL)**
 - .1 Touch Panel Column Surface or Bollard Mounted
 - .1 Sturdy extrusion touch panel with architectural finish, aluminum Ingress-R.E.X Touch Panel Column, fully active
 - .1 SPDT by SDC Security
 - .2 Or accepted equal
 - 2.2 **TAPE SWITCH**
 - .1 Surface mounted, momentary contact, press at any point linear switch, clear encase impact-resistant and vandal resistant Lexan housing, actuation force of 5 lbs. Colour, text and graphics as indicated on the Drawings.
 - .1 "NexGen Tamper Resistant Switches" by Tapeswitch or accepted equal.
 - 2.3 **TACKBOARDS**
 - .1 Tackboards (TK-1): Natural cork tackboard.
 - .1 Refer to Finishes schedule for type, colour, manufacturer, and locations.

- .2 Frames: Extruded aluminum, manufacturer's standard widths, with neatly joined, reinforced corners. Exposed surfaces shall be clear anodized.

2.4 **EXTERIOR DOOR RAMP - METAL**

- .1 Exterior ramp at entry door: Aluminum alloy 6063, mill finish, slip resistant. Select appropriate height and width to match existing site conditions.
 - .1 "Interlocking Ramp" by National Guard Products Inc (NGP) as distributed by DMG Services or accepted equal.

3 Execution

3.1 **INSTALLATION**

- .1 Install miscellaneous specialties perfectly rigid in accordance with manufacturers' printed directions.
 - .2 After installation, test-operate and adjust operable parts as required for ease of operation.
- End of Section

1 General

1.1 **SUMMARY**

.1 Section Includes

- .1 Labour, Products, equipment and services necessary to complete the Work of this section.
- .2 Work includes, but is not necessarily limited to, the following:
 - .1 Sign graphics
 - .2 Cut-out letters
 - .3 Wall plates
 - .4 Door plates
 - .5 Number plates
 - .6 Barrier-free signage plates
 - .7 Signage at magnetic locked doors
 - .8 Project Information signage for public buildings

1.2 **REFERENCES**

.1 Conform to the latest edition of the following:

- .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 B32 - Standard Specification for Solder Metal
- .3 ASTM B456 - Standard Specification for Electrodeposited Coatings of Copper Plus Nickel Plus Chromium and Nickel Plus Chromium
- .4 - Aluminum Association Designation System for Aluminum Finishes
- .5 CAN/CSA-G164 - Hot Dip Galvanizing of Irregularly Shaped Articles
- .6 CSA W47.2 - Certification of Companies for Fusion Welding of Aluminum
- .7 CSA W59-M - Welded Steel Construction (Metal Arc Welding)
- .8 CAN/CGSB-1.108 - Bituminous Solvent Type Paint
- .9 CGSB 41-GP-6M - Sheets, Thermosetting Polyester Plastics, Glass Fiber Reinforced
- .10 CSA - Canadian Standards Association
- .11 CNIB - Canadian National Institute for the Blind
- .12 AODA - Accessibility for Ontarians with Disabilities Act

1.3 **SUBMITTALS**

.1 Shop Drawings

- .1 Submit Shop Drawings in accordance with Section 01 33 00.
- .2 Submit Shop Drawings and catalogue sheets.
- .3 Indicate materials, thicknesses, sizes, finishes, colours, construction details, removable and interchangeable components, mounting methods, schedule of signs.
- .4 Submit full size templates drawn-to-scale details for individually fabricated (or incised) lettering indicating word and letter spacing.

.2 Samples

- .1 Submit samples in accordance with Section 01 33 00.
- .2 Submit sample of each type sign, sign image and mounting method.

1.4 **QUALIFICATIONS**

- .1 Manufacturer of signs shall be specialist in this field having minimum five years proven experience in sign manufacturing and installation of each type of signs specified.

1.5 **MAINTENANCE DATA**

- .1 Provide maintenance data for signs for incorporation into manual specified in Section 01 33 00.

2 Products

2.1 **MATERIALS**

- .1 Acceptable manufacturers:
 - .1 Forward Signs Inc.
 - .2 or accepted equal
- .2 Source sign fabrication made by one manufacturer from one of the following:
 - .1 Spectra Advertising
 - .2 WSI Signage
 - .3 Neon Products Ltd.
 - .4 Steel Art Signs Ltd.
 - .5 Imperial Sign Ltd.
- .3 Aluminum extrusions: Aluminum Association alloy AA 6063-T5, minimum 2 mm thick, free from scratches and surface blemishes.
- .4 Sheet aluminum: Aluminum alloy AA6063-T5, minimum 0.75 mm thick for exposed work requiring finish to match extruded Sections.

- .5 Prefinished sheet aluminum: Plain sheet with manufacturer applied baked enamel finish to Aluminum Association designation AA-M22-C22-A41 (clear) or AA-M22-C22-A42 (black) 0.25 mm thick on face and 0.0076 mm thick on back.
- .6 Prefinished sheet steel: Conforming to Canadian Steel Sheet Building Institute Bulletin finished with Z275 zinc coating in accordance with CSSBI Standards and prepainted as follows:
 - .1 Finish: Coil coated, baked-on, 70% Kynar 500 or Hylar 5000 based fluoropolymer enamel, 10000 Series by Stelco Inc., or Dofasco Inc. on exposed surfaces as applied by Baycoat. Coil coated surfaces pretreated and primed prior to application of coating. Paint colour: As selected by Consultant.
- .7 Galvanized steel sheet: Commercial quality to ASTM A653/A653M, GRADE A, with zinc coating designation.
- .8 Acrylic sheet: Polymethylmethacrylate (PMMA) cast sheet suitable for intended use in sign fabrication, colours as indicated.
- .9 Engraving sheet: Lamicaid 3.2 mm thick plastic sheet, black or white core.
- .10 Welding materials: To CSA W59.
- .11 Solder: To ASTM B32.
- .12 Self-stick foam tape: Minimum 1.6 mm thick, 352.4 kg/m³ density polyurethane open-cell foam tape for sign purposes, with synthetic self-stick adhesive on both sides. Width to suit sign sizes.
- .13 Adhesives, paints, sealants and solvents for acrylic.: Type recommended by sheet manufacturer for applicable condition.
- .14 Acrylic topcoat: Clear, non-yellowing, exterior grade, satin finish, acrylic polyester resin protective coating, compatible with acrylic or metal surface of type recommended by sheet manufacturer.
- .15 Bituminous paint: To CAN/CGSB-1.108, Type 2.

2.2 **FINISHES**

- .1 Anodized Aluminum
 - .1 Clear finish: Conform to Aluminum Association designation AA-M22-C22-A41 in uncoloured anodized finish with film thickness of 0.25 mm.
 - .2 Colour finish: Conform to Aluminum Association designation AA-M22-C22-A42 to match sample.
- .2 Galvanized finish: On irregular shaped articles, 600 g/m² zinc coating to CAN/CSA G164.
- .3 Chrome and nickel plating: To ASTM B456, satin finish.
- .4 Prefinished metals: As specified herein.

2.3 **GENERAL FABRICATION REQUIREMENTS**

- .1 Fabricate signs in accordance with details on Drawings, Specifications and Shop Drawings to present a safe and rigid installation.
- .2 Build units square, true, accurate to size, free from visual or performance defects.

- .3 Accurately fit and securely join sections to obtain tight, closed joints.
- .4 Allow for thermal movement without distortion of components.
- .5 Do not use exposed fasteners unless indicated otherwise on Drawings, and shall be inconspicuous and same finish and colour as base metal on which they occur.
- .6 Polish exposed edges of plastic and metal to smooth, slightly convex profile.
- .7 Do steel welding to CSA W59 aluminum welding to CSA W47.2 Finish exposed welds flush and smooth.
- .8 Brush-apply bituminous paint to aluminum in contact with dissimilar metals, concrete or masonry.
- .9 Do not locate manufacturer's nameplates on sign surfaces visible in completed work.
- .10 Letters shall be as indicated otherwise on Drawings, and be clear cut and free from ragged or indistinct edges.

2.4 **SIGN GRAPHICS**

- .1 Sign graphics to be well defined, arranged for balanced appearance, and properly word- and letter-spaced. Acceptable manufacturers for computer cut graphics:
 - .1 System Graphics
 - .2 Alpine Graphics Productions
 - .3 Autograph Trim
 - .4 Canada Decal Inc.
- .2 Silk screen process: Apply colour photographic produced silk screen printed images to face of sign.
- .3 Self-stick vinyl film: Individual letters, numerals and symbols cut from 0.1 mm thick matte finish, exterior grade PVC film, with self-stick adhesive backing. Colour selected by Consultant from manufacturer's standard range.
- .4 Decals: Silk screened or printed images on minimum 0.025 mm, clear matte finish, PVC film, with self-stick adhesive backing. Protect image subject to abuse with laminated film overlay of same material as decal base.

2.5 **WALL PLATES**

- .1 Plastic Wall Plates
 - .1 Fabricate from (clear) (colour) (acrylic sheet) (fibreglass) minimum 3.2 mm thick. Sizes as indicated.
 - .2 Sign graphics: Apply by silk screen or self-stick vinyl film letters.
- .2 Metal Wall Plates
 - .1 Fabricate from (aluminum sign plates, minimum 3.2 mm thick, with clear finish. Sizes as indicated.
 - .2 Sign graphics: Apply by silk screen or self-stick vinyl letters.

- .3 Interchangeable mounting: Supply wall plates with semi-concealed, retaining holders that permit quick but vandal-resistant interchange of sign face. No exposed fasteners permitted. Exposed portions to match sign face.
- .4 Fixed mounting: Prepare wall plates for fixing by self-stick foam tape. Include back-up plates for fixing to uneven surfaces where required.
- .5 Bracket mounting: Fabricate brackets for wall projecting or as detailed.

2.6

DOOR PLATES

- .1 Fabricate sign faces of acrylic sheet. Sizes and thickness as indicated on Drawings.
- .2 Sign graphics: Apply by silk screen or self-stick vinyl letters.
- .3 Interchangeable mounting: Supply door plates with semi-concealed, retaining holders that permit quick but vandal-resistant interchange of sign face. No exposed fasteners permitted. Exposed portions to match sign face.
- .4 Fixed mounting: Use self-stick foam tape.
- .5 Mounting on transparent surfaces: Use self-stick foam tape. Include blank back-up plate for opposite side.
- .6 Washroom pictographs: Cut-out figures without backgrounds.
- .7

2.7

BARRIER-FREE SIGNAGE PLATES

- .1 3D-graphics signs for the visually impaired, the Barrier-Free Act, building codes and CNIB and CSA recommendations. Minimum description:
 - .1 Raised letters, Grade 1, Braille and graphics system on injection moulded acrylic, styrene or polycarbonate substrate and protected with a non-glare, matt finish.
 - .2 Double sided tape mounting.
 - .3 Colours as selected by the Consultant.
- .2 Washroom Door
 - .1 Tactile type universal male or female symbol and a universal barrier-free symbol on a dark coloured high square. Size and colour as indicated on Drawings.
 - .2 Braille signs under the universal symbols, within the square.
 - .3 Tactile type bilingual text (Men-Hommes) or (Women-Femmes).
- .3 Stair Shaft
 - .1 The sign is to be multi-layer process consisting of substrate, laminating adhesive, background film, profile film, test film and top film.
 - .2 Location: Mounted on wall on the latch side of doors leading to stair shafts.
- .4 Handrails
 - .1 150 mm long high contrast handrail wayfinding sign with Braille and 25 mm wide hazard strip on either side of the sign to be 200 mm in total length indicating the stair number and floor/level number.

- .2 Location: On centre within the extension piece of the handrail.
- .3 Colour: as indicated on Drawings.
- .4 Acceptable Manufacturer:
 - .1 Atec Signs Inc.
 - .2 or accepted equal.

2.8 **SIGNAGE AT MAGNETIC LOCKED DOORS**

- .1 Aluminum plate with the following text engraved in Helvetica typeface, 25 mm high: "EMERGENCY EXIT, UNLOCKED BY FIRE ALARM".
- .2 Paint plate with one colour. Paint engraved text with a contrasting colour. Paint to be baked enamel finished.
- .3 Colours as selected by Consultant.

2.9 **PROJECT INFORMATION SIGNAGE FOR PUBLIC**

- .1 Refer to Section 10 14 00.01 City of Toronto Construction-Improvement Signs for information on the standard template to be used for projects accessible to the public.

3 Execution

3.1 **INSTALLATION**

- .1 Erect and secure signs plumb and level at elevations.
- .2 Comply with sign manufacturer's installation instructions and approved Shop Drawings.
- .3 Mechanical Attachment
 - .1 Apply signage to concrete or solid masonry with lag screws and expansion bolts or screws.
 - .2 Apply to hollow masonry with toggle bolts or equivalent.
 - .3 Secure behind stud walls or above ceilings into framing members.
 - .4 Mechanical fasteners shall be non-staining, non-ferrous type.
 - .5 Fabricate special fasteners as required for installation conditions.
- .4 Adhesive attachment: Use self-stick adhesive foam tape to manufacturer's instructions to adequately fix sign and prevent "rocking". Keep tape maximum 1.6 mm from edges.

3.2 **CLEANING**

- .1 Leave signs clean and polish all exposed surfaces.
- .2 Touch up any damaged finishes.

End of Section

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- 1 General
- 1.1 **SUMMARY**
 - .1 Section Includes
 - .1 Products, equipment and services necessary to complete the Work of this section.
- 1.2 **REFERENCES**
 - .1 Conform to the latest edition of the following:
 - .1 AODA - Accessibility for Ontarians with Disabilities Act
 - .2 TADG - Toronto Accessibility Design Guidelines
- 1.3 **SUBMITTALS**
 - .1 Submit manufacturer's specifications and technical data, installation instructions, as required, and catalogue cuts and templates where required to explain the construction and incorporate it into the project.
 - .2 Submit shop drawings showing complete fabrication details, fastener and anchor location, plans of plate placement including joints, and material to be used as well as outlining installation materials and procedure.
 - .3 Samples: Submit sample illustrating colour and finish.
- 1.4 **QUALIFICATIONS**
 - .1 Installers: Provide work of this Section executed by competent installers with minimum 5 years' experience in the application of the Products, systems and assemblies specified and with approval and training of the Product manufacturers.
 - .1 Installers shall have received training from the manufacturer for the installation of the specified tactile warning systems.
- 1.5 **MANUFACTURER'S INSPECTION**
 - .1 Manufacturer's representative shall visit Site during this Work and verify in writing, that application is in accordance with this Specification and manufacturer's recommendations.
 - .2 Upon completion of this Work, manufacturer's representative shall verify, in writing, that the application has been completed in accordance with this Specification and manufacturer's recommendation.
- 1.6 **DELIVERY, STORAGE AND HANDLING**
 - .1 Deliver packaged materials in original, undamaged containers with manufacturer's labels and seals intact. Handle and store materials in accordance with manufacturer's and Supplier's recommendations to prevent damage thereto.
- 1.7 **WARRANTY**
 - .1 Warrant Work of this section against defects and deficiencies for a period of five years from date Work is certified as substantially performed in accordance with the conditions of the Contract.

.2 Promptly make good defects and deficiencies which become apparent within the Warranty Period by replacing defective Work satisfactory to the Consultant and at no expense to the Owner.

.3 Defects shall include, but not be limited to, loss of bond, breakage, deformation, fading and loosening of tiles.

1.8 PROTECTION

.1 Protect the Work of this section from damage of any kind. Protect other work from damage resulting from Work of this section. Replace damaged work which cannot be repaired, cleaned or restored.

2 Products

2.1 TACTILE WALKING SURFACE INDICATORS

.1 Surface Applied Composite Polymer Tile

.1 Engineered polymers truncated dome tile with beveled edges, surface mounted and secured with adhesive and fasteners matching the colour of the tile.

.1 Application: Interior and existing exterior applications, existing cured concrete surfaces where a detectable warning system is required, curb ramps, pedestrian crossings, parking areas, wheelchair ramps, top and bottom of stairs, or platforms.

.2 Basis of Design: Kinesik Engineered Products or accepted equal

.2 Surface Applied Vitrified Polymer Tile

.1 Diamond-hard vitrified polymer composite with bevelled edges, weather and wear resistance. Slip Resistance of Tile when tested by ASTM C1028 of 0.80 wet and dry static coefficient of friction on top of domes and field area.

.1 Application: Interior non-fire rated and exterior application in existing cured concrete surfaces where a detectable warning system is required, curb ramp, parking areas, pedestrian crossings, top of stairs or where a change in elevation greater than 250mm or a slope steeper than a ratio of 1:3.

.2 Basis of Design: Kinesik Engineered Products or accepted equal

.3 Stainless Steel Surface Applied Plate Tactile Indicators

.1 Surface applied 316L marine grade stainless steel plate with truncated domes attention indicator or directional wayfinding bars.

.1 Application: Exterior and interior applications, wheelchair ramps, parking areas, top of stair landings, revolving door approaches, or where the change in elevation is greater than 250 mm or the slope is steeper than in a ratio of 1:3.

.2 Basis of Design: Kinesik Engineered Products or accepted equal

.4 Individual Metallic Tactile Domes and Guidance Bars

.1 Truncated Domes

.1 Interior application

- .1 Individual 316L marine grade stainless steel installed on any type of flooring, for high aesthetic finish applications
- .2 Application: Non-heritage floor and carpeting.
- .3 Installation method: drilled. Domes to be installed in widths/depth of 610 mm
- .4 Pattern: Concentric Ring Design.
- .5 Basis of Design: Kinesik Engineered Products or accepted equal

.2 **Guidance Bars**

- .1 Wayfinding, individual stainless steel, brass, or aluminum, Dome Pattern: Carborundum Insert, Crosshatch or linear groove design. Bars to be installed in widths/depth of 610 mm.
- .2 Use: Interior application, installed on any type of flooring, for high aesthetic finish applications or non-heritage designated stairs.
- .3 Pattern: Dome Pattern: Carborundum Insert, Crosshatch or Concentric Ring Design.
- .4 Basis of Design: Kinesik Engineered Products or accepted equal

2.2 **ACCESSORIES**

.1 **Fasteners and anchors:**

- .1 As recommended by manufacturer for secure anchorage of tactile warning surfaces. Provide noncorrosive fasteners that are compatible with each material joined, and complying with the following:
 - .1 Furnish color appropriate nylon sleeve, stainless-steel fasteners for exterior use.
 - .2 Fastener Heads: for nonstructural connections, use flathead or oval countersunk screws and bolts with tamper-resistant heads, colored to match tile.

.2 **Adhesives:**

- .1 **Tactile Walking Surface Indicators:**
 - .1 Adhesives: As applicable for type of installation. Acceptable manufacturers Mapei, Bostik, Sika, Tactile Bond & Seal or accepted equal.
- .2 **Textural and Colour Contrast Warning Strip and Nosing:**
 - .1 Adhesives: polyurethane adhesive, mechanically fastened or as recommended by the manufacturer

.3 **Sealant:**

- .1 As recommended by manufacturer for sealing perimeter of tactile warning surfacing unit.

3 **Execution**

3.1 **EXAMINATION**

- .1 Verification of Conditions:
 - .1 Verify existing conditions and finishes are ready to receive specified work. Ensure backings are structurally sound, level and plumb within required tolerances. Notify Consultant in writing of unacceptable substrate conditions.
 - .2 Ensure compatibility of adhesion, reinforcing and fillers with adjacent substrate and component coming in contact with these products.
 - .3 Ensure manufacturers, examine substrate conditions, verify conditions are suitable for installation prior to commencement and review application procedures. If requested, submit written reports.
- .2 Evaluation and Assessment:
 - .1 Prior to installation, set aside for further inspection and replacement, tiles that are sub-standard, fractured, chipped or has pinholes or voids that are unusable for cuts. Contractor shall replace substandard and/or pre-damaged tiles at no additional cost to the Owner.
 - .2 Before setting, examine tile backs for possible dust or other contaminants. If necessary, use a slightly damp towel and wipe tile backs to remove any dust or contaminant residues.
 - .3 Commencement of work implies acceptance of previously completed work.

3.2 **PREPARATION**

- .1 Ensure substrates are clean and free of dust, oil, grease, paint, tar, wax, curing agent, primer, sealer, form release agent or any deleterious substance and debris which may prevent or reduce adhesion.
- .2 Thoroughly clean the surface with an appropriate floor cleaner, ensuring all paint or sealant is removed.
- .3 Provide templates and rough-in measurements as required.

3.3 **INSTALLATION**

- .1 Install tactile warning systems and accessories to manufacturer's written instructions.
- .2 Install securely and rigidly, bonded to substrate.
- .3 Cast-in-place Tactile
 - .1 Install cast-in-place tactile surface tile system on full surface of barrier-free curb ramps.
 - .2 Retain factory-installed plastic sheeting in place during installation to protect the tile surface. Do not remove concrete from the area where the tiles are to be installed; avoid any air voids below the tile.
 - .3 Place tactile tiles in wet concrete, immediately after finishing concrete, using a rubber mallet and checking the slope electronic level. Tamp tiles into the concrete. Tiles to be set with the top of domes level to the adjacent concrete on the top and sides of ramp, to prevent damage by snow plows, with centre portion of the base/field level with concrete at the bottom of the ramp to allow water drainage. Ensure installation does not present a tripping hazard.

- .4 While concrete is still workable, use an edging tool to create a finished edge, then a steel trowel to finish the concrete around the tile perimeter. After concrete has cured, remove protective plastic wrap from the tile.

3.4 **FIELD QUALITY CONTROL**

- .1 Non-Conforming Work: Replace damaged work which cannot be satisfactorily repaired, restored or cleaned, to satisfaction of Consultant and no cost to the Owner.
- .2 Manufacturer Services: Have manufacturer's representative visit site at commencement of work to give proper direction and thereafter at regular intervals to ensure proper workmanship.

3.5 **PROTECTION**

- .1 Protect other parts of work from spatters, stains or damage.
- .2 Protect finished work from foot traffic and heavy commercial and equipment traffic. Follow Product instructions for requirements.
- .3 Protect finished work from damage by other trades and general abuse until substantial completion or acceptance.
- .4 Protect installed tactile warning indicator tiles from damage during construction by covering with plywood.

3.6 **CLEANING**

- .1 Remove grout and other residue immediately while work progresses and before materials harden on tile surface.
- .2 Clean tile completely leaving no apparent cement laitance on the surface.
- .3 Clean adjacent surfaces that have been soiled or otherwise marred, to completely remove evidence of materials causing same.
- .4 Comply with manufacturer's maintenance manual for cleaning and maintaining tile surface.

End of Section

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1 General

1.1 **SUMMARY**

.1 Section Includes

- .1 Products, equipment and services necessary to complete the Work of this section.
- .2 Work include but are not limited to the following:
 - .1 Pre-finished extruded aluminum framing systems for interior use.
 - .2 Frameless swing glass doors for interior use.
 - .3 Glass and other Glazing Panels

1.2 **REFERENCES**

.1 Conform to the latest edition of the following:

- .1 AAMA 611, Voluntary Specification for Anodized Architectural Aluminum.
- .2 AAMA 2603, Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic coatings on Extruded Aluminum and Panels.
- .3 ANSI ICC A117.1, Accessible and Usable Buildings and Facilities.
- .4 ANSI/BHMA A156.115, Hardware Preparation in Steel Doors or Steel Frames.
- .5 ANSI Z97.1, Safety Glazing Materials Used in Buildings – Safety performance Specifications and Methods of Test.
- .6 ASTM A666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
- .7 ASTM B221, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
- .8 ASTM B456, Standard Specification for Electrodeposited Coatings of Copper Plus Nickel Plus Chromium and Nickel Plus Chromium.
- .9 ASTM B633, Standard Specification for Electrodeposited Coatings of Zinc on iron and Steel.
- .10 ASTM C864, Standard Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers.
- .11 ASTM C1048, Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass.
- .12 NECB, "National Energy Code of Canada for Buildings"
- .13 ASHRAE 90.1, "Energy Standard for Sites and Buildings Except Low-Rise Residential"
- .14 OBC SB-10, "Energy Efficiency Requirements"
- .15 GANA Publications: GANA's "Laminated Glazing Reference Manual" and GANA's Glazing Manual."

- .16 AAMA Publications: AAMA GDSG-1, "Glass Design for Sloped Glazing," and AAMA TIR-A7, "Sloped Glazing Guidelines."
- .17 IGMA Publication for Sloped Glazing: IGMA TB-3001, "Guidelines for Sloped Glazing."
- .18 IGMA Publication for Insulating Glass: IGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."
- .19 NFRC 100, "Procedure for Determining Fenestration Product U-Factors"
- .20 NFRC 200, "Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and VLT"

1.3

DESIGN REQUIREMENTS

- .1 Drawing and Specifications.
 - .1 Drawings are diagrammatic and do not purport to identify or solve the specified performance criteria the Work is required to meet or surpass.
 - .2 Details shown on Drawings are schematic and show general arrangement and intent.
 - .3 Drawings indicate profiles and configurations required together with relationships to the building structure and other exterior and interior building elements with which the Work is required to interface.
 - .4 Drawings do not purport to solve problems at the glass lines associated with glass installation, movements, pressure fractures and thermal shocks.
 - .5 Drawings contain details that suggest directions for addressing some of the major design requirements. The Contractor may use the details and develop them as deemed best to obtain the required design criteria.
 - .6 Specifications are performance type and include minimum requirements. Specifications are not intended to limit the method of achieving the required performance.
- .2 General: Provide aluminum-framed office fronts and doors of dimensions and configurations shown, complying with performance requirements indicated, based on manufacturer's testing of doors representative of those specified:
 - .1 Aluminum frames and fixed panels shall withstand gravity loads and a lateral deflection is limited to the lesser of L/175 or 3/4 inch, whichever is less, when tested under a uniformly distributed load of 5 lb/sq. ft. (24.4 kg/sq. m) according to ASTM E 72.
 - .2 Glazing Rebates: Design glass framing system to limit lateral deflections of glass panel edges to less than 1/175 of glass-edge length or 3/4 inch (19 mm), whichever is less.
- .3 Where floor elevation on one side of a wall is more than 600 mm higher than the elevation of a floor on the other side of the wall, portions of the interior glass partitions located below 1070 mm AFF to be designed and constructed in accordance with the requirements for guards in Part 4 of the OBC. Provide glazing of thicknesses and strengths to meet these requirements. Framing members be sized and reinforced as required. Provide written confirmation from the engineer responsible for the review of the shop drawings that these requirements have been met.

1.4 **SUBMITTALS**

- .1 Product data and certifications: Submit manufacturer's product data, installation instructions, use limitations and recommendations for each door and frame product used. Provide manufacturer's certifications stating that products and assemblies comply with specification requirements.
 - .1 Include construction details, material descriptions, dimensions of individual components and profiles, hardware, finishes, and installation instructions for each type of aluminum frames indicated.
 - .2 Include information on factory finish, glass, glazing gaskets, deflection tracks, accessories and other required components.
- .2 Shop Drawings: Submit schedule indicating opening numbers, frame types, dimensions, swing/slide direction and clearances, and hardware requirements.
 - .1 Include plans, elevations and details indicating frame types, profiles, conditions at openings, methods and locations of anchoring, glazing requirements, hardware locations and reinforcements for hardware.
- .3 Coordination Drawings: Reflected ceiling plans drawn to scale and coordinating partitions with ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings. Plans shall also show coordination of and with the overhead support structure.
- .4 Calculations: Where installed Work is indicated to comply with certain design loadings, provide professionally prepared calculations, material properties, certification, and other information required for structural analysis of performance of Work.
- .5 Samples:
 - .1 Selection samples: Submit printed colour charts or sample chains indicating manufacturer's complete range to determine colour, texture, shape and/or composition for each type of material finish exposed to view for review by Consultant before commencing work. Samples to be clearly labelled with manufacturer's name and type.
 - .2 Final selection samples: Submit products for acceptance, those required prior to manufacturing to verify close tolerances, shapes and/or specifically required aesthetics. Submit extrusions or formed shapes in lengths of 300 mm demonstrating each specified finish for review by Consultant before commencing work. Samples to be clearly labelled with manufacturer's name and type.

1.5 **QUALITY ASSURANCE**

- .1 Installer Qualifications: Contractor executing Work, must have a minimum of five (5) years continuous Canadian experience in successful installation of work of type and quality shown and specified. Contractor must have adequate equipment and skilled tradesmen to perform it expeditiously and to the highest quality standards for this type of Work. Submit proof of experience upon Consultant's request.
- .2 Manufacturer's qualifications: Company specializing in the manufacturing of door frame system with a minimum of 5 years of documented experience on a comparable size project.
- .3 Engineering: Provide the Services of a Professional Engineer, currently registered in the Province of Ontario, to design and certify that the Work of this Section meets or exceeds the performance requirements specified in this section.

1.6 **DELIVERY, STORAGE AND HANDLING**

- .1 Deliver frames and doors in cartons to provide protection during transit and storage at project site.
- .2 Inspect frames and doors upon delivery for damage.
 - .1 Repair minor damage to pre-finished products by means as recommended by the manufacturer.
 - .2 Replace frames that cannot be satisfactorily repaired.
- .3 Store frames at the project site under cover and as near as possible to the final installation location. Do not use covering material that will cause discoloration of aluminum finish.

1.7 **PROJECT/SITE CONDITIONS**

- .1 Field measurements: Verify partition layout by field measurements and indicate measurements on Shop Drawings. Coordinate with construction progress to avoid delaying the Work.
- .2 Coordination of Work: Coordinate layout and installation of partition components with other units of Work, including ceilings, lighting fixtures, HVAC equipment, and fire-suppression systems.

1.8 **WARRANTY**

- .1 Warrant Work against defects in materials and workmanship in accordance with the General Conditions, for a period of two (2) years from date of Substantial Performance and agrees to repair or replace faulty materials or Work which appears during the warranty period, without cost to the Owner. Defects include but not limited to, structural failures including excessive deflection, faulty operation of operators and hardware, deterioration of metals, metal finishes and other frame component materials.

2 Products

2.1 **MATERIALS**

- .1 Aluminum: Controlled alloy billets meeting requirements of ASTM B221, 6063 T5 alloy, to assure compliance with tight dimensional tolerances and maintain colour uniformity.
 - .1 Member wall thickness: Meet specified performance requirements and minimum dimension requirements.
 - .2 Tolerances: Reference to tolerances for wall thickness and other cross-sectional dimensions of storefront members are nominal and in compliances with AA Aluminum Standards and Data.
- .2 Glass: Manufacturer's standard fully tempered clear, low-iron float glass, with protective coating as indicated on Drawings and Finish Schedule.

2.2 **INTERIOR GLASS PARTITIONS**

- .1 Fixed Glass Panel Partitions: Framed glass panel partition with perimeter channel frames, butt-glazed dry joint and framed joints between panels, equipped with swinging doors where indicated. Refer to Drawings and Schedules for material, Finishes, type, size and location.
 - .1 Agardy Glass and Aluminum Inc. (Basis of Design)

- .2 Or accepted equal
- .2 Framing: Aluminum studs and top, bottom, deflection tracks, depth as standard with the manufacturer.
- .3 Trim: Aluminum, continuous, factory-finished, snap-on type; adjustable for variations in floor and ceiling levels as standard with the manufacturer.
 - .1 Trim Profiles: As indicated on Drawings.
 - .2 Cornice Trim: Continuous over tops of partial-height units for maximum stability.
- .4 Swing Doors: Aluminum framed, as indicated on Drawings. Size as indicated on Drawings.
 - .1 Accessibility Standard: Comply with applicable provisions in ADA-ABA Accessibility Guidelines for Buildings and Facilities and ICC A117.1
 - .2 Single Door: Glass panel matching partition panel material and thickness.
- .5 Door Frames: Manufacturer's standard aluminum frames for doors, factory mortised to receive hardware.
- .6 Hardware: As indicated on Drawings and in hardware schedule. For exposed components, match metal and finish of exposed partition fittings unless otherwise noted.
- .7 Glazing Frames: Manufacturer's standard aluminum frames for glazing thickness indicated.
- .8 Seals: Manufacturer's standard.
- .9 Accessories
 - .1 Fasteners: Aluminum, nonmagnetic stainless steel or other non-corrosive metal fasteners compatible with aluminum framing members, trim hardware, anchor, and other components.
 - .2 Anchor, Clips, and accessories: Aluminum, nonmagnetic stainless steel, or zinc coated steel or iron complying with ASTM B633 for severe conditions or other suitable zinc coating; provide sufficient strength to withstand design pressure indicated.
 - .3 Reinforcing Members: Aluminum, nonmagnetic stainless steel, or nickel/chrome plated steel complying with ASTM B456 for severe conditions, or zinc coated steel or iron complying with ASTM B633 for severe conditions or other suitable zinc coating; provide sufficient strength to withstand design pressure indicated.
 - .4 Door silencers (Mutes): Manufacturers standard mohair or vinyl (black, grey or white).
 - .5 Glazing gaskets: Glazing gasket shall comply with ASTM C864 and be extruded of a silicone compatible EPDM rubber that provides for silicon adhesion.

2.3 **FABRICATION**

- .1 General Requirements: Fabricate work to be truly rigid, straight, plumb, level and square. Provide work matching sizes, shapes, and profiles indicated on approved shop drawings.

- .2 Hardware Preparation: Fabricate frames to receive hardware as indicated on approved final hardware schedules. Comply with applicable provisions of ANSI/BHMA A156.115 series specifications for hardware preparation.
- .3 Pre-machine jambs and prepare for hardware, with concealed reinforcement plates, drilled and tapped as required, and fastened within the frame.
- .4 Provide corner reinforcements and alignment clips for precise butt or mitered connections.
- .5 Fabricate frames for glazing with removable stops to allow glazing replacement without dismantling frame. Locate removable stops on the inside of spaces accessed by keyed doors.
- .6 Fabricate all components to allow secure installation without exposed fasteners.
- .7 Manufacturer shall pre-cut and ship all frame materials knock-down.
- .8 Hardware Locations: Locate hardware as indicated on final hardware shop drawings or, if not shown, as indicated in 'Recommended Locations for Builder's Hardware', published by Door and Hardware Institute.

2.4 **FINISHES**

- .1 Finish designations prefixed by AA conform to the system establish by the Aluminum Association for designating aluminum finishes.
- .2 Anodized Finishes:
 - .1 Class I, Clear Anodic Finish: AA-M12C22A41 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm (.7 mils) or thicker complying with AAMA 611.
 - .2 Class I, Color Anodic Finish: AA-M12C22A42/A44 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.
 - .3 Colour: as indicated on Drawings.

3 Execution

3.1 **EXAMINATION**

- .1 Examine substrates to receive the Work and ensure that work of other sections is complete and that there are no conditions which adversely affect the Work.
- .2 Verify that supporting structure, framing, and wall construction are acceptable for partition installation.
- .3 Notify the Construction Manager immediately of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected.
- .4 Commencement of Work implies acceptance of surfaces and conditions.

3.2 **INSTALLATION.**

- .1 Install interior glass partitions in strict accordance with reviewed shop drawings and manufacturer's written instructions.

- .2 Provide appropriate anchorage devices to securely and rigidly fit frames into place, absolutely level, straight, plumb and square. Install frames in proper elevation, plane and location, and in proper alignment other work.
- .3 Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials.

3.3 **DEMONSTRATION.**

- .1 Engage a factory-authorized service representative to demonstrate and train Owner's maintenance personnel.
- .2 Adjust partitions and trim. Replace damaged or malfunctioning components.
- .3 Train Owner's maintenance personnel on procedures for installing, relocating, servicing and refinishing partitions and components.
- .4 Review data in maintenance manuals.

3.4 **ADJUSTING, TOUCH-UP AND REPAIR.**

- .1 After installation of doors and hardware, adjust clearances and operating parts to work easily, smoothly, and correctly. Doors shall not rub frames not bind.
- .2 Touch-up damaged shop coatings and repair minor damage to eliminate all evidence of repair. Remove and replace work which cannot be satisfactory repaired.

3.5 **PROTECTION.**

- .1 Provide protection required to assure that frames will be without damage or deterioration upon substantial completion of the project.

End of Section

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- 1 General
 - 1.1 **SUMMARY**
 - .1 Section Includes
 - .1 Labour, Products, equipment and services necessary to complete the Work of this section.
 - 1.2 **REFERENCES**
 - .1 Conform to the latest edition of the following:
 - .1 CAN/CGSB-12.5-M - Mirrors, Silvered
 - .2 AODA - Accessibility for Ontarians with Disabilities Act
 - .3 TADG - Toronto Accessibility Design Guidelines
 - .4 ETL - Electrical Testing Laboratories
 - 1.3 **SUBMITTALS**
 - .1 Shop Drawings
 - .1 Submit in accordance with Section 01 33 00.
 - .2 Submit Shop Drawings in the form of catalogue cuts and fully illustrating specified materials with description of components, surface finishes, hardware and securement devices.
 - 1.4 **DELIVERY, STORAGE AND HANDLING**
 - .1 Deliver materials in sealed cartons and containers with manufacturer's name and Product description clearly marked thereon.
 - 1.5 **WARRANTY**
 - .1 Warrant the following Work against defects and deficiencies for the period specified from date Work is certified as substantially performed in accordance with the general conditions of the Contract:
 - .1 Deterioration of mirror silvering: Ten years
 - .2 Promptly make good defects and deficiencies which become apparent within the Warranty Period by replacing defective Work satisfactory to the Consultant and at no expense to the Owner.
- 2 Products
 - 2.1 **SOAP DISPENSERS (ACC-02)**
 - .1 Touch free, one piece, cast brass construction above deck, single mount foam soap dispenser with adjustable sensor and vandal resistant below deck box. Refer to Plumbing and Washroom Schedule for manufacturer, product, model and finish.
 - 2.2 **HAND DRYERS (ACC-03)**
 - .1 Nickel finish, Low voltage option, polycarbonate casing with anti-microbial molded additive. Anti-microbially integrated external plastics and seals with anti-tamper M4 exterior pin-hex screws. Water ingress protection to IP24.

- .2 Refer to Plumbing and Washroom Schedule for manufacturer, product, model and finish.
- 2.3 **PAPER TOWEL DISPENSERS AND WASTE RECEPTACLE (ACC-04)**
- .1 Semi-Recessed: Type-304, heavy-gauge stainless steel Exposed surfaces with satin-finish, stainless steel door, Refer to Plumbing and Washroom Schedule for manufacturer, product, model and finish.
- 2.4 **TOILET TISSUE DISPENSERS (ACC-05)**
- .1 Surface mounted: Jumbo roll type, one-piece seamless construction, with hood and chrome plated plastic spindles with internal springs. Refer to Plumbing and Washroom Schedule for manufacturer, product, model and finish.
- 2.5 **CLOTHES HOOK (ACC-06)**
- .1 Wall mounted Stainless steel, with vandal -resistant. Refer to Plumbing and Washroom Schedule for manufacturer, product, model and finish.
- 2.6 **STAINLESS STEEL SHELF (ACC-07)**
- .1 Stainless steel, type-304, 18-gauge (1.2mm) stainless steel with satin finish and all welded corners. Refer to Plumbing and Washroom Schedule for manufacturer, product, and model
- 2.7 **NAPKIN DISPOSAL BINS (ACC-09)**
- .1 Recessed mounted all welded construction, Refer to Plumbing and Washroom Schedule for manufacturer, product, model and finish.
- 2.8 **GRAB BARS**
- .1 L-shaped grab bar (ACC-10): Type 304 stainless steel, 18-gauge stainless steel tubing, 38 diameter, satin finish with peened gripping surface. Complete with standard mounting plates, concealed flanges and accessories. Refer to Plumbing and Washroom Schedule for manufacturer, product, model and finish.
- .2 Straight grab bar type (ACC-11): Stainless steel, 38 mm diameter, 609.6 mm long, Type 304 stainless steel, 18-gauge tubing with satin finish, peened gripping surface, 38 mm maximum clearance from the wall, and complete with standard mounting plates, concealed flanges and accessories. Refer to Plumbing and Washroom Schedule for manufacturer, product, model and finish.
- .3 Folding grab bar: Swing-up (ACC-12) Type 304, 18-gauge 1.2 mm stainless steel tubing with satin finish with peened gripping surface, 32 mm outside diameter. 5 mm thick backplate, satin finish stainless steel with four screw holes for attachment to wall. Refer to Plumbing and Washroom Schedule for manufacturer, product, model and finish.
- .4 Folding grab bar with padded back rest (ACC-13): Type 304, stainless steel, 18-gauge, concealed mounting flange, snap flange cover. Complete with polyurethane integral foam backrest secured to grab bar with stainless steel C-clamps. Refer to Plumbing and Washroom Schedule for manufacturer, product, model and finish.
- 2.9 **UNIT MIRRORS (ACC-14)**
- .1 6 mm float glass, thermosetting infrared cured paint backing with Poly-Glaze protective finish. Frame shall be one-piece, rolled formed stainless steel with bright annealed finish, channel return at rear with snap locking design and 16-gauge galvanized sheet steel backing. All edges protected by shock-absorbing, neoprene tubing.

3 Execution

3.1 **INSTALLATION**

- .1 Install miscellaneous washroom and shower room accessories as per manufacturer's printed installation instructions.
- .2 Install grab bars to withstand minimum 1112 N (250 lb. pound-force) downward pull.
- .3 Install wall reinforcement for miscellaneous fixtures, equipment and accessories. Provide fire retardant treated wood blocking and minimum 18 gauge sheet steel secured to stud to support manufactured components and accessories. Provide wall reinforcement to support future adult change table designed for a minimum load of 1.33 kN. All anchoring devices shall be appropriate for specific wall construction.
- .4 Provide exposed screws of stainless steel or chrome plated steel to match units, with theft proof heads.
- .5 Adjust accessories for proper operation and verify mechanisms function smoothly.
- .6 Coordinate with Consultant and fill units with necessary supplies before final acceptance of building.
- .7 Clean and polish exposed surfaces.

End of Section

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Plumbing & Washroom Schedule

10 28 13.1

Washroom Plumbing & Accessories Schedule

Project Name: Office Modernization for Toronto Water Office

Project Number: 1418121

Date: 2025-02-03






Symbol	Description	Quantity & Location	Image
Plumbing Fixtures			
PLB-01	Item: Wall Hung Toilet Manufacturer: American Standard (Or approved alternative) Product: Afwall - Millennium - Back Spud Elongated Wall-Hung EverClean [®] Bowl Model #: No. 3353101.020 Finish: White Finish	1 - Universal Washroom	
PLB-02	Item: Wall Hung Sink Manufacturer: Kohler (Or approved alternative) Product: Brenham [®] Model #: K-1997-1R-0 Finish: White Finish	1 - Universal Washroom	
PLB-03	Item: Sensor Faucet Manufacturer: Kohler (Or approved alternative) Product: Composed [®] Touchless single-hole lavatory sink faucet with Kinesis [®] sensor technology and temperature mixture, AC powered Model #: K-103C37-SANA-CP Finish: Chrome	1 - Universal Washroom	
ACC-01	Item: Commercial Toilet Seat Manufacturer: American Standard (Or approved alternative) Product: Commercial Heavy Duty Open Front Elongated Toilet Seat with EverClean [®] Surface Model #: 5901110T.020 Finish: White	1 - Universal Washroom	
ACC-02	Item: Soap Dispenser Manufacturer: Kohler (Or approved alternative) Product: Composed [®] Touchless foaming soap dispenser, AC-powered Model #: K-22847-CP Finish: Chrome	1 - Universal Washroom	
ACC-03	Item: Hand Dryer Manufacturer: Dyson (Or approved alternative) Product: Dyson Airblade [®] V Quiet Low Voltage Hand Dryer HU02 Model #: No. 307174-01 Finish: Nickel	1 - Universal Washroom	
ACC-04	Item: Paper Towel Dispenser & Waste Receptacle Manufacturer: Bobrick (Or approved alternative) Product: Semi-Recessed Paper Towel Dispenser/Waste Receptacle Model #: No. B-38032 Finish: Satin-finish stainless steel	1 - Universal Washroom	
ACC-05	Item: Double Toilet Tissue Dispenser Manufacturer: Bradley (Or approved alternative) Product: Surface Mounted Twin Jumbo Roll Toilet Tissue Dispenser. Finish: Satin Finish Stainless Steel.	1 - Universal Washroom	
ACC-06	Item: Wall Mount Coat Hook Manufacturer: Gingers (Or approved alternative) Product #: Kubic - 4610 Finish: Polished Chrome	2 - Universal Washroom	
ACC-07	Item: Stainless Steel Shelf Manufacturer: Bobrick (Or approved alternative) Product #: Gamco Stainless Steel Mirror Shelf No.MS-18 Finish: Stainless Steel	1 - Universal Washroom	

Washroom Plumbing & Accessories Schedule

Project Name: Office Modernization for Toronto Water Office

Project Number: 1418121

Date: 2025-02-03

Symbol	Description	Quantity & Location	Image
ACC-08 RESERVE			
ACC-09	Item: Manufacturer: Model #: Finish:	Recessed Sanitary Napkin Disposal Bobrick (Or approved alternative) B-35303 Stainless Steel	1 - Universal Washroom 
ACC-10	Item: Manufacturer: Product: Model #: Finish:	L-Shaped Grab 38mm. 30"x30" Bobrick (Or approved alternative) 1 1/4" (32mm) DIAMETER STAINLESS STEEL 30" x 30" (762 x 762mm) 90-DEGREE GRAB BAR B-5898 Satin	
ACC-11	Item: Manufacturer: Product #: Finish:	Grab Bar - 30" Bobrick (Or approved alternative) B-5806 Series - Straight Grab Bar No. B-5806 x 30 30" (760mm) Satin	
ACC-12	Item: Manufacturer: Product #: Finish:	Wall-Mounted Swing Up Grab Bar Bobrick (Or approved alternative) B-4998 Satin	
ACC-13	Item: Manufacturer: Product #: Finish:	Back Bar Rest Bobrick (Or approved alternative) Grab Bar Rail with Padded Back Bar B-5892 Stainless Steel	
ACC-14	Item: Manufacturer: Product: Type:	Flat Mirror Wall Mount Glass Supplier Custom Frameless / Tilted Mirror	

- 1 General
- 1.1 **SUMMARY**
 - .1 Section Includes
 - .1 Labour, Products, equipment and services necessary to complete the Work of this section.
 - .2 Solid-surface material countertops and backsplashes
- 1.2 **SUBMITTALS**
 - .1 Samples: Submit samples of countertop materials to the Consultant for acceptance. The materials used in the building shall correspond to the approved samples.
 - .2 Shop Drawings
 - .1 Submit Shop Drawings for the fabrication and installation of Work of this section for review in accordance with Section 01 33 00.
 - .2 Show and describe items, dimensions, finishes, installation details, anchors and fastenings, details of construction and related work and location.
 - .3 Show locations and sizes of furring, blocking, including concealed blocking and reinforcement required.
 - .4 Show locations and sizes of cutouts and holes for plumbing fixtures, faucets, soap dispensers and other items installed in solid surface.
 - .3 Maintenance Data and Material
 - .1 Submit manufacturer's care and maintenance data, including repair and cleaning instructions. Include in project closeout documents.
 - .2 Provide maintenance kit for finishes.
- 1.3 **DELIVERY, HANDLING AND STORAGE**
 - .1 Deliver units to meet installation schedule. Arrange for strategic, off-the-ground, covered storage locations.
 - .2 Surfaces shall be covered with heavy kraft paper, or tops shall be put in cartons for protection during shipment.
 - .3 Provide adequate protection until finally accepted. Protect installed surface with heavy kraft paper secured in position with masking tape.
- 1.4 **PROTECTION**
 - .1 Countertop surfaces shall be covered with heavy kraft paper, or tops shall be put in cartons for protection during shipment.
 - .2 Protect installed countertop with heavy kraft paper secured in position with masking tape. Do not remove until final inspection.
- 1.5 **WARRANTY**
 - .1 Warrant the Work of the section against warpage or manufacturing defects for a period of ten (10) years from the date the Work is certified as substantially performed.

- .2 Promptly make good any defects and deficiencies which become apparent within the Warranty Period by replacing defective Work satisfactory to the Consultant and at no expense to the Owner.
- 2 Products
- 2.1 **COUNTERTOP AND BACKSPLASH**
 - .1 Solid Surface (SS-1):
 - .1 Refer to Section 09 06 00 Product and Finishes Schedule for type, sizes, finish, color and location.
 - .2 Basis of Design: Caesarstone
 - .2 Adhesive: Type recommend by manufacturer for application and conditions of use. Adhesive that will be visible in finished work should be tinted to match surface.
 - .3 Joint Sealant: manufacturer standard mildew-resistant silicone sealant recommended by manufacturer for application and conditions of use.
 - .4 Cleaning Agents: non-abrasive or as recommended by manufacturer.
 - 2.2 **FABRICATION**
 - .1 Obtain and verify dimensions at the building before fabrication of casework takes place, and in ample time to prevent unnecessary delays in the Work.
 - .2 Make work plumb, level and true, in as long lengths as practicable with joints arranged to be as inconspicuous as possible, and with proper provision for shrinkage.
 - .3 Factory-fabricate components to greatest extent practical to sizes and shapes indicated, in accordance with reviewed Shop Drawings and manufacturer's printed instructions and technical bulletins.
 - .4 Form joints between components using manufacturer's standard joint adhesive without conspicuous joints.
 - .5 Provide factory cutouts for plumbing fittings and accessories as indicated on the Drawings.
 - .6 Rout and finish component edges with clean, sharp returns. Rout cutouts, radii and contours to template. Smooth edges. Repair or reject defective and inaccurate Work.
 - .7 Fabricate tops in one piece, unless otherwise indicated. Comply with surfacing-material manufacturer's written recommendations for adhesives, sealers, fabrication, and finishing.
 - .8 Countertop Framing:
 - .1 Fabricate countertop framing, using steel shapes and plates, and cold finished mild steel bars at exposed conditions, for support framing and plywood, to thicknesses, sizes and shapes shown, and as required to produce work of adequate strength and durability.
 - .2 Slabs for horizontal surfaces, such as countertops to be supported not less than every 457 mm (18").
- 3 Execution
- 3.1 **EXAMINATION**

- .1 Inspect existing conditions upon which Work of this section is dependent. Report to the Consultant in writing any defects or discrepancies. Commencement of Work implies acceptance of existing conditions.
- .2 Substates must be sound, flat, smooth and free from dust or other surface contaminants.
- .3 Site verify by field measurements prior to fabrication.

3.2 **INSTALLATION**

- .1 Install surfacing components plumb, level and true and in accordance to approved shop drawings and manufacture's instruction.
- .2 Fasten surfacing components to base cabinets or other supporting substrates with suitable adhesives acceptable to manufacturer.
- .3 Form joint seams with seam adhesive. Seams to be inconspicuous in completed work. Seams in location shown on approved shop drawings and acceptable to Consultant.
- .4 Install backsplashes and end splashes where indicated on Drawings. Caulk space between backsplash and wall with silicone sanitary sealant.
- .5 If cutting, grinding, or polishing is required at the jobsite, use water-cooled tools.
- .6 Remove and replace surfacing components that are damaged and cannot be satisfactorily repaired at no cost to the owner.

3.3 **CLEANING**

- .1 Promptly as Work proceeds and upon completion, clean up and remove from the site all rubbish and surplus materials resulting from Work under this section.
- .2 Clean surfacing components according to manufacturer's recommendations. Completely remove excess adhesives and sealants from finished surfaces.
- .3 Protect completed work from damage during construction period.

End of Section

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- 1 General
 - 1.1 **SUMMARY**
 - .1 Section Includes
 - .1 Labour, Products, equipment and services necessary to complete the Work of this section.
 - 1.2 **CODES, REGULATIONS AND STANDARDS**
 - .1 Comply with municipal and provincial codes, rules and regulations and/or authorities having jurisdiction.
 - .2 Comply with the National Building Code in areas where municipal or provincial regulations and/or codes are not mandatory.
 - .3 Revisions issue: Latest version as amended to date.
 - 1.3 **REFERENCES**
 - .1 Comply with applicable requirements of the latest issue of the following Standards:
 - .1 OFC - Ontario Fire Code
 - .2 NFPA 10 - Portable Fire Extinguishers
 - .3 SMACNA - Seismic Restraint Manual Guidelines for Mechanical Systems
 - .4 NFPA - 13 Installation of Sprinkler Systems
 - .5 ASHRAE - HVAC Applications, Seismic and Wind Restraint Design
 - .6 CAN/ULC-S508 - Rating and Fire Testing of Fire Extinguishers
 - .7 NFPA - All relevant sections
 - 1.4 **WORKING DRAWINGS AND DOCUMENTS**
 - .1 Design Drawing Intent
 - .1 The design drawings are schematic in arrangement and describe the general design intent but do not show the exact details for the installation. They are not fabrication or installation drawings.
 - .2 The Work is suitably outlined on the drawings with regard to sizes, locations, general arrangements and installation details, and has been generally coordinated for routing of services. The routing of ductwork, piping and equipment arrangement are shown more or less in diagram except where in certain cases the Drawings may include details giving the exact locations and arrangements required.
 - .3 The location of equipment, and the associated arrangement of piping, ductwork, and other material describes the general requirements of the Work. Final location is dependant on the actual equipment supplied. The Consultant reserves the right to make reasonable adjustment of up to 1 m to the location of equipment, floor drains, routing of major piping and ductwork, at no cost to the Owner.
 - .4 In order to provide clarity to the arrangement of the Work, not all details including valves, thermometers, pressure gauges, etc. are shown on the Plan Drawings.

Refer to Schematic Drawings, standard details, and the Specification for these requirements.

- .5 Where specific installation dimensions for location of equipment and access space requirements are indicated on the drawings, install to these requirements.
- .6 Where standard details are provided, these show the general installation requirements, and are applicable to each occurrence in the Work, unless otherwise specified or shown.

.2 Contractor Coordination Responsibilities

- .1 Provide the services of a mechanical/electrical coordination supervisor, to coordinate this division of the Work, as well as providing coordination with other divisions and/or contracts. This supervisor may be full time or part time on site, as appropriate to the work stage and complexity of the Work, at the discretion of the Owner.
- .2 Where multiple trades are required, the mechanical coordinating supervisor shall be the lead coordinator.
- .3 The Owner reserves the right to require the coordinating supervisor to increase their attendance at site, at no cost to the Owner, if in the Owner's opinion the current level of coordination is not sufficient for the progress of the Work.
- .4 Make changes and modifications as necessary to ensure coordination and to avoid interference and conflicts with other trades.
- .5 Prepare construction/installation/fabrication drawings, coordinated with other trades and contracts, as required.
 - .1 Provide sufficient detail to disclose critical interferences of major equipment and services to ensure adequate accessibility.
 - .2 Specific dimensions for equipment location or access which are shown on the Consultants Drawings.
 - .3 Indicate sleeves, openings, and stress points (such as anchors, guides and inserts).
 - .4 Indicate deviation in sizes and weights and also in water, drainage, electric power or other service requirements for all equipment proposed which is different from those shown on the design drawings.
 - .5 Provide these drawings to other trades for coordination with their work.
 - .6 Update these drawings as part of the As-Built Drawings, showing actual locations of major equipment, services, access doors, shut-off valves, etc.
- .6 The Design Drawings show the major requirements for the installation of equipment based on one manufacturer's requirements but may not show all installation requirements. The Contractor will include as part of the Work the specific manufacturer's installation requirements for the equipment actually provided by the Contractor.
- .7 The construction/installation/fabrication drawings are not to be submitted as Shop Drawings. Make them available for viewing at site when requested by the Consultant.

- .3 Review Before Proceeding (HOLD)
 - .1 Where the word "HOLD" appears on drawings and other Contract Documents, the Work is included in the Contract.
 - .2 Execute such Work only after verification of dimensions, verification of materials and obtaining Consultant's written permission to proceed.
- 1.5 **COORDINATION AND EXAMINATION**
 - .1 Reference
 - .1 To Section 01 10 00.
 - .2 Examination
 - .1 Carefully examine Work and Drawings of all related trades and thoroughly plan the Work so as to avoid interferences.
 - .2 Report defects which would adversely affect the Work. Do not commence installation until such defects have been corrected.
 - .3 Coordination
 - .1 Coordinate Work of Division 21, 22, 23 and 25 such that items will properly interface with work of other divisions. Prepare Installation Drawings of critical locations and submit to Consultant for review.
 - .2 Architectural Drawings, or in their absence, Mechanical Drawings govern all locations.
- 1.6 **EXISTING SERVICE**
 - .1 Tie-in to Existing Services
 - .1 Do not shut down or make tie-in connections to any existing service without written permission of the Owner and/or Consultant.
 - .2 Arrange Work to minimize interruption to physical access to the building.
 - .3 Include for all costs associated with making connections to existing services, including but not limited to, cutting and patching of existing floors, partitions, ceilings and finishes.
 - .2 Work in Existing Buildings
 - .1 Route pipes, conduits, and other services to avoid interference with existing installation.
 - .2 Relocate existing services and equipment to suit installation of new work.
 - .3 Cut back and cap existing services not being used, so that finished Work presents a neat and clean appearance.
 - .4 Unless noted to be reused, fixtures and materials being removed become the property of the Contractor and are to be removed from site, unless otherwise noted.
 - .3 Continuity of Services

- .1 Be responsible for any damage to existing systems, including insulation and coverings, when making connections.
- .2 Keep existing buildings in operation with minimum length of shut-down periods.
- .3 Include overtime work to tie-in piping or wiring at night or on weekends.

1.7 **PROVISION FOR FUTURE**

.1 Future Equipment

- .1 Where indicated as reserved for future equipment or services, leave identified space clear and install services and equipment so that connections can be made in the future.

1.8 **SUBMITTALS**

.1 Shop Drawings

- .1 Conform to Section 01 33 00 and the following.
- .2 Shop Drawings showing more than one size or model will not be considered unless properly marked up.
- .3 For electrically driven, and fuel fired appliances, provide the following information:
 - .1 Electrical characteristics including voltage, phase, frequency and power rating.
 - .2 For motors, NEMA, class and efficiency ratings.
 - .3 Fuel input ratings including flow rates and pressures.
 - .4 Equipment performance ratings, including flow rates, pressures, efficiencies, part load values and/or efficiencies (IPLV's), plotted flow characteristics (pump and fan curves) with operating points clearly plotted.
- .4 For other equipment include the following information:
 - .1 Equipment performance ratings, including flow rates, pressures drops.
 - .2 Electrical control power requirements.
- .5 For all equipment, include the following:
 - .1 Equipment dimensions and weights.
 - .2 Itemized product description with optional items clearly marked as being included.
- .6 Provide wiring Shop Drawings:
 - .1 Wiring diagrams and schematics for all equipment which has electrical controls or devices furnished with the equipment.
 - .2 Wiring diagrams alone are not sufficient; schematic and interconnecting drawings and sequence of operation of equipment are required for review.

- .3 Clearly indicate the materials and/or equipment being supplied.
 - .1 Details of construction, finish, accurate dimensions, capacities, and performance.
 - .2 Certify drawings correct for construction by the manufacturer before submission.
 - .3 Identify equipment Shop Drawings with designations as shown on the drawings or in the Specifications.
 - .4 If not complied with, Shop Drawings will not be reviewed and will be returned to the Contractor.
- .4 Coordinate equipment which attaches to and/or where external wiring provided connects to other equipment.
 - .1 Do such coordination whether such equipment is supplied under this or other contracts or subcontracts, for which relevant information will be provided by Owner/Consultant.
- .7 Shop Drawings shall conform to the requirements of NFPA 13, NFPA 14, NFPA 20, and other relevant sections as necessary.

1.9 **"AS-BUILT" RECORD DRAWINGS**

- .1 Reference
 - .1 Conform to Section 01 33 00.
 - .2 Maintain an accurate dimensional record of all underground piping and all deviations and changes in aboveground piping and equipment.

1.10 **INSTALLATION AND START-UP INSTRUCTIONS**

- .1 Reference
 - .1 Conform to Section 01 33 00.
 - .2 Submit copies of installation instructions and copies of start-up instructions for any item of equipment when requested by the Consultant.

1.11 **OPERATING AND MAINTENANCE INSTRUCTION MANUALS**

- .1 Reference
 - .1 Conform to Section 01 33 00.
 - .2 In addition, include the following in the manuals:
 - .1 Non-dimensional layout showing location of all electrical devices on mechanical equipment.
 - .2 Operating instructions, including start-up and shut-down procedure.
 - .3 Lubricating instructions and recommended cycle of lubrication for each item of equipment, including various types of lubricants.
 - .4 List of spare parts.

- .3 All the above applies to component parts of equipment whether they are manufactured by the Supplier of the equipment or are supplied as a component part of an item of equipment.

1.12 **CLEANING, TESTING AND APPROVAL RECORDS**

- .1 Records
 - .1 Maintain records of all pressure tests and flushing and sterilization tests, glycol/water concentrations, inspections, and approvals by the plumbing inspector.
 - .2 Forward these tests to the Owner on completion of the Work in accordance with Section 01 33 00.
 - .3 Forward to Consultant, copy of records on site on completion of each test, cleaning operation, etc.

1.13 **DIMENSIONS AND QUANTITIES**

- .1 Dimensions
 - .1 Dimensions shown on drawings are approximate.
 - .2 Verify dimensions by reference to Shop Drawings and field measurement.
- .2 Quantities
 - .1 Quantities or lengths indicated in any of the Contract Documents are approximate only and shall not be held to gauge or limit the Work.

1.14 **TRADE QUALIFICATIONS**

- .1 Applicable to the following trades
 - .1 Sprinkler/Fire Protection
- .2 Requirements
 - .1 Trade workers to have a certificate of qualification as journeyman or apprentice registration for the province where the work is performed or an interprovincial certificate.
 - .2 Ratio of journeyman to apprentice not to exceed the defined ratio in the Apprenticeship Act of Ontario.
 - .3 On award of Contract, submit a list of trade journeyman and apprentices, together with their certificate and registration numbers.
 - .4 Certificates and registration must be provided to the Consultant on request.
 - .5 Maintain on-site an up-to-date record listing journeyman and apprentices working on site.

2 Products

2.1 **MATERIALS**

- .1 Use new materials and equipment, free from defects impairing strength and durability, as specified or specified equivalent.
- .2 Of Canadian manufacture wherever possible.

- .3 Labelled or listed as required code and/or inspection authorities.
- .4 Design of mechanical systems has been based on the first listed Supplier and model number/size stated on the equipment schedules on the drawings. Bear all costs due to physical or performance differences between stated equipment and proposed equipment. These differences include but are not limited to size, layout, arrangement, connection size, location and/or quantity of connections, or performance differences such as noise, power requirements, flow, throw, etc.

2.2 **EQUIPMENT/STRUCTURE COORDINATION**

- .1 Locations and dimensions of curbs and roof and floor opening framing, where indicated on the drawings, are based on an arrangement to suit the above-named Supplier.
- .2 Be responsible to verify the actual size requirements of the openings and notify the Consultant immediately in case the dimension of the unit supplied and the connecting ductwork/piping, etc. are at variance with the dimensions given on the Drawings.
- .3 Bear all costs for modification of curbs and floor/roof openings resulting from failure to notify the Consultant prior to the fabrication or construction of opening framing and curb.

2.3 **STANDARD SPECIFICATIONS**

- .1 Product Quality
 - .1 Ensure that the chemical and physical properties, design, performance characteristics and methods of construction of all Products provided comply with the latest issue of applicable standard Specifications issued by authorities having jurisdiction.
 - .2 Do not apply such standard Specifications to decrease the quality of workmanship, Products and services required by the Contract Documents.

2.4 **MANUFACTURER'S NAMEPLATES**

- .1 Metal Nameplates
 - .1 Provided with raised or recessed lettering, on each piece of equipment.
 - .2 Mechanically fasten nameplate on a metal stand-off bracket arranged to clear insulation.
 - .3 Mount, on same stand-off, Underwriters Laboratories and/or CSA registration plates.
- .2 Nameplate Data
 - .1 Indicate:
 - .1 Size
 - .2 Capacity
 - .3 Equipment model
 - .4 Manufacturer's name
 - .5 Serial number

- .6 Voltage
- .7 Cycle
- .8 Phase and power of motors

2.5 **MOTORS AND WIRING**

- .1 In accordance with Section 23 05 13 Motors and Wiring for Mechanical.

2.6 **PIPES, FITTINGS AND VALVES**

- .1 In accordance with Section 23 05 23 Pipes, Fittings and Valves.

2.7 **HANGERS AND SUPPORTS**

- .1 In accordance with Section 23 05 29 Pipe Hangers and Supports.

2.8 **VIBRATION AND SEISMIC RESTRAINT**

- .1 In accordance with Section 23 05 48 Noise and Vibration Control, and Section 23 05 49 Seismic Control.

2.9 **IDENTIFICATION FOR EQUIPMENT AND PIPING**

- .1 In accordance with Section 23 05 53 Mechanical Identification.

2.10 **GAUGES**

- .1 Pressure Gauge
 - .1 90 mm dial and overload stops and dial range approximately double the operating pressure, with 1% accuracy.
 - .2 Polished brass case, phosphor bronze bushed rotary movement, bronze bourdon tube.
 - .3 Needle valve: Round handle, with NPS ¼ connecting piping or tubing with each gauge. Each gauge shall be provided with a snubber.
 - .4 Acceptable Manufacturers:
 - .1 Tetric
 - .2 Ashcroft
 - .3 Winters
 - .4 Weksler
- .2 Thermometers
 - .1 225 mm scale, straight adjustable angle tubular glass type with red appearing mercury in lens front tube.
 - .2 Cast aluminum case, and brass stem complete with separable socket, and combination Celsius/Fahrenheit scale.
 - .3 Scale range to be approximately double the operating temperature range of the particular system in which thermometers are to be installed.

- .4 Stems to be of sufficient length to provide for proper insertion in piping or equipment in which they are installed to ensure correct temperature readings.
 - .5 Acceptable Manufacturers
 - .1 Terice
 - .2 Ashcroft
 - .3 Weksler
 - .4 Winters
 - .3 Level Gauges
 - .1 150 mm diameter dial, with graduated scale with minor markings, and numbers at major depth levels.
 - .2 Scale range to be a minimum of 110% higher than overflow level of tank.
 - .3 Black finished cast aluminum case, adjustable micrometer type pointer, stainless steel bourdon tube and stainless-steel rotary type movement. Dial range to be 0 to 18 m.
 - .4 Acceptable Manufacturers
 - .1 Ashcroft
 - .2 Terice
 - .3 Winters
 - .4 Weksler
- 2.11 **SUPERVISORY SWITCHES**
- .1 Tamper Switches
 - .1 120 volt, N.O. switches on riser valves and other isolating valves. Listing: ULC, FM approved.
 - .2 Acceptable Manufacturers
 - .1 Potter Electric
 - .2 System Sensor
 - .3 Viking
 - .2 Flow Switches
 - .1 120 volt, N.O. switches in risers in locations indicated on Drawings. Listing: ULC, FM approved.
 - .2 Acceptable Manufacturers
 - .1 Potter Electric
 - .2 System Sensor
 - .3 Viking

2.12 **FIRE DEPARTMENT PUMPER (INLET) CONNECTIONS**

- .1 Wall Siamese Fittings - Flush Type
 - .1 Cast brass body, brass plate, brass swivel adapters and brass plugs with polished finish. ULC listed and FM approved.
 - .2 64 mm "Ontario" standard hose threads with caps and chains
 - .3 Double inlet clappers
 - .4 Imprinted escutcheon plate, embossed "SPRINKLER SYSTEM CONNECTION", "STANDPIPE" or "AUTOSPKR AND STANDPIPE" as required.
 - .5 Ball drip on yard side of Siamese check valve.
 - .6 Acceptable Manufacturers
 - .1 National Fire Equipment Ltd.
 - .2 Wilson and Cousins
 - .3 Croker
- .2 Sidewalk Siamese Fitting - Standpipe Mounted
 - .1 Free-standing double inlet with 500 gpm capacity, ULC listed, and FM approved.
 - .2 Cast brass construction.
 - .3 64 mm "Ontario" standard hose thread with caps and chains
 - .4 Double inlet clappers
 - .5 Imprinted escutcheon plate embossed "SPRINKLER SYSTEM CONNECTION", "STANDPIPE" or "AUTO SPKR AND STANDPIPE" as required.
 - .6 Acceptable Manufacturers
 - .1 National Fire Equipment
 - .2 Wilson and Cousins
 - .3 Croker

2.13 **PORTABLE FIRE EXTINGUISHING EQUIPMENT**

- .1 Portable Fire Extinguishers
 - .1 Extinguishers to be complete with full operating charge and wall mounting bracket, and of the following class:
 - .1 Dry Chemical Class ABC 2.3 kg
 - .2 Acceptable Manufacturers
 - .1 Levitt (Ansul)/Tyco
 - .2 National Fire Equipment
 - .3 Flag Fire Equipment

- .2 Fire Extinguisher Cabinets
 - .1 1.6 mm (16 gauge) steel tub
 - .2 2.8 mm (12 gauge) hollow channel door and rebated frame
 - .3 Where flush mounted, return edges by 13 mm or bevel on outer edge of door trim
 - .4 Semi-concealed piano hinges
 - .5 Door latch and 5 mm plate glass in door
 - .6 Cabinet finish: Grey primer to door, trim and full cabinet
 - .7 Door finish: Polished chrome plated.
 - .8 Acceptable Manufacturers
 - .1 National Fire Equipment
 - .2 Herbert Williams
 - .3 Wilson and Cousins

2.14 **SIGNS**

- .1 Enamelled steel with fire department red enamel background, white letters; inscription in accordance with (NFPA) (FM) Standards.
- .2 150 mm x 150 mm for automatic control valves and alarm valves.
- .3 50 mm x 150 mm for other valves.
- .4 Fitted on control valves, shut-off valves, drain valves and test valves.

3 Execution

3.1 **GENERAL**

- .1 Execute Work in accordance with requirements specified in the various sections of Division 22.
- .2 Lay out Work of each trade so that it does not interfere with work under other divisions of Specifications.
- .3 Make good any damage to Owner's property or other trade's work caused by improperly locating or carrying out of Work.
- .4 Supply anchor bolts and templates for installation by other divisions.
- .5 Location of pipes, ductwork, raceways and equipment may be altered without extra cost provided alteration is made before installation.

3.2 **EQUIPMENT INSTALLATION**

- .1 Set equipment in place, align, connect, and place in operation with:
 - .1 Controls set for efficient, stable operation.
 - .2 Initial lubrication and oil sumps filled.
 - .3 Connections and required safety devices installed.

- .2 Protect equipment from damage during and after installation, and on completion of Work ensure that equipment is free from cracks, scratches, discoloration, tool marks, and other defects.
- .3 Thoroughly clean finished surfaces before acceptance of Work.
- .4 Install heater vents complete with necessary supports, hangers, braces, roof flashing, storm collar, and round top.

3.3 **PROTECTION**

- .1 Protect Work and materials before, during and after erection, from weather and other hazards and keep in a clean and orderly manner.
- .2 Protect pipe ends, valves and parts of equipment left unconnected to prevent damage or intrusion of foreign matter. Provide pipe caps for threaded male connections and plugs for threaded female connections.
- .3 Protect plumbing fixtures or mechanical equipment having a baked enamel finish by covering with polyethylene sheet securely held in place.
- .4 Protect finished floor slabs from scuffing, cracking, chipping, staining, cutting and other damage resulting from Work of this Contract.
 - .1 Place a 19 mm thick plywood underlaid with 25 mm thick polystyrene insulation board adhered to same, over floor areas when working from, or over, such surfaces.
 - .2 Provide such protection below hoist rigs, ladders, pallets of material, and in other circumstances where the flooring is exposed to potential damage.
 - .3 Work damaged due to failure in providing such protection is to be removed and replaced, or repaired, as directed by the Owner, at no increase in Contract Price.

3.4 **MAINTENANCE OF BEARINGS**

- .1 During Construction
 - .1 Turn-over rotating equipment at least once a month after delivery.
 - .1 Run-in sleeve type bearings in accordance with manufacturer's recommendations.
 - .2 Drain, flush out and refill with new charge of oil or grease.
 - .3 Protect bearings, shafts and sheaves against damage, corrosion, and dust accumulation.
 - .4 Provide extended grease nipples for bearing lubrication.

3.5 **FIRE EXTINGUISHERS**

- .1 Provide fire extinguishers as follows:
 - .1 In each fire hose cabinet

- .2 One extinguisher for each 300 m² of floor area in an electrical or mechanical service room.
- .3 In each extinguisher cabinet and at intervals to comply with the local fire code.
- .4 At each fire hose reel, rack or tray, mounted to wall construction with substantial wall brackets provided with extinguishers.
- .5 Type: Class ABC unless shown otherwise.
- .6 As shown on drawings.

End of Section

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- 1 General
- 1.1 **SUMMARY**
 - .1 Section Includes
 - .1 Labor, Products, equipment, and services necessary to complete the Work of this section.
 - .2 Section includes, but is not necessarily limited to, the following:
 - .1 Design of automatic sprinkler systems
 - .2 Preparation of Working Drawings
 - .3 Incorporation of facilities and equipment in an overall fire protection system
 - .4 Connection to buried fire mains 1.5 m outside building wall and buried leads into building and to above floor line including thrust blocks at buried elbows.
 - .5 Exterior pumper connections
 - .6 Wet pipe sprinkler system(s)
 - .7 Dry pipe sprinkler system(s)
 - .8 Excavating, bedding, and backfilling of pipe trenches for buried piping installed under this section.
 - .9 Supervisory switches on riser valves and other isolating valves, waterflow switches and pressure switches on alarm valves and risers
 - .10 Electrical wiring as noted and/or as shown on Drawings.
- 1.2 **REFERENCE STANDARDS**
 - .1 Comply with the latest edition of the following:
 - .1 National Fire Protection Association
 - .1 NFPA 13 Standard for the Installation of Sprinkler Systems
 - .2 NFPA 72 National Fire Alarm and Signaling Code
- 1.3 **DESIGN CRITERIA**
 - .1 Design Submissions
 - .1 Prepare complete drawings of fire protection system to include:
 - .1 Drawings and calculations bearing stamp of a Professional Engineer employed by the fire protection company and who is registered as a member of the Association of Professional Engineers of the Province of Ontario.
 - .2 Submit six copies of plans, hydraulic design calculation sheets, Shop Drawings, and equipment submittals through Owner's fire insurance broker for approval by designated organization. Shop Drawings shall conform to NFPA 13 requirements.

- .3 Submit all copies of drawings, etc., duly approved by Owner's insurance underwriter to Consultant for final review prior to commencement or work.
 - .4 Submit reviewed Shop Drawings to local municipal authority.
 - .5 Provide systems in accordance with approved drawings, subject to inspection and testing requirements of Owner's Insurance Underwriter and Consultant.
- .2 Underwriters/Owners Approval
- .1 Fire protection work requires approval of Owner's fire insurance underwriter and Consultant.
 - .2 Reviewing organization:
 - .1 Insurers Advisory Organization
 - .2 Canadian Industrial Risks Insurers
 - .3 FM Global
 - .4 Factory Insurance Association
- 1.4 **SUBMITTALS**
- .1 Shop Drawings
 - .1 Submit Shop Drawings in accordance with Section 01 33 00.
 - .2 Sprinklers shall be referred to on drawings and Product submittals and be specifically identified by the manufacturer's listed model or series designation. Trade names and other abbreviated listings are not allowed.
 - .2 Samples
 - .1 Submit samples for the following:
 - .1 Each type of sprinkler.
 - .2 Signs.
 - .3 Operation and Maintenance Data
 - .1 Submit printed operating instructions and maintenance data in accordance with Section 01 33 00.
 - .4 Maintenance Materials
 - .1 Provide the following materials at Project handover:
 - .1 Storage cabinet.
 - .2 Sprinkler wrench.
 - .3 Spare stock of sprinklers. Include at least one head of each type and temperature rating installed in system.
- 1.5 **QUALITY ASSURANCE**
- .1 Qualifications

- .1 An accredited member in good standing of the Canadian Automatic Sprinkler Association.

1.6 **CODES AND REGULATIONS, PERMITS, COSTS AND FEES**

- .1 Comply with municipal and provincial codes, rules and regulations and/or authorities having jurisdiction.
- .2 Apply for and obtain permits required for this Work and pay costs levied for permits, inspections, and fees.
- .3 Comply with the National Building Code in areas where municipal or provincial regulations and/or codes are not mandatory.

- .1 Revisions issue: Latest version as amended to date.

2 Products

2.1 **LINE MATERIALS**

- .1 General
 - .1 Unless otherwise noted, equipment and apparatus to be ULC listed and labelled, and FM approved.
 - .2 All grooved couplings and fittings, valves and specialties shall be the Products of a single manufacturer. Grooving tools shall be of the same manufacture as the grooved components.
 - .1 All castings used for coupling housings, fittings, valve bodies, etc., shall be date stamped for quality assurance and traceability.

2.2 **SPRINKLER HEADS**

- .1 Ratings
 - .1 ULC and FM listed for fire service.
 - .2 Sprinkler body shall be die-cast, with a hex-shaped wrench boss integrally cast into the sprinkler body to reduce the risk of damage during installation. Wrenches shall be provided by the sprinkler manufacturer that directly engage the wrench boss.
 - .3 Standard orifice size: 12 mm diameter orifice or 13 mm diameter orifice.
 - .4 Standard temperature rating: 57°C to 74°C (135°F to 165°F).
 - .5 Intermediate and high temperature rating heads to suit local conditions.
- .2 Type
 - .1 Indicated by type in accordance with the following:
 - .2 No ceilings
 - .1 "U-1": Upright, bronze body, glass-bulb or link and lever type
 - .3 Suspended or drop ceilings.
 - .1 "P-1": Pendent, chrome plated body and escutcheon plate, link and lever type.

- .2 "P-2": Pendent, chrome plated body and escutcheon plate, glass bulb type.
- .3 "P-3": Recessed, chrome plated body ring and cup, glass bulb type.
- .4 "P-4": Flush, concealed with adjustable, diffusable (chrome) (white) (factory painted, color to be selected) cover plate.
- .4 Side wall
 - .1 "S-1": Side wall, bronze body and chrome escutcheon plate, glass bulb or fusible solder type.
 - .2 "S-2": Side wall, chrome plated body and escutcheon plate, glass bulb or fusible solder type.
- .5 Deluge systems.
 - .1 Open type heads, of style to suit location.
- .6 Spare heads and cabinet
 - .1 Each sprinkler system: ULC approved metal cabinet containing required number of spare sprinkler heads of each type and temperature rating.
 - .2 Wrench for removal and replacement of sprinkler heads.
- .7 Acceptable Manufacturers
 - .1 Victaulic Company
 - .2 Viking Sprinkler Company
 - .3 Reliable Automatic Sprinkler Company
 - .4 Tyco
 - .5 Or accepted equal.
- .3 In lieu of rigid pipe offsets or return bends for sprinkler drops, the Victaulic VicFlex™ Multiple-Use Flexible Stainless-Steel Sprinkler Drop System may be used to locate sprinklers as required by final finished ceiling tiles and walls.
 - .1 The drop system shall consist of a braided type 304 stainless steel flexible tube, zinc plated steel 1" NPT male threaded nipple for connection to branch-line piping, and a zinc-plated steel reducer with a 1/2" or 3/4" NPT female thread for connection to the sprinkler head.
 - .2 Include a ULC/UL approved Series AH2 braided hose with bend radius to 50 mm to allow for proper installation in confined spaces.
 - .1 The hose shall be listed for (four bends at 787.5 mm length) (five bends at 915 mm length) (six bends at 1220 mm length) (six bends at 1524 mm length) (seven bends at 1830 mm length). Union joints shall be provided for ease of installation.
 - .3 The flexible drop shall attach to the ceiling grid using a one-piece open gate Series AB1 bracket.
 - .1 The bracket shall allow installation before the ceiling tile is in place.

- .4 The braided drop system is ULC/UL listed and FM approved for sprinkler services to 1206 kPa (175 psi).

2.3 **ALARM CHECK VALVES**

.1 General

- .1 ULC and FM listed for fire service.
- .2 Of same manufacture as specified for sprinkler heads.
- .3 Valve internal components shall be replaceable without removing the valve from the installed position.

.2 Wet Sprinkler Systems

.1 Construction

- .1 Resiliently seated wet alarm check valve
- .2 Fitted with OS & Y gate valves or supervised butterfly valves.
- .3 Flow and pressure switches.
- .4 Alarm piping connection to water motor gong.
- .5 Upstream and downstream pressure gauges
- .6 Test connection.
- .7 Main drain valve

.3 Dry Sprinkler Systems

.1 Construction

- .1 Resiliently seated dry alarm check valve with accelerator
- .2 Required air pressure shall be 90 kPa (13 psig)
- .3 Valve shall be externally resettable.
- .4 Fitted with OS & Y gate valves or supervised butterfly valves.
- .5 Flow and pressure switches.
- .6 Alarm piping connection to water motor gong.
- .7 Upstream and downstream pressure gauges
- .8 Test connection.
- .9 Main drain valve

.2 Air compressor

- .1 Electric motor drive air compressor.
- .2 Complete with piping and controls for automatic operation of compressor to maintain air pressure on downstream side of each dry pipe valve.

- .3 Normally Open pressure switches with snubbers on downstream side of each dry pipe valve.

2.4 **ANCILLARY EQUIPMENT**

.1 Water Gong

- .1 Water operated outside alarm bell; weather protected.

.2 Excess Pressure Pump

.1 Construction

- .1 Close coupled bronze pump with stainless steel shaft.
- .2 Motor size, pump size, and head capacity as shown.
- .3 Pressure switch with pressure differential of 100 kPa (5 psi) to operate excess pressure pump.
- .4 Shut-off valve and strainer on pump inlet.
- .5 Relief valve, check valve and shut-off valve on pump discharge connection.

.2 Acceptable Manufacturers

- .1 Albany
- .2 Price Pump Company

.3 Double Check Valves and Backflow Preventers

.1 Construction

- .1 ULC and FM listed for fire service.
- .2 Double check valve assemblies to be in accordance with CSA Standard B64.5, latest edition.
- .3 Backflow preventer assemblies to be in accordance with CSA Standard B64.4, latest edition.

.2 Acceptable Manufacturers

- .1 Zurn
- .2 Watts
- .3 Victaulic
- .4 Conbraco
- .5 Or accepted equal.

3 Execution

3.1 **GENERAL**

.1 Apportionment of the Work

- .1 Classify and apportion all materials and the performance of all labour to trades involved in accordance with all local customs, rules, regulations, jurisdictional awards, decisions, etc., insofar as they may apply and as required to efficiently execute the work involved in this Contract.
- .2 Measurements and Deviations
 - .1 Where any parts of the Work are specifically located by dimensions on the Drawings, check and verify these dimensions on the Site prior to installation.
 - .2 Examine work of other trades or Contractors prior to commencement of fire protection installations. Immediately report in writing to Consultant any discrepancies on the part of any other Contractor which will affect fire protection installations. Failure to report discrepancies shall be considered acceptance of conditions.
 - .3 Where Site conditions require minor deviations from indicated arrangements or locations, make changes on approval of Consultant without additional cost to Owner.
 - .4 Should discrepancies occur during installation of fire protection work which will necessitate major revisions, immediately notify Consultant and secure his authorization in writing before proceeding with the Work.

3.2 **INSTALLATION**

.1 Sprinkler Head Selection

- .1 Select heads for general areas in accordance with the following:

Exposed - no ceilings	U-1
Suspended or drop ceilings - unless otherwise shown on Drawings	(P-1) (P-2) (P-3) (P-4)
Side wall	(S-1) (S-2)
Installation in column webs	S-1

- .2 In T-bar ceilings, locate heads in centre of ceiling tile to present an orderly appearance.
- .3 For deluge systems, use open type heads, of style to suit location.
- .2 Do not install any sprinklers that have been dropped, damaged, or show a visible loss of fluid. Never install any sprinkler with a cracked bulb.
 - .1 Sprinkler bulb protector shall be removed by hand. Do not use any tools or devices that could damage the bulb.
- .3 Test Connections and Drains
 - .1 Locate inspector's test connections, complete with valve, sight glass, and drain piping either at high points of sprinkler system or at the end of the longest run of sprinkler piping in accordance with NFPA 13.
- .4 Flushing of Piping
 - .1 Flush sprinkler system piping in accordance with NFPA requirements.

- .2 Flush underground piping and lead-in connections before connection is made to sprinkler system risers.

3.3 **TESTING**

.1 Requirements

- .1 Execute fire protection systems and equipment tests in accordance with NFPA requirements.
- .2 Minimum hydrostatic test of not less than 1380 kPa (200 psig) pressure for two hours, or at 345 kPa (50 psi) in excess of maximum static pressure developed in system, if maximum static pressure is in excess of 1034 kPa (150 psig).
- .3 Execute tests in presence of Consultant and Owner's authorized representative.
- .4 Promptly repair defects which develop during tests, and then re-test system to complete satisfaction of authorized inspectors.
- .5 Submit a certificate covering materials and tests to Underwriter's Inspection Authority, together with a request for inspection and approval of complete fire protection system. On receipt of approval, forward certificate to Owner.

End of Section

- 1 General
- 1.1 **SUMMARY**
 - .1 Section Includes
 - .1 Labor, Products, equipment, and services necessary to complete the Work of this section including but not limited to that listed herein.
 - .2 The terms “mechanical work”, “Mechanical Contractor” or their derivatives includes the Work of Divisions 21, 22, 23, and 25, unless otherwise specified.
 - .3 Piping systems:
 - .1 Storm drainage system within building(s) including roof drains and connection to buried storm sewer 1.5 m outside building wall.
 - .2 Sanitary drainage and venting system within building(s) including connection to buried sanitary sewer 1.5 m outside building wall.
 - .3 Domestic cold, hot and recirculating water piping to plumbing fixtures within building.
 - .4 Domestic cold-water piping to 1.5 m outside building wall
 - .5 Natural gas piping
 - .6 Excavation, bedding, and backfilling of pipe trenches for buried piping inside building and to 1.5 m outside
 - .4 Equipment:
 - .1 City water meter
 - .2 Plumbing specialties
 - .3 Drainage specialties
 - .4 Plumbing fixtures and fittings
 - .5 Hot water storage tank(s) and heater(s)
 - .6 Pumps
- 1.2 **CODES, REGULATIONS AND STANDARDS**
 - .1 Comply with municipal or provincial codes, rules, and regulations and/or authorities having jurisdiction.
 - .2 Comply with the National Building Code in areas where municipal or provincial regulations and/or codes are not mandatory.
 - .3 Revisions issue: Latest version as amended to date.
- 1.3 **PERMITS AND INSPECTIONS**
 - .1 Material Approvals

- .1 Obtain special inspection and approvals by CSA and/or local authorities, for materials where specified.
- .2 Obtain such approval for the particular installation with the co-operation of the material Supplier.
- .2 Permits
 - .1 Obtain permits required for the installation of mechanical trades work including:
 - .1 Plumbing inspection
 - .2 Electrical inspection
 - .2 Arrange for inspections and tests and pay all fees and costs for the permits, inspections, and tests. Obtain permits immediately after notification of award of Contract.
 - .3 Obtain copies of Drawings from the Consultant for submission with application for permits.

1.4 **WORKING DRAWINGS AND DOCUMENTS**

- .1 Design Drawing Intent
 - .1 The design drawings are schematic in arrangement and describe the general design intent but do not show the exact details for the installation. They are not fabrication or installation drawings.
 - .2 The Work is suitably outlined on the Drawings with regard to sizes, locations, general arrangements and installation details, and has been generally coordinated for routing of services. The routing of ductwork, piping and equipment arrangement are shown more or less in diagram except where in certain cases the Drawings may include details giving the exact locations and arrangements required.
 - .3 The location of equipment, and the associated arrangement of piping, ductwork, and other material describes the general requirements of the Work. Final location is dependant on the actual equipment supplied. The Consultant reserves the right to make reasonable adjustment of up to 1 m to the location of equipment, floor drains, routing of major piping and ductwork, at no cost to the Owner.
 - .4 In order to provide clarity to the arrangement of the Work, not all details including valves, thermometers, pressure gauges, etc. are shown on the plan drawings. Refer to Schematic Drawings, standard details, and the Specification for these requirements.
 - .5 Where specific installation dimensions for location of equipment and access space requirements are indicated on the Drawings, install to these requirements.
 - .6 Where standard details are provided, these show the general installation requirements, and are applicable to each occurrence in the Work, unless otherwise specified or shown.
- .2 Contractor Coordination Responsibilities
 - .1 Provide the services of a mechanical/electrical coordination supervisor, to coordinate this division of the Work, as well as providing coordination with other divisions and/or contracts. This supervisor may be full time or part time on site,

- as appropriate to the work stage and complexity of the Work, at the discretion of the Owner.
- .2 Where multiple trades are required, the mechanical coordinating supervisor shall be the lead coordinator.
 - .3 The Owner reserves the right to require the coordinating supervisor to increase their attendance at site, at no cost to the Owner, if in the Owner's opinion the current level of coordination is not sufficient for the progress of the Work.
 - .4 Make changes and modifications as necessary to ensure coordination and to avoid interference and conflicts with other trades.
 - .5 Prepare construction/installation/fabrication drawings, coordinated with other trades and contracts, as required.
 - .1 Provide sufficient detail to disclose critical interferences of major equipment and services to ensure adequate accessibility.
 - .2 Specific dimensions for equipment location or access which are shown on the Consultants Drawings.
 - .3 Indicate sleeves, openings, and stress points (such as anchors, guides and inserts).
 - .4 Indicate deviation in sizes and weights and also in water, drainage, electric power or other service requirements for all equipment proposed which is different from those show on the Design Drawings.
 - .5 Provide these Drawings to other trades for coordination with their Work.
 - .6 Update these Drawings as part of the As-Built Drawings, showing actual locations of major equipment, services, access doors, shut-off valves, etc.
 - .6 The Design Drawings show the major requirements for the installation of equipment based on one manufacturer's requirements but may not show all installation requirements. The Contractor will include as part of the Work the specific manufacturer's installation requirements for the equipment actually provided by the Contractor.
 - .7 The construction/installation/fabrication Drawings are not to be submitted as Shop Drawings. Make them available for viewing at Site when requested by the Consultant.
- .3 Review Before Proceeding (HOLD)
- .1 Where the word "HOLD" appears on Drawings and other Contract Documents, the Work is included in the Contract.
 - .2 Execute such Work only after verification of dimensions, verification of materials and obtaining Consultant's written permission to proceed.
- 1.5 **COORDINATION AND EXAMINATION**
- .1 Reference
 - .1 To Section 01 10 00.
 - .2 Examination

- .1 Carefully examine Work and Drawings of all related trades and thoroughly plan the Work so as to avoid interferences.
 - .2 Report defects which would adversely affect the Work. Do not commence installation until such defects have been corrected.
 - .3 Coordination
 - .1 Coordinate Work of Division 21, 22, 23 and 25 such that items will properly interface with Work of other divisions. Prepare Installation Drawings of critical locations and submit to Consultant for review.
 - .2 Architectural Drawings, or in their absence, Mechanical Drawings govern all locations.
- 1.6 **EXISTING SERVICE**
- .1 Tie-in to Existing Services
 - .1 Do not shut down or make tie-in connections to any existing service without written permission of the Owner and/or Consultant.
 - .2 Arrange Work to minimize interruption to physical access to the building.
 - .3 Include for all costs associated with making connections to existing services, including but not limited to, cutting and patching of existing floors, partitions, ceilings and finishes.
 - .2 Work in Existing Buildings
 - .1 Route pipes, ducts, conduits, and other services to avoid interference with existing installation.
 - .2 Relocate existing services and equipment to suit installation of new work.
 - .3 Temporarily remove existing plumbing fixtures to suit new construction; reconnect fixtures at completion of the Work.
 - .1 Do not reuse existing fixtures in new locations.
 - .4 Cut back and cap existing services not being used, so that finished Work presents a neat and clean appearance.
 - .5 Unless noted to be reused, fixtures and materials being removed become the property of the Contractor and are to be removed from site, unless otherwise noted.
 - .3 Continuity of Services
 - .1 Be responsible for any damage to existing systems, including insulation and coverings, when making connections.
 - .2 Keep existing buildings in operation with minimum length of shut-down periods.
 - .3 Include overtime work to tie-in piping or wiring at night or on weekends.
- 1.7 **PROVISION FOR FUTURE**
- .1 Future Equipment

- .1 Where indicated as reserved for future equipment or services, leave identified space clear and install services and equipment so that connections can be made in the future.

1.8 **SUBMITTALS**

.1 Shop Drawings

- .1 Conform to Section 01 33 00 and the following:
 - .2 Shop Drawings showing more than one size or model will not be considered unless properly marked up.
 - .3 For electrically driven, and fuel fired appliances, provide the following information:
 - .1 Electrical characteristics including voltage, phase, frequency, and power rating.
 - .2 For motors, NEMA, class and efficiency ratings.
 - .3 Fuel input ratings, including flow rates and pressures.
 - .4 Equipment performance ratings, including flow rates, pressures, efficiencies, part load values and/or efficiencies (IPLV's), plotted flow characteristics (pump and fan curves) with operating points clearly plotted.
 - .4 For other equipment include the following information:
 - .1 Equipment performance ratings, including flow rates, pressures drop.
 - .2 Electrical control power requirements.
 - .5 For all equipment, include the following:
 - .1 Equipment dimensions and weights.
 - .2 Itemized product description with optional items clearly marked as being included.
 - .6 Provide wiring Shop Drawings:
 - .1 Wiring diagrams and schematics for all equipment which has electrical controls or devices furnished with the equipment.
 - .2 Wiring diagrams alone are not sufficient; schematic and interconnecting drawings, and sequence of operation of equipment are required for review.
 - .3 Clearly indicate the materials and/or equipment being supplied:
 - .1 Details of construction, finish, accurate dimensions, capacities and performance.
 - .2 Certify drawings correct for construction by the manufacturer before submission.
 - .3 Identify equipment Shop Drawings with designations as shown on the Drawings or in the Specifications.

- .4 If not complied with, Shop Drawings will not be reviewed and will be returned to the Contractor.
 - .4 Coordinate equipment which attaches to and/or where external wiring provided connects to other equipment.
 - .1 Do such coordination whether such equipment is supplied under this or other contracts or subcontracts, for which relevant information will be provided by Owner/Consultant.
- 1.9 **AS-BUILT" RECORD DRAWINGS**
- .1 Reference
 - .1 Conform to Section 01 33 00.
 - .2 Maintain an accurate dimensional record of all underground piping and all deviations and changes in aboveground piping and equipment.
- 1.10 **INSTALLATION AND START-UP INSTRUCTIONS**
- .1 Reference
 - .1 Conform to Section 01 33 00.
 - .2 Submit copies of installation instructions and copies of start-up instructions for any item of equipment when requested by the Consultant.
- 1.11 **OPERATING AND MAINTENANCE INSTRUCTION MANUALS**
- .1 Reference
 - .1 Conform to Section 01 33 00.
 - .2 In addition, include the following in the manuals:
 - .1 Non-dimensional layout showing location of all electrical devices on mechanical equipment.
 - .2 Operating instructions, including start-up and shut-down procedure.
 - .3 Lubricating instructions and recommended cycle of lubrication for each item of equipment, including various types of lubricants.
 - .4 List of spare parts.
 - .3 All the above applies to component parts of equipment whether they are manufactured by the Supplier of the equipment or are supplied as a component part of an item of equipment.
- 1.12 **CLEANING, TESTING AND APPROVAL RECORDS**
- .1 Records
 - .1 Maintain records of all pressure tests and flushing and sterilization tests, glycol/ water concentrations, inspections, and approvals by the plumbing inspector.
 - .2 Forward these tests to the Owner on completion of the Work in accordance with Section 01 33 00.

- .3 Forward to Consultant, copy of records on site on completion of each test, cleaning operation, etc.

1.13 **DIMENSIONS AND QUANTITIES**

.1 Dimensions

- .1 Dimensions shown on Drawings are approximate.
- .2 Verify dimensions by reference to Shop Drawings and field measurement.

.2 Quantities

- .1 Quantities or lengths indicated in any of the Contract Documents are approximate only and shall not be held to gauge or limit the Work.

1.14 **TRADE QUALIFICATIONS**

.1 Applicable to the following trades:

- .1 Plumbers

.2 Requirements

- .1 Trade workers to have a certificate of qualification as journeyman or apprentice registration for the province where the work is performed or an interprovincial certificate.
- .2 Ratio of journeyman to apprentice: not to exceed the defined ratio in the Apprenticeship Act of Ontario.
- .3 On award of Contract, submit a list of trade journeyman and apprentices, together with their certificate and registration numbers.
- .4 Certificates and registration must be provided to the Consultant on request.
- .5 Maintain on-site an up-to-date record listing journeyman and apprentices working on site.

2 Products

2.1 **MOTORS AND WIRING**

- .1 In accordance with Section 23 05 13 Motors and Wiring for Mechanical

2.2 **METERS AND GAUGES**

- .1 In accordance with Section 23 05 19 Meters

2.3 **PIPE, FITTINGS AND VALVES**

- .1 In accordance with Section 23 05 23 Pipes, Fittings and Valves

2.4 **EXPANSION FITTINGS AND LOOPS**

- .1 In accordance with Section 23 05 24 Piping Specialties

2.5 **HANGERS AND SUPPORTS**

- .1 In accordance with Section 23 05 29 Pipe Hangers and Supports

2.6 **VIBRATION AND SEISMIC RESTRAINT**

- .1 In accordance with Section 23 05 48 Noise and Vibration Control and 23 05 49 Seismic Restraint
- 2.7 **IDENTIFICATION FOR EQUIPMENT AND PIPING**
 - .1 In accordance with Section 23 05 53 Mechanical Identification
- 2.8 **PIPING INSULATION**
 - .1 In accordance with Section 23 07 19 Piping Insulation
- 2.9 **MATERIALS**
 - .1 Use new materials and equipment free from defects impairing strength and durability, as specified or specified equivalent.
 - .2 Of Canadian manufacture wherever possible.
 - .3 Labelled or listed as required by code and/or inspection authorities.
 - .4 Design of mechanical systems has been based on the first listed Supplier and model number/size stated on the equipment schedules on the Drawings. Bear all costs due to physical or performance differences between stated equipment and proposed equipment. These differences include but are not limited to size, layout, arrangement, connection size, location and/or quantity of connections, or performance differences such as noise, power requirements, flow, throw, etc.
- 2.10 **EQUIPMENT/STRUCTURE COORDINATION**
 - .1 Locations and dimensions of curbs and roof and floor opening framing, where indicated on the Drawings, are based on an arrangement to suit the above-named Supplier.
 - .2 Be responsible to verify the actual size requirements of the openings and notify the Consultant immediately in case the dimension of the unit supplied and the connecting ductwork/piping, etc. are at variance with the dimensions given on the Drawings.
 - .3 Bear all costs for modification of curbs and floor/roof openings resulting from failure to notify the Consultant prior to the fabrication or construction of opening framing and curb.
- 2.11 **STANDARD SPECIFICATIONS**
 - .1 Product Quality
 - .1 Ensure that the chemical and physical properties, design, performance characteristics and methods of construction of all Products provided comply with the latest issue of applicable standard Specifications issued by authorities having jurisdiction.
 - .2 Do not apply such standard Specifications to decrease the quality of workmanship, products and services required by the Contract Documents.
- 2.12 **MANUFACTURER'S NAMEPLATES**
 - .1 Metal Nameplates
 - .1 Provided with raised or recessed lettering, on each piece of equipment.
 - .2 Mechanically fasten nameplate on a metal stand-off bracket arranged to clear insulation.

- .3 Mount on same stand-off Underwriters Laboratories and/or CSA registration plates.
- .2 Nameplate Data
 - .1 Indicate:
 - .1 Size
 - .2 Capacity
 - .3 Equipment model
 - .4 Manufacturer's name
 - .5 Serial number
 - .6 Voltage
 - .7 Cycle
 - .8 Phase and power of motors
- 3 Execution
 - 3.1 **GENERAL**
 - .1 Execute Work in accordance with requirements specified in the various sections of Division 22.
 - .2 Lay out work of each trade so that it does not interfere with work under other divisions of Specifications.
 - .3 Make good any damage to Owner's property or other trade's work caused by improperly locating or carrying out of Work.
 - .4 Supply anchor bolts and templates for installation by other divisions.
 - .5 Location of pipes, ductwork, raceways, and equipment may be altered without extra cost provided alteration is made before installation.
 - 3.2 **INSTALLATION**
 - .1 General
 - .1 Install complete plumbing, drainage, and vent piping within washrooms, etc. in accordance with the Ontario Building Code, standard trade practice and as specified herein.
 - .2 Arrange piping within pipe spaces behind washroom fixtures to allow unimpeded access to piping for servicing.
 - .2 Balancing Valves
 - .1 Where two or more branches connect to a domestic hot water recirculating line, provide each return branch with a globe or circuit balancing valve.
 - .3 Air Handling Equipment Drains

- .1 Provide drains for fan casings, air handling equipment, and low points in ductwork in locations and in arrangements as indicated on the Drawings, or as required by design.
- .2 Drain piping is as specified for sanitary drainage, with deep seal copper trap.
- .3 Install trap seal equivalent to not less than one and one-half times the maximum static pressure in duct system.

3.3 **EQUIPMENT INSTALLATION**

- .1 Set equipment in place, align, connect, and place in operation with:
 - .1 Controls set for efficient, stable operation.
 - .2 Initial lubrication and oil sumps filled.
 - .3 Connections and required safety devices installed.
- .2 Protect equipment from damage during and after installation, and on completion of Work ensure that equipment is free from cracks, scratches, discoloration, tool marks, and other defects.
- .3 Thoroughly clean finished surfaces before acceptance of Work.
- .4 Install heater vents complete with necessary supports, hangers, braces, roof flashing, storm collar, and round top.

3.4 **FLUSHING AND STERILIZATION**

- .1 Sterilize water piping connected to municipal water supply in accordance with local municipal requirements.
- .2 Flush each system after completion by allowing full flow of water through the system for a period of fifteen minutes or longer when directed by the Consultant.
- .3 After flushing of the system is completed, perform a twenty-four-hour contact sterilization treatment by treating the water with 50 ppm of chlorine as recommended in AWWA Specification C-651.
- .4 After sterilization period has elapsed, flush system to reduce chlorine content to an acceptable level, but not less than thirty minutes.
- .5 Remove and clean strainer screens after flushing operation is completed. Repeat two weeks after initial operation of systems and within two weeks after Substantial Completion.

3.5 **SPARE PARTS**

- .1 Furnish spare parts.
 - .1 One set of packing glands for each size of pump gland.
 - .2 One casing joint gasket for each size pump.
 - .3 One head gasket for each heat exchanger.
 - .4 One glass for each gauge glass.
 - .5 One set of V-belts for each drive.

- .6 One filter cartridge or set of filter media for each filter or filter bank installed.

3.6 **PROTECTION**

- .1 Protect work and materials before, during and after erection from weather and other hazards and keep in a clean and orderly manner.
- .2 Protect pipe ends, valves and parts of equipment left unconnected to prevent damage or intrusion of foreign matter. Provide pipe caps for threaded male connections and plugs for threaded female connections.
- .3 Protect plumbing fixtures or mechanical equipment having a baked enamel finish by covering with polyethylene sheet securely held in place.
- .4 Protect finished floor slabs from scuffing, cracking, chipping, staining, cutting, and other damage resulting from work of this Contract.
 - .1 Place a 19 mm thick plywood underlaid with 25 mm thick polystyrene insulation board adhered to same, over floor areas when working from, or over, such surfaces.
 - .2 Provide such protection below hoist rigs, ladders, pallets of material, and in other circumstances where the flooring is exposed to potential damage.
 - .3 Work damaged due to failure in providing such protection is to be removed and replaced, or repaired, as directed by the Owner, at no increase in Contract Price.

3.7 **MAINTENANCE OF BEARINGS**

- .1 During Construction
 - .1 Turn-over rotating equipment at least once a month after delivery.
 - .1 Run-in sleeve type bearings in accordance with manufacturer's recommendations.
 - .2 Drain, flush out and refill with new charge of oil or grease.
 - .3 Protect bearings, shafts and sheaves against damage, corrosion and dust accumulation.
 - .4 Provide extended grease nipples for bearing lubrication.

End of Section

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- 1 General
- 1.1 **SUMMARY**
 - .1 Section Includes
 - .1 Labor, Products, equipment, and services necessary to complete the Work of this section.
- 1.2 **SUBMITTALS**
 - .1 Shop Drawings
 - .1 Submit Shop Drawings in accordance with Section 01 33 00.
 - .2 Operation and Maintenance Data
 - .1 Submit printed operation instructions and maintenance data in accordance with Section 01 33 00.
- 1.3 **REFERENCE STANDARDS**
 - .1 Back-flow preventers: To CAN/CSA B64 standard series
- 2 Products
- 2.1 **BACK FLOW PREVENTERS**
 - .1 General
 - .1 Products from Watts have been used as a guide to establish standard of construction. Comparable Products are acceptable from the following manufacturers:
 - .1 Watts
 - .2 Honeywell/Braukmann
 - .3 Zurn Wilkins
 - .4 Cla-Val
 - .5 Apollo
 - .6 Conbraco
 - .2 Vacuum Breakers, Pressure Type (PVB)
 - .1 To CSA B64.1.2 for back-siphonage, no back pressure.
 - .2 Working pressure: To 1000 kPa (150 psig).
 - .3 Working temperature: To 60°C (140°F).
 - .4 NPS ½ to NPS 2: Anti-siphon pressure vacuum breaker complete with bronze body and spring-loaded single float and disc with independent first check, shut off valves and bronze type test cocks for winterization draining. Springs should be of stainless-steel construction.
 - .3 Double Check Valve Assemblies (DCVA)

- .1 To CSA B64.5
 - .2 Two independent positive seating check valves with captured springs and seat discs. The valve seat and discs shall be replaceable. All internal components shall be serviceable by access cover(s).
 - .3 Working pressure: To 1200 kPa (175 psig).
 - .4 Working temperature: To 60°C (140°F).
 - .5 NPS ½ to NPS 2: Complete with quarter turn shut-off valves, bronze strainer, and test cocks.
 - .6 NPS 2½ to 10: Complete modular check valve assemblies with centre stem guiding, non-rising stem gate valves, test cocks and strainer.
- .4 Backflow Preventer with Intermediate Atmospheric Vent (DCAP)
- .1 To CSA B64.8.
 - .2 Two independent check valves with intermediate vacuum breaker and relief vent.
 - .3 Working pressure: To 1200 kPa (175 psig).
 - .4 NPS ½ to NPS ¾: All bronze construction complete with integral strainer, union connection on inlet and outlet.
- .5 Dual Check Vacuum Breaker for Vending Machines
- .1 To CSA B64.8.
 - .2 Dual check valve, ball check valve and atmospheric vent.
 - .3 Working pressure: To 1000 kPa (150 psig).
 - .4 NPS 3/8: Stainless steel body construction.
- .6 Reduced Pressure Principle (RPP)
- .1 To CSA B64.4.
 - .2 Two independent check valves with captured springs, access for maintaining internals, replaceable valve seats, intermediate relief valve, shut-off valves and ball type test cocks.
 - .3 Working pressure: To 1200 kPa (175 psig).
 - .4 NPS ½ to NPS 2: Complete with quarter turn shut-off valves and bronze strainer.
 - .5 NPS 2½ to NPS 10: Complete with non-rising stem, shut-off gate valves and strainer.
 - .6 Backflow preventer test kit: Pressure gauge, colour coded needle valves and hose, adaptors, replaceable hose filters and valve stem seals, carrying case.

2.2 MISCELLANEOUS EQUIPMENT

- .1 Make-up Water Feeder Valves
 - .1 Line size, complete with adjustable pressure reducing valve, anti-siphon check and strainer. Products from the following manufacturers are acceptable.

- .1 Taco
- .2 Armstrong
- .3 Watts
- .2 Water Pressure Reducing Valve
 - .1 Spring loaded, field adjustable, strainer, replaceable seat. Access for servicing internal components. Products from the following manufacturers are acceptable.
 - .1 Watts
 - .2 Zurn
 - .3 Conbraco
- .3 Shock Absorbers
 - .1 Water hammer arrestor, sized in accordance with P.D.I.-WH201. Products from the following manufacturers are acceptable.
 - .1 Watts
 - .2 Zurn Shoktrol
 - .3 PPP Inc.
- .4 Non-Freeze Wall Hydrants (WH)
 - .1 "WH-1": Non-freeze box type, flush mounting to wall, with NPS 3/4 hose connection, self-draining, integral hose end vacuum breaker, hinged locking cover, galvanized wall sleeve, ground joint union elbow adapter and operating key. Products from the following manufacturers are acceptable.
 - .1 Ancon
 - .2 Zurn
 - .3 MI Fab
 - .2 "WH-2": Non-freeze exposed type, with NPS 3/4 hose connection, self-draining, integral hose end vacuum breaker, galvanized wall sleeve, ground joint union elbow adapter and operating key.
 - .1 Ancon
 - .2 Zurn
 - .3 MI Fab
- .5 Hose Bibbs (HB)
 - .1 Rough brass construction with hose end spout, size as indicated.
 - .1 Emco
 - .2 Cambridge Brass

3.1 **INSTALLATION - MISCELLANEOUS**

.1 Back Flow Preventers

- .1 Provide backflow preventers selected in conformance to CSA B64.10, where a connection is made between any system conveying potable water and a system carrying non-potable water or any other liquid.
- .2 Install backflow preventers where shown on Drawings, in accordance with manufacturers recommendations, and as follows:
 - .1 Locate RPP devices at 1.2 mm above finished floor.
 - .2 Locate VBP devices exposed as close to fixture connection as possible.
 - .3 Provide drain collector at relief valves and NPS 3/4 drain from DCAP and RPP devices and run drain to nearest floor drain.
- .3 Testing:
 - .1 Provide the services of an independent inspection agency to verify operation of all backflow prevention devices provided with testing ports.
 - .2 Provide inspection tag on each such device.
 - .3 Submit test results to building plumbing inspector and Consultant.

.2 Make-up Water Valves

- .1 Locate in domestic water lines to heating and cooling systems where shown.

.3 Water Pressure Reducing Valves

- .1 Locate in domestic water lines as shown, with capacity and pressure reduction ratings as shown.
- .2 Provide pressure gauge on downstream side of pressure relief valve, complete with petcock.
- .3 Provide pressure relief valve suitably sized and pipe to drain.

.4 Shock Absorbers

- .1 Locate shock absorbers in hot and cold-water lines:
 - .1 At far ends of mains
 - .2 At branch lines to each flush valve and quick closing valve
 - .3 At dead ends of branch piping or to groups of plumbing fixtures
 - .4 At isolated individual plumbing fixtures

.5 Wall Hydrants

- .1 Verify wall thickness at each hydrant to ensure correct hydrant length.

.6 Hose Bibbs

- .1 Mount 1050 mm above finished floor.
- .2 Provide a line mounted vacuum breaker selected for continuous pressure.

End of Section

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- 1 General
 - 1.1 **SUMMARY**
 - .1 Section Includes
 - .1 Labor, Products, equipment, and services necessary to complete the Work of this section.
 - 1.2 **SUBMITTALS**
 - .1 Shop Drawings
 - .1 Submit Shop Drawings in accordance with Section 01 33 00.
 - .2 Operation and Maintenance Data
 - .1 Submit printed operation instructions and maintenance data in accordance with Section 01 33 00.
- 2 Products
 - 2.1 **DRAINAGE SPECIALTIES**
 - .1 Acceptable Manufacturers
 - .1 Watts
 - .2 Zurn Industries Ltd.
 - .3 MI Fab
 - .2 Products from Watts have been used as a guide to establish the standard of construction. Comparable Products are acceptable from the above listed manufacturers. Sizes are as shown on Drawings.
 - 2.2 **FLOOR DRAINS**
 - .1 General Construction
 - .1 Drain body to have tapped primer connection.
 - .2 The type letter allocated to the following list of floor drains identifies that particular drain on the Drawings.
 - .2 FD-"A"
 - .1 Two-piece Dura coated cast iron body with double drainage flange, weep holes, non-puncturing flashing collar, adjustable 13 mm thick, 150 mm diameter polished nickel bronze strainer, and push-on, caulked or "MJ" bottom outlet.
 - .3 FD-"B"
 - .1 Two-piece Dura coated cast iron body with double drainage flange, weep holes, non-puncturing flashing collar, adjustable 13 mm thick, 150 mm diameter polished nickel bronze strainer, sediment bucket, and push-on, caulked or "MJ" bottom outlet.
 - .4 FD-"D"

- .1 Two-piece Dura coated cast iron body with double drainage flange, weep holes, non-puncturing flashing collar, adjustable 125 diameter nickel bronze combination strainer and 100 mm x 225 mm oval funnel, and push on, caulked or "MJ" bottom outlet.
- .5 FD-"E"
 - .1 Two-piece Dura coated cast iron body with double drainage flange, weep holes, non-puncturing flashing collar, adjustable 100 mm diameter cast iron above floor hub and push-on, caulked or "MJ" bottom outlet.
- .6 FD-"F"
 - .1 Dura coated cast iron body with 300 mm square fixed top, double drainage flange, clamp device, weep holes, heavy duty Dura coated iron grate, removable sediment bucket, and push on, caulked or "MJ" bottom outlet.
- .7 FD-"H"
 - .1 Dura coated cast iron scupper drain with flashing flange, removable bolted brass sloping grate with flange serving as flashing clamp, and ninety-degree threaded outlet.
- .8 FFD-A
 - .1 Dura coated cast iron floor drain with anchor flange, cast iron clamp ring with primary and secondary weep holes for water proofing membrane, and standard 25 mm thick, 225 mm diameter, ductile iron tractor grate, and a 100 mm x 228 mm cast iron funnel.
- .9 Floor Drain Traps and Primers
 - .1 Trap seal primer valves: Cast brass body, integral vacuum breaker and NPS ½ sweat connections.
 - .2 Automatic flush tank for priming of trap: Automatic syphon, tank liner, concealed top cover, bottom supply and screwdriver stop.
 - .3 As an alternative to automatic flush tanks electronic trap seal primer system with air gap and 13 mm solenoid valve.

2.3 DRAINAGE CLEANOUTS

- .1 Buried Piping
 - .1 Flush floor type: Cast iron ferrule with inside caulked or spigot connection outlet, seal plug and nickel brass frame, cover suitable for type of floor in which it is to be installed, e.g. tile, terrazzo, carpet, concrete, etc. and push on, caulked or "MJ" bottom outlet. Provide membrane clamp if installed on membrane floors.
- .2 Exposed Piping
 - .1 Cast iron piping in exposed location or in accessible pipe chases: Cast iron body with straight threaded, coated plug having a tapered shoulder that seats against a lead seal.
 - .2 Copper stack piping in exposed locations or in accessible pipe chases: Bronze cleanout tee, bronze ferrule and cover, secured to ferrule by bronze cap screws.

- .3 Access cover for cleanouts concealed in walls: Type to suit wall surface and construction.
- .4 Cover for cleanouts at base of vertical sanitary stacks or rainwater leaders: Bolted type, neoprene gasket, and brass cap screws or bolt studs, unless shown otherwise on Drawings.

2.4 MISCELLANEOUS PRODUCTS

.1 Back-Water Valves

- .1 Cast iron body with gasketed cover, removable bronze disc and seat, and access cover.
- .2 In finished areas, provide nickel bronze frame and round scoriated type cover.

3 Execution

3.1 INSTALLATION

.1 Floor Drains

- .1 Provide each floor drain installation with a deep seal "P" trap unless otherwise shown, complete with trap primer connection tapping to conform to code requirements.

.2 Floor Drain Primers

- .1 Provide each floor drain with a trap seal primer.
 - .1 Exception: Floor drains located in shower stalls, group showers and other locations where the floor is exposed to water on a daily basis.
 - .2 Use trap seal primer valves where a domestic cold-water line serving a washroom fixture (preferably a water closet) is within 15.25 m of the floor drains.
 - .1 Above ground floor drains: Provide an NPS ½ Type K copper pipe to primer connection on drain body.
 - .2 Below ground floor drains: Provide an NPS ½ Type K copper pipe to within 300 mm of the floor line. Provide 9.5 mm white polybutylene tubing from this point and connect to drain body.
 - .3 Install trap primer in truss space or other accessible location, or as directed by Consultant.
 - .4 In other areas with remote floor drains, use an automatic flush tank.

.3 Cleanouts

- .1 Locate drainage cleanout fittings in drainage piping:
 - .1 At locations indicated on the Drawings.
 - .2 At base of each vertical stack.
 - .3 As required to comply with applicable plumbing code.

.4 Back-Water Valves

- .1 Provide where shown.

.5 Expansion Joints

- .1 Provide vertical expansion joints near top of drainage pipe risers where total riser height exceeds 10 m from ground level.
- .2 Provide horizontal expansion joints on suspended drainage pipe which:
 - .1 Is welded.
 - .2 Crosses a building expansion joint, whether the pipe is welded or not.

End of Section

- 1 General
- 1.1 **SUMMARY**
 - .1 Section Includes
 - .1 Products, equipment and services necessary to complete the Work of this section.
 - .2 General Requirements
 - .1 The following products will be supplied by NEXT Plumbing Supply (NPS):
 - .1 Lavatories
 - .1 L1
 - .2 L1H (Barrier Free Use)
 - .3 L2H
 - .2 Urinals
 - .1 U1H
 - .3 Water Closets
 - .1 W1
 - .2 W1H
 - .3 W2
 - .4 W2H
 - .5 W3
 - .6 W3H
 - .2 As part of the Shop Drawing submittal, Contractor is to submit a by-building order form to the Consultant and Owner listing the items and quantities for each building the equipment is to be installed in. Refer to the Appendices for the Plumbing and Accessories Order Form
 - .3 Once the shop drawings are reviewed and the order form quantities are verified by the Consultant and Owner, the Owner will submit the order form to NPS for processing as well as pay NPS for the order directly.
 - .4 The Contractor is to coordinate delivery of supplied items with NPS and store on site as needed prior to installation.
 - .5 Material defects of the products and equipment are the responsibility of NEXT and the Contractors to coordinate and replace.
 - .6 Replacement of any equipment or appurtenances listed in section 1.1.2.1 of this specification will be at the expense of the Contractor.
- 1.2 **REFERENCES**
 - .1 Conform to the latest edition of the following:

.1 AODA - Accessibility for Ontarians with Disabilities Act

.2 TADG - Toronto Accessibility Design Guidelines

1.3 **SUBMITTALS**

.1 Shop Drawings

.1 Submit Shop Drawings in the form of catalogue cuts and fully illustrating specified materials with description of components, surface finishes, hardware and securement devices.

1.4 **WARRANTY**

.1 Warrant the following Products against defects and deficiencies for a period of two years from date Work is certified as substantially performed in accordance with the general conditions of the Contract:

.2 Promptly make good defects and deficiencies which become apparent within the Warranty Period by replacing defective Product satisfactory to the Consultant and at no expense to the Owner.

2 Products

2.1 **PLUMBING FIXTURES**

.1 General Requirements

.1 CSA approved plumbing fixtures and fittings, of make, type and size specified herein.

.2 Comply with the current water saving ratings of the Ontario Building Code, and ASHRAE/IEEE 90.1.

.1 Lavatories: Maximum 8.3 L/min at 413 kPa (60 psig)

.2 Urinals: Maximum 3.8 L/flush

.3 Water closets: Maximum 6.0 L/flush

.4 Shower heads: Maximum 9.5 L/min

.3 Plumbing supplies and fixture trim material to be of CSA approved plumbing brass with chrome plated finish, and of make and type specified.

.1 Each item to bear name of manufacturer or identifying trademark.

2.2 **LAVATORIES**

.1 Lavatories - Type L1H (Barrier Free Use)

.1 Type: Wall hung, vitreous china.

.2 Lavatory: White, 508 mm x 464 mm for barrier free use, dilled for concealed arm carrier with single faucet hole and overflow, complete with semi-pedestal P-trap cover.

.1 American Standard "Decorum with EverClean" No. 9024.001EC.020

.3 Supply fitting: Electronic, adjustable infrared sensor-activated faucet, polished chrome finish, single hole mounting, magnetic solenoid valve.

- .1 Moen Align Sensor Faucet - 8559 (Electronic No-Touch Hardwired)
 - .1 Moen AC Conversion Kit - 182538
 - .2 Moen AC Transformer – 104630
- .4 Lavatory supplies: Chrome plated polished brass, ¼ turn ball valve angle stop, convertible ¼ turn/loose key handles, horizontal extension tubes, escutcheons and flexible copper risers. Products from the following manufacturers are acceptable.
 - .1 McGuire Supply Kit - H170LK-BV-RB
- .5 Trap: Adjustable durable solid brass “P” trap with 32 mm O.D outlet, adjustable rotation on tube outlet, slip joint inlet and cleanout plug. Products from the following manufacturers are acceptable:
 - .1 McGuire No. MC-8872CB
- .6 Sanitary Covering:
 - .1 McGuire MC-PW-2000 PW2000 PROWRAP
- .7 Waste fitting: Drain with open grid strainer, cast brass one piece top and tailpiece.
 - .1 McGuire No. 155A
- .8 Basin carrier: Heavy duty steel uprights with integral welded feet., concealed arms, wall flanges to attach to backing plate secured in wall with locking device and levelling screws, wall mounted steel plated hardware. Type and model as recommended by manufacturer for each wall hung basin to suit wall construction. Products from the following manufacturers are acceptable.
 - .1 Watts No. WCA-411-CA-481
- .9 Water Mixing Valve
 - .1 Powers Point of use Under Counter Thermostatic Mixing Valve
 - .1 LFE480-10
- .2 Lavatories Type L1:
 - .1 Type: Countertop, self-rimming, vitreous china
 - .2 Lavatory: White, self-rimming, rear/front overflow, drilled for 100 mm supply fitting.
 - .1 American Standard "Aqualyn" #0475.047.020 518 x 441 mm
 - .3 Supply fitting: Electronic, adjustable infrared sensor-activated faucet, polished chrome finish, single hole mounting, magnetic solenoid valve.
 - .1 Moen Align Sensor Faucet - 8559 (Electronic No-Touch Hardwired)
 - .1 Moen AC Conversion Kit - 182538
 - .2 Moen AC Transformer - 104630
 - .3 McGuire Supply Kit - H170LK-BV-RB

- .4 Lavatory supplies: Chrome plated polished brass, ¼ turn ball valve angle stop, convertible ¼ turn/loose key handles, horizontal extension tubes, escutcheons, and flexible copper risers. Products from the following manufacturers are acceptable.
 - .1 McGuire Supply Kit - H170LK-BV-RB
- .5 Trap: Adjustable durable solid brass "P" trap with 32 mm O.D outlet, adjustable rotation on tube outlet, slip joint inlet and cleanout plug. Products from the following manufacturers are acceptable:
 - .1 McGuire No. MC-8872CB
- .6 Waste fitting: Chrome plated drain with open grid strainer with adjustable offset waste connection, cast brass construction.
 - .1 McGuire No. 155A
- .7 Sanitary Covering
 - .1 McGuire MC-PW-2000 PW2000 PROWRAP.
- .8 Trap: NPS 1¼ adjustable tubular chrome plated polished cast brass "P" Trap with cleanout and wall escutcheon. Products from the following manufacturers are acceptable.
 - .1 McGuire No. 8872CB
- .9 Water Mixing Valve
 - .1 Powers Point of use Under Counter Thermostatic Mixing Valve
 - .1 LFE480-10
- .3 Lavatories Type L2H: (Barrier Free Use):
 - .1 Type: Countertop, self-rimming with rim sealant, vitreous china
 - .2 Lavatory: White, for barrier free use, self-rimming with sealant, overflow, drilled for 100 mm supply fitting.
 - .1 American Standard "Aqualyn" #0475.047.020 518 x 441 mm
 - .3 Supply fitting: Electronic, adjustable infrared sensor-activated faucet, polished chrome finish, single hole mounting, magnetic solenoid valve.
 - .1 Moen Align Sensor Faucet - 8559 (Electronic No-Touch Hardwired)
 - .1 Moen AC Conversion Kit - 182538
 - .2 Moen AC Transformer - 104630
 - .3 McGuire Supply Kit - H170LK-BV-RB
 - .4 Waste fitting: Chrome plated drain with open grid strainer with adjustable offset waste connection, cast brass construction.
 - .1 McGuire No. 155WC

- .5 Trap: NPS 1¼ adjustable tubular chrome plated polished cast brass "P" Trap with cleanout and wall escutcheon. Products from the following manufacturers are acceptable.
 - .1 McGuire No. 8872CB
- .6 Sanitary Covering
 - .1 McGuire MC-PW-2000 PW2000 PROWRAP.
- .7 Lavatory supplies: Chrome plated polished brass, ¼ turn ball valve angle stop, convertible ¼ turn/loose key handles, horizontal extension tubes, escutcheons, and flexible copper risers. Products from the following manufacturers are acceptable.
 - .1 McGuire No. H170LK-BVRB
- .8 Water Mixing Valve
 - .1 Powers Point of use Under Counter Thermostatic Mixing Valve
 - .1 LFE480-10

2.3 URINALS

- .1 Urinals - Type U1H (Barrier Free Use)
 - .1 Type: Wall hung, exposed electronic "No Touch" automatic flush valve.
 - .2 Urinal: White, vitreous china, washdown, with integral extended shields, and trap; complete with 19 mm top spud, non-metallic strainer, outlet connection and wall hanger.
 - .1 American Standard "Washbrook FloWise" No.6590001.020
 - .3 Automatic flush control: Exposed, chrome plated, 1.9 L factory set flow, quiet action diaphragm type, urinal flushometer complete with infrared sensor with solenoid operated flush controller circuitry, back-check angle stop, vacuum breaker located above urinal.
 - .1 Moen Sensor Operated WC flush valve – 8315AC05
 - .1 Moen AC Transformer - 104630
 - .4 Carrier: Complete Steel hanger plate with epoxy coated steel uprights with welded feet support. Products from the following manufacturers are acceptable.
 - .1 Watts No. CA-321
 - .5 Wall cleanout: Urinal cleanout with stainless steel access cover and stainless-steel vandal proof securing screw. Products from the following manufacturers are acceptable:
 - .1 American Standard "WUCO"

2.4 WATER CLOSETS

- .1 Water Closets - Type W1 - Flushometer Valve
 - .1 Type: Wall hung, exposed flush valve, vitreous china.

- .2 Closet bowl: White, vitreous china with Everclean antimicrobial surface, syphon-jet bowl with elongated bowl, direct-fed siphon jet action, concealed trap and NPS 1½ top spud.
 - .1 American Standard "Afwall Millennium FloWise " No. 3351.101.020
- .3 Flush valve: Exposed, sensor-operated, complete with angle stop, 1½ high back pressure vacuum breaker with spud coupling and flange, vandal-resistant cap.
 - .1 Moen Sensor Operated WC flush valve – 8311AC12
 - .1 Moen AC Transformer - 104630
- .4 Closet seat: White, solid plastic elongated open front seat, less cover with reinforced stainless steel check hinge and post nuts and washers.
 - .1 Centoco – 500STSCC
- .5 Closet carrier: Type and model as recommended by manufacturer for each wall hung closet to suit wall construction. Products from the following manufacturers are acceptable.
 - .1 Watts No. ISCA-101-L/R-M11
- .2 Water Closets - Type W1H (Barrier Free Use) - Flush Valve
 - .1 Type: Wall hung, flushometer valve
 - .2 Closet bowl: White, vitreous china, direct-fed syphon-jet, elongated bowl and 38 mm top spud, concealed trap way. Bowl height from floor to rim 400 mm - 410 mm.
 - .1 American Standard "Afwall Millennium FloWise" No. 3351.101.002
 - .3 Flush valve: Exposed, sensor-operated, complete with angle stop, 1½ high back pressure vacuum breaker with spud coupling and flange, vandal-resistant cap.
 - .1 Moen Sensor Operated Flush Valve – 8311AC12
 - .1 Moen AC Transformer – 104630
 - .2 Moen 24" Flush Tube - 104585
 - .4 Toilet seat: White, elongated solid plastic, heavy duty open front, less cover, stainless steel check hinges with gasket,
 - .1 Centoco 500 Series No. 500STSCC
 - .5 Toilet Back Rest:
 - .1 Bobrick – CM-16104
 - .6 Closet carrier: Type and model as recommended by manufacturer for each wall hung closet to suit wall construction. Products from the following manufacturers are acceptable.
 - .1 Watts No. ISCA-101-L/R-M11
- .3 Water Closets - Type W2 - Flush Valve
 - .1 Type: Floor mounted, bottom outlet, flush valve.

- .2 Closet bowl: White vitreous china, syphon-jet bowl with elongated bowl, condensation channel, bolt caps and 38 mm top spud, and china bolt caps.
 - .1 American Standard "Madera" No. 3451.001.020
- .3 Flush valve: Exposed, sensor-operated, complete with angle stop, 1½ high back pressure vacuum breaker with spud coupling and flange, vandal-resistant cap.
 - .1 Moen Sensor Operated Flush Valve – 8311AC12
 - .1 Moen AC Transformer – 104630
- .4 Closet seat: White solid plastic elongated open front seat, less cover, reinforced stainless steel check hinges and post nuts and washers.
 - .1 Centoco 500 Series No. 500STSCC
- .4 Water Closets - Type W2H (Barrier Free Use) - Flush Valve
 - .1 Type: Floor mounted, bottom outlet, flush valve.
 - .2 Closet bowl: White vitreous china, syphon-jet bowl with elongated bowl, condensation channel, bolt caps and 38 mm top spud, and china bolt caps.
 - .1 American Standard "Madera" No. 3461.001.020
 - .3 Flush valve: Exposed, sensor-operated, complete with angle stop, 38 mm high back pressure vacuum breaker with spud coupling and flange, vandal-resistant cap.
 - .1 Moen Sensor Operated Flush Valve – 8311AC12
 - .1 Moen AC Transformer – 104630
 - .2 Moen 24" Flush Tube - 104585
 - .4 Closet seat: White solid plastic elongated open front seat, less cover, reinforced stainless steel check hinges and post nuts and washers.
 - .1 Centoco 500 Series No. 500STSCC
 - .5 Toilet Back Rest:
 - .1 Bobrick – CM-16104
- .5 Water Closets - Type W3
 - .1 Type: Floor mounted, back outlet, pressure assist flush tank, low consumption.
 - .2 Closet combination: White vitreous china, siphon jet flush closet bowl with elongated rim and close coupled vitreous china pressure assisted closet tank complete with fittings.
 - .1 American Standard "Cadet RH PA Universal Bowl – White"
 - .1 American Standard – PA Tank, 1.1 GPF White
 - .3 Closet seat: White, heavy duty, solid plastic elongated open front with cover, with stainless steel check hinges and stainless-steel posts and nuts.
 - .1 Centoco No. 820STS

- .4 Closet supply: NPS 3/8 with lockshield, rigid copper sweat tube nipples, combination V.P. loose key handle, turn ball angle stop and wall escutcheon and flexible risers. Products from the following manufacturers are acceptable.
 - .1 McGuire No. MC-H172LK-BV
- .6 Water Closets - Type W3H (Barrier Free Use) - Pressure Assist Tank
 - .1 Type: Floor mounted, back outlet, pressure assist flush tank.
 - .2 Closet combination: White vitreous china, siphon jet flush trap closet bowl with elongated rim and close coupled vitreous china pressure assisted closet tank complete with fittings.
 - .1 American Standard "Cadet RH PA Universal Bowl – White
 - .1 American Standard – PA Tank, 1.1 GPF White
 - .3 Closet seat: White, heavy duty, solid plastic elongated open front with cover, with stainless steel check hinges and stainless-steel posts and nuts.
 - .1 Centoco No. 500STSCC
 - .4 Closet supply: 13 mm turn ball valve angle stops, coppers sweat nipples, combination V.P. loose key stop and wall escutcheon and flexible copper risers. Products from the following manufacturers are acceptable.
 - .1 McGuire No. MC-H172LK-BV
- 2.5 **SERVICE SINK**
 - .1 Mop Sinks - Type M2
 - .1 Type: Pre-cast terrazzo floor mounted.
 - .2 Sink: 610 x 610 mm, precast terrazzo with one-piece integral stainless steel cap on all four sides and integral drain with strainer. "P" trap under floor.
 - .1 Stern Williams Serviceptor No. SB-900
 - .2 Fiat
 - .3 Or accepted equal.
 - .3 Faucets: Mop sink supply fitting with vacuum breaker, integral stops, cross or lever handles, rigid spout with pail hook, brace to wall, minimum 787 mm hose and stainless-steel hanger, adjustable wall flanges and NPS ½ IPS connections.
 - .1 Chicago Faucets No. 897-RCF-Hose
 - .2 American Standard
 - .3 Delta
 - .4 Zurn
 - .5 Or accepted equal.
 - .2 Mop Sinks - Type M3
 - .1 Type: Terrazzo floor mounted corner mop sink.

- .2 Sink: Precast terrazzo 711 x 711 x 304 mm deep, floor mounted, with stainless steel cast integral cap on front drop and integral drain with strainer, "P" trap under floor, and two stainless steel wall guards.
 - .1 Stern Williams No. CRS2200
 - .2 Fiat
 - .3 Or accepted equal.
- .3 Faucets: Mop sink supply fitting with vacuum breaker, integral stops, cross or lever handles, rigid spout with pail hook, brace to wall, 787 mm rubber hose and coupling, adjustable wall flanges and NPS ½ IPS connections.
 - .1 American Standard No. GL-8344.111-002
 - .2 Chicago Faucets
 - .3 Delta
 - .4 Zurn
 - .5 Or accepted equal.

2.6 **STAINLESS STEEL SINKS**

- .1 Stainless Steel Sinks - Type S1 (Barrier Free Use)
 - .1 Single compartment: 406 x 533 x 127 mmOD undermount, stainless steel sink drawn from 18-10 Type 304 heavy gauge stainless steel, with undercoating, and complete with 90 mm stainless steel crumb cup strainer and brass tailpiece.
 - .1 Franke Commercial UCS6105P
 - .2 Blanko
 - .3 Kindred Industries Limited
 - .4 AMI Industries
 - .2 Faucets: Chrome plated solid cast brass deck type sink supply fitting with 232 mm swing spout, single lever handle and maximum 8.3 L/min flow, water saver aerator, pull-out spray with adjustable spray pattern, lock & turn activation button, 10 mm compression inlets, braided flexible supply hoses.
 - .1 American Standard No. 7074100.002
 - .2 Chicago Faucets
 - .3 Delta
 - .4 Zurn
 - .5 Or accepted equal.
- .2 Stainless Steel Sinks - Type S2 (Barrier Free Use)
 - .1 Double compartment: 451 x 784 x 127 mm OD undermount stainless steel sink drawn from 18-10 Type 304 heavy gauge stainless steel, with undercoating, and complete with 90 mm stainless steel crumb cup strainers and brass combination tailpiece.

- .1 Franke Commercial UCD6405P
- .2 Blanko
- .3 Kindred Industries Limited
- .4 AMI Industries
- .2 Faucets: Chrome plated solid cast brass deck type sink supply fitting with 232 mm swing spout, single lever handle and maximum 8.3 L/min flow, water saver aerator, pull-out spray with adjustable spray pattern, lock & turn activation button, 10 mm compression inlets, braided flexible supply hoses.
 - .1 American Standard No. 7074100.002
 - .2 Chicago Faucets
 - .3 Delta
 - .4 Zurn
 - .5 Or accepted equal.
- .3 **Stainless Steel Sinks - Type S3 (Barrier Free Use)**
 - .1 Single compartment: 406 x 533 x 127 mmOD undermount, stainless steel sink drawn from 18-10 Type 304 heavy gauge stainless steel, with undercoating, and complete with 90 mm stainless steel crumb cup strainer and brass tailpiece.
 - .1 Franke Commercial UCS6105P
 - .2 Blanko
 - .3 Kindred Industries Limited
 - .4 AMI Industries
 - .2 Faucets: Electronic "No-Touch" AC powered faucet, chrome plated finish, cast brass body, high arc spout, single hole only, single lever handle and 5.7 L/min flow, pull-down spray with adjustable spray pattern, 10 mm compression inlets, braided flexible supply hoses.
 - .1 Moen Align with MotionSense No. 7565EC
 - .2 American Standard
 - .3 Chicago Faucets
 - .4 Delta
 - .5 Zurn
 - .6 Or accepted equal.
- .4 **Stainless Steel Sinks - Type S4 (Barrier Free Use)**
 - .1 Double compartment: 451 x 784 x 127 mm OD undermount stainless steel sink drawn from 18-10 Type 304 heavy gauge stainless steel, with undercoating, and complete with 90 mm stainless steel crumb cup strainers and brass combination tailpiece.
 - .1 Franke Commercial UCD6405P

- .2 Blanko
- .3 Kindred Industries Limited
- .4 AMI Industries
- .2 Faucets: Electronic "No-Touch" AC powered faucet, chrome plated finish, cast brass body, high arc spout, single hole only, single lever handle and 5.7 L/min flow, pull-down spray with adjustable spray pattern, 10 mm compression inlets, braided flexible supply hoses.
 - .1 Moen Align with MotionSense No. 7565EC
 - .2 American Standard
 - .3 Chicago Faucets
 - .4 Delta
 - .5 Zurn
 - .6 Or accepted equal.
- .5 Fittings
 - .1 Trap: Adjustable cast brass 38 mm "P"-trap 38 mm with cleanout.
 - .2 Sanitary Covering: PW2000 PROWRAP or accepted equal.
 - .3 Supplies: Pair 12 mm rough stops with flexible risers.
 - .1 Acceptable manufacturers for trap and supplies:
 - .1 McGuire
 - .2 Zurn
 - .3 Kohler
 - .4 Water Mixing Valve
 - .1 Lawler TMM-1070
 - .2 Symmons
 - .3 Powers
 - .4 Leonard
 - .5 Zurn
 - .6 Or accepted equal.
 - .5 Provide tee, adaptors, and flexible copper tubing to suit installation.
- 2.7 **SHOWER**
 - .1 Individual Showers - Type SH2
 - .1 Type: Non-scald pressure balance shower valve with lever handle, integral service stops or and check stops, deluxe shower head with adjustable spray

pattern and 9.5 L/min at test pressure of 550 kPa flow restrictor, bent arm and escutcheon.

.1 Symmons No. 1-100

The above-mentioned manufacturer/trade name/catalogue number has been used as a guide to establish the standard of construction and style. Comparable Products from the following manufacturers are acceptable.

.2 Zurn

.3 Delta

.2 Individual Showers - Type SH2H (Barrier Free Use)

.1 Type: Non-scald pressure balancing shower trim and mixing valve with high temperature limit stop, shower head with flow restrictor, wall mount shower arm and wall flange, hand shower set with 1752mm flexible hose, vacuum breaker, bracket, and wall supply. In wall 3-way diverter trim and valve kit with single lever handle.

.1 Chicago Faucets No. SH-PB1-13-040

.2 Leonard

.3 Delta

2.8 **MISCELLANEOUS**

.1 Below Deck Mechanical Water Mixing

.1 Type: Bronze body, temperature adjusting dial, high temperature thermostatic limit stop, shut-off valve with automatic reset.

.2 Capacity: 1.9 L/min to 19 L/min at 140 kPa (20 psig) pressure drop, or as shown. Products from the following manufacturers are acceptable:

.1 Lawler Model No. TMM-1070

.2 Symmons

.3 Powers

.4 Leonard

.5 Or accepted equal.

.2 Combination Fixture – Type WLP1H (Barrier Free Use)

.1 Type: Combination fixture, on-floor mounting, wall waste outlet.

.1 Acorn Penal-Ware 1449-LO-2-03-M-DMS-1.6GPF-FVH

- .2 Closet Bowl: Heavy gauge type 304 stainless-steel, satin finish toilet bowl, blow out jet flushing action.
- .3 Flush Valve: Chase mounted hydraulic flush valve, 6.0 LPF
- .4 Lavatory: Heavy gauge type 304 stainless-steel, stain finish, standard oval lavatory bowl.
- .5 Supply fitting: Deck mounted spout, 5.4 LPM, Air-Trol pneumatic single temperature metering.
- .6 Waste fitting: 60mm OD toilet waste outlet and 38mm OD LAV standard elbow waste outlet.
- .7 Toilet seat: Integral contoured seat.
- .8 Fire resistant and sound-deadened cabinet
- .9 Grab bar: positioned behind toilet installed to cabinet and to wall.
- .10 Water Mixing Valve
 - .1 Thermostatic Mixing Valve
 - .1 Powers
 - .2 Acorn

3 Execution

3.1 **INSTALLATION**

.1 Water Flow Rate

- .1 Flush valve urinals and water closets.
 - .1 Adjust flush valves to provide specified water flow rate based on manufacturers calibration data for valve open time vs. inlet water pressure.
- .2 Showers:
 - .1 Adjust valve so that maximum temperature will be not more than 40°C.

.2 Barrier Free Use

- .1 Rough-in and install plumbing fixtures and drinking fountains at the recommended height for normal or handicapped use as applicable to location.
- .2 Water closets:
 - .1 Seat located between 400 and 460 mm above the floor.
 - .2 Horizontal position is between 460 and 480 mm between centerline of fixture and at least one adjacent side wall.

- .3 Lavatory:
 - .1 Top not more than 840 mm above floor.
 - .2 Horizontal position is not less than 460 mm from centerline of fixture and side wall.
 - .3 Insulate exposed supplies.
- .4 Showers:
 - .1 Locate shower head complete with hose and slide rail to be within reach of the seated position.
- .3 Wall Hung Lavatories and Urinals
 - .1 Install hanger brackets supplied with fixtures to wall with 10 mm bolt studs welded to steel anchor plates embedded within wall.
 - .2 In locations where a pipe space is provided behind wall, extend bolt studs through wall and anchor with steel back-plates. Ensure proper placement and positioning of anchor plates and bolt studs during wall construction.
- .4 Wall Hung Water Closets
 - .1 Install chair carriers of type as recommended by manufacturer for each particular installation with due regard to construction and piping details.
- .5 Floor Mounted Water Closets
- .6 On sloping floors, where the slope exceeds 6 mm from the back to the front of the fixture, level the fixture by grouting the base until the slope is within the above limits.

End of Section

1 General

1.1 **SUMMARY**

.1 Section Includes

- .1 Labor, Products, equipment, and services necessary to complete the Work of this section.
- .2 The terms “Mechanical Work”, “Mechanical Contractor” or their derivatives includes the work of Division 21, 22, and 23 unless otherwise specified.

1.2 **DESIGN AND SYSTEM REQUIREMENTS**

.1 General

- .1 Building heating and cooling systems for all new and major retrofits shall align with the goals of TransformTO Net Zero Strategy.
- .2 Primary source of building heating and cooling shall be non fossil fuel-based systems, unless not to be technically feasible.
- .3 Mechanical option analysis must consider a lifecycle cost analysis, payback period, estimated reductions of energy consumption, and estimated reductions in greenhouse gas emissions.
- .4 Consideration will be given to the existing equipment, systems and overall condition of the building prior to selection of the heating system and equipment.
- .5 The selection of the systems shall take into account system operation and maintenance with the aim of simplicity.

.2 Functional Requirements

- .1 Provisions to be in place for heat recovery when simultaneous heating and cooling is required. Provisions for free cooling shall to in place when winter cooling is required.

.3 Performance Requirements

- .1 External design conditions shall be based on the current Ontario Building Code, Appendix SB-1:
 - .1 Summer: 2.5% July dry bulb and wet bulb temperatures and wind velocity of 2.3 m/s.
 - .2 Winter: 1% January design temperature and wind velocity of 4.6 m/s.
- .2 Design conditions shall be based on project specific requirements or otherwise as per the following:

Space Type	Temperature	Humidity
Office/Conference Rooms	Summer: 24°C ± 2°C Winter: 22°C ± 2°C	30% - 60% RH
Public Spaces	Summer: 24°C ± 2°C Winter: 22°C ± 2°C	30% - 60% RH

Kitchen/Kitchenettes	Summer: 24°C ± 2°C Winter: 22°C ± 2°C	30% - 60% RH
Washrooms	Summer: 27°C ± 2°C Winter: 20°C ± 2°C	Uncontrolled
Mechanical Rooms	Summer: 38°C ± 2°C Winter: 10°C ± 2°C	Uncontrolled
Electrical Rooms	Summer: 30°C ± 2°C Winter: 10°C ± 2°C	Uncontrolled

- .3 Hydronic heat supply water temperature shall be maximum of 57.2°C (135°F)
- .4 Hydronic cooling supply water temperature shall be no less than 6.1°C (43°F)
- .5 All spaces shall be ventilated based on project specific requirements, but in no case, less than required by ASHRAE 62.1 – Latest Version.
- .6 Demand Control Ventilation (DCV) based on occupancy shall be provided to comply with ASHRAE 90.1.

1.3 CODES, REGULATIONS AND STANDARDS

- .1 Comply with municipal or provincial codes, rules and regulations and/or authorities having jurisdiction.
- .2 Comply with the National Building Code in areas where municipal or provincial regulations and/or codes are not mandatory.
- .3 Comply with the Occupational Health and Safety Act and Regulations for Construction Projects, Ontario Regulation 691.
- .4 Owners Health and Safety Requirements.
- .5 Revisions issue: Latest version as amended to date.

1.4 PERMITS AND INSPECTIONS

- .1 Material Approvals
 - .1 Obtain special inspection and approvals by CSA and/or local authorities, for materials where specified.
 - .2 Obtain such approval for the particular installation with the co-operation of the material Supplier.
- .2 Permits
 - .1 Obtain permits required for the installation of mechanical trades work including:
 - .1 Plumbing inspection
 - .2 Pressure vessel inspection.
 - .3 Piping and boiler inspection

.4 Electrical inspection

- .2 Arrange for inspections and tests and pay all fees and costs for the permits, inspections, and tests. Obtain permits immediately after notification of award of Contract.
- .3 Obtain copies of Drawings from the Consultant for submission with application for permits.

1.5 **WORKING DRAWINGS AND DOCUMENTS**

.1 Design Drawing Intent

- .1 The Design Drawings are schematic in arrangement, and describe the general design intent but do not show the exact details for the installation. They are not fabrication or installation drawings.
- .2 The Work is suitably outlined on the Drawings with regard to sizes, locations, general arrangements and installation details, and has been generally coordinated for routing of services. The routing of ductwork, piping and equipment arrangement are shown more or less in diagram except where in certain cases the Drawings may include details giving the exact locations and arrangements required.
- .3 The location of equipment, and the associated arrangement of piping, ductwork, and other material describes the general requirements of the Work. Final location is dependant on the actual equipment supplied. The Consultant reserves the right to make reasonable adjustment of up to 1 m to the location of equipment, floor drains, routing of major piping and ductwork, at no cost to the Owner.
- .4 In order to provide clarity to the arrangement of the work, not all details including valves, thermometers, pressure gauges, etc. are shown on the Plan Drawings. Refer to Schematic Drawings, standard details, and the Specification for these requirements.
- .5 Where specific installation dimensions for location of equipment and access space requirements are indicated on the Drawings, install to these requirements.
- .6 Where standard details are provided, these show the general installation requirements, and are applicable to each occurrence in the Work, unless otherwise specified or shown.

.2 Contractor Coordination Responsibilities

- .1 Provide the services of a mechanical/electrical coordination supervisor, to coordinate this division of the Work, as well as providing coordination with other divisions and/or contracts. This supervisor may be full time or part time on site, as appropriate to the work stage and complexity of the work, at the discretion of the Owner.
- .2 Where multiple trades are required, the mechanical coordinating supervisor shall be the lead coordinator.
- .3 The Owner reserves the right to require the coordinating supervisor to increase their attendance at site, at no cost to the Owner, if in the Owner's opinion the current level of coordination is not sufficient for the progress of the Work.
- .4 Make changes and modifications as necessary to ensure coordination and to avoid interference and conflicts with other trades.

- .5 Prepare Construction/Installation/Fabrication Drawings, coordinated with other trades and contracts, as required.
 - .1 Provide sufficient detail to disclose critical interferences of major equipment and services to ensure adequate accessibility.
 - .2 Specific dimensions for equipment location or access which are shown on the Consultants drawings.
 - .3 Indicate sleeves, openings, and stress points (such as anchors, guides and inserts)
 - .4 Indicate deviation in sizes and weights and also in water, drainage, electric power or other service requirements for all equipment proposed which is different from those shown on the Design Drawings.
 - .5 Provide these Drawings to other trades for coordination with their Work.
 - .6 Update these Drawings as part of the As-Built Drawings, showing actual locations of major equipment, services, access doors, shut-off valves, etc.
 - .6 The Design Drawings show the major requirements for the installation of equipment based on one manufacturer's requirements but may not show all installation requirements. The Contractor will include as part of the Work the specific manufacturer's installation requirements for the equipment actually provided by the Contractor.
 - .7 The Construction/Installation/Fabrication Drawings are not to be submitted as Shop Drawings. Make them available for viewing at site when requested by the Consultant.
 - .3 Review Before Proceeding (HOLD)
 - .1 Where the word "HOLD" appears on Drawings and other Contract Documents, the Work is included in the Contract.
 - .2 Execute such Work only after verification of dimensions, verification of materials and obtaining Consultant's written permission to proceed.
- 1.6 **COORDINATION AND EXAMINATION**
- .1 Reference
 - .1 To Section 01 10 00.
 - .2 Examination
 - .1 Carefully examine Work and Drawings of all related trades and thoroughly plan the Work to avoid interferences.
 - .2 Report defects which would adversely affect the Work. Do not commence installation until such defects have been corrected.
 - .3 Coordination
 - .1 Coordinate Work of Mechanical Division such that items will properly interface with Work of other divisions. Prepare Installation Drawings of critical locations and submit to Consultant for review.

.2 Architectural Drawings, or in their absence, Mechanical Drawings govern all locations.

.4 Measurements and Deviations

.1 Where any parts of the mechanical work are specifically located by dimensions on the Drawings, check and verify these dimensions on site prior to installation.

.2 Before installing piping, review Architectural, Structural and Electrical Drawings with Mechanical Drawings

.3 Where interference may occur and departures from arrangements as shown are required, consult with other trades involved, come to agreement as to changed locations or elevations and obtain approval of the Consultant for proposed changes before proceeding with the Work.

.4 Where site conditions require minor deviations from indicated arrangements or locations, make such changes on approval of the Consultant without additional cost to the Owner.

.5 Should any discrepancies occur during installation of mechanical work which will necessitate major revisions to the mechanical trades work or the work of other trades or contractors, notify the Consultant immediately and obtain written authorization before proceeding with the work.

1.7 **SCAFFOLDING AND HOISTING EQUIPMENT**

.1 References

.1 To Section 01 10 00.

.2 Building Attachments

.1 Obtain prior written Consultant's approval before drilling, cutting or welding of the building steel or building structure for erection of materials or equipment.

.3 Overloading

.1 During installation of mechanical work, do not load any part of the building structure with a load greater than it is capable of bearing.

.2 Should any accident occur or damage result through the violation of this requirement, the contractor shall be held solely responsible.

.3 Design temporary supports used during installation as being equivalent to permanent supports.

.4 Remove temporary supports at completion of Work.

1.8 **CUTTING AND PATCHING**

.1 Do not cut, remove or burn structural parts or sections of the building, whether they are steel, concrete or masonry without the written authorization of the Consultant.

.2 Should cutting, repairing, and patching of previously finished work of other trades be required to allow installation of mechanical work, pay all costs for the trade concerned to perform the work.

- 1.9 **EXISTING SERVICE**
- .1 Tie-In to Existing Services
- .1 Do not shut down or make tie-in connections to any existing service without written permission of the Owner and/or Consultant.
- .2 Arrange work to minimize interruption to physical access to the building.
- .3 Include for all costs associated with making connections to existing services, including but not limited to, cutting and patching of existing floors, partitions, ceilings and finishes.
- .2 Work in Existing Buildings
- .1 Route pipes, ducts, conduits, and other services to avoid interference with existing installation.
- .2 Relocate existing services and equipment to suit installation of new work.
- .3 Cut back and cap existing services not being used, so that finished Work presents a neat and clean appearance.
- .4 Unless noted to be reused, fixtures and materials being removed become the property of the Contractor and are to be removed from site, unless otherwise noted.
- .3 Continuity of Services
- .1 Be responsible for any damage to existing systems, including insulation and coverings, when making connections.
- .2 Keep existing buildings in operation with minimum length of shut-down periods.
- .3 Include overtime work to tie-in piping or wiring at night or on weekends.
- 1.10 **PROVISION FOR FUTURE**
- .1 Future Equipment
- .1 Where indicated as reserved for future equipment or services, leave identified space clear and install services and equipment so that connections can be made in the future.
- 1.11 **SUBMITTALS**
- .1 Shop Drawings
- .1 Conform to Section 01 33 00 and the following.
- .2 Shop Drawings showing more than one size or model will not be considered unless properly marked up.
- .3 For electrically driven, and fuel fired appliances, provide the following information:
- .1 Electrical characteristics including voltage, phase, frequency and power rating.
- .2 For motors, NEMA, class and efficiency ratings

- .3 Fuel input ratings, including flow rates and pressures.
- .4 Equipment performance ratings, including flow rates, pressures, efficiencies, part load values and/or efficiencies (IPLV's), plotted flow characteristics (pump and fan curves) with operating points clearly plotted.
- .4 For other equipment include the following information:
 - .1 Equipment performance ratings, including flow rates, pressures drop.
 - .2 Electrical control power requirements.
- .5 For all equipment, include the following:
 - .1 Equipment dimensions and weights.
 - .2 Itemized product description with optional items clearly marked as being included.
- .6 Provide wiring Shop Drawings:
 - .1 Wiring diagrams and schematics for all equipment which has electrical controls or devices furnished with the equipment.
 - .2 Wiring diagrams alone are not sufficient; schematic and interconnecting drawings, and sequence of operation of equipment are required for review.
 - .3 Clearly indicate the materials and/or equipment being supplied:
 - .1 Details of construction, finish, accurate dimensions, capacities and performance.
 - .2 Certify Drawings correct for construction by the manufacturer, before submission.
 - .3 Identify Equipment Shop Drawings with designations as shown on the Drawings or in the Specifications.
 - .4 If not complied with, Shop Drawings will not be reviewed and will be returned to the Contractor.
 - .4 Coordinate equipment which attaches to and/or where external wiring provided connects to other equipment.
 - .1 Do such coordination whether such equipment is supplied under this or other contracts or subcontracts, for which relevant information will be provided by Owner/Consultant.

1.12 **"AS-BUILT" RECORD DRAWINGS**

- .1 Reference
 - .1 Conform to Section 01 33 00.
 - .2 Maintain an accurate dimensional record of all underground piping and all deviations and changes in aboveground piping and equipment.

1.13 **INSTALLATION AND START-UP INSTRUCTIONS**

- .1 Reference
 - .1 Conform to Section 01 33 00.
 - .2 Submit copies of installation instructions and copies of start-up instructions for any item of equipment when requested by the Consultant.
- 1.14 **OPERATING AND MAINTENANCE INSTRUCTION MANUALS**
 - .1 Reference
 - .1 Conform to Section 01 33 00.
 - .2 In addition, include the following in the manuals:
 - .1 Non-dimensional layout showing location of all electrical devices on mechanical equipment.
 - .2 Operating instructions, including start-up and shut-down procedure.
 - .3 Lubricating instructions and recommended cycle of lubrication for each item of equipment, including various types of lubricants.
 - .4 List of spare parts.
 - .3 All the above applies to component parts of equipment whether they are manufactured by the Supplier of the equipment or are supplied as a component part of an item of equipment.
- 1.15 **CLEANING, TESTING AND APPROVAL RECORDS**
 - .1 Records
 - .1 Maintain records of all pressure tests and flushing and sterilization tests, glycol/water concentrations, inspections and approvals by the plumbing inspector.
 - .2 Forward these tests to the Owner on completion of the Work in accordance with Section 01 33 00.
 - .3 Forward to Consultant, copy of records on site on completion of each test, cleaning operation, etc.
- 1.16 **DIMENSIONS AND QUANTITIES**
 - .1 Dimensions
 - .1 Dimensions shown on Drawings are approximate.
 - .2 Verify dimensions by reference to Shop Drawings and field measurement.
 - .2 Quantities
 - .1 Quantities or lengths indicated in any of the Contract Documents are approximate only and shall not be held to gauge or limit the Work.
- 1.17 **TRADE QUALIFICATIONS**

- .1 Applicable to the following trades
 - .1 Sheet metal workers
 - .2 Plumbers
 - .3 Steamfitters
- .2 Requirements
 - .1 Trade workers to have a certificate of qualification as journeyman or apprentice registration for the province where the Work is performed or an interprovincial certificate.
 - .2 Ratio of journeyman to apprentice: Not to exceed the defined ratio in the Apprenticeship Act of Ontario.
 - .3 On award of Contract, submit a list of trade journeyman and apprentices, together with their certificate and registration numbers.
 - .4 Certificates and registration must be provided to the Consultant on request.
 - .5 Maintain on-site an up-to-date record listing journeyman and apprentices working on site.
- 2 Products
- 2.1 **MATERIALS AND EQUIPMENT**
 - .1 Materials
 - .1 Use new materials and equipment, free from defects impairing strength and durability, as specified or specified equivalent.
 - .2 Of Canadian manufacture wherever possible.
 - .3 Labelled or listed as required by code and/or inspection authorities.
 - .4 Design of mechanical systems has been based on the first listed Supplier and model number/size stated on the equipment schedules on the Drawings. Bear all costs due to physical or performance differences between stated equipment and proposed equipment. These differences include but are not limited to size, layout, arrangement, connection size, location and/or quantity of connections, or performance differences such as noise, power requirements, flow, throw, etc.
 - .2 Equipment/Structure Coordination
 - .1 Locations and dimensions of curbs and roof and floor opening framing, where indicated on the Drawings, are based on an arrangement to suit the above-named Supplier.
 - .2 Be responsible to verify the actual size requirements of the openings and notify the Consultant immediately in case the dimension of the unit supplied and the connecting ductwork/piping, etc. are at variance with the dimensions given on the Drawings.
 - .3 Bear all costs for modification of curbs and floor/roof openings resulting from failure to notify the Consultant prior to the fabrication or construction of opening framing and curb.

2.2 STANDARD SPECIFICATIONS

.1 Product Quality

- .1 Ensure that the chemical and physical properties, design, performance characteristics and methods of construction of all Products provided comply with the latest issue of applicable standard specifications issued by authorities having jurisdiction.
- .2 Do not apply such standard specifications to decrease the quality of workmanship, Products and services required by the Contract Documents.

2.3 MANUFACTURER'S NAMEPLATES

.1 Metal Nameplates

- .1 Provided with raised or recessed lettering, on each piece of equipment.
- .2 Mechanically fasten nameplate on a metal stand-off bracket arranged to clear insulation.
- .3 Mount on same stand-off Underwriters Laboratories and/or CSA registration plates.

.2 Nameplate Data

- .1 Indicate:
 - .1 Size
 - .2 Capacity
 - .3 Equipment model
 - .4 Manufacturer's name
 - .5 Serial number
 - .6 Voltage
 - .7 Cycle
 - .8 Phase and power of motors

2.4 PHASE AND POWER OF BUILDING ATTACHMENTS

.1 Welding Studs

- .1 Maximum size: 10 mm for attaching miscellaneous materials and equipment to building steel.
- .2 If the weight of materials or equipment require bolts or studs larger than 10 mm diameter, use steel clips or brackets, secured to building steel by (welding or) bolting as approved by the Consultant.
- .3 Acceptable Manufacturers:
 - .1 Graham
 - .2 Omark
 - .3 Nelson

- .2 Self Drilling Expansion Type Concrete Inserts
 - .1 To secure miscellaneous equipment and materials to masonry or concrete construction already in place.
 - .2 Of sufficient number and size to prevent concrete from breaking away.
 - .3 The use of powder or power actuated fasteners will not be allowed unless prior written approval is obtained from the Consultant.
 - .4 Acceptable Manufacturers:
 - .1 ITW "Redhead"
 - .2 Star "SSS"
 - .3 USM "Parabolt"
- .3 Supports For Any Suspended Items
 - .1 Do not fasten/attach to or extend through steel pan type roofs or through concrete slab roofs.
- .4 Beam Clamps
 - .1 Two-bolt design, and of such type that the rod load is transmitted only concentrically to the beam web centreline.
 - .2 The use of "C" and "I" beam side clamps, etc., will not be allowed without written consent of the Consultant.
 - .3 Acceptable Manufacturers:
 - .1 Grinnell
 - .2 Myatt
 - .3 Carpenter & Paterson
 - .4 Taylor Pipe Supports

2.5 **DRIVES AND ACCESSORIES**

- .1 Drives
 - .1 V-belt drive selection: 150 percent of the motor size rating.
 - .2 Sheaves: Cast iron construction with machined grooves.
 - .1 Sheaves 75 mm size and larger diameter: taper lock bushings.
 - .2 Multi-belt drives: Matched sets.
 - .3 Statically and dynamically balance all sheaves as an operating unit.
 - .3 Adjustable sheaves:
 - .1 Motors less than 11 kW (15 HP) rating: Adjustable pitch motor sheave with diameter range selected to obtain specified RPM of the driven equipment at approximately the mid-point setting of the sheave.
 - .4 Fixed sheaves:

- .1 Motors of 11 kW (15 HP) and greater: Solid type.
- .2 Drive Couplings
 - .1 Acceptable Manufacturers:
 - .1 Falk
 - .2 Fast
 - .3 Thomas
 - .3 Lubricating Devices
 - .1 Equipment to have oil reservoirs with level indicators, or pressure grease fittings.
 - .2 Inaccessible fittings: Provide extended tubes to an accessible location.
 - .3 Grease fittings: Zerk or Alemite.
 - .1 All fittings of one type.
- .4 Drive Guards
 - .1 To OSHA requirements.
 - .2 Build guards of all welded construction on exposed rotating parts or elements and on all drives including the following:
 - .1 V-belt drives
 - .2 Flexible couplings
 - .3 Gear drives.
 - .3 Construction (except fan drives):
 - .1 Total enclosure type fabricated of minimum 1.3 mm (18 gauge) black sheet steel.
 - .2 Hinged side to allow access for lubrication, inspection or removal of the drive parts.
 - .3 Maximum clearance of openings in guards to rotating parts: Not to exceed 13 mm.
 - .4 Make provision for slide rail adjustment.
 - .4 Construction for fan drives:
 - .1 V-belt drives: Total enclosure type as specified above.
 - .2 Enclosure sides: 13 mm mesh, 2.7 mm wire screening.
 - .3 Tachometer holes at shaft centres, reinforced as required to maintain rigidity of guard.
 - .5 Flexible drive coupling guards:
 - .1 Location: Between motor and driven equipment.

- .2 Minimum 1.3 mm (18 gauge) black sheet steel, securely fastened to the equipment baseplate and readily removable.
- .3 Leave a clearance of approximately 13 to 25 mm between the guard and the coupling.
- .4 Extend the guard to within 13 mm of both motor and driven equipment housing.
- .6 Rework any substandard guards supplied with mechanical equipment to conform to the above requirements.

2.6 **SEALANTS, CONCRETE AND GROUTS**

- .1 Pipe Sleeve Seals
 - .1 Acceptable Manufacturers:
 - .1 Thunderline "Link-Seal" Series LS
- .2 Concrete
 - .1 Strength: 25 MPa concrete: to CSA-A23.1/A23.2
- .3 Concrete Grouts
 - .1 Acceptable Manufacturers:
 - .1 Sternson "M-Bed Standard"
 - .2 Sika "Sikagrout 212"
 - .3 Master Builders "Construction Grout"
 - .4 Meadows "CG-86"
 - .5 Euclid "Euco NS Grout"
 - .6 CPD "Non-Shrink Grout"
- .4 Bonding Agents
 - .1 Acceptable Manufacturers:
 - .1 Sika "Sikadur 32" Hi-Mod
- .5 Caulking Compounds
 - .1 Acceptable Manufacturers:
 - .1 Denso-Plast
- .6 Firestopping
 - .1 ULC listed firestopping assembly.
 - .2 Rating to suit wall and floor penetrations.
 - .3 Acceptable Manufacturers:
 - .1 Fire Stop Systems

- .2 Dow Corning
- .3 3M
- .4 Tremco
- .5 A/D Fire Protection System
- .6 Johns Manville
- .7 Hilti

2.7 MISCELLANEOUS

.1 Access Doors

- .1 Minimum size: 200 mm x 200 mm size, unless otherwise specified on the Drawings or in other divisions of the Specifications, or as required to replace or repair said equipment.
- .2 Material:
 - .1 Fabricated of 2.5 mm (12 gauge) bonderized steel.
 - .2 Fabricated of 2.5 mm (12 gauge) stainless steel in areas finished with tile or marble surfaces.
 - .3 Flush mounted, concealed hinges and screwdriver lock.
 - .4 Plast lock and anchor straps.
 - .5 Doors to be of a type and fire rating to suit the particular type of wall or ceiling construction in which they are to be installed.
- .3 Acceptable Manufacturers:
 - .1 E.H. Price
 - .2 Titus
 - .3 Controlled Air
 - .4 Williams (S.M.S.)
 - .5 Acudor

.2 Isolating Unions

- .1 Acceptable manufacturers:
 - .1 Epco
 - .2 Marpac "Petro"
 - .3 Corrosion Service

.3 Fabricated Equipment Supports (Floor Stands and Ceiling or Wall Mounted Supports)

- .1 Structural steel members of welded construction or steel pipe and fittings, suitably braced and secured to the floor by mild steel floor pads or pipe flanges with bolts or anchors.

- 3 Execution
- 3.1 **GENERAL**
 - .1 Execute Work in accordance with requirements specified in the various sections of Division 23.
 - .2 Lay out Work of each trade so that it does not interfere with work under other divisions of Specifications.
 - .3 Make good any damage to Owner's property or other trade's work caused by improperly locating or carrying out of Work.
 - .4 Supply anchor bolts and templates for installation by other divisions.
 - .5 Location of pipes, ductwork, raceways, and equipment may be altered without extra cost provided alteration is made before installation.
- 3.2 **EQUIPMENT INSTALLATION**
 - .1 General
 - .1 Install equipment in a compact, neat and workmanlike manner.
 - .2 Align, level and adjust for satisfactory operation.
 - .3 Install in such a manner that connecting and disconnecting of piping and accessories can be made readily and that all parts are easily accessible for inspection, operation, maintenance, and repair.
 - .4 Install and start up items of equipment in accordance with the manufacturer's printed installation and operating instructions.
 - .2 Noise and Vibration
 - .1 Noise and vibration levels of equipment and systems shall be within design intent.
 - .2 If noise or vibration levels created by any mechanical equipment and systems and transmitted to occupied portions of building or other mechanical work are over the limits, make all necessary changes and additions as approved by the Consultant without additional cost.
 - .3 Lubrication
 - .1 Lubricate all equipment prior to start up in accordance with the manufacturer's printed instructions.
 - .2 Supply all lubrication including sufficient quantity for drainage and refilling of oil sumps, etc., when required by manufacturer's instructions.
- 3.3 **EQUIPMENT SUPPORTS**
 - .1 Housekeeping Bases and Pads
 - .1 Construct bases and pads for all mechanical equipment as required to allow the proper performance of the equipment.
 - .1 Exception: Bases and pads detailed on the Structural Drawings are for purposes of design intent only.

- .2 Construction:
 - .1 20 m deformed dowel anchors to concrete slabs (six per base or pad).
 - .2 Drill slabs and grout dowels in place.
 - .3 Bond pads and bases to floor. Use grout and bonding agent according to manufacturer's printed instructions.
 - .4 Height of bases and pads: Minimum of 150 mm or as shown.
 - .5 Width and length: Sufficient to extend 75 mm beyond centreline of anchor bolts, or to extend a minimum of 50 mm beyond equipment base.
 - .6 Chamfer all upper perimeter edges of base.
 - .7 On approval of the Consultant, concrete pads of 150 mm maximum thickness may be poured under equipment after equipment is set in place, with concrete fully vibrated into place under the equipment base plate.
- .3 Layout coordination:
 - .1 Verify size of bases shown on Structural Drawings with actual requirements and advise the Consultant and the respective trades if change in size or shape of pad is required.
- .4 Anchor bolts:
 - .1 Supply anchor bolts required for mechanical equipment unless indicated otherwise on the Drawings.
 - .2 Sleeve anchor bolts.
 - .3 Supply anchor bolts and sleeves to trade constructing bases in sufficient time for setting in formwork prior to placing concrete and provide anchor bolt location drawing or template for locating anchor bolts.
 - .4 Check anchor bolt locations for proper position before concrete is poured.
- .2 Setting and Alignment of Equipment - Rotating Equipment (fans, pumps, etc):
 - .1 Use millwrights to set and align to lines established with an engineer's level.
 - .2 Shim equipment using standard brass or bronze shim stock of suitable thickness to provide proper level and alignment.
 - .3 Place 25 mm minimum thick grout between equipment base and concrete pad or foundation.
 - .4 Have Consultant approve equipment settings for equipment mounted on concrete pads or foundations prior to grouting.
 - .5 Re-check alignment prior to start-up of equipment.
- .3 Floor Stands
 - .1 Provide stands for floor mounted equipment.
 - .2 Secure to the floor by mild steel floor pads or pipe flanges with bolts or anchors.

- .4 Ceiling or Wall Mounting
 - .1 Where ceiling or wall mounting is indicated or required, provide a suspended platform, bracket, or shelf.
 - .2 Materials: Standard steel members and steel plates of welded construction throughout.
 - .3 Attach to building steel with rod hangers and beam clamps or attach to precast structure as the case may be.
 - .4 Place additional structural steel as required between building steel where beam spacing does not meet requirements.
 - .5 Do not use inserts unless specifically shown on the Drawings or approved by the Consultant for any particular item of equipment.
 - .6 Attach brackets or shelves to vertical member or sections of the building structure as hereinbefore specified.
- .5 Suspended Equipment Support
 - .1 Provide double locknuts on suspended equipment supports as follows.
 - .2 Upper attachment
 - .1 Beam clamp: Provide a double nut on end of beam clamp tie rod.
 - .2 Supplemental steel: Double nut all mechanical fasteners fixing supplemental steel to building structural steel.
 - .3 Middle attachment
 - .1 Upper load bearing point, to beam clamp: Not applicable.
 - .2 Upper load bearing point, to supplemental steel: Double nut on top of load bearing point, single locknut on underside of bearing point.
 - .3 Lower load bearing point, all: Double nut on underside of bearing point, single locknut on top of bearing point.
 - .4 Lower attachment
 - .1 Trapeze hanger or equipment fastening: Refer to middle attachment requirements above.
 - .5 Apply Loctite 242 to the second nut (and matchmark both nuts).

3.4 MISCELLANEOUS STEEL

- .1 Hang or support equipment, piping, ductwork etc., with miscellaneous structural supports, platforms, braces as may be required unless Drawings or other sections of the Specifications state otherwise.
- .2 Materials and Fabrication
 - .1 Conform to:
 - .1 CAN/CSA-S16.1-M for materials, design of details and execution of the work.

- .2 CSA-G40.20/G40.21 grade 300W for structural shapes, plates, etc.
 - .3 CSA W47.1 for qualification of welders.
 - .4 CSA W48.1-M for electrodes (only coated rods allowed).
 - .5 CSA W59-M for design of connections and workmanship.
 - .6 CSA W117.2 for safety.
- .3 Construction
- .1 Welded construction wherever practicable.
 - .2 Chip welds to remove slag and grind smooth.
 - .3 Bolted joints allowed for field assembly using high strength steel bolts.
- .4 Painting and Cleaning
- .1 Clean steel to Steel Structures Painting Council SSPC-SP6, Commercial Blast Cleaning.
 - .2 Apply one coat of oil alkyd primer conforming to CISC/CPMA 2.75 to all miscellaneous steel.
 - .3 In the field, touch up all bolt heads and nuts, previously unpainted connections and surfaces damaged during erection with primer as hereinbefore specified.
 - .4 Apply two coats of primer to all surfaces which will be inaccessible after erection.
 - .5 Thoroughly remove all foreign matter from steelwork on completion of installation.
- 3.5 **CONCRETE INSERTS**
- .1 Install inserts required for attachment of hangers, either for suspension of piping or equipment.
 - .2 For masonry or poured concrete construction use expansion type units. Insert into the concrete after concrete has cured. Do not use anchors or inserts installed by explosive means.
- 3.6 **FLASHINGS**
- .1 Flash and counter flash all gas vent stacks through roof, with Thaler Model MEF-4A.
 - .2 Safety vents, plumbing vents and all other pipes passing through roofs, stack flashings will be supplied and installed by roofing trade, unless otherwise shown on Drawings.
- 3.7 **FIRE STOPPING**
- .1 Submit Shop Drawings, including the following information:
 - .1 ULC/CUL listing number.
 - .2 Installation Drawings for each type of penetration.
 - .3 Installation materials.
 - .2 General

- .1 Seal piping, ductwork, conduits and miscellaneous support steel penetrating fire separations.
- .2 Install firestopping in accordance with manufacturer's instructions and ULC listing requirements.
- .3 Provide a written report on completion of firestopping, by area or floor if necessary, indicating the Work is completed and ready for inspection. Do not cover over firestopping, including installation of walls and ceilings, until Work is inspected.

3.8 **ACCESS DOORS**

- .1 Supply access doors for installation by other trades in walls or ceilings where accessibility is required for the operation and/or maintenance of:
 - .1 Concealed valves
 - .2 Traps
 - .3 Cleanouts
 - .4 Dampers
 - .5 VAV boxes
 - .6 Control equipment.

3.9 **SPARE PARTS**

- .1 Furnish spare parts.
 - .1 One set of packing glands for each size of pump gland.
 - .2 One casing joint gasket for each size pump.
 - .3 One head gasket for each heat exchanger
 - .4 One glass for each gauge glass
 - .5 One set of V-belts for each drive
 - .6 One filter cartridge or set of filter media for each filter or filter bank installed.

3.10 **PROTECTION**

- .1 Protect Work and materials from weather and other hazards before, during, and after erection, and keep in a clean and orderly manner.
- .2 Protect pipe ends, valves and parts of equipment left unconnected to prevent damage or intrusion of foreign matter. Provide pipe caps for threaded male connections and plugs for threaded female connections.
- .3 Protect plumbing fixtures or mechanical equipment having a baked enamel finish by covering with polyethylene sheet securely held in place.
- .4 Protect finished floor slabs from scuffing, cracking, chipping, staining, cutting and other damage resulting from work of this Contract.

- .1 Place a 19 mm thick plywood underlaid with 25 mm thick polystyrene insulation board adhered to same, over floor areas when working from or over, such surfaces.
- .2 Provide such protection below hoist rigs, ladders, pallets of material, and in other circumstances where the flooring is exposed to potential damage.
- .3 Work damaged due to failure in providing such protection is to be removed and replaced, or repaired, as directed by the Owner, at no increase in Contract Price.

3.11 **MAINTENANCE OF BEARINGS**

- .1 During Construction
 - .1 Turn-over rotating equipment at least once a month after delivery.
 - .1 Run-in sleeve type bearings in accordance with manufacturer's recommendations.
 - .2 Drain, flush out and refill with new charge of oil or grease.
 - .3 Protect bearings, shafts and sheaves against damage, corrosion, and dust accumulation.
 - .4 Provide extended grease nipples for bearing lubrication.

3.12 **CONSTRUCTION REVIEW**

- .1 The construction review will include milestone and periodic reviews.
- .2 Milestone Reviews
 - .1 Specific milestone reviews will be performed by the Consultant for compliance with the Ontario Building Code, including any or all of the following:
 - .1 Buried drainage.
 - .2 Before installation of roofing membrane
 - .3 Before closure of service shafts and pipe chases
 - .4 Before closure of walls
 - .5 Before closure of ceilings
 - .6 Equipment demonstration and training
 - .7 Substantial Performance and deficiency review
 - .8 Total Performance
 - .2 Some or all of these reviews are of portions of the Work which may be concealed. If Work is enclosed before the Consultant can review the installation, the Consultant may direct the Contractor to expose the Work for it to be examined, at no additional cost to the Project, including rework affecting other trades.
 - .3 If deficiencies are noted during any review where Work will be enclosed, correct noted deficiencies and have them reviewed by the Consultant prior to the Work being enclosed.

- .4 Provide a minimum of seven Calendar Days written notice to the Consultant when requesting each review date.
 - .5 The Consultant will provide a checklist to the Contractor of required milestone reviews which must be completed. Maintain this list on site along with identified test reports and make available for Consultants review when requested. When completed, include this checklist form with the test reports forms specified in Section 23 08 16.
- .3 Periodic Reviews
- .1 The Consultant will conduct periodic reviews as required for the Project. These reviews are for the benefit of the Owner to describe the progress and workmanship of the Work and are not intended as any form of quality assurance for the Contractor.
 - .2 Deficiencies will generally not be reported as part of this review, as the Work has not been reported by the Contractor as being complete. However, deficiencies may be reported where it may not be possible to correct the Work at a later date, or at great expense.
 - .3 The Contractor shall not rely on these periodic reviews to identify deficiencies during the progress of the Work.
- .4 Deficiency Review
- .1 The Consultant will conduct a deficiency review only after the Contractor submits an application for Substantial Performance. As part of this application, the Contractor shall submit their own comprehensive deficiency list of incomplete or incorrect work. Failure by the Contractor to list any deficiency does not relieve the Contractor from correcting or completing the Work.
 - .2 The Consultant shall review the work and any deficiencies noted will be classified as Major or Minor.
 - .1 Major deficiencies are required to be corrected as part of obtaining Substantial Performance.
 - .2 Minor deficiencies may be corrected before or after Substantial Performance.
- .5 Final Review
- .1 The Consultant will conduct a final review only after the Contractor submits a declaration that all of the following has been completed:
 - .1 Noted deficiencies have been corrected.
 - .2 Final As-Built Drawings have been submitted to the Owner.
 - .3 Final Operating and Maintenance Manuals have been submitted to the Owner.
 - .4 Final test reports, including alternate season tests have been submitted to the Owner.
 - .2 The Consultant will only review the deficiency list to confirm these deficiencies have been corrected.

3.13 **PERFORMANCE TESTING AND BALANCING**

- .1 Refer to 23 08 00 series.

3.14 **ADJUSTMENT AND OPERATION OF SYSTEMS**

- .1 When the Work is complete:
 - .1 Adjust equipment items of the various systems for proper operation within the framework of design intent, and the operating characteristics as published by the equipment manufacturer.
 - .2 Complete additional instructions are specified under the respective sections of Division 23.
- .2 The Consultant reserves the right to require the services of an authorized representative of the manufacturer in the event that any item of equipment is not adjusted properly.
 - .1 Arrange for such services and pay all costs thereof.
 - .2 After completion of adjustments, place systems in full operating condition and advise Consultant that the Work is ready for acceptance.

3.15 **ACCEPTANCE**

- .1 After all equipment has been installed and adjusted and all systems balanced:
 - .1 Conduct performance tests in the presence of the Consultant and the Owner.
 - .2 Arrange the time for these tests at the convenience of the Consultant and Owner.
 - .3 Conduct tests under climatic circumstances to ensure complete and comprehensive tests and of such a manner and duration as the Consultant may deem necessary.
- .2 During these tests:
 - .1 Demonstrate the correct performance of all equipment items and of the systems they comprise.
 - .2 Should any system or any equipment item fail to function as required, make such changes, adjustments, or replacements necessary to meet performance requirements.
 - .3 Repeat tests until requirements have been fully satisfied and all systems accepted by the Consultant.

End of Section

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- 1 General
- 1.1 **SUMMARY**
 - .1 Section Includes
 - .1 Labor, Products, equipment, and services necessary to complete the Work of this section.
 - .2 This section shall be read in conjunction with Appendix A City of Toronto Corporate Building System Design Requirements. Appendix A shall take precedence where there is a conflict in this Section.
- 1.2 **RELATED SECTIONS**
 - .1 Division 26: Electrical
 - .1 Power wiring between the electrical distribution system and motor or equipment.
 - .2 Motor Control Centres (MCC).
 - .3 Motor starters including variable frequency drives and soft-start starters, except where specified as an integral component of the mechanical equipment.
 - .4 Fused or unfused disconnects, except where specified as an integral component of the mechanical equipment.
- 1.3 **REFERENCE STANDARDS**
 - .1 Standards
 - .1 CSA 390 M (motor efficiency ratings).
 - .2 IEEE 112 (motor efficiency ratings) for three phase motors.
 - .3 IEEE 114 (motor efficiency ratings) for single phase motors.
- 1.4 **CODES AND REGULATIONS; PERMITS, COSTS AND FEES**
 - .1 Codes
 - .1 Electrical Safety Authority (ESA).
 - .2 Canadian Electrical Code.
 - .2 Permits
 - .1 Obtain electrical permits and inspections and pay all costs for the portion of the Work performed by this division.
- 1.5 **QUALITY ASSURANCE**
 - .1 Contractor Qualifications
 - .1 Electrical wiring for mechanical trades work performed by a specialist firm with an established reputation in this field.
- 1.6 **SUBMITTALS**
 - .1 Shop Drawings

- .1 Submit in accordance with Section 01 33 00.
 - .2 Include nameplate data, motor efficiencies, NEMA rating and insulation rating.
- 2 Products
- 2.1 **MOTORS**
- .1 General
 - .1 Motor nameplate rating:
 - .1 Not less than input brake horsepower of driven equipment plus 5%, at specified operating conditions, and
 - .2 Not less than the scheduled minimum horsepower.
 - .3 Premium efficiency.
 - .4 Selected for chemical duty or explosion proof where scheduled.
 - .5 Service factor: 1.15 minimum for three phase motors.
 - .2 Single Phase Motors
 - .1 Continuous duty, resilient mount.
 - .1 Motor rating: Less than 375 W (1/2 HP).
 - .2 Voltage, frequency, and RPM as scheduled.
 - .3 Three Phase Motors, 350 W to 525 W (1/2 HP to 3/4 HP)
 - .1 EEMAC, Class B, Type F insulation, squirrel cage induction, continuous duty, ball bearing.
 - .1 Voltage, frequency, and RPM as scheduled.
 - .2 Motor type: ODP with 90°C (194°F) temperature rise (TEFC with 80°C (176°F) temperature rise) unless otherwise scheduled.
 - .3 1800 RPM or as scheduled.
 - .4 Three Phase Motors, 750 W (1 HP) and Larger
 - .1 EEMAC, T-Frame, Class B, Type F insulation, squirrel cage induction, continuous duty, ball or sleeve bearing.
 - .1 Motor efficiency: Premium efficiency.
 - .2 Voltage and frequency as scheduled.
 - .3 Motor type: TEFC with 80°C (176°F) temperature rise (ODP with 90°C (194°F) temperature rise) unless otherwise scheduled.
 - .4 1800 RPM or as scheduled.
 - .5 Three Phase Motors, 750 W (1 HP) and Larger, Variable Frequency Drive Applications
 - .1 EEMAC, T-Frame, Class B, Type F triple build, form wound insulation, squirrel cage induction, continuous duty, ball bearing, 40°C (104°F) temperature rise.

- .1 Motor efficiency: Premium efficiency.
- .2 Inverter duty rated.
- .3 Maximum speed turndown: 25%.
- .4 Voltage and frequency as scheduled.
- .5 Motor type: ODP for variable torque applications, TEFC for constant torque applications.
- .6 1800 RPM or as scheduled.
- .6 Multiple Speed Motors
 - .1 For 2:1 speed ratios: Single winding consequent pole (two winding).
 - .2 For all other speed ratios: Two winding.
- .7 Grounding Lug
 - .1 Motors less than 15 kW (20 HP):
 - .1 Ground lug on motor terminal box.
 - .2 Motors 15 kW (20 HP) and larger:
 - .1 Directly bolted to motor frame.
 - .2 Located inside terminal box on motor.
- .8 Winding Temperature Sensors - RTD's
 - .1 Where required:
 - .1 Motors greater than 224 kW (300 HP).
 - .2 Inverter duty motors greater than 112 kW (150 HP).
 - .2 Type:
 - .1 RTD sensor in each winding, wired to separate terminal box on side of motor.
 - .2 RTD relay/control circuit by others.
- .9 Winding Temperature Sensor Protection
 - .1 Where required:
 - .1 Motors 37 kW (50 HP) up to 225 kW (300 HP).
 - .2 Motors 18.6 kW (25 HP) up to 30 kW (40 HP) located in air ducts, plenum chambers or in air stream inside air conditioning equipment.
 - .2 Type:
 - .1 Winding temperature sensor wired to disconnect motor on high temperature.
 - .2 120 V control transformer.

- .3 "Push-to-Test" red pilot light (high winding temperature).
- .4 Reset button.
- .5 Supply control unit to the Contractor under Division 26 for installation in motor starter.
- .6 Acceptable Manufacturers:
 - .1 Siemens Canada Limited - PTC thermistor with 3-UN2131 tripping unit.
- .10 Winding Temperature Thermostat
 - .1 Where required:
 - .1 Single phase, and three phase motors up to 15 kW (20 HP) located in air ducts, plenum chambers or in air stream inside air conditioning equipment.
 - .2 Type:
 - .1 Klixon Motor winding thermostats.
- 2.2 **WIRING AND CONDUIT**
 - .1 Wire
 - .1 RW-90 X-link.
 - .2 Minimum No. 12 AWG for power.
 - .3 Colour coded No. 14 AWG for control power, 120 VAC and lower.
 - .4 Individually identify conductors on each end with slip-on, plastic wire markers. Identification to match wiring diagrams.
 - .2 Conduit
 - .1 Thin wall conduit:
 - .1 Up to 32 mm size in ceilings, furred spaces, in hollow walls and partitions and where not exposed to mechanical injury.
 - .2 Rigid galvanized steel:
 - .1 38 mm size and larger.
 - .2 Any size where located in poured concrete, and where exposed.
- 2.3 **EQUIPMENT SERVICE LIGHTS**
 - .1 Service Lights
 - .1 LED type with tempered glass globe and wire guard (silicone free).
 - .2 Acceptable Manufacturers:
 - .1 Crouse Hinds
 - .2 Killark

- .2 Switches
 - .1 Twenty ampere, single pole, with pilot light, installed in cast metal box.
 - .2 Acceptable Manufacturers:
 - .1 Hubbell
 - .2 P & S
 - .3 Arrow Hart
 - .4 Leviton
- 2.4 **CORROSION PROTECTION ANODES**
 - .1 Sacrificial Anode
 - .1 High grade electrolytic zinc, 99.99% pure: To ASTM B-418 Type II.
 - .2 Supplied with 5 mm diameter minimum steel core with #8 TWH stranded connecting wire or bolt-on strap connection where required.
- 3 Execution
- 3.1 **INSTALLATION**
 - .1 Motor and Equipment Control
 - .1 Motor control centre, starters and/or disconnect switch for each motor or electrically connected item: Provided by Electrical Division 26.
 - .1 Exception: Disconnects which are specified as part of the equipment.
 - .2 Power Conduit and Wire
 - .1 Provided by Mechanical Division:
 - .1 Line voltage thermostats, and wiring from thermostat to fan coil units, unit heaters and cabinet unit heaters.
 - .2 Hardwire interlock wiring between control devices (pressure switches, temperature switches, limit switches, etc.) and motor starters.
 - .3 Between junction box provided by Division 26, to switch and equipment service lights.
 - .2 Provided by Electrical Division 26:
 - .1 Power wiring at all voltages 120 VAC and higher to motors or equipment.
 - .2 To junction box on adjacent wall, column, or ceiling for equipment service lights (marine lights).
 - .3 Control Conduit and Wire
 - .1 Provided by Mechanical Division:
 - .1 Control wiring, conduit, and relays to interlock starters and connect safety and operating controls.
 - .4 Equipment Service Lights

- .1 Mount switches in accessible location on outside of plenum.
- .2 Provide one switch for each fan system.
- .3 Provide minimum of one marine light per 3 m length of plenum.
- .5 Grounding
 - .1 Ground electrical equipment and wiring in accordance with Electrical Safety Authority and local authority's rules and regulations.
- .6 Corrosion Protection Anodes
 - .1 Provide external corrosion protection anodes for:
 - .1 Buried ductile iron water mains, fittings, and hydrants.
 - .2 Metallic services as shown.

End of Section

- 1 General
- 1.1 **SUMMARY**
 - .1 Section Includes
 - .1 Labor, Products, equipment, and services necessary to complete the Work of this section.
- 1.2 **DESIGN CRITERIA**
 - .1 Refer to drawings schedule.
- 1.3 **REFERENCE STANDARDS**
 - .1 Gas Meters
 - .1 CGA approved.
- 1.4 **SUBMITTALS**
 - .1 Shop Drawings
 - .1 Submit Shop Drawings in accordance with Section 01 33 00.
 - .2 Operation and Maintenance Data
 - .1 Submit printed operation instructions and maintenance data in accordance with Section 01 33 00.
- 2 Products
- 2.1 **GENERAL**
 - .1 Sensor Elements
 - .1 Selected for thermowells designed for 50 mm insulation.
- 2.2 **FLOW INDICATORS**
 - .1 Liquids
 - .1 Construction:
 - .1 Visual flow indication.
 - .2 Equipped with a dual flow scale L/s-USgpm.
 - .3 Protected against accidental breakage of the glass indicator.
 - .4 In-line type for pipe sizes up to NPS 1½.
 - .5 By-pass type with isolating valves for larger sizes.
 - .2 Acceptable Manufacturer:
 - .1 ITT Bell & Gossett - Thermoflow
- 2.3 **VOLUME FLOW MEASUREMENT**
 - .1 Turbine Type

- .1 Operating medium:
 - .1 Water
- .2 Primary flow element:
 - .1 Bidirectional turbine flow meter
- .3 Flow transmitter:
 - .1 Measuring transmitter with 0-10 VDC pulse output
 - .2 Pulse output: [0.06 L/s] [0.6 L/s] [6.0 L/s]
 - .3 Digital register (dual) L/s (USGPM)
 - .4 Maximum pressure drop 7 kPa (1 psi) at full flow
 - .5 Maximum operating temperature: 95°C (200°F)
 - .6 Square root extractors
 - .7 Additional contacts for remote monitoring and/or initiation of system chemical feed pumps after each 200 liters
 - .8 Accuracy: $\pm 1\%$ of full range
 - .9 Repeatability: $\pm 0.1\%$
 - .10 Power supply: 120VAC
- .4 Acceptable Manufacturers:
 - .1 Neptune
- .2 Rotary Type
 - .1 Operating medium:
 - .1 Natural gas
 - .2 Primary flow element:
 - .1 Rotary positive displacement
 - .2 Line mounting body style.
 - .3 Contra-rotating impeller
 - .4 Splash lubricated ball bearing design.
 - .3 Flow transmitter.
 - .1 Microprocessor based flow meter.
 - .2 Alkaline battery operation
 - .3 Magnetic shaft sensors
 - .4 Single point temperature calibration/compensation
 - .5 Liquid crystal display in cubic meters

- .6 Four isolated, adjustable output points
- .7 Accuracy: $\pm 0.3^{\circ}\text{C}$ ($\pm 0.5^{\circ}\text{F}$)
- .8 Temperature resolution: 0.1°C ($\pm 0.1^{\circ}\text{F}$)
- .9 Pulse outputs: One non-compensated, two compensated, one alarm.
- .10 Pulse output range: Refer to Drawings for each meter.
- .11 NEMA 4X enclosure
- .4 Acceptable Manufacturers:
 - .1 Roots-Dresser M175 Series with VTC Transmitter
- .3 Differential Pressure Type
 - .1 Operating medium:
 - .1 Water
 - .2 Natural gas
 - .2 Primary flow element:
 - .1 Insertion bar or orifice differential pressure type
 - .2 Integral three-valve manifold
 - .3 Pipe size: NPS 2 to NPS 20
 - .4 Material: Type 316SS
 - .5 (Designed for "Hot-Tap" installation on existing piping)
 - .3 Flow rate transmitter:
 - .1 Simultaneous calibration of flow element and transmitter
 - .2 Keypad entry and display of information including span and zero.
 - .3 Accuracy: $\pm 1\%$ of reading over a minimum of 10:1 turndown
 - .4 Repeatability: $\pm 0.1\%$
 - .5 Output: 4-20 mA flow rate transmitter with a three-valve manifold for isolation and testing
 - .6 Square root extractors
 - .7 Remote mounted for systems operating at 93°C (200°F) and over.
 - .8 NEMA 4 housing
 - .9 Power supply: 120 VAC
 - .10 HART communication module, overlaid on 4-20 mA wiring)
 - .4 Acceptable Manufacturers:
 - .1 Annubar

- .2 Elsag Bailey
- .3 Rosemount
- .4 Foxboro

2.4 **MASS FLOW**

- .1 Differential Pressure Type
 - .1 Operating medium:
 - .1 Natural gas
 - .2 Primary flow element:
 - .1 Insertion bar or orifice differential pressure type
 - .2 Integral three-valve manifold
 - .3 Pipe size: NPS 2 to NPS 20
 - .4 Material: Type 316SS and Inconel
 - .5 (Designed for "Hot-Tap" installation on existing piping)
 - .3 Flow rate transmitter:
 - .1 Simultaneous calibration of flow element and transmitter
 - .2 Keypad entry and display of information including span and zero.
 - .3 Accuracy: $\pm 1\%$ of reading over a minimum of 10:1 turndown
 - .4 Repeatability: $\pm 0.1\%$
 - .5 Output: 4-20 mA flow rate transmitter with a three-valve manifold for isolation and testing
 - .6 Square root extractors
 - .7 Remote mounted for systems operating at 93°C (200°F) and over.
 - .8 NEMA 4 housing
 - .9 Power supply: 120 VAC
 - .4 Pressure transmitter.
 - .1 Piezo-electric silicon chip sensor
 - .2 Rangeability: 5:1 turndown
 - .3 Type 316SS body and drain valves.
 - .4 Electronics housing: NEMA 4
 - .5 Output: 4-20 mA
 - .6 Power supply: 120 VAC
 - .5 Temperature sensor:

- .1 Three wire, 100 OHM platinum RTD
- .2 4-20 mA output
- .3 Accuracy: 0.2% of calibrated span
- .4 Aluminum housing
- .5 Power supply: 24 VDC
- .6 Mass flow rate computer:
 - .1 Calculates Reynolds numbers, flow profiles, and mass flow rate compensated for temperature and pressure.
 - .2 Adjustable digital flow averaging
 - .3 Menu-driven software entered through face mounted keypad.
 - .4 Two-line x twenty character LCD display
 - .5 Output: RS-422 serial communication, dry contact, 2x 4-20 mA configurable
 - .6 Lithium battery back-up
 - .7 NEMA 4X enclosure
 - .8 Power supply: 120 VAC
- .7 Acceptable Manufacturers:
 - .1 Annubar
 - .2 Elsag Bailey
 - .3 Rosemount
 - .4 Foxboro

2.5 ENERGY FLOW METERING

- .1 Differential Pressure Type
 - .1 Operating medium:
 - .1 Hydronic heating and cooling systems
 - .2 Primary flow element:
 - .1 Insertion bar or orifice differential pressure type
 - .2 Matching flanges and pressure taps for orifice plates
 - .3 Integral three-valve manifold
 - .4 Pipe size: NPS 2 to NPS 20
 - .5 Material: Type 316SS and Inconel
 - .6 (Designed for "Hot-Tap" installation on existing piping)
 - .3 Flow rate transmitter:

- .1 Simultaneous calibration of flow element and transmitter
- .2 Keypad entry and display of information including span and zero.
- .3 Accuracy: $\pm 1\%$ of reading over a minimum of 10:1 turndown
- .4 Repeatability: $\pm 0.1\%$
- .5 Output: 4-20 mA flow rate transmitter with a three-valve manifold for isolation and testing
- .6 Square root extractors
- .7 Remote mounted for systems operating at 93°C (200°F) and over.
- .8 NEMA 4 housing
- .9 Power supply: 120 VAC
- .4 Temperature sensors:
 - .1 Quantity: Two
 - .2 Three wire, 100 OHM platinum RTD
 - .3 4-20 mA output
 - .4 Accuracy: 0.2% of calibrated span
 - .5 Aluminum housing
 - .6 Power supply: 24 VDC
- .5 Energy rate computer:
 - .1 Calculates Reynolds numbers, flow profiles, and energy flow rate.
 - .2 Adjustable digital flow averaging
 - .3 Menu-driven software entered through face mounted keypad.
 - .4 Two-line x twenty character LCD display
 - .5 Output: RS-422 serial communication, dry contact, 2x 4-20 mA configurable
 - .6 Lithium battery back-up
 - .7 NEMA 4X enclosure
 - .8 Power supply: 120 VAC
- .6 Acceptable Manufacturers:
 - .1 Annubar
 - .2 Elsag Bailey
 - .3 Rosemount
 - .4 Foxboro

2.6 **AUXILIARY EQUIPMENT**

.1 Chart Recorders

.1 (Wall mounted) (Free standing) flow meter:

- .1 Single pen recorder for measuring volume flow for water.
- .2 Two pen recorder for measuring mass flow and pressure for steam and natural gas
- .3 Electronic seven-day (circular) (or) (strip) chart
- .4 One year's supply of charts and ink

.2 Acceptable Manufacturers:

- .1 Elsag Bailey Controls Limited
- .2 Fisher Controls
- .3 Dietrich Standard

3 Execution

3.1 **INSTALLATION**

.1 Metering Devices

- .1 Install flow measuring devices in horizontal straight pipe runs, free of valves and fittings.
- .2 Provide isolating valve at each connection to transmitter.
- .3 Length of straight pipe before and after metering elements.
 - .1 Not less than 1 m before and 1 m after or,
 - .2 As recommended by manufacturer.
- .4 Mount meters and provide piping and wiring between measuring elements and meters.

.2 Remote Measuring Elements

- .1 Where measuring element is located more than 1.8 m above floor level, or is not otherwise readily accessible, locate transmitter at 1.2 m above floor in accessible location.
- .2 Run signal lines in Schedule 40 threaded steel pipe, except final connections to transmitter can be in type L copper with silver solder joints. Bronze quarter turn isolating valve may be used in place of a dielectric union to separate the copper and steel pipe.
- .3 Provide isolating valve at each connection to transmitter and provide valved and capped drains at bottom of signal risers.
- .4 For remote transmitters on steam service, provide inverted loop from top of flow measuring element, and provide colour dyed water in downcomer leg to transmitter.

.3 Calibration

- .1 Provide services of manufacturer's service representative to calibrate and commission the equipment.
- .2 Make calibration checks on flow measuring instruments before attempting system balancing.
- .3 Return instrument systems failing to meet accuracy and repeatability criteria to the manufacturer for re-calibration and/or repair.

End of Section

- 1 General
- 1.1 **SUMMARY**
 - .1 Section Includes
 - .1 Labor, Products, equipment and services necessary to complete the Work of this section.
- 1.2 **REFERENCE STANDARDS**
 - .1 Contractor Certification
 - .1 Contractors providing Work regulated under O.Reg. 220/01 Boilers and Pressure Vessels are to be holders of a Technical Standards and Safety Authority (TSSA) certificate of authorization to conduct this Work, including:
 - .1 Pressure piping fabrication and installation.
 - .2 Boiler and pressure vessel repairs and alterations
 - .2 Registration
 - .1 Register with the TSSA, and pay associated registration and inspection costs, for pressure piping systems regulated under O.Reg. 220/01 Boilers and Pressure Vessels.
- 1.3 **SUBMITTALS**
 - .1 Shop Drawings
 - .1 Submit valve Shop Drawings in accordance with Section 01 33 00.
- 2 Products
- 2.1 **BEDDING AND BACKFILL**
 - .1 Materials
 - .1 From bottom of trench to 300 mm above top of pipe:
 - .1 New Granular "A" material of bank run sand and gravel or crushed stone of non-organic nature.
 - .2 From 300 mm above top of pipe to underside of gravel subbase or landscaping soil:
 - .1 New granular material conforming to OPSS 1010 Granular "B" requirements.
 - .2 Samples
 - .1 Submit hand carry samples of backfill materials in heavy duty, clear plastic bags to the Consultant at the Job site prior to purchasing.
 - .2 Material delivered to the Job site will be inspected by the Consultant and any material considered unsuitable will be rejected.
- 2.2 **ESCUTCHEON PLATES**
 - .1 Materials

- .1 Heavy chrome plated cast brass or stamped metal.
- .2 Two-piece construction fitted with substantial hinges and positive latches.
- .3 Fit all plates with tempered springs to ensure positive attachment to the pipe.

2.3 **PIPE AND FITTINGS - PRESSURE PIPING - FERROUS**

.1 General

- .1 Pressure class and pipe schedules as shown on piping data sheets unless specified herein.
- .2 Galvanized pipe and fittings: Where indicated on piping data sheets unless specified herein.
- .3 Grooved piping systems - acceptable manufacturers:
 - .1 Victaulic
 - .2 Anvill Gruvlok
 - .3 Shurjoint

.2 Pipe

.1 Carbon steel - general use

- .1 Black carbon steel: To ASTM A53 Grade B, seamless or ERW
- .2 Black carbon steel, for fire protection systems: To ASTM A795, A53, A135
- .3 Beveled, plain or grooved ends as per piping data sheets.
- .4 For buried pipe: "Yellow Jacket" polyethylene jacket coating, minimum 22 mil thickness

.2 Carbon steel - grooved - fire protection systems

- .1 Black carbon steel: To ASTM A120, seamless or ERW
- .2 Grooved ends

.3 Stainless steel

- .1 Type 304: To ASTM A312
- .2 Beveled ends

.3 Tubing

.1 Stainless steel

- .1 Type 316 seamless, fully annealed and welded, redrawn, fully annealed suitable for bending: To ASTM A269
- .2 Maximum hardness: Rockwell B80

.4 Fittings

- .1 Threaded

- .1 Black banded malleable iron threaded fittings: To ASTM A197 and ANSI B16.3
- .2 Black cast iron threaded fittings: To ASTM A126 Class A and ANSI B16.1
- .2 Flanged
 - .1 Galvanized cast iron, flanged flat face: To ASTM A126 Class A and ANSI B16.1
 - .2 Black cast iron flanged flat face: To ASTM A126 and ANSI B16.4
- .3 Drainage
 - .1 Standard galvanized cast iron drainage fittings: To ANSI B16.12
- .4 Socket welded.
 - .1 Forged steel socket welding type: To ASTM A105 Grade 2 and ANSI B16.11
 - .2 For underground pipe: Protect joints and fittings with Shaw “Shrink-Sleeves” or a coating of Denso Paste wrapped with Denso Tape applied with at least 50% overlap.
- .5 Butt welded.
 - .1 Seamless carbon steel butt weld fittings, with wall thickness to match pipe: To ASTM A234 WPB and ANSI B16.9
 - .2 For underground pipe: Protect joints and fittings with Shaw “Shrink-Sleeves” or a coating of Denso Paste wrapped with Denso Tape applied with at least 50% overlap.
 - .3 Long radius elbows
- .6 Grooved
 - .1 NPS 10 and less: Ductile iron to ASTM A536 Grade 65-45-12
 - .2 NPS 12 and over: Same material as pipe to ASTM A234, with grooved ends to CSA B242-M
- .7 Stainless steel (pipe)
 - .1 Seamless stainless-steel type 304/304L butt weld fittings, with wall thickness to match pipe: To ASTM A312 WPW 304/304L
 - .2 3000# stainless steel socket welded fittings: To ASTM A182
 - .3 Stainless steel threaded fittings
 - .4 Grooved Fittings:
 - .1 ASTM A403 or factory-fabricated from ASTM A312 stainless steel pipe.
 - .2 NPS 2 and Smaller: Pressure-Sealed, cold drawn stainless steel with elastomer O-ring seals (grade to suit the intended service), suitable for operating pressure to 3450-kPa (500-psi).

- .8 Stainless steel (tubing)
 - .1 Type 316: To ASTM A182
 - .2 Parker "Triple-Lok" 37-degree flared tube fittings, Swagelok two-ferrule four-piece joint, Union Carbide
- .5 Unions
 - .1 General use
 - .1 Black malleable iron with brass ground joint and screwed ends: To ASTM A197 and ANSI B2.1
- .6 Flanges
 - .1 Welded
 - .1 Forged steel raised face slip-on or weld neck type: To ASTM A181 Grade 1 and ANSI B16.5
 - .2 Provide flat faced flanges for connection to cast iron valves, or equipment having a flat faced flange.
 - .2 Screwed
 - .1 Cast iron, galvanized, flat face, screwed: To ASTM A126 Class A and ANSI B16.1
 - .3 Grooved
 - .1 Hinged, two piece, shouldered or keyed cast ductile iron: To ASTM A536 Grade 65-45-12
 - .2 Synthetic rubber gaskets, selected for service: To ASTM D2000
 - .3 Lock bolt.
 - .4 Stainless steel (pipe)
 - .1 1.6 mm raised face, forged stainless steel: To ASTM A182 and ANSI B16.5
- .7 Flange Gaskets
 - .1 General service water < 94°C (200°F) maximum pressure: 1720 kPa (250 psig)
 - .1 1.6 mm thick red rubber, ring type for raised face flanges.
 - .2 Full face type for flat faced flanges
 - .2 Hot water 94°C - 152°C (200°F - 305°F) maximum pressure: 6890 kPa (1000 psig)
 - .1 1.6 mm thick Garlock No. 3000 with nitrile binder flat ring type, or equivalent asbestos-free material manufactured by Anchor or Phelps
 - .3 High temperature hot water 153°C - 232°C (306°F - 450°F) maximum pressure: 8200 kPa (1200 psig)

- .1 1.6 mm thick Garlock No. 3500 PTFE gasket with silica binder flat ring type, or equivalent asbestos-free material manufactured by Anchor or Phelps
- .4 Gas piping, coolant piping, waste oil piping, maximum pressure: 6890 kPa (1000 psig)
 - .1 1.6 mm thick Garlock No. 3000 with nitrile binder flat ring type, or equivalent asbestos-free material manufactured by Anchor or Phelps
- .5 Stainless steel piping
 - .1 1.6 mm thick graphite with Type 316 stainless steel insert manufactured.
- .6 For Van Stone flanges increase gasket thickness to 3.2 mmthick.
- .8 Flange Bolting
 - .1 General use
 - .1 Semi-finished hex head machine bolts, carbon steel: To ASTM A193 Grade B7
 - .2 Semi-finished hex nuts, carbon steel: To ASTM A194 Grade 2H
 - .2 High pressure piping
 - .1 Semi-finished hex head machine bolts, carbon steel: To ASTM A307 Grade A
 - .2 Semi-finished hex nuts, carbon steel: To ASTM A307 Grade A
 - .3 Stainless steel flanges
 - .1 Stainless steel bolt studs, hex head, machine finished: To ASTM A193, Grade B8 and ANSI B18.21
 - .2 Machine finished stainless steel heavy hex nuts: To ASTM A194, Grade 8 and ANSI B18.22
- .9 Couplings
 - .1 Grooved for Carbon Steel Pipe
 - .1 Cast segmented ductile iron: To ASTM A536 Grade 65-45-12.
 - .2 Grooved machine type: To CSA B242-M or similar
 - .3 Oval track-head bolts and heavy hex nuts: To ASTM A183 & A449
 - .4 Synthetic rubber gaskets, selected for service: To ASTM D2000
 - .1 Grade EHP EPDM gaskets suitable for water temperatures up to 120°C (250°F).
 - .5 Rigid Type: Housings cast with offsetting, angle-pattern, bolt pads to provide system rigidity and support and hanging in accordance with ANSI B31.1 and B31.9. Installation-Ready for complete installation without field disassembly.

- .6 Flexible Type: For use in locations where vibration attenuation and stress relief are required. Standard of Acceptance:
- .7 Two-segment couplings for pipe sizes NPS 14 and larger, with lead-in chamfer on housing key.

	At pump connections and concealed piping	Mechanical rooms and exposed piping
Victaulic	Fig 77, 177 or W77	Fig 107N or W07
Anvil (Gruvlok)	Fig 7001	Fig 7401
Shurjoint	Fig 7705	Fig 7771

- .2 Grooved for Stainless Steel Pipe:
 - .1 Housings: Ductile iron to ASTM A536 Grade 65 45 12 or stainless steel to ASTM A351, Grade CF8M.
- .3 Grooved machine type: To CSA B242-M or similar
 - .1 NPS 12 and smaller Schedule 5S or 10S pipe shall be roll grooved using a grooving tool specifically designed for stainless steel pipe.
- .4 Rigid: Housing key shall engage the bottom of the groove:
 - .1 Victaulic Style 89 (ductile iron) or 489 (stainless steel)
 - .2 Anvil Gruvlok
 - .3 Shurjoint
- .5 Flexible Type: For use in locations where vibration attenuation and stress relief are required:
 - .1 Victaulic Style 77S and 77-DX
 - .2 Anvil Gruvlok
 - .3 Shurjoint
- .6 Two-segment couplings for pipe sizes NPS 14 and larger, with wide-width gasket and lead-in chamfer on housing key:
 - .1 Victaulic Style W89 (rigid)
 - .2 Anvil Gruvlok
 - .3 Shurjoint
- .10 Miscellaneous
 - .1 Plugs
 - .1 Class 3000, threaded, square head, machined from solid steel or forging: To ASTM A105 Grade 2
 - .2 Closures, welded.
 - .1 Schedule 40 seamless butt-welded caps, carbon steel, with wall thickness to match pipe: To ASTM A234 Grade B

- .3 Thread compound.
 - .1 General service: Teflon tape or Master metallic compound
 - .2 Petroleum based fluids service: Teflon base pipe thread compound.
 - .3 Ammonia service: X-Pando or approved equal.
- .11 Press Fitting System – Stainless Steel
 - .1 Pipe
 - .1 Schedule 10S stainless steel: To ASTM A312 Type [304/304L] [316/316L], with plain ends
 - .2 Size NPS ½ to NPS 2
 - .2 Fittings, couplings, and adapters
 - .1 Housing: Type 304L [316L] stainless steel, minimum 1.65mm wall thickness
 - .2 Maximum working pressure 2068kPa (300PSI).
 - .3 Self-contained Grade E EPDM O-ring seals for water services, up to +110°C (+230°F)
 - .4 Adapter fittings at valves and equipment connections
 - .5 Certified to NSF 61
 - .6 Acceptable manufacturers:
 - .1 Victaulic Vic-Press
 - .2 Anvil AnvilPress
- 2.4 **PIPE AND FITTINGS - PRESSURE PIPE - NON-FERROUS**
 - .1 Copper Tubing
 - .1 Tubing
 - .1 Type “L” hard drawn copper tubing: To ASTM B88
 - .2 Fittings
 - .1 Wrought copper, solder joint, pressure type.
 - .2 Solder to threaded adaptors as screwed valves or equipment.
 - .3 Unions
 - .1 All bronze construction with ground joint
 - .2 Either solder joint or screwed ends as required
 - .3 Grooved Joint: Copper-tube dimensioned couplings, consisting of two ductile iron housings cast with offsetting angle-pattern bolt pads. Installation-Ready, for direct stab installation without field disassembly:
 - .1 Victaulic Style 607N.

- .2 Anvil Gruvlok CTS COPPER SYSTEM
- .3 Shurjoint
- .2 Copper Pipe
 - .1 Pipe
 - .1 Seamless copper pipe standard sizes: To ASTM B42
OR
 - .2 Seamless red brass pipe standard sizes: To ASTM B43
 - .2 Fittings
 - .1 Brass or bronze threaded water fittings: To ANSI B16.15 "Cast Bronze Threaded Fittings (Classes 125 and 250)"
 - .2 Grooved: Wrought copper to ASME B16.22 or cast bronze to ASME B16.18, manufactured to copper-tube dimensions.
 - .1 Victaulic Copper Fittings
 - .2 Anvil Gruvlok CTS COPPER SYSTEM
 - .3 Shurjoint
 - .3 Flanges and flange fittings
 - .1 Brass or bronze flanges and flange fittings: To ANSI B16.24 "Bronze Pipe Flanges and Flanged Fittings (Class 150 and 300)"
 - .4 Flange gaskets.
 - .1 1.6 mm thick red rubber, full face type
 - .5 Flange bolting.
 - .1 Semi-finished hex head machine bolts, carbon steel: To ASTM A193 Grade B7
 - .2 Semi-finished hex nuts, carbon steel: To ASTM A194 Grade 2H
- .3 Copper - Refrigerant Piping
 - .1 Pipe
 - .1 Type ACR copper tubing, soft annealed or hard drawn.
 - .2 Type ACR copper tubing, hard drawn: To ASTM B280
 - .3 Deoxidized and dehydrated, with ends factory sealed and identified by the manufacturer as being suitable for refrigeration service.
 - .2 Fittings
 - .1 Heavy wrought copper, solder joint type
 - .2 Adapter fittings at screwed connections
 - .3 On NPS 5/8 and less, flareless compression type

- .3 Unions
 - .1 Rating: 150°C (300°F) maximum temperature rating, 2760 kPa (400 psi) working pressure
 - .2 Brass tail piece adaptors for copper tubing, forged steel flanges, steel bolts, bronze nuts and asbestos-free fiber gasket
 - .3 Acceptable manufacturers: Henry Valve Company Type P30
- .4 Flexible hose
 - .1 Bronze construction with braided wire exterior jacket and union connection on one end
 - .2 Minimum length: Six times the diameter of the hose
 - .3 Rating: suitable for 150°C (300°F) maximum temperature and 2760 kPa (400 psi) working pressure
 - .4 Acceptable manufacturers: Flexonics or Anaconda
 - .5 Coiled section of soft annealed tubing may be used instead of hose on lines not larger than NPS 5/8
- .5 Sight glass
 - .1 Provided in refrigeration piping.
 - .2 Combination moisture and liquid indicator feature and extended ends for solder joint connection.
- .6 Filter dryer
 - .1 Provided in refrigeration piping.
 - .2 Replaceable cartridge type
- .4 PVC Pipe
 - .1 Pipe and fittings.
 - .1 PVC with solvent welded socket fittings: To CSA B137.3
 - .2 Victaulic Company PGS-300 CPVC Piping system may be used on water and chemical services where IPS size Schedule 80 CPVC pipe is approved for use. Pipe and fittings shall be cut grooved to Victaulic's PGS-300 groove specification. Schedule 80 CPVC pipe shall meet the requirements of ASTM F441 and ASTM D1784 - minimum cell classification 23447 Pipe.
- .5 Polyethylene Pipe
 - .1 Pipe and fittings.
 - .1 Flexible polyethylene: Certified to CSA B137.1

- .1 Copper - Buried
 - .1 Pipe
 - .1 Type "K" soft annealed tubing: To ASTM B88
 - .2 Fittings
 - .1 Wrought copper, solder joint pressure type.
 - .2 Compression type or cold flared fittings as manufactured by Mueller or Emco
- .2 Polyethylene - Buried - Water
 - .1 Pipe
 - .1 Series 160 psi polyethylene pipe: Certified to CSA B137.1
 - .2 Smooth finish free of imperfections such as grooves and ripples
 - .2 Fittings
 - .1 Nylon insert type, with serrated ends and insert adapters with threaded end where threaded connections are required: To ASTM D2609
 - .2 Secure pipe to insert fittings by using two stainless steel type clamps over each insert end of fitting.
 - .3 Where water service enters building, provide transition from plastic to copper no more than 450 mm above the floor.
- .3 Polyethylene - Buried - Gas
 - .1 Pipe
 - .1 Series 120 psi polyethylene pipe: Certified to CSA B137.1
 - .2 Smooth finish free of imperfections such as grooves and ripples
 - .2 Fittings
 - .1 Series 125 polyethylene socket welding type: Certified to CSA B137.1
 - .2 Heat fusion joints, installed in accordance with manufacturer's installation manuals.
 - .3 Install in accordance with CSA Z184-M and Z184S1
- .4 PVC - Buried
 - .1 Pipe
 - .1 Class 150 PVC DR18 pressure type, PVC resin: To ASTM D1784
 - .2 Class 200 PVC DR14 pressure type, PVC resin: To ASTM D1784
 - .2 Fittings
 - .1 Class 250 cast grey iron or ductile iron, mechanical joint ends to AWWA C110

- .2 Tar coated outside.
- .3 Cement mortar lined: To AWWA C104
- .4 Polyethylene encasement: To AWWA C105
- .3 Joints
 - .1 To AWWA C-900 and CAN-B137.3
 - .2 Maximum working pressure: 1035 kPa at 23°C (150 psi at 74°F)
- .5 Glass Fiber Reinforced Epoxy Resin - Buried
 - .1 Pipe
 - .1 Type 1 (Filament-Wound) Grade 1 (Glass Fiber Reinforced Epoxy Resin pipe) Class H (Thermoplastic Resin Liner) pipe: to ASTM D2996 classification 11HZ5001
 - .2 Pipe designed in accordance with ASTM D2992 and D2996
 - .3 Maximum working pressure: 2413 Pa at 23°C (350 psi at 73°F) or as approved by ULC
 - .4 Integral bell, push-on type joints
- 2.6 **PIPE AND FITTINGS - DRAINAGE SYSTEMS**
 - .1 Cast Iron Soil Pipe
 - .1 Pipe and fittings.
 - .1 Cast iron soil pipe: To CAN/CSA-B70-M
 - .2 Plain end pipe and fittings
 - .2 Joints
 - .1 Bell and spigot, with lead and oakum joints
 - .2 NPS 8 and smaller: Neoprene sleeves with stainless steel gear type clamps, where approved by local authorities.
 - .2 Acid Resistant Cast Iron Soil Pipe
 - .1 Pipe and fittings.
 - .1 High silicon alloy acid resistant cast iron
 - .2 Sleeve couplings: Inner Teflon sleeve, outer neoprene sleeve and two bolt stainless steel sleeve clamp.
 - .3 Bell and spigot joints, with acid proof rope packing and lead.
 - .4 (Split flange joints with flange bolts) (Bell and spigot joints)
 - .5 (Gaskets for split flange joints: 1.6 mm thick, Garlock style 3000 with nitrile binder or equivalent asbestos-free material manufactured by Anchor)
 - .3 PVC Soil Pipe

- .1 Pipe - below grade - sanitary and storm drainage.
 - .1 All sizes: To CAN/CSA-B181.2 "PVC Drain, Waste and Vent Pipe and Pipe Fittings"
 - .2 Bell and spigot ends.
 - .3 Rubber ring gaskets with bell
- .2 Pipe - below grade - storm drainage (alternate)
 - .1 2" to 6": To CSA B182.1-M
 - .2 8" and up: To CSA B182.2-M
 - .3 Bell and spigot ends.
 - .4 Rubber ring gaskets with bell
- .3 Pipe - above grade - sanitary and storm drainage.
 - .1 All sizes: To CAN/CSA-B181.2 "PVC Drain, Waste and Vent Pipe and Pipe Fittings"
 - .2 Plain end with solvent weld joints
 - .3 ABS or PVC solvent cement
- .4 Pipe - above grade - storm drainage (alternate)
 - .1 NPS 2" to 6" ABS: To CSA B182.1-M
 - .2 8" and up: To CSA B182.2-M
 - .3 Plain end with solvent weld joints
 - .4 ABS or PVC solvent cement
- .5 Pipe – Concrete Embedded Gravity Drain:
 - .1 Schedule 40 solvent weld rigid PVC drain, waste and vent pipe and fittings in accordance with CSA B181.2.
 - .2 Fittings: PVC injection molded, solvent weld type ends.
- .6 Weeping tile (foundation drainage)
 - .1 Perforated PVC BDS solvent. Weld sewer and drainpipe in accordance with CSA B182.1 [or perforated high density polyethylene (HDPE) per ASTM D 3350].
 - .2 Minimum stiffness of 210 kPa at 5% deflection per ASTM D2412.
- .7 Fire stop seal for combustible pipe.
 - .1 Certification: to CAN4-S115-M tested at a pressure differential of 50 Pa (0.007 psi)
 - .2 Fire stop rating: Class F
 - .3 Fire resistance rating: Not less than that of the fire separation being penetrated.

- .8 Acceptable Manufacturers:
 - .1 3M - Ultra Plastic Pipe Device
- .4 Copper - DWV
 - .1 Pipe
 - .1 Hard drawn copper drainage tube (DWV): To ASTM B306
 - .2 Drainage fittings
 - .1 Wrought copper solder joint: To ANSI B16.29
 - .2 Cast brass solder joint: To CSA B158.1
 - .3 Manufacturer standard heat fusion tool system
- 2.7 **PIPE AND FITTING – ABOVEGROUND PRESSURIZED DRAIN (PUMP DISCHARGE):**
 - .1 Galvanized steel:
 - .1 NPS 2-1/2 and smaller:
 - .1 Schedule 40 galvanized steel pipe, in accordance with ASTM A53/A53M.
 - .2 Fittings: Malleable iron galvanized, screwed, in accordance with ANSI/ASME B16.3.
 - .3 Joints: Threaded, in accordance with ANSI/ASME B1.20.1.
 - .2 NPS 3 and larger:
 - .1 Schedule 40 galvanized steel pipe, in accordance with ASTM A53/A53M.
 - .2 Fittings:
 - .1 Flanged: Galvanized ductile iron, flanged, in accordance with ANSI/ASME B16.5.
 - .2 Grooved: Rigid grooved coupling, hot dip galvanized, flush seal gaskets, and roll grooved piping.
 - .1 Victaulic Style 107
 - .2 Anvil Gruvlok, Fig. 7401
 - .3 Shurjoint
 - .3 Gasket: Styrene-Butadiene (SBR) or Ethylene - Propylene Diene Monomer (EPDM). [For oily waste use Nitrile].
 - .2 Copper:
 - .1 NPS 2 1/2 and smaller:
 - .1 Copper Type M hard copper pipe, in accordance with ASTM B88.
 - .2 Fittings: Wrought copper, solder joint, in accordance with ASME B16.29.
 - .1 Solder material: Lead free solder (tin-antimony or tin-silver).

- .2 NPS 3 and larger:
 - .1 Copper Type M hard copper pipe, in accordance with ASTM B88. Roll grooved.
 - .2 Fittings: Wrought copper roll grooved
 - .3 Couplings: Flush seal gasket.
 - .1 Victaulic Style 606 or 607 Rigid grooved coupling
 - .2 Anvil Gruvlok, Fig 6400
 - .3 Shurjoint
 - .3 Gasket: EPDM. [For oily waste use Nitrile].
- .3 PVC
 - .1 Schedule 40 solvent weld rigid PVC pressure pipe and fittings in accordance with CSA B 137.3, and ASTM D1785 or ASTM D2241.
 - .2 Fittings: PVC injection molded, solvent weld type ends, and friction fit
- 2.8 **PIPE AND FITTING – BURIED AND CONCRETE EMBEDDED PRESSURIZED DRAIN (PUMP DISCHARGE):**
 - .1 PVC
 - .1 Schedule 40 solvent weld rigid PVC pressure pipe and fittings in accordance with CSA B 137.3, and ASTM D1785 or ASTM D2241.
 - .2 Fittings: PVC injection molded, solvent weld type ends, and friction fit
- 2.9 **VACUUM TRUCK CONNECTION:**
 - .1 Above ground: Galvanized steel pipe, in accordance with ASTM A53/53M.
 - .1 Fittings:
 - .1 Flanged: Galvanized ductile iron, flanged, in accordance with ANSI/ASME B16.5.
 - .2 Grooved: Rigid grooved coupling, hot dip galvanized, flush seal gaskets, and roll grooved piping.
 - .3 Couplings:
 - .1 Victaulic Style 107 hot-dip galvanized couplings
 - .2 Anvil Gruvlok, Fig. 7401
 - .3 Shurjoint
 - .4 Gasket: Nitrile [SBR or EPDM]
 - .2 Buried and Concrete Embedded PVC
 - .1 Schedule 40 solvent weld rigid PVC pressure pipe and fittings in accordance with CSA B 137.3, and ASTM D1785 or ASTM D2241.

.2 Fittings: PVC injection molded, solvent weld type ends, and friction fit.

2.10 VALVES

.1 General

.1 Gate valves re-packable under pressure, when fully open

.2 Plug valves packed with lubricant suitable for service.

.3 Globe and check valves provided with composition discs suitable for type of service.

.4 Renewable seats on iron body valves

.5 Materials

ASTM B62 Bronze valves - gate, globe, and check - steam rated
125 and 150 psig

ASTM B61 Bronze valves - gate, globe, and check - steam rated
200 and 350 psig

ASTM B283 C3770 Brass valves - ball valves

ASTM A126 Class B Iron valves - gate, globe, and check

.6 Markings

MSS-SP-25 Steam or WOG (water, oil, and gas) rated pressure,
manufacturer's trademark, size

.7 End Connections

ANSI B2-1 Threaded ends

ANSI B16.18 Soldered ends

ANSI B16.10 Face to face dimensions

.8 Testing and Materials

MSS-SP-80 Bronze valves, gate, globe, and check

MSS-SP-70 Iron gate valves

MSS-SP-85 Iron globe valves

MSS-SP-71 Iron check valves

MSS-SP-67 Butterfly valves

.2 Gate Valves

.1 GTV 1

.1 Class 125 bronze body, threaded ends, solid or split wedge disc, rising stem.

.1 Crane Fig 428

.2 Jenkins Fig 990AJ

.3 Nibco T-111

.4 Toyo Red-White Fig 293

.5 Kitz Fig 24

- .2 GTV 2
 - .1 Class 125 iron body, OS&Y bronze mounted, flanged ends.
 - .1 Crane Fig 465 ½
 - .2 Jenkins Fig 454J
 - .3 Nibco F-617
 - .4 Toyo Red-White Fig 421JA
 - .5 Kitz Fig 72
- .3 GTV 3
 - .1 Class 125 bronze body, threaded ends, rising stem, wedge disc, screw-in bonnet.
 - .1 Crane Fig 428
 - .2 Jenkins Fig 990AJ
 - .3 Nibco T-111
 - .4 Toyo Red-White Fig 293
 - .5 Kitz Fig 24
- .4 GTV 4
 - .1 175 psi working pressure, to AWWA C-500, non-rising stem, iron body, bronze mounted, renewable seat rings, stuffing box and packing gland, mechanical joint ends. Valve box to grade, with guide plate and cover identifying the service. Valves and valve box finish: Two heavy coats of coal tar enamel. Provide one extension key for each valve box installed.
 - .2 Valve
 - .1 MAS W10-A-NL-FF-B-HW
 - .2 Jenkins Fig 2397A
 - .3 Box
 - .1 Bibby VB Series
 - .2 Canada Valve Fig 1322
 - .3 Mueller Fig A769
- .5 GTV 5
 - .1 175 psi WOG, ULC and FM approved, iron body, bronze mounted, cast iron disc, resilient seat, mechanical joint ends, non-rising stem, square operating nut. Finish: Two heavy coats of coal tar enamel
 - .1 Clow
 - .2 Mueller Canada
 - .3 MAS W10-A-NL-FF-B-HW

- .6 GTV 6
 - .1 175 psi WOG, ULC and FM approved, iron body, bronze mounted, OS&Y, flanged ends.
 - .1 Clow
 - .2 Mueller Canada
 - .3 Nibco F-607
 - .4 MAS W10-A-RS-FF-B-HW
- .7 GTV 7
 - .1 Class 125, bronze body, wedge disc, non-rising stem, solder ends
 - .1 Crane Fig 13240
 - .2 Jenkins Fig 993AJ
 - .3 Toyo Red-White Fig 281
 - .4 Kitz Fig 41
 - .5 Nibco S-113
- .8 GTV 13
 - .1 Main stop valve, service box of required length with ribbed cover brought up flush to finished grade or floor, shut-off key.
 - .1 Mueller Corporation
- .3 Globe Valves
 - .1 GLV 1
 - .1 Class 125 bronze body, threaded ends, solid or split wedge disc, rising stem.
 - .1 Crane Fig 5TF
 - .2 Jenkins Fig 106BJ
 - .3 Nibco T-211
 - .4 Toyo Red-White Fig 221
 - .5 Kitz Fig 09
 - .2 GLV 2
 - .1 Class 125 iron body, bronze mounted, yoke bonnet, composition disc, renewable and re-grindable bronze set ring, flanged.
 - .1 Crane Fig 351
 - .2 Jenkins Fig 2342J
 - .3 Nibco F-718-B

		.4	Toyo Red-White	Fig 400
		.5	Kitz	Fig 76
.3	GLV 3			
	.1		Class 125 bronze body, composition disc and solder ends	
		.1	Crane	Fig 1310
		.2	Jenkins	Fig 995AJ
		.3	Kitz	Fig 10
		.4	Nibco	S-211-Y
.4	GLV 10			
	.1		Class 450, maximum 3100 kPa (450 psi) working pressure, 135°C (275°F) maximum temperature rating, bronze body, forged brass wing cap seal, back seating, molded ring packing, forged brass bolted bonnet with bonnet seal, solder ends.	
		.1	Henry Valve Co.	Fig 203 – Globe style
		.2	Henry Valve Co.	Fig 216 – Angle style
.4	Ball Valves			
	.1	BV 1		
		.1	Class 150-600 WOG brass body, threaded ends, Teflon ends, Teflon seats, Teflon packing, bronze or chrome plated, solid ball and lever handle with plastic protector, AGA and CGA approved for gas service.	
		.1	Crane	Fig F9201
		.2	Jenkins	Fig 201J
		.3	Worcester Econ-O-Mite	Fig 4211T
		.4	NCI	TFP600
		.5	NCI	TFP601
		.6	Neles-Jamesbury	Fig 351
		.7	Toyo Red-White	Fig 5044A
		.8	Kitz	Fig 58
		.9	M.A.S.	Fig B-3
		.10	Bray Flow-Tek	SB5
	.2	BV 2		
		.1	Class 150-600 WOG brass body, soldered ends, Teflon ends, Teflon seats, Teflon packing, bronze or chrome plated, solid ball and lever handle with plastic protector, AGA and CGA approved for gas service.	
		.1	Crane	Fig F9202

	.2	Jenkins	Fig 202J
	.3	Worcester Econ-O-Mite	Fig 4211
	.4	NCI	SFP600
	.5	NCI	SFP601
	.6	Neles-Jamesbury	Fig 341
	.7	Toyo Red-White	Fig 5044A or 5049A
	.8	Kitz	Fig 58 or 59
	.9	Apollo	Fig 77-100 or 77-200
	.10	MAS	Fig B-3 or B-4
	.11	Bray Flow-Tek	Triad SP
.5		Butterfly Valves	
	.1	BFV 1	
	.1	Class 150 full tapped lug type, cast iron body, bronze disc, 304 stainless steel shaft, EPDM seat, notched top plate.	
	.2	Lever lock handle for valve sizes NPS 6 and smaller	
	.3	Worm gear operator with handwheel for valves NPS 8 and larger	
	.1	Crane	Fig 44 BXZ
	.2	Keystone	Fig FH12-CBJ-2
	.3	Jenkins	Fig 2232Elj
	.4	Nibco	LD-2000
	.5	Nibco	N-200
	.6	Centerline	Fig 200 Series
	.7	De Zurik	Fig BGS, L1/632
	.8	Victaulic	704Vic 300 MasterSeal and AGS
	.9	Apollo	Fig Series 143
	.10	Bray	Fig 31H-375
	.11	Challenger	Fig 20-CS4E
	.12	Kitz	Fig 6122EL/G
	.13	Toyo	Fig 918BESL/G
	.14	MAS	D-Series #LD4AE
	.2	BFV 2	
	.1	175 psi ULC and FM approved full lug, cast iron body, bronze disc, EPDM seat.	

- .2 Lever lock handle for valve sizes NPS 6 and smaller
- .3 Worm gear operator with handwheel for valves NPS 8 and larger
- .4 Indicator flag painted "safety yellow" and provision for mounting supervisory switch.
 - .1 MAS W50-A-ED-LL
 - .2 Grinnell
- .6 Plug Valves
 - .1 PV 1
 - .1 Class 175 WOG rating, lubricated plug valve, semi-steel body, tapered plug, screwed ends, wrench operated.
 - .1 Rockwell-Nordstrom Fig 142
 - .2 Newman-Milliken Fig 170M
 - .3 Walworth Fig 1796
 - .2 PV 2
 - .1 Class 175 WOG rating, lubricated plug valve, semi-steel body, tapered pug, flat faced flanged ends drilled to 862 Pa (125 lb) ANSI.
 - .2 Valves NPS 6 and less: Manual lever operated.
 - .3 Valves NPS 8 and larger: Worm gear operated.
 - .1 Rockwell-Nordstrom Fig 143
 - .2 Newman-Milliken Fig 172M
 - .3 Walworth Fig 1797F
- .7 Check Valves
 - .1 CV 1
 - .1 Class 125 horizontal swing check valve, bronze body, screwed ends, screwed cap and re-grindable bronze disc
 - .1 Crane Fig 37
 - .2 Jenkins Fig 996AJ
 - .3 Grinnell Fig 3300
 - .4 Nibco T-413
 - .5 Toyo Red-White Fig 236
 - .6 Kitz Fig 22
 - .7 Bray Rite 12CBT
 - .2 CV 2

- .1 Class 125 horizontal check valve, iron body, bronze mounted, flat face flanged ends, renewable and re-grindable bronze seat ring and disc
 - .1 Crane Fig 373
 - .2 Jenkins Fig 587J
 - .3 Grinnell Fig 6300A
 - .4 Nibco F-918
 - .5 Toyo Red-White Fig 435JA
 - .6 Victaulic Series 715
 - .7 Gestra "CB" Series
 - .8 Kitz Fig 78
 - .9 Bray Rite 12CBT

- .3 CV 3
 - .1 Class 125 wafer type non-slam check valve, cast iron body, bronze plates and Buna-N seals.
 - .2 Install between two flat faced flanges as specified for piping NPS 4 and larger.
 - .1 Mission Valve "Duo-Chek"
 - .2 Ritepro "Check Rite"
 - .3 Gestra "RK" Series
 - .4 Crane Fig R-1-66-4-F-1-X
 - .5 Centerline 800 Series
 - .6 Grinnell Fig 300
 - .7 Jenkins Fig R-1-66-4-F-1-X
 - .8 Nibco W-920-W
 - .9 Mueller Steam 71-AHH-3-H
 - .10 Bray Rite D15DBZ

- .4 CV 4
 - .1 Class 125 horizontal swing check, bronze body, screwed ends, screwed cap and re-grindable bronze disc
 - .1 Crane Fig 37
 - .2 Jenkins Fig 4092J
 - .3 Grinnell Fig 3300
 - .4 Nibco S-413

- .5 Toyo Red-White Fig 236
- .6 Victaulic Series 712
- .7 Kitz Fig 22
- .5 CV 5
 - .1 Class 125 ULC and FM approved for 1200 Pa (175 psig) WOG, iron body, bronze mounted, horizontal swing check, bolted cap, flanged ends.
 - .2 For above ground or in valve pit
 - .1 Clow
 - .2 Bray Rite 212ULC/FM
 - .3 MAS W30 Series
- .6 CV 19
 - .1 Class 450, 3100 kPa (450 psi) working pressure, 150°C (300°F) maximum temperature rating, floating piston, Teflon seat disc, bronze body, solder ends.
 - .1 Henry Valve Co. Fig 205.

3 Execution

3.1 **TRENCHING, BEDDING AND BACKFILL**

.1 General

- .1 Extent:
 - .1 For buried services inside building and to 1.5 m outside building wall.
- .2 Trench depth:
 - .1 To 75 mm 150 mm below the correct elevation and slope established for the bottom of the pipe.
- .3 Bedding:
 - .1 Refill the bottom elevation of the trench with hand-placed bedding materials.
 - .2 Thoroughly compact to the approval of the Consultant.
 - .3 At pipe hubs or couplings, remove bedding in the bottom of the trench as necessary to provide for even and constant support for each length of pipe.
- .4 Shoring:
 - .1 Provide adequate shoring, bracing and sheeting in pipe trenches.
 - .2 Place barriers and temporary crossings as necessary to ensure support, safety, and protection at all times.
- .5 Unstable soil conditions:

- .1 When encountered, advise the Consultant.
- .2 Excavate pipe trenches to a depth as directed by the Consultant and then backfill to the correct grade with bedding material.
- .6 Backfill:
 - .1 Where joints occur, do not backfill until joint testing is approved by Consultant.
 - .2 Hand place backfill to 300 mm above the top of the pipe in 100 mm layers taking particular care to place and compact the backfill simultaneously on both sides of the pipe.
 - .3 From 300 mm above the top of the pipe backfill in 150 mm layers and mechanically compact.
- .7 Keep excavations dry at all times.
- .8 Compaction:
 - .1 Mechanically tamp and thoroughly compact each layer of new granular bedding and backfill material to 95 percent Modified Proctor Density.
- .9 In fill areas, allow a minimum clearance of 100 mm on all sides of the pipe passing under or through building grade beams to prevent possible damage from settling of building. If a greater settlement can be expected, increase the clearance to prevent possible damage.
- .10 Remove and dispose of excess excavated material off-site.

3.2

GENERAL PIPING CONSTRUCTION METHODS

- .1 General
 - .1 Standards:
 - .1 To ANSI sections B31.1 to B31.9 as applicable to service, unless specified otherwise herein.
 - .2 Do not use soldered joints in compressed air piping.
 - .2 Inserts, sleeves, and anchors:
 - .1 Avoid unnecessary cutting of masonry.
 - .2 Supply inserts, sleeves, and anchors to other trades for building in as the Work proceeds.
 - .3 Arrange with other trades to leave openings, slots, and chases to accommodate later installation of mechanical Work.
 - .3 Inspect pipe and fittings for soundness and clean off all dirt and other foreign matter immediately prior to installation.
 - .1 Reject all damaged items.
 - .4 Pipe layout:
 - .1 Install piping in the most direct, straight, and functional manner possible.

- .2 Except where otherwise shown, install all vertical lines plumb, and run horizontal lines parallel to building walls.
- .3 Install piping close to walls, partitions, and ceilings.
- .4 On multiple runs of piping, space piping to allow for installation of insulation and for proper servicing of valves.
- .5 Conceal piping in finished areas and rooms within walls or ceilings, and in furred spaces elsewhere.
 - .1 Provide access doors or panels as hereinafter specified for access to concealed piping specialties, etc.
- .2 Expansion and Contraction
 - .1 Installation:
 - .1 Install all piping free from strain and distortion due to expansion and contraction: to section 6, Chapter 3 of ANSI B31.1, except as hereinafter modified.
 - .2 Allow for expansion and contraction by offsets, expansion U-bends or loops.
 - .3 Expansion joints of any type will not be allowed unless specifically indicated on the Drawings or specified under another section of this division for a particular installation.
 - .2 Expansion/contraction allowance criteria:
 - .1 Steel pipe: 25 mm movement per 30 m of pipe.
 - .2 Brass and copper pipe: 38 mm movement per 30 m of pipe.
 - .3 Temperature difference: for each 55°C (100°F) temperature difference from 21°C (70°F) ambient.
 - .4 Fabricate expansion bends in steel pipe from pipe sections and long radius welding elbows.
 - .3 Swing and swivel joints:
 - .1 On steam or hot water heating piping for connections from mains to risers and from risers to radiation and other heating units.
 - .2 Use at least five fittings from main to riser including tee in main.
 - .3 Use at least four fittings from riser to heating unit including tee in riser.
- .3 Lines, Grades and Slopes
 - .1 Install piping in conformity with elevations and grades indicated on the Drawings using axis lines and benchmarks provided under general construction.
 - .1 Verify such axis lines and benchmarks.

- .2 Lay out Work and be responsible for lines, elevations, measurements, etc., required for installation of the Work.
- .2 Slopes:
 - .1 Slope piping drains and sewers as indicated on the Drawings.
 - .2 Install so that slope between elevations shown on the Drawings is even and constant.
 - .3 Install liquid and air lines free of pockets and pitch to drain at low points in the line with valves or traps installed as required for drainage of the lines.
- .3 Minimum slopes:
 - .1 As shown on Drawings; if not shown, then as follows.
 - .2 Drainage piping, NPS 3 and less: 1:50.
 - .3 Drainage piping, NPS 4 and larger: 1:100.
 - .1 In special circumstances as provided for under the codes and regulations and the express approval of the Consultant, drains of NPS 4 size and larger may be laid at a lesser slope.
 - .4 Domestic water lines: pitch to low points so that all lines may be completely drained.
 - .5 Hot water heating, chilled water and condenser water lines: Slope up 1:500 in direction of flow.
- .4 Where pipe slope causes pipe to rise to top of ceiling space, or fall to bottom of structural members, ceiling space or defined service space, provide risers as follows:
 - .1 Domestic water lines: Provide drain valve at bottom of low point and Provide riser to increase elevation of piping.
 - .2 Hot water heating, chilled water, and condenser water lines: Provide automatic air vent, complete with drainage piping, at high point, provide drain valve at bottom of low point and Provide riser to lower elevation of pipes.
 - .3 Natural gas: Provide a drip pocket with capped end, drain valve and Provide riser to increase elevation of piping. Pocket depth to be the greater of 75 mm deep or equal to diameter of pipe. Pocket diameter to be the lesser of: NPS 2 or gas main pipe diameter.
- .4 Immersion Wells and Sensing Bulbs
 - .1 Fitting size:
 - .1 Pipe size NPS 2½ size and less: Increase pipe length for 300 mm to minimum one pipe size larger to maintain equivalent unobstructed cross-sectional area.

- .2 Pack immersion wells in piping for liquids up to a temperature of 150°C (300°F) with a mineral type grease prior to installation of sensing bulb.
 - .5 Piping Connections to Mains
 - .1 Make branch connections to respective horizontal piping of larger diameter to the upper quadrant of the larger pipe.
 - .2 Water piping:
 - .1 Make down feed piping connections to horizontal supply and return mains to the bottom quadrant of the mains.
- 3.3 **SYSTEM REQUIREMENTS**
- .1 Plumbing
 - .1 Install complete plumbing, drainage, and vent piping for washrooms, etc, in accordance with the Ontario Building Code.
 - .2 Size vent lines based on developed pipe length and hydraulic load.
 - .3 Arrange piping within pipe spaces behind washroom fixtures to allow unimpeded access to piping for servicing.
 - .2 Gas Piping - Buried - Cathodic Protection
 - .1 Isolate buried piping between two buildings at both ends with dielectric unions or flanges.
 - .2 Protect piping by at least one 1 kg magnesium sacrificial anode every 30 m of run, welded to the buried gas pipe, to manufacturer's installation instructions.
 - .3 Provide dielectric unions on piping NPS 2½ and less and dielectric flanges on piping NPS 3 and larger.
 - .3 Copper Pipe - Type L
 - .1 Provide dielectric unions or couplings at all connections between copper tubing and ferrous piping.
 - .4 Copper Pipe - Buried
 - .1 Provide dielectric unions at connection between cast iron or ductile iron water main and copper tubing.
 - .2 When required by municipal authority, provide 900 mm long copper gooseneck after corporation stop at connection to water main. Connection at water main to be at forty-five degrees and gooseneck to have minimum 160 mm radius bend.
 - .5 Refrigerant Piping
 - .1 Install piping to conform to applicable requirements of ANSI B31.5 Code for Pressure Piping Section 5 "Refrigeration Piping" and CSA B52-M "Mechanical Refrigeration Code" latest issue.
 - .2 Make solder type joints with "sil-fos" silver solder or similar high melting point solder having a melting point of at least 538°C (1000°F). Remove all interior parts of refrigerant specialties and valves before applying heat to the joint.

- .3 Provide refrigerant hoses on refrigerant line connections to equipment with reciprocating or rotating elements.
 - .4 Test procedure and evacuation procedures: Conform to ANSI B31.5.
 - .5 Test pressure: In accordance with CSA Code B52-M.
 - .6 Provide all refrigerant required for testing and charging of the system.
 - .7 Purge refrigerant piping with anhydrous nitrogen prior to making connection to pre-evacuated equipment to ensure removal of all moisture and non-condensable gases.
 - .8 Completely evacuate to 0.5 torr (500 micron), seal and leave for twenty-four hours, re-evacuate to 0.5 torr, and charge all components of refrigeration system not evacuated by manufacturer, in accordance with manufacturer's printed recommendations.
 - .9 Do not use the refrigeration compressor to evacuate the system under any circumstances. Evacuate the system using a vacuum pump at an ambient temperature not less than 2°C (35°F) to ensure removal of all moisture and non-condensable gases.
 - .10 After testing, evacuation and charging is completed, allow system to operate under normal conditions for a minimum period of twenty-four hours, at which time, moisture indicator should indicate a dry system. If it does not so indicate, change dryer and operate unit for another twenty-four hours. Repeat this procedure until moisture indicator indicates a thoroughly dry system.
- .6 PVC - Buried - Pressure and Drainage Piping
- .1 Provide a tracer wire directly over PVC pipe.
- .7 PVC Drainage, Waste and Vent Piping
- .1 Below grade: Install in accordance with CSA B182.11 and manufacturer's recommendations.
 - .2 Above grade: Install in accordance with CSA B181.11 and B181.12 and manufacturer's recommendations.
 - .3 Provide fire stop seals on all fire separation penetrations, except at connections through concrete floor slabs to non-combustible water closets.
 - .4 Do not use combustible piping in return air ceiling plenums or vertical riser shafts.
- .8 Polypropylene - Laboratory Drainage
- .1 Make heat fusion joints in accordance with manufacturer's written instructions.
- .9 Polyethylene - Laboratory Drainage
- .1 Make heat fusion joints in accordance with manufacturer's written instructions.
- .10 Borosilicate Glass - Beaded End
- .1 Install and support piping system to manufacturer's written instructions.
 - .2 Provide pipe hangers with padding material between hanger and glass pipe.

- .11 Borosilicate Glass - Plain End
 - .1 Install and support piping system to manufacturer's written instructions.
 - .2 Provide pipe hangers with padding material between hanger and glass pipe.
- 3.4 **SLEEVES**
 - .1 Installation Requirements
 - .1 Provide where piping passes through foundations, above grade floors and walls.
 - .2 Materials
 - .1 Schedule 40 black steel pipe or type "K" copper tubing for installation in foundations or floors
 - .2 1 mm (20 gauge) galvanized sheet steel where installed in above grade walls.
 - .3 Terminate sleeves flush with finished ceilings, walls and floors on grade.
 - .1 For piping passing through floors above grade extend sleeve a minimum of 75 mm above the floor.
 - .4 Sleeve sizes.
 - .1 Large enough to pass full thickness of pipe covering where same is used.
 - .2 With sufficient clearance between pipe/insulation and sleeve to allow for any lateral movement of piping due to expansion and contraction.
 - .5 Assume responsibility for the setting of all sleeves necessary for this Work in masonry walls during construction or in concrete forms before concrete is poured.
 - .6 Coat exterior surface of all sleeves of ferrous material with a heavy asphalt emulsion.
 - .2 Foundation Sleeves
 - .1 For pipes entering structures from below grade, seal the annular space between sleeve and pipe with prefabricated seals.
 - .3 Firestopping
 - .1 Provide firestopping on pipes passing through firewalls, fire separation walls or through walls, partitions or floors which are considered as serving as firestops.
 - .1 Provide at partitions around washrooms.
 - .2 Seal the space around the pipe, in the sleeve, in accordance with Section 23 05 01 and Section 07 84 00.
 - .4 Pipe Sleeves Through Roofs
 - .1 Supplied and installed under other Contracts or under roofing section, unless specifically shown otherwise on the Drawings.
 - .5 Future Services

.1 Fill sleeves for future use with lime mortar.

.6 Escutcheon Plates

.1 Place escutcheon plates on bare piping passing through finished walls or floors.

3.5 JOINTS, UNIONS, FLANGES AND FITTINGS

.1 Pipe Joints

.1 Preparation

.1 Ream pipe ends and thoroughly clean all dirt, cuttings, and foreign matter from pipe after cutting and threading.

.2 Thoroughly clean all fittings, valves and equipment before connections are made.

.3 Cut copper tubing with a tube cutter and clean the joining surfaces of the tubing and fitting with fine emery cloth. Wipe clean with a dry cloth.

.2 Cast iron pipe sleeve joints.

.1 For cast iron plain end soil pipe, install sleeve type couplings such as Titan Foundry Type MJ, or Bibby MJ Series 2000 in strict accordance with manufacturer's printed instructions.

.3 Cast iron bell and spigot joints.

.1 Make joints either neoprene compression type preformed gaskets such as Bibby "Bi-seal", and caulk in such a manner to produce a permanently tight joint.

.2 Cold caulking compound in cord form such as W.R. Meadows PC4 may also be used.

.3 Assemble preformed neoprene gaskets to manufacturer's printed instructions.

.4 Mechanical joints:

.1 Assemble mechanical joint on ductile iron pressure pipe with cast iron gland, rubber sealing gasket and high strength malleable iron bolts in accordance with the manufacturer's recommendations.

.5 Soldered joints:

.1 Make soldered joints on copper tubing in accordance with the following usage:

Service	Solder Type
Domestic hot and cold water	95/5 with matching flux
Drainage, waste, vent	50/50 with matching flux
Compressed air service	"Sil-Fos" silver solder or brazed

.2 Do not use core type solder.

- .6 Threaded joints:
 - .1 Use Teflon tape or Masters metallic compound with the compound applied to the male threads only and particular care taken to prevent the compound from reaching the interior of the pipe or fittings.
 - .7 Carbon steel welded joints:
 - .1 To ANSI B31.1 Section IX for welding.
 - .2 Fusion welded joints made by electric arc welding, gas metal arc welding, or oxy-acetylene gas welding.
 - .3 Ensure that supervisory staff, fitters, and welders are fully conversant with the requirements laid down by that standard prior to the commencement of welding.
 - .4 Employ qualified welders holding a current up-to-date provincial certificate for the process and rating involved as required by the provincial regulations.
 - .5 Unless more stringent methods of inspections are specified the Consultant will visually inspect welded joints for fusion of metal, icicles, alignment, etc.
 - .1 Remove any defects and remake the joint to his satisfaction.
 - .6 For welding of materials other than carbon steel, conform to the requirements specified in the relevant section of the Specification.
 - .8 Grooved end piping systems:
 - .1 Install couplings, fittings, etc. in accordance with manufacturer's printed instructions.
-
- .2 Unions and Flanges
 - .1 Provide unions or flanges in the following locations:
 - .1 For by-passes around equipment or control valves or devices in piping systems.
 - .2 At connection to steam traps and in by-passes around traps.
 - .3 At connections to equipment. Locate between shut-off valve and equipment.
 - .4 In screwed or solder joint drainage tubing at inlet side of trap.
 - .2 If unions are concealed in walls, partitions, or ceilings, build access thereto.
 - .3 Provide dielectric unions or isolating type companion flanges at all connections between copper tubing and ferrous piping.

- .1 Brass body valves between ferrous piping and copper tubing are acceptable as a dielectric union.
- .4 Flange joints.
 - .1 Assemble joints with appropriate flanges, gaskets, and bolting.
 - .2 Allow clearance between flange faces such that the connections can be gasketed and bolted tight without undue strain on the piping system, with flange faces parallel and bores concentric.
 - .3 Centre gaskets on the flange faces so as not to project into the bore.
 - .4 Lubricate bolts before assembly and provide two hardened steel washers under the head of each unit to assure uniform bolt stressing.
 - .5 Machine off raised face flanges when joining to a flat companion flange and use a full-face gasket.
 - .6 Follow gasket manufacturer's instructions for correct bolting procedure.
 - .7 Use calibrated torque wrench and tighten bolts in recommended sequence in four equal steps to required final torque value.
- .3 Fittings
 - .1 Couplings
 - .1 Minimize couplings on runs of pipes.
 - .2 Do not use running couplings in any pipeline.
 - .3 NPS 2 and smaller: Threaded coupling.
 - .4 NPS 2½ and larger: Welded joints.
 - .2 Fittings and ancillary items installed in systems operating at pressures in excess of 103 kPa (15 psig):
 - .1 Register in accordance with CSA B51-M.
 - .3 Eccentric reducer fittings
 - .1 To provide proper drainage or venting of the lines.
 - .2 At change of pipe sizes.
 - .3 At connections to equipment and control valves.
 - .4 Do not use bushings.
 - .4 Tee connections in welded piping
 - .1 Factory fabricated standard butt weld fittings.
 - .2 Bonney Forge "Weldolets", "Thredolets" or "Sockolets".
 - .3 Mitering, notching or direct welding of branches to mains is not permitted.
 - .5 Change of direction

- .1 Use standard pipe fittings.
- .2 Use long radius welded steel elbows unless short radius elbows are specifically authorized by the Consultant.
- .3 Mitered joints or field fabricated pipe bends are not permitted.
- .6 Tees, copper tubing
 - .1 Direct connection of branch into main using "T-Drill" method may be used where allowed by the code, in lieu of manufactured tee fittings.

3.6

VALVES

- .1 Installation
 - .1 General
 - .1 Wherever possible, source valves from one manufacturer.
 - .2 Where required.
 - .1 At locations shown on the Drawings.
 - .2 At all piping connections to equipment.
 - .3 At all connections to control valves or control devices.
 - .4 Where required for sectionalizing a system or floor.
 - .5 Check valves wherever required to ensure flow of liquid in one direction.
 - .3 Type
 - .1 Shut-off service: Gate, butterfly type, and ball (quarter-turn).
 - .2 Throttling service: Double regulating, globe or plug type for throttling purposes.
 - .4 Drain valves.
 - .1 Hose thread outlet connection or valve with long nipple on outlet at all low points of each water system and above all riser or branch stop valves for proper drainage of lines.
 - .5 Valve chains.
 - .1 Provide chain wheel operators and operating chain for valves located more than 2 m above floor or walkway.
 - .2 Provide chain of sufficient length to extend to within 2 m of operating platform or floor for free handing chains, or to within 1.5 m of floor in locations where chain can be secured to wall or column. Secure chain to wall or column with a wall hook.
 - .3 Chain wheels using rustproof chain complete with guide and of size recommended by valve manufacturer for proper operation of valve.

3.7

INSPECTION AND TESTING

- .1 Pressure Leak Testing

- .1 Make specified pressure tests on all piping included in this Contract.
 - .2 Furnish all pumps, compressors, gauges and connectors necessary for the tests.
 - .3 Test sections as authorized by Consultant to accommodate construction schedule. However, test complete systems on completion of Work.
 - .4 Conduct tests in the presence of:
 - .1 Consultant
 - .2 Personnel of governing authorities having jurisdiction
 - .5 Notify above personnel in ample time to permit them to be present.
 - .6 Conduct tests before piping is painted, covered or concealed.
 - .7 Disconnect pumps or compressors used for applying the test pressure, during the test period.
 - .8 Disconnect and/or remove equipment or specialties not designed to withstand the test pressure during the test and reconnect same after completion of test.
 - .9 Promptly correct any defects that develop through tests and re-test to the complete satisfaction of the Consultant and other parties involved.
 - .10 Forward copies of all final tests on all pressure and drainage piping and a copy of governing authority approvals to the Consultant immediately on acceptance of tests and/or approvals.
 - .11 Final payment for the Work will not be made until the above has been received.
-
- .2 Hydrostatic Tests
 - .1 Conduct tests for a minimum period of two hours, or longer when requested by the Consultant or governing authority at the test pressure specified under the respective section of the Specifications.
 - .2 Test requirements:
 - .1 Pressure to remain constant over test period to a pressure of one and one-half times the operating pressure but not to exceed the material pressure class rating.
 - .2 Exterior surfaces of pipe or fittings free of cracks or other form of leak.
 - .3 Tests to be performed at a constant ambient temperature.
 - .3 Pneumatic Tests
 - .1 Initially pressurize the system with air to approximately one-half the specified operating pressure but not to exceed 345 kPa (50 psig).
 - .1 Examine joints for leaks with a soapsuds solution.
 - .2 Repair leaks as detected.
 - .3 Repeat test and repairs until soap test passes.

- .2 Provide a final pressure test on the system with air to the test pressure specified under the respective section of the Specifications.
- .4 Natural and Propane Gas Piping
 - .1 Conduct final tests in accordance with the requirements of the local utility or governing authority.
 - .2 If feasible, make tests when ambient air temperature is approximately constant.
 - .1 Corrections for pressure change due to temperature differential shall be allowed as approved by the Consultant.
- .5 Drainage and Potable Water Testing
 - .1 Test drainage piping and potable water piping in accordance with requirements of the Ontario Building Code, latest edition, and any additional requirements of applicable local by-laws.
- .6 Specific Test Requirements
 - .1 Test the following services with compressed air or inert gas at one and one-half times the working pressure, but in no event less than 345 kPa (50 psig).
 - .1 Natural gas piping
 - .2 Vacuum piping
- 3.8 **PRE-OPERATIONAL CLEANING**
 - .1 Temporary Connections
 - .1 Make temporary crossovers, blank-off equipment connections, install drain and fill lines for circulating cleaning fluid through piping.
 - .2 Flushing of Piping Systems
 - .1 Flush water piping with water flowing at a velocity of not less than 1.8 m/sec, for a period of fifteen minutes or longer as required to remove all dirt, scale, and cuttings from the entire length of the piping.
 - .2 Thoroughly clean, prior to fabrication, sections of new piping which cannot be isolated for flushing purposes.
 - .3 Thoroughly clean, insofar as possible, welded joints by swabbing interior of pipe with swabs soaked with a caustic solution.
 - .4 Flush stainless-steel piping with water as described above, then immediately flush with design Product fluid. Do not leave city water or chlorinated water in piping.
 - .3 Chilled Water, Condenser Water, Glycol and Heating Water Systems
 - .1 Clean systems with neutral pH, non-chromate chemical cleaner to remove sludge oil and debris. Use cleansing compound at rate of 10 kg per 5000 liters of water in system.
 - .2 Circulate cleaner for seventy-two hours at room temperature then drain and refill with water and inhibitor.
 - .3 Circulate inhibitor treated water for an additional six hours and drain.

- .4 Refill each system with working fluid and add chemicals to provide protection against corrosion.
- .5 Recirculate fluid for four hours and test samples from system for iron content. Drain, refill, and add chemicals so that total iron content in system is less than 1 ppm. (When iron content of glycol system is satisfactory, add glycol to achieve design concentration.)

3.9

PIPING SYSTEMS STANDARDS

.1 Abbreviations

.1 The Mechanical Pipe Standards (MPS) include the following abbreviations:

End Treatment		Material	
B&S	Bell and Spigot	ARCI	Acid Resisting Cast Iron
BDE	Beaded End	CB	Cast Bronze
BE	Beveled End	CBR	Cast Brass
BW	Butt Weld	CGI	Cast Grey Iron
CJ	Compression Joint	CI	Cast Iron
FE	Flange End	CK	Copper type "K" soft annealed
GE	Groove or Rolled End	CL	Copper Type "L" hard drawn
HFJ	Heat Fusion Joint	CS	Carbon Steel
LUG	Full Tapped Lug	CTSL	Cast Steel
MJ	Mechanical Joint	Cu	Copper
PE	Plain End	DWV	DWV Copper
SJ	Solder Joint	FS	Forged Steel
SO	Slip On	Galv	Galvanized
SW	Socket Weld	MI	Malleable Iron
SWJ	Solvent Weld Joint	PET	Polyethylene
TE	Threaded End	PPE	Polypropylene
WFR	Wafer	PVC	PVC
WN	Weld Neck	SMS	Semi-Steel
		SS	Stainless Steel
		TBS	Tempered Borosilicate Glass
		WC	Wrought Copper

End of Section

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- 1 General
- 1.1 **SUMMARY**
 - .1 Section Includes
 - .1 Labor, Products, equipment, and services necessary to complete the Work of this section.
- 1.2 **SUBMITTALS**
 - .1 Shop Drawings
 - .1 Submit Shop Drawings in accordance with Section 01 33 00.
 - .2 Operation and Maintenance Data
 - .1 Submit printed operation instructions and maintenance data in accordance with Section 01 33 00.
- 2 Products
- 2.1 **THERMOMETERS AND PRESSURE GAUGES**
 - .1 General
 - .1 To match existing thermometers and pressure gauges
 - .2 Scale Reading Units
 - .1 Thermometers to read (both Fahrenheit and Celsius) (Fahrenheit) (Celsius) scale.
 - .2 Pressure gauges to read (both psi and kPa) (psi) (kPa) scale.
 - .3 Gauge stems and separable sockets of sufficient length to provide for proper insertion in piping or equipment in which they are installed.
 - .3 Products are identified by model designations from H.O. Trerice Co. and to be used as a guide to establish standard of construction. Comparable Products are acceptable from the following manufacturers:
 - .1 H.O. Trerice Company
 - .2 Dresser Canada Inc. - Ashcroft
 - .3 Weiss
 - .4 Weksler - Baker Instruments
 - .5 Winter's Thermogauges Limited
 - .2 Direct Reading Thermometers
 - .1 Industrial 230 mm scale length, variable angle type, liquid filled, aluminum case
 - .1 H.O. Trerice Company - A400 series
 - .2 Bi-metal dial type, 125 mm diameter, variable angle, stainless shell type 300 series case and stem with calibration screw.

- .3 H.O. Trerice Company - B85600 series
- .3 Remote Reading Thermometers
 - .1 115 mm diameter, liquid filled or gas activated type, braided bronze armor over copper capillary, stainless steel bulb and cast aluminum case for surface mounting.
 - .1 H.O. Trerice Company - Series No. L80300 (liquid filled)
- .4 Thermometer Wells
 - .1 Provide wells in pipelines as follows:
 - .1 For copper pipe: Brass.
 - .2 For steel pipe: Brass or stainless steel.
- .5 Conversion Kit
 - .1 Retrofit kit for converting wells of straight liquid filled thermometers to accept bi-metal dial thermometers.
- .6 Direct Reading Pressure Measurement
 - .1 Dial type, 100 mm diameter, glycerin liquid filled
 - .1 Case: Stainless steel type 304
 - .2 Movement: Stainless steel
 - .3 Tube and socket: Stainless steel type 304
 - .4 Adjustable pointer
 - .5 Two-way gauge cock
 - .6 Operating temperature range, glycerin: -17°C to +115°C (0°F to 240°F)
 - .7 Operating temperature range, silicone: -34°C to +115°C (-30°F to 240°F)
 - .8 Accuracy: ASME B40.1 Grade 1A $\pm 1\%$ full scale
 - .9 H.O. Trerice Company - Series 700
- .7 Differential pressure measurement at pumps, refrigeration machines and where shown.
 - .1 Same as for direct reading pressure measurement, and:
 - .1 Maximum registering pointer
 - .2 Impulse snubber
 - .3 Three way switching valve
- .8 Sanitary Direct Reading Pressure Measurement
 - .1 Dial type, 100 mm diameter, food grade glycerin liquid filled
 - .1 Case and ring: Polished stainless-steel type 316

- .2 Movement: Stainless steel type 316
- .3 Capsule and socket: Stainless steel type 316.
- .4 Adjustable pointer
- .5 Operating temperature range, glycerin: -20°C to +100°C (-4°F to +212°F)
- .6 Accuracy: ASME B40.1 Grade 1A ±1% full scale
- .7 Approvals: 3A and USDA
- .8 H.O. Trerice Company - Series 700TALF
- .9 Test wells. For use with partial immersion laboratory type thermometers.
 - .1 Manufactured from bar stock or forged brass with cap and chain, compatible with thermometers used.
 - .2 Registered with Technical Standards and Safety Association, Boiler and Pressure Vessel Safety Branch, and have C.R.N. Registration number.
 - .1 H.O. Trerice Company

2.2 **STRAINERS AND FILTERS**

- .1 "Y" Pattern Strainers
 - .1 NPS 2 and under:
 - .1 "Y" pattern
 - .2 Class 125 (860 kPa) bronze body
 - .3 Screwed ends and screwed cleanout.
 - .2 NPS 3 and larger:
 - .1 "Y" pattern
 - .2 Class 125 (860 kPa) cast iron body
 - .3 Flanged ends and bolted cleanout cap
 - .4 Blow-off drain connection.
 - .3 Screen material: 20 mesh stainless steel unless otherwise noted.
 - .4 Manufacturers:
 - .1 Erwel
 - .2 Spirax Sarco
 - .3 Streamflo
 - .4 Brooks – Hart
 - .5 Mueller
- .2 Basket Strainers

- .1 NPS 2 to 12, WOG service
 - .1 Single basket
 - .2 Class 150 (1033 kPa) cast iron body with quick release cover
 - .3 Bottom blow down valve.
- .2 NPS 2 to 12, steam service
 - .1 Single basket
 - .2 Class 125 (860 kPa) cast iron body with bolted cover
 - .3 Bottom blow down valve.
- .3 Basket Screens
 - .1 Stainless steel
 - .2 NPS 2 and 3: 1.15 mm perforation mesh
 - .3 NPS 4 and over: 3.2 mm perforation mesh
- .4 Manufacturers
 - .1 Erwel
 - .2 Spirax Sarco
 - .3 Streamflo
 - .4 Brooks – Hart
 - .5 Mueller

2.3 **FLEX CONNECTIONS AND EXPANSION COMPENSATION**

- .1 Flexible Metal Hose Connections
 - .1 Size Application
 - .1 Steel piping: NPS ½ to NPS 14
 - .2 Construction
 - .1 Corrugated inner hose of bronze or stainless steel.
 - .2 Outer jacket of bronze or stainless-steel braided wire mesh.
 - .3 Screwed or female soldered end connections up to NPS 2.
 - .4 Forged steel raised face flanged NPS 2½ and above.
 - .5 Selected for 1034 kPa (150 psi) working pressure and 93°C (200°F) working temperature.
 - .6 Designed to absorb 150 mm transverse movement.
 - .7 Flexible length not less than six times nominal size.
 - .3 Manufacturer

- .1 Senior Flexonics (Canada) Limited
 - .2 Piping Accessories Canada Ltd.
 - .3 SSI Equipment Inc.
 - .4 Anaconda Flexpipe
 - .5 United Flexible Metallic Tubing (Canada) Limited
- .2 Flexible Rubber Expansion Joints
- .1 Size Application
 - .1 Steel piping: NPS 1½ to NPS 12
 - .2 Construction
 - .1 Double arch, sphere design bellows
 - .2 Composite three-layer EPDM or neoprene with nylon reinforcement construction
 - .3 Floating flanges complete with control units.
 - .4 Operating pressure: Minimum 860 kPa (125 psig)
 - .5 Operating temperature: -10°C to +100°C (14°F to 212°F)
 - .3 Manufacturer
 - .1 Senior Flexonics (Canada) Ltd - Style 102
 - .2 SSI - model ATM
 - .3 UniRoyal Rubber - Style 4140
- .3 Expansion Compensators (bellows type)
- .1 Size Application
 - .1 Steel piping: NPS ¾ to NPS 2
 - .2 Copper piping: NPS ¾ to NPS 3
 - .2 Construction
 - .1 Pressure external to bellows.
 - .2 Internal guides, limit stops and anti-torque device.
 - .3 Copper pipe installation: Bronze construction with female solder type ends.
 - .4 Steel pipe installation: Steel construction with stainless steel bellows and screwed ends.
 - .5 Selected for 1035 kPa (150 psi) (1380 kPa (200 psi)) working pressure.
 - .3 Manufacturers
 - .1 Senior Flexonics (Canada) Limited

- .2 Badger
- .3 Hispan
- .4 Uncontrolled Type Expansion Joints
 - .1 Size Application
 - .1 Steel piping: NPS 2 to NPS 24
 - .2 Construction
 - .1 Stainless steel bellows
 - .2 Flanged ends
 - .3 Suitable for axial extension and compression, lateral off-set, and angular rotation.
 - .4 Temperature rating: -29°F to +426°C (-20°F to +800°F)
 - .5 Selected for 1035 kPa (150 psi) (1380 kPa (200 psi)) steam working pressure.
 - .3 Manufacturers
 - .1 Senior Flexonics (Canada) Limited
 - .2 Adscos Division - Yuba Industries Inc.
 - .3 Hispan
- .5 Ring Controlled Type Expansion Joints
 - .1 Size Application
 - .1 Steel piping: NPS 3 to NPS 24
 - .2 Construction
 - .1 Stainless steel bellows, limit stops and guides.
 - .2 Reinforcing control rings
 - .3 Flanged ends
 - .4 Anchor type bases where required.
 - .5 Temperature rating: -29°F to +426°C (-20°F to +800°F)
 - .6 Selected for 1035 kPa (150 psi) (1380 kPa (200 psi) 2070 (300 psig)) steam working pressure.
 - .3 Manufacturers
 - .1 Senior Flexonics (Canada) Limited
 - .2 Adscos Division - Yuba Industries Inc.
 - .3 Hispan
- .6 Slip Type Expansion Joints

- .1 Size Application
 - .1 Steel piping: NPS 1½ to NPS 24
- .2 Construction
 - .1 Packing chamber, limit stops, lubrication fittings, or lubricant impregnated packing rings
 - .2 Adjustable packing gland or fixed packing gland arrangement with a packing injection assembly
 - .3 Slip pipe of hard chrome plated carbon steel to ASTM A53-82
 - .4 Anchor base
- .3 Manufacturers
 - .1 Senior Flexonics (Canada) Ltd.
 - .2 Rockwell
 - .3 Yarway
 - .4 United Flexible Metallic Tubing (Canada) Limited
 - .5 Adsco
 - .6 Hispan
- 2.4 **MISCELLANEOUS**
 - .1 Pressure Relief Valves
 - .1 ASME rated, selected of relieving flow at 25% above the working pressure.
 - .2 Body construction and trim: To suit specific service.
 - .3 Manufacturers
 - .1 STM Specialty Sales
 - .2 Watts
 - .3 Fisher
 - .4 Consolidated
 - .2 Drain Valves
 - .1 NPS ½ brass sediment faucets with hose outlets
 - .2 Manufacturers
 - .1 Emco 10740
 - .2 Cambridge Brass 32W201
- 3 Execution
- 3.1 **INSTALLATION - THERMOMETERS AND PRESSURE GAUGES**

.1 General

- .1 Installation height: Not greater than 3 m from floor or platform.
- .2 Installation heights exceeding 3 m from floor or platform: Install remote reading thermometers and gauges, with dial mounted at 1500 mm above floor or platform, on steel or aluminum plate.

.2 Thermometers

- .1 Install thermometers in wells.
- .2 Install wells with extension necks in piping or equipment that is to be insulated.
- .3 Provide thermometers at inlet and outlet of:
 - .1 Domestic hot water tanks
 - .2 Water heating and cooling coils
 - .3 Water boilers
 - .4 and as shown
- .4 Thermometer Ranges

SYSTEM	SCALE RANGE
City water	(-5° to 40°C) (25° to 100°F)
Domestic cold water	(-5 °to 40°C) (25°to 100°F)
Domestic hot water	(5° to 120°C) (40° to 180°F)
Hot water heating (scheduled & constant temperature)	(5° to 115°C) (40° to 240°F)

.3 Pressure Gauges

- .1 Selection
 - .1 Normal operating reading: Between one-half and two-thirds of full scale or range and expected maximum and minimum readings are within range.
 - .2 Provide pressure gauges at inlet and outlet of:
 - .1 Domestic water heaters
 - .2 Water heating and cooling coils
 - .3 Water boilers
 - .4 Water filters
 - .5 Pressure reducing valves.
 - .6 Pumps (pressure differential)
 - .7 and as shown.
 - .3 For direct pressure measurement, provide for each gauge:
 - .1 One-quarter turn bronze ball valve complete with lever handle.

- .2 Pressure snubber.
- .3 Syphons for gauges in steam service
- .4 Isolation diaphragms where shown for gauges in corrosive service
- .4 For differential pressure measurement, provide for each gauge:
 - .1 Three-way three position (left-off-right) switching valve with lever handle.
 - .2 Pressure snubber.
 - .3 Impulse dampener
 - .4 Syphons for gauges in steam service
 - .5 Isolation diaphragms where shown for gauges in corrosive service
- .4 Test Plugs
 - .1 Provide test plugs for temporary insertion of thermometers and pressure gauges at locations shown on Drawings.

3.2 **INSTALLATION - STRAINERS AND FILTERS**

- .1 "Y" Strainers
 - .1 Horizontal installation: Install with minimum 300 mm clearance between bottom of strainer and any obstruction.
 - .2 Vertical installation: Install with basket drain pointing down, and with minimum 300 mm clearance between bottom of strainer and any obstruction.
 - .3 Provide drain valve complete with chain and cap on NPS 3 and larger strainers.
 - .4 Remove baskets, clean, and replace at time of building handover.
- .2 Basket Strainers
 - .1 Install basket strainers with minimum of 450 mm clearance above strainer.
 - .2 Provide pipe supports on piping immediately adjacent to strainer; do not directly support strainer, or have adjacent piping supported through the strainer.
 - .3 Remove baskets, clean, and replace at time of building handover.
- .3 Automatic Back-Wash Filters
 - .1 Install automatic backwash filters in accordance with manufacturer's recommendations.
 - .2 Provide drain to back-wash drain connection and pipe to floor drain. (Pipe-up domestic cold-water connection).

3.3 **INSTALLATION - FLEX CONNECTIONS AND EXPANSION COMPENSATION**

- .1 Selection Criteria
 - .1 Provide manufactured expansion compensation units where shown on Drawings.
 - .2 Provide expansion loops where shown on Drawings.

- .3 Select expansion joints to compensate for thermal expansion in pipe between anchors with not less than 25% safety factor calculating expansion from -18°C (0°F) ambient up to maximum possible operating fluid temperature, but not less than 93°C (200°F).
- .2 Provision of expansion joints and flex connections:
 - .1 Flexible Metal Hoses
 - .1 On suction and discharge connections of domestic water booster pumps.
 - .2 On suction and discharge connections of base mounted double suction pumps.
 - .3 On discharge connections of sump and sewage pumps.
 - .4 In steam, hot water, chilled water, or glycol piping connections to coils and humidifiers in air supply units when units, or sections of units to which piping is connected, are supported, or suspended by means of springs or isolation pads.
 - .5 On piping connections to domestic hot water tanks.
 - .6 Cooling tower supply and return connections at tower.
 - .2 Flexible Rubber Expansion Joint
 - .1 Cooling tower supply and return piping connections at pump.
 - .2 Above ground drainage piping where shown on Drawings.
- .3 Expansion Compensators
 - .1 Domestic hot water supply and recirculation piping up to and including NPS 3.
 - .2 Heating system piping up to and including NPS 2 size.
 - .3 Compressed air, maximum 860 kPa (125 psig).
- .4 Uncontrolled Type Expansion Joints
 - .1 Domestic hot water and recirculating water piping NPS 3½ size and larger.
 - .2 Heating system piping NPS 2½ size and larger.
- .5 Ring Controlled Type Expansion Joints Slip Type
 - .1 High pressure steam piping over 100 kPa (15 psig).
- .6 Slip Joints
 - .1 High temperature hot water over 100°C (212°F).
- .7 Expansion joint installation:

- .1 Provide pipe guides for each expansion joint using two guides on each side of and adjacent to joint.
- .2 Refer to Section 15060 for pipe guides.
- .3 Guide may be omitted between joint and anchor where an anchor is located within 900 mm of expansion joint.
- .4 Provide anchors consisting of structural steel angles, channels, or plates secured to building structure.
- .8 Flexible metal hose connection installation:
 - .1 Support or guide piping firmly adjacent to flexible connections and prevent pipes from swaying.
 - .2 At steam coils locate hoses between control valve and coil on steam supply side and on main condensate line leaving coil or bank of coils on return side.
 - .3 At chilled and/or hot water coils locate hoses on supply side between strainer and coil and on return side between coil and control valve.

3.4 **INSTALLATION - MISCELLANEOUS**

- .1 Pressure Relief Valves
 - .1 Install relief valves downstream of pressure reducing valves, and on pressure vessels where shown.
 - .2 Provide discharge elbow drain, and pipe drain with NPS ¾ pipe to nearest floor drain.
 - .3 Terminate relief vent up through roof, at height as follows:
 - .1 900 mm for water systems below 92°C (200°F).
 - .2 1800 mm for water and steam systems above 92°C (200°F).
- .2 Drain Valves
 - .1 Provide at:
 - .1 Low points of water piping systems in order to completely drain each system.
 - .2 Cooling and heating coils.
 - .3 Reheat coils where detailed on Drawings.
 - .4 Other locations as shown.

End of Section

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- 1 General
- 1.1 **SUMMARY**
 - .1 Section Includes
 - .1 Labor, Products, equipment, and services necessary to complete the Work of this section.
- 1.2 **SUBMITTALS**
 - .1 Shop Drawings
 - .1 Submit Shop Drawings in accordance with Section 01 33 00.
 - .2 Submit Layout Drawings showing each type and placement of manufactured, prefabricated roof piping support system. Submit details for fixing roofing pad to roof.
- 2 Products
- 2.1 **MATERIALS**
 - .1 Acceptable Manufacturers
 - .1 Hangers:
 - .1 Anvil
 - .2 Myatt
 - .3 Carpenter & Paterson
 - .4 Hunt
 - .5 B-Line
 - .6 Taylor Pipe Supports
 - .2 Insulation shields:
 - .1 Anvil
 - .2 Myatt
 - .3 Pipe Shields Inc.
 - .4 Taylor Pipe Supports
 - .2 Lower Attachment
 - .1 Clevis hanger – steel pipe
 - .1 Standard weight black steel clevis hangers with level adjustment and locknut.
 - .2 Anvil figures 260 and 300.
 - .3 For figure 260, provide clevis bolt spacer on insulated piping.
 - .2 Clevis hanger – copper pipe

- .1 Light weight black steel clevis hangers with copper colored finish and plastic insert to suit local authority requirements, with level adjustment and locknut (double bottom locknut).
- .2 Anvil figure CT-65.
- .3 Roller hanger
 - .1 Adjustable roller type hangers with locknuts.
 - .2 Rollers of sufficient width to clear the outside diameter of the insulation on the piping.
 - .3 Support rollers at both ends, either by a yoke, swivel type hanger or by two adjustable rods with locknuts (double locknuts).
 - .4 Anvil figure 177 or 171 as applicable.
- .3 Insulation Protection
 - .1 Insulation saddles, for welding to pipe:
 - .1 Anvil figure 160-165 as applicable.
 - .2 Insulation shields
 - .1 Either shop fabricated, or manufactured plates of the size required to properly fit the outside diameter of the pipe insulation.
 - .2 Anvil figure 167, modified with holes at each end to suit 12 mm wide. Stainless steel band clamps.
 - .3 Shop-fabricate bearing plates conforming to the following table for various pipe sizes:

Pipe Size (NPS)	Length of Plate mm	Thickness of Plate mm (gauge)
½ to 2	300	1.2 (18)
3 to 4	300	1.52 (16)
6	450	1.52 (16)
8 and over	600	1.9 (14)
 - .4 Form the bearing plates to the O.D. of the adjoining pipe insulation and extend the plate up to the horizontal centre line of the pipe.
- .4 Middle Attachment
 - .1 Machine threaded rods.
 - .1 Black steel finish in concealed areas.
 - .2 Galvanized finish in mechanical rooms and exposed areas.
- .5 Upper Attachments
 - .1 Beam clamps:
 - .1 Malleable iron C-clamp with retaining clip, FM approved: Anvil figure 87, NPS ½ to NPS 2; maximum load: 180 kg.

- .2 Malleable beam clamp FM approved: Anvil figure 218, NPS 2½ to NPS 8; maximum load: 540 kg.
- .3 For pipes NPS 10 and larger, provide supplementary steel members supported from structural steel.
- .4 Do not use top beam clamps.
- .2 Concrete inserts (new construction):
 - .1 Single hanger: Malleable iron body and nut, universal nut style: Anvil figure 282, to NPS 8.
 - .2 Continuous hanger: Cold formed hot dipped galvanized strip steel with end caps: Power-Strut PS 449.
- .3 Concrete clevis plates (existing concrete):
 - .1 Carbon steel plate, with clevis attachment.
 - .2 Anvil figure 49.
 - .3 Do not use explosive driven anchors.
- .6 Rooftop Pipe Supports
 - .1 Prefabricated pipe support system:
 - .1 Bases: (Injection molded plastic or polycarbonate resin, with UV inhibiting additive) (Stainless steel) (Hot dipped galvanized steel).
 - .2 Framing: Channel strut system of size suitable for the load involved.
 - .3 Hangers: As specified above.
 - .4 Clamps, bolts, nuts and washers to suit installation, same material as framing members.
 - .5 Roof pads to suit roof construction.
 - .2 Acceptable Manufacturers:
 - .1 Portable Pipe Hangers
 - .2 Taylor Ecofoot
 - .3 Miro Industries Inc.
- .7 Riser Clamps
 - .1 Black steel double clamp: Anvil figure 261, supported at floors; Anvil figure 240, supported by hanger rods.
- .8 Pipe Guides
 - .1 Outer hinged housing with sliding spider clamp.
 - .1 Carbon steel, black steel finish.
 - .2 Anvil figure 256.

3.1 **INSTALLATION**

.1 General

- .1 Support or suspend piping with necessary hangers, structural supports and/or brackets, to prevent sagging, warping and vibration and to allow for movement due to expansion and contraction.
- .2 Place hangers and supports close to fittings, elbows, valves and/or other heavy parts.
- .3 Do not allow loads of any nature to be transmitted through the piping connections to equipment not specifically designed for such loads.
 - .1 Where flexible connections are not called for at connections to equipment, support the pipe by stands attached to both pipe and supporting structure so that force in any direction is not transmitted to the equipment.
- .4 Place suitably dampened spring hangers at the first three supports from the equipment connection on piping subject to excessive movement or shock from any source, thermal expansion and contraction.
 - .1 Where it is evident that no undue loads will be transmitted to the equipment by the system concerned, i.e. small-bore connections to comparatively large equipment, cold service piping not subject to shock, etc., then spring hangers may be omitted and standard hangers used.
- .5 Use trapeze type hangers where pipes are grouped together, unless specifically indicated otherwise on the Drawings.
 - .1 Suspend horizontal member by adjustable rods with locking feature for maintaining level and slope.
 - .2 Space trapeze type hangers based on the closest interval required by any pipe supported thereon.
 - .3 Provide any auxiliary steel required to support trapeze between building steel.
- .6 Do not hang pipe from another pipe unless specifically shown on the Drawings.

.2 Hanger Selection

- .1 Select lower attachment and insulation protection based on the following, unless otherwise shown on drawings:

Pipe Size NPS	Operating Temperature		
	Less than 21°C (70°F)	Between 21°C (70°F) and 43°C (110°F)	Greater than 43°C (110°F)
	Insulated	Non-insulated	Insulated
2 and less, steel	Clevis and shield	Clevis only	Clevis
2½ to 6, steel	Clevis and shield	Clevis only	Roller and saddle

Pipe Size NPS	Operating Temperature		
	Less than 21°C (70°F)	Between 21°C (70°F) and 43°C (110°F)	Greater than 43°C (110°F)
	Insulated	Non-insulated	Insulated
8 and over, steel	Roller and saddle	Roller only	Roller and saddle
½ to 4, copper	Clevis and shield	Clevis	Clevis and shield

.2 Install temporary spacers between the insulation shield and the pipe equal to the thickness of insulation specified. Refer to Section 23 07 19.

.3 Saddles and Roller Supports

.1 Place saddles at roller supports for piping carrying liquids at 43°C (110°F) or higher.

.2 Weld saddles to black or galvanized steel piping.

.3 Refinish galvanized surfaces destroyed by the welding with a zinc rich paint such as W.R. Meadows "Galvafruid", Kerry Industries "ZRC" or Niagara Paint Inc. "PL052898".

.4 Insulation Shields

.1 Place insulation shields at pipe supports for pipes carrying liquids at 21°C (70°F) or less.

.2 Field or factory punch a hole at each end of the shield to allow a 12 mm stainless steel band clamp to pass through opening.

.3 Secure shields with two @ 12 mm stainless steel band clamps per shield.

.5 Hanger Spacing - General

.1 Horizontal runs of plumbing and drainage piping: To hanger spacing requirements of the Ontario Building Code.

.2 Place additional hangers in locations where there are concentrated loads such as valves, specialties, etc.

.6 Hanger Spacing - Black Steel and Galvanized Pipe

.1 For horizontal runs of black or galvanized steel pipe, other than for plumbing service.

.2 Maximum distances between supports and with minimum diameter rods as follows:

Pipe Size NPS	Rod Size mm	Spacing	
		Water Service m	Gas, Steam or Air m
Thru 1	10	2.0	2.7
1¼	10	2.0	2.7
1½	10	2.7	3.6
2	10	3.0	3.9
2½	12	3.3	4.2

Pipe Size NPS	Rod Size mm	Spacing	
		Water Service m	Gas, Steam or Air m
3	12	3.6	4.5
4	16	4.2	5.0
6	19	5.0	6.4
8	19	5.7	7.3
10	22	5.7	7.3
12	22	7.0	7.9
14	25	7.6	9.7
16	25	8.2	10.6
18	25	8.5	11.2
20	32	9.0	11.8
24	38	9.7	12.8
30	51	10.0	13.4
36	51	13.7	18.0

.7 Hanger Spacing - Copper Tubing

- .1 For horizontal runs of copper tubing for services other than plumbing:
- .2 Maximum distances between supports and with minimum diameter rods as follows:

Pipe Size NPS	Rod Size mm	Spacing	
		Water Service m	Gas, Steam or Air m
Thru ¾	10	1.5	1.8
1	10	1.8	2.4
1¼	10	2.0	2.7
1½	10	2.4	3.0
2	10	2.4	3.3
2½	12	2.7	3.9
3	12	3.0	4.2
4	16	3.6	4.8

.8 Hanger Spacing - PVC or CPVC

- .1 For horizontal runs of PVC or CPVC for services other than plumbing.
- .2 Maximum distances between supports and with minimum rods sizes for un-insulated pipe as follows.

Pipe Size NPS	Rod Size mm	Pipe Schedule			
		PVC 40	CPVC 40	PVC 80	CPVC 80
½	10	1.2	1.2	1.2	1.2
¾	10	1.2	1.2	1.2	1.5
1	10	1.2	1.5	1.5	1.8
1¼	10	1.2	1.5	1.5	1.8

Pipe Size NPS	Rod Size mm	Pipe Schedule			
		PVC 40	CPVC 40	PVC 80	CPVC 80
1½	10	1.5	1.8	1.8	1.8
2	10	1.5	1.8	1.8	2.0
2½	12	1.8	2.0	1.8	2.4
3	12	1.8	2.0	2.0	2.4
4	16	1.8	2.0	2.0	2.7
6	19	2.0	2.4	2.7	3.0
8	19	2.4	2.4	2.7	3.0
10	22	2.7	-	3.3	-
12	22	3.0	-	3.6	-

- .3 For insulated pipe, reduce spacing by 30%.
- .4 Do not restrain axial movement.
- .5 Spacing based on fluids with specific gravity of 1.0 and 26°C (80°F). For other conditions, use other published data approved by Consultant.

.9 Vertical Piping Supports

- .1 Vertical plumbing and drainage piping:
 - .1 To the Ontario Building Code, unless more stringent requirements are specified herein.
- .2 Vertical support spacing:
 - .1 Cast iron soil pipes: At every floor with riser clamps.
 - .2 Other piping: At every other floor with riser clamps, unless otherwise required by expansion conditions or otherwise specified.
- .3 Support bottom of riser with base fitting set on concrete pier or by hanger located at top of riser pipe as close to riser as possible.
- .4 Riser clamps:
 - .1 Bolted securely to pipes.
 - .2 Rest ends of clamp on the pipe sleeve or on the floor.
 - .3 Weld shear lugs to pipe to transfer load to riser clamp.
- .5 Stabilize vertical piping laterally by fabricated brackets or malleable iron, extension type split hangers.
- .6 Run vertical piping at columns in the column webs, on either or both sides of the column, unless otherwise directed by the Consultant.

.10 Anchors and Guides

- .1 Use anchors where shown on the Drawings and/or as required to maintain permanent location of pipe lines.
 - .1 Construct anchors for steel or galvanized pipe of approved steel straps and/or rods.

- .2 For anchoring copper lines, use copper plated anchors, or use insulation bands between tubing and clamps if steel straps or rods are used.
- .2 Provide minimum two pipe guides on each side of an expansion joint and expansion compensator.
 - .1 1.2 m between each guide.
 - .2 Not more than 900 mm between last guide and start of expansion joint or expansion compensator.
- .3 For special expansion joint/compensator or for special applications, where more than two guides on each side are required, follow manufacturer recommendations for location of guides.
- .11 Inserts
 - .1 In new construction, set inserts onto formwork prior to pouring of concrete.
 - .1 Provide a 200 mm length of rebar and wire through insert.
 - .2 Mechanical rooms and other areas of multiple pipe runs.
 - .1 Provide continuous type insert channels at 1.8 m intervals along route of piping.
 - .2 Provide a 200 mm length of rebar and wire through insert.
- .12 Upper Attachments - Structural Steel
 - .1 For pipe size NPS 10 and larger supported from structural steel:
 - .1 Provide supplementary structural steel and weld or bolt to structural steel.
 - .2 Submit Plan Drawings and details to the Structural Engineer for review.
- .13 Roof Mounted Piping
 - .1 Manufacturer site responsibilities:
 - .1 Provide on site assistance and inspection as required for installation.
 - .2 Provide Layout Drawing, located positions of each hanger.
 - .2 Hanger system installation:
 - .1 Remove roofing ballast and debris from areas of base.
 - .2 Adhere roofing pad to roof membrane with adhesion system as recommended by manufacturer.
 - .3 Adhere base to roofing pad with adhesion system as recommended by manufacturer.
 - .4 Set frame legs in to bases and assemble hangers.
 - .5 Remove excess adhesive from frame, bases and pads.
 - .6 Replace roof ballast up to edge of base.

End of Section

100% Review

1 General

1.1 **SUMMARY**

.1 Section Includes

- .1 Labor, Products, equipment, and services necessary to complete the Work of this section.

1.2 **DESIGN CRITERIA – NOISE AND VIBRATION**

.1 General

- .1 Limit noise and vibration levels of equipment and systems within design intent.
- .2 If noise or vibration levels created by any mechanical equipment and systems and transmitted to occupied portions of building or other mechanical Work, or are over the limits, make all necessary changes without additional cost.
- .3 Install equipment, piping and ductwork in accordance with good noise and vibration control engineering practice in order to meet the requirements specified below.
- .4 Maximum sound levels, combined internal background and mechanical equipment generated noise:

Room	N.C. Levels
Open Plan Offices	35-38
Cellular Offices	33-35
Service/Plant Areas	50

- .1 Exclude environmental transient noise (traffic, etc).
- .5 Meet the seismic requirements for the region as listed in the latest edition of the Ontario Building Code.

.2 Vibration Limits of Mechanical Equipment

.1 Equipment classification:

- .1 One of three categories defined in ISO standard 2372.
- .2 Vibration severity limits corrected for hard and soft support as defined by ISO standard 3945.
- .3 Maximum vibration severity, as measured: Not to exceed category A (Good).

.2 Summary of the standards:

- .1 Hard support: The fundamental frequency of the machine on its support is higher than its main excitation frequency (in general, rigidly mounted machine).
- .2 Soft support: The fundamental frequency of the machine on its support is lower than its main excitation frequency (in general, machines on vibration isolators).

.3 Vibration severity: The largest of all the rms values of vibration velocity of a machine measured at three perpendicular axes at main support bearings of the rotor.

.3 Vibration severity limits:

.1 For equipment on hard support.

Type of Machine	Class	Vibration Severity Limit mm/s
Small Equipment (up to 20 HP)	I	0.71
Medium Equipment (21-100 HP)	II	1.11
Large Equipment (over 100 HP)	III	1.80

.2 For soft support the limits are 1.6 times higher:

.4 These limits apply for all normal running conditions of the equipment.

.5 Measurement equipment: To ISO standard 2954.

.1 Carry out measurements by a technically competent person.

.3 Minimum Requirements

.1 Refer to Mechanical Drawings and schedules for the minimum requirements of vibration isolation and sound attenuation.

1.3 **SUBMITTALS**

.1 Shop Drawings

.1 Submit in accordance with Section 01 33 00.

2 Products

2.1 **MANUFACTURERS**

.1 Acceptable manufacturers of noise and vibration control hardware are:

.1 Vibron

.2 Vibro-Acoustics

.3 Korfund-Sampson

.2 Noise and vibration control hardware: Supplied by a single Supplier.

.1 Exception: Where vibration isolation is supplied as an internal component as part of a manufactured Product.

2.2 **MATERIALS**

.1 Pad Isolators

.1 Rubber in shear, minimum 13 mm thick, bonded to 6 mm steel plates.

.2 Neoprene Isolators

- .1 Captured mount design with threaded insert and hold down bolts.
 - .2 Double deflection isolator refers to mounts with design static deflection of 13 mm.
 - .3 Selection: Not loaded beyond its design limit, but not less than 60% of its design value.
- .3 Spring Isolators
- .1 Colour coded stable springs, levelling devices and neoprene insert or pad for acoustical isolation.
 - .2 Lateral spring stiffness: Minimum 0.8 times vertical stiffness.
 - .3 Mounting hardware: Zinc chromate plated.
 - .4 Bolt holes for hold down bolts and suitably stepped rubber washers.
 - .5 Stable spring types for open spring mounts.
 - .6 Steel spring operating load rating: Load to between 50% and 70% of the SOLID spring deflection.
 - .7 Rubber spring operating load rating: Between 60% to 100% of rated maximum.
 - .8 Neoprene pads: Size pads at the base of the steel spring mounts to deflect between 1.5 to 2.5 mm at the operating load (for acoustical isolation above the first spring resonance).
- .4 Resilient Hangers
- .1 Captured mount design with threaded insert and hold down bolts.
 - .2 Capable of tolerating vertical misalignment for a total of plus or minus ten degrees with the specified hanger rod and at the rated deflection.
 - .3 Double deflection isolator refers to mounts with design static deflection of 13 mm.
 - .4 Selection: Not loaded beyond its design limit, but not less than 60% of its design value.
- .5 Structural Steel Fan Bases
- .1 Continuous integral box section structural steel base reinforced as necessary to withstand the belt tension without drive misalignment or distortion.
 - .2 Drill holes in the structural base to correspond with anchor bolt holes of fan base.
 - .3 Provide built-in motor slide rails in each base.
 - .4 Beams and brackets, flange, and web thickness: Minimum of 5 mm.
 - .5 Use height saving brackets in all mounting locations to provide a base clearance of 25 mm.
 - .6 Minimum depth: 1/10th of the longer dimension, but not less than 125 mm.
 - .7 Maximum depth: 300 mm unless specifically advised by the Consultant.
 - .8 Beam stiffness: Maximum deflections in between the support points (at the isolators) do not exceed 1/8th of the deflection of the isolators.

- .9 Overall stiffness: Withstand the reaction torque of the drive without relative deflection at the corners of more than 1/8th the isolator deflection.
- .6 Thrust Restraints
 - .1 Design: Similar to open spring restricted mount for intake, and pre-compressed hanger for discharge.
 - .2 Specified precompression complete with attachment rods and angle brackets.
 - .3 Stiffness: Less than one-fifth of the horizontal stiffness of the main isolation system.
- .7 Concrete Inertia Bases
 - .1 Continuous integral box section structural steel base reinforced as necessary to withstand the belt tension without drive misalignment or distortion.
 - .1 T-shaped base to support piping elbows for base mounted pumps.
 - .2 Drill holes in the structural base to correspond with anchor bolt holes of fan base.
 - .3 Provide built-in motor slide rails in each base.
 - .4 Beams and brackets, flange, and web thickness: minimum of 5 mm.
 - .5 Form with full depth perimeter frames with flanges pointed to the centre of base.
 - .6 Base reinforcement: Reinforcing rods at maximum 250 mm centres in both directions and minimum 38 mm up from the bottom of the steel channels, or place additional steel as required by structural condition or by code.
 - .7 Metal pans: Minimum 1.6 mm (16 gauge) welded sheet metal.
 - .8 Use height saving gusseted brackets in all mounting locations to provide a base clearance of 25 mm from housekeeping pad.
 - .9 Minimum base depth: 1/12th of the longer dimension, but not less than 125 mm.
 - .10 Maximum base depth: 300 mm unless specifically advised by the Consultant.
 - .11 Stiffness: Deflection in between the support points (at the isolators) does not exceed 1/40th deflection of the isolators.
 - .12 Overall base stiffness: Sufficient to withstand the reaction torque of the drive without relative deflection of the corners of base of more than 1/40th isolator deflection.
 - .13 Concrete fill: 30 MPa concrete.
- .8 Isolated Rooftop Equipment Rail Support
 - .1 Continuous support roof rails.
 - .1 Upper aluminum channel frame construction: Minimum height 120 mm.
 - .2 Distributed open springs, designed to suit equipment load distribution.

- .3 Lower aluminum channel plate, continuous contact to roof curb.
- .4 Elastomeric air and weather seal on outside edge of frame (concealing springs).
- .5 Aluminum weather seal flashing.
- .6 Internal levelling system.

3 Execution

3.1 **INSTALLATION**

.1 General

- .1 Carry out the Work of this section in accordance with manufacturer's instructions (and supervision where required) and only by workers experienced in the installation of such systems.

.2 Noise Control

- .1 Select and install isolation equipment to ensure that the mechanical equipment does not produce undue amounts of noise and vibration induced noise.

.2 Oversized pipe sleeves:

- .1 Location: At wall or floor within the first one hundred times diameter length from a noise/vibration source.
- .2 Sleeve size: At least 50 mm larger than the pipe diameter.
- .3 Sleeve sealing: Pack the periphery with firestopping, or high-density mineral wool (greater than 5 lb/cu.ft.) at not more than 50% compression.
- .4 Caulk the ends of the packing and seal with non-hardening caulk such as Tremco Dymeric (with colourpak if weatherproof quality is required).

.3 Duct sealing:

- .1 Pack and seal all spaces and cracks around ducts passing through mechanical room walls or floor, as described above for pipes.

.3 Vibration Control

.1 Types of vibration isolation hardware:

.1 Isolation mount types (xx specifies static deflection)

CSxx	Closed spring mount
OSxx	Open spring mount
OSRxx	Open spring restricted mount
OSRIxx	Open spring restricted mount with internal levelling devices
ERxx	Elastomer rubber mount

.2 Rubber isolation pad types

R	Single layer rubber waffle pad
N	Single layer neoprene waffle pad

RSR	Multiple layers of rubber and steel as indicated
NSN	
RSRSR, etc	

.3 Isolation hanger types

SH	Spring hanger
SHR	Spring hanger with rubber isolator
SHP	Either of above spring hangers with precompressed spring rubber isolator hanger
SHRP	
RH	Rubber isolator hanger

.4 Base types

IS	Integral steel base
CI	Concrete inertia base
IR	Isolated rooftop equipment curb

.2 Minimum vibration isolation requirements for all motor driven equipment: type R

- .1 Refer to equipment schedules for isolation requirements.
- .2 Use neoprene in potentially oily areas or outdoors.

.3 IS bases

- .1 Use IS base type structural steel frame as required for the support rigidity of the installation of the isolators.
- .2 Maximum isolation frequency: Not to exceed one-third of the lowest speed of the rotating equipment unless specified otherwise.

.4 Floor mounted equipment

- .1 Install on a housekeeping concrete pad.
- .2 Adjust and level the isolators for a 50 mm clearance unless otherwise noted.

.4 Isolator Requirements

- .1 Vibration isolation supplier to examine and conform to the overall requirements for the Project in accordance with the requirements specified herein.
- .2 Include:
 - .1 Consider RPM of equipment in determining the disturbing frequency on all fans, pumps, compressors, etc.
 - .2 Establish vibration isolation requirements from equipment manufacturer's certified Shop Drawings and performance data.
 - .3 Select spring isolators from the manufacturer's catalogue inventory wherever possible.
 - .4 Should deflection requirements warrant the use of special springs, provide complete design data to the Consultant with the Review Drawings.

- .5 Equip base type spring isolators with 9 mm thick neoprene or neoprene composition anti-vibration pads bonded to the base and with combination levelling bolts.
- .6 Equip hanger type spring isolators with neoprene or composition pads at both ends of the spring.

.5 Equipment Isolation

- .1 Mount equipment as follows, unless otherwise shown on Equipment Schedules.

Equipment	Remarks	Base Type	Isolation Type	Minimum Deflection mm
Centrifugal fans floor mounted suspended slab	up to 30 HP	IS	OS	25
	over 30 HP	CI	OS	45
Centrifugal fans - suspended	-	None	S4	45
Base mounted pumps	Basement or slab-on-grade	None	R	6
	Suspended slab	CI	OS	25
Refrigeration machines	Basement or slab-on-grade	None	RSR	6
	Suspended slab	None	OSRI	25
Cooling towers		Supplemental Steel	OSR	64
Air compressors	Up to 10 HP	None	CS	25
	Over 10 HP	CI	CS	25
Boilers	Basement or slab-on-grade	None	R	-
	Suspended slab	None	R	-
Propeller fans and roof exhausters		None	R	-
Air handling units	Fans internally isolated as above	None	R	-
Packaged rooftop equipment	Fans internally isolated as above	None	R	-

.6 Thrust Restraints

- .1 Required locations:
- .1 Fan intakes in excess of 1 kPa (4" W.G.) static vacuum.
 - .2 Fan discharge other than vertical, in excess of 1 kPa (4" W.G.) static gauge pressure.
 - .3 On hanger supported, horizontally mounted axial fans with more than 34 kg thrust due to static pressure.
- .2 Unless specified otherwise, attach horizontal restraints at the centreline of thrust and symmetrically on either side of the unit.

- .3 If horizontal thrust restraints are used, adjust same after installation for a maximum of 6 mm movement at start and stop.

3.2 **INSPECTION AND REPORTING**

.1 Supervision of Installation

- .1 Manufacturer/Supplier of hardware to provide on-site technical supervision of installation during construction.
- .2 Hardware Supplier to inspect and report in writing that the installation has been carried out to their satisfaction.

.2 On-Site Testing

- .1 If, after the start-up of mechanical equipment, the Consultant is not satisfied that noise and vibration goals have been met, the Consultant retains the option of asking for a sound and vibration test report of all areas under question.
- .2 Carry out measurements by a competent person using equipment meeting general requirements of international standards following measurement methods that follow similar standards.

.3 Remedial Work

- .1 If Consultant finds any installation of equipment and piping, and fabrication and installation of ductwork to be unsound or poor with regard to sound and vibration requirements, refabricate and reinstall such works as required at no increase in Contract Price.

End of Section

- 1 General
 - 1.1 **SUMMARY**
 - .1 Section Includes
 - .1 Labor, Products, equipment, and services necessary to complete the Work of this section.
 - .2 This section shall be read in conjunction with Appendix A City of Toronto Corporate Building System Design Requirements. Appendix A shall take precedence where there is a conflict in this Section.
 - 1.2 **SUBMITTALS**
 - .1 Shop Drawings
 - .1 Submit Shop Drawings in accordance with Section 01 33 00.
 - .2 Submit schedule of equipment identification nameplates for review.
 - .2 Samples
 - .1 Submit samples of piping, valve and ductwork identification markers.
- 2 Products
 - 2.1 **MATERIALS**
 - .1 Equipment Nameplates
 - .1 Laminated phenolic plastic with white finish and minimum 10 mm high black letters.
 - .2 Three rows of text, based as shown in equipment schedules.
 - .1 Line 1: Equipment ID (e.g. P-1)
 - .2 Line 2: Equipment name (e.g. northwest zone heating pump)
 - .3 Line 3: Optional, up to fifteen characters (e.g. standby pump)
 - .3 This identification is in addition to manufacturer's nameplate data.
 - .2 Ductwork Identification
 - .1 Painted stencil lettering: 50 mm high.
 - .2 Paint colour:
 - .1 Black paint on canvas covered insulated ductwork.
 - .2 Black paint on metal covered insulated ductwork.
 - .3 Black paint on uninsulated ductwork
 - .3 Two levels of text in accordance with designations shown on schedules:
 - .1 Level 1: Abbreviated name of air handling system for supply systems (e.g. AHU-1), or fan number for exhaust or ventilation only systems (e.g. F-1)

- .2 Level 2: System name (e.g. general supply)
- .4 Direction arrows: 65 mm high
- .3 Pipe Identification – Type 1: Adhesive Labels
 - .1 Pre-printed 6 mil thick vinyl cloth, plastic coated with pressure sensitive self-adhesive backing surface. On insulated pipe, use adhesive suitable for this application.
 - .1 Pipe diameter (including insulation) 75 mm or less: 29 mm width, 25 mm high lettering. Length of labels as dictated by legend.
 - .2 Pipe diameter (including insulation) greater than 75 mm: Minimum width of 64 mm and with 50 mm high letters.
 - .3 Primary label colour: To CAN/CGSB-24.3.
 - .4 Pipe label to include service pressure for steam, compressed air, natural gas (if more than one gas service pressure inside of building), and vacuum.
 - .5 Legend: Black with the legend printed in full wherever feasible.
 - .2 Direction arrow banding tape: Colour coded vinyl tape with pressure sensitive adhesive backing, 50 mm wide, with directional arrows.
 - .3 Acceptable Manufacturers:
 - .1 Brady
 - .2 Safety Supply Co.
 - .3 S.M.S
 - .4 Revere-Seton
- .4 Pipe Identification – Type 2: Coil Wrap Labels
 - .1 Reversible direction, semi-rigid plastic vinyl, with subsurface printing, and integral direction arrows.
 - .1 Up to 150 mm diameter: Coil wrap six rows of printing.
 - .2 Over 150 mm diameter: Saddle type with two rows of printing, fastened with stainless steel springs.
 - .3 Lettering Size:

Outside Diameter	Letter Height
Less than 5/8"	1/4"
3/4" – 1 1/4"	1/2"
1 1/8" – 2 3/8"	3/4"
2 1/2" – 4 1/2"	1 1/4"
 - .4 Primary label colour: To CAN/CGSB-24.3.
 - .5 Pipe label to include service pressure for, natural gas and vacuum.
 - .6 Legend: Black with the legend printed in full wherever feasible.

- .2 Acceptable Manufacturers:
 - .1 Brady
 - .2 Safety Supply Co.
 - .3 S.M.S
 - .4 Revere-Seton
- .5 Valve Identification
 - .1 Laminated phenolic plastic with minimum 10 mm high lettering, with brass keychain.
 - .2 Minimum two lines of text:
 - .1 Line 1: Valve designation
 - .2 Line 2: Valve position instruction
 - .3 Acceptable manufacturers
 - .1 S.M.S.
 - .2 Brady
 - .3 Safety Supply Co.
 - .4 Revere-Seton
- 3 Execution
- 3.1 **INSTALLATION**
 - .1 Equipment Nameplates
 - .1 Identify mechanical and electrical equipment installed under this division with nameplates describing the function or use of the particular equipment involved.
 - .2 Do not commence fabrication of nameplates until after receipt of Consultant's review.
 - .3 Equipment includes, but not limited to:
 - .1 Equipment as shown on schedules and specified.
 - .2 Motor starters
 - .3 Motor control centers
 - .4 Pushbutton stations
 - .5 Control panels.
 - .6 Time switches
 - .7 Disconnect switches.
 - .8 Contactors or relays in separate enclosures

- .4 Equipment nameplates for building automation system components are specified under Section 25 05 00.
- .5 Securely fasten nameplates to the equipment with round-head cadmium plated steel self-tapping screws.
- .2 Ductwork Identification
 - .1 Label ductwork installed under this division to indicate the content and direction of flow.
 - .2 Locate labels as follows:
 - .1 Within 1.5 m of air handling units and free-standing fans.
 - .2 Within 3 m of divisions in exposed ductwork.
 - .3 On each exposed duct passing through a wall, partition, or floor (one on each side of such wall, partition or floor).
 - .4 At intervals not to exceed 15 m along every exposed duct run exceeding 15 m in length.
 - .5 On every concealed duct where it enters a floor area that it serves.
 - .3 Labels to be visible from 1.5 m above the adjacent floor or platform.
 - .4 Clean surfaces with a trisodium phosphate solution before application of paint.
- .3 Piping Identification
 - .1 Label all piping installed under this division to indicate the content and direction of flow with Type 1 or Type 2 labeling system.
 - .2 For piping carrying steam, compressed air, and vacuum, show on label the pressure or vacuum, and working units as applicable.
 - .3 Locate labels as follows:
 - .1 At every end of pipe run, adjacent to the valve or item of equipment serviced.
 - .2 At valves, tees, and changes of direction.
 - .3 On each exposed pipe passing through a wall, partition, or floor (one on each side of such wall, partition or floor).
 - .4 At intervals not to exceed 15 m along every exposed pipe run exceeding 15 m in length.
 - .5 At every access point on concealed piping.
 - .4 Labels to be visible from 1.5 m above the adjacent floor or platform.
 - .5 Type 1 Labels.
 - .1 Clean surfaces before application of labels.
 - .2 Secure label with direction arrow banding tape for full circumference of pipe, at each end of label.

- .6 Natural gas piping: In addition to pipe labels specified above, paint all piping and tubing with one coat oil alkyd primer and one topcoat of alkyd enamel, bright yellow.
- .7 Natural gas piping: As specified above except provide labels every 6 m.
- .4 Valve Tags
 - .1 Provide valve tags on all valves, except as follows:
 - .1 At plumbing fixtures.
 - .2 On balancing valves at equipment being served.
 - .3 On isolation valves around control valves
 - .2 Provide a valve identification directory for each system.
 - .1 Quantity: Two copies of valve identification directories for each system
 - .2 Documented as follows (example given):

Valve No.	Service	Valve Location	Nearest Column
HV-1	Northwest Zone Heating	Penthouse, North Side	A-8

End of Section

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- 1 General
- 1.1 **SUMMARY**
 - .1 Section Includes
 - .1 Labor, Products, equipment, and services necessary to complete the Work of this section.
 - .2 Section Excludes
 - .1 The following items are not to be insulated, or are factory insulated.
 - .1 Ductwork:
 - .1 Variable volume terminal boxes
 - .2 Internal acoustically insulated ductwork, except overlap thermal insulation 300 mm over acoustic insulation section.
 - .3 Supply ductwork, which is exposed to the occupied space, unless otherwise noted
- 1.2 **REFERENCE STANDARDS**
 - .1 General
 - .1 Provide insulation materials and adhesives of fire-retardant type with flame spread and smoke developed ratings not exceeding ULC, government, or municipal standards.
 - .2 Fire retardant materials with flame spread/smoke developed ratings not exceeding 25/50 when tested in accordance with CAN/ULC-S102 and complying with the requirements stated in the building code having jurisdiction.
 - .3 Identify insulation, coverings and adhesives where required by federal and/or provincial health and safety WHMIS legislation.
 - .4 Asbestos-free materials.
 - .2 Reference Standards
 - .1 Comply with the latest edition of:
 - .1 NFPA 90-A, Standard for the Installation of Air-Conditioning and Ventilating Systems
 - .2 NFPA 255, Standard Method of Test of Surface Burning Characteristics of Building Materials
 - .3 CAN/ULC-S102, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies
 - .4 ASTM C-411, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation
- 1.3 **SUBMITTALS**
 - .1 Samples

- .1 Submit in accordance with Section 01 33 00.
- .2 Before ordering insulation materials prepare sample board on which mount cross-section sample of types of insulation, including exterior jacket, properly identified for various services and equipment on Project. State types of adhesives.
- .3 Submit sample board to Consultant for review. After review and acceptance keep sample board in Consultant's Site office for duration of Project, for reference. No deviation from accepted samples will be allowed.

1.4 **PRODUCT DELIVERY, STORAGE AND HANDLING**

- .1 General
 - .1 Retain insulation materials in original cartons or containers until immediately prior to application and store in dry location.
 - .2 Keep adhesives in their original containers with manufacturer's name and catalogue number clearly stated. Protect contents against freezing.

1.5 **DEFINITIONS**

- .1 For the purposes of this section, the following definitions apply:
 - .1 "Conditioned supply ducts": Ductwork conveying air which has either been heated or cooled.
 - .2 "Concealed": Mechanical services and equipment located in ceiling spaces above solid drywall and T-bar ceilings; space beneath raised floors; vertical service shafts; trenches; and non-accessible chases and furred spaces.
 - .3 "Exposed": Mechanical services and equipment in all other spaces not considered to be "concealed" as defined above. Services in tunnels are to be treated as "Exposed".

2 Products

2.1 **DUCTWORK INSULATION**

- .1 Type D1
 - .1 Fiberglass: To ASTM C553
 - .2 Flexible blanket
 - .3 Laminated kraft-aluminum foil facing jacket.
 - .4 Operating temperatures: 4°C to 121°C (40°F to 250°F)
 - .5 Density: 12 kg/m³
 - .6 k value: 0.051 W/m°C @ 24°C (0.35 BTUH•in/ft²°F @ 75°F)
 - .7 Acceptable Manufacturers
 - .1 Johns Manville - Microlite
 - .2 Knauf Fibreglass
- .2 Type D2

- .1 Fiberglass: To ASTM C553
- .2 Semi-rigid board
- .3 Laminated kraft-aluminum foil facing jacket.
- .4 Operating temperatures: 4°C to 121°C °F
- .5 Density: 48 kg/m³
- .6 k value: 0.044 W/mC @ 24C
- .7 Acceptable Manufacturers
 - .1 Owens Corning - 703/AF530
 - .2 Johns Manville - Spin-Glas Series 814
 - .3 Knauf Fibreglass
- .3 Type D3
 - .1 Inorganic mineral fibre: To ASTM C518
 - .2 Flexible blanket or rigid board
 - .3 ULC approved ductwork fire rating: To two hours.
 - .4 Laminated kraft-aluminum foil facing jacket.
 - .5 Maximum operating temperature: -173°C to +1260°C °F
 - .6 Acceptable manufacturers
 - .1 3M Ceramics Materials - Firemaster Duct Wrap
Firemaster Grease Duct
Firemaster Board

2.2 **INSULATION FINISH**

- .1 Canvas Jacket
 - .1 ULC listed plain weave cotton fabric.
 - .2 Weight: 220 gm/m²
 - .3 Acceptable manufacturers
 - .1 Fattal's Thermocanvas
- .2 PVC (Polyvinyl Chloride) Jacket
 - .1 Minimum thickness: 20 mil
 - .2 Maximum permeability: 0.09 perms
 - .3 Premoulded one-piece fitting covers
 - .4 Tape: Vinyl, pressure sensitive, colour matched
 - .5 Acceptable manufacturers

- .1 Johns Manville - Manville Zeston 2000
- .2 ACWIL Insulations
- .3 Sure Fit Systems
- .3 Metal Jacket
 - .1 Aluminum: Stucco embossed, minimum 0.45 mm thick
 - .2 Stainless steel: Corrugated, minimum 0.25 mm thick
 - .3 Fittings: Custom made, swaged ring or lobster back style on bends, die shaped over fittings, valves, strainers, and flanges
 - .4 Bands: 13 mm wide stainless steel with mechanical fasteners
 - .5 Acceptable manufacturers
 - .1 Alcan Canada Products - Thermaclad Type 1
 - .2 Childers Products Inc - Fab straps
- 2.3 **ADHESIVES**
 - .1 Contact Bond Cement
 - .1 Quick setting for metal surfaces
 - .2 Acceptable manufacturers:
 - .1 Henry - 200-37
 - .2 Foster - 85-75
 - .2 Lap Seal Adhesive
 - .1 For joints and lap sealing of vapour barriers
 - .2 Acceptable manufacturers:
 - .1 Henry - 230-39
 - .2 Foster - 85-75
 - .3 Contact Adhesive
 - .1 Acceptable manufacturers:
 - .1 Foster - 85-20
 - .4 Lagging Adhesive
 - .1 Acceptable manufacturers:
 - .1 Henry - 120-18
 - .2 Foster - 30-36
- 2.4 **MASTIC**
 - .1 Interior

- .1 Acceptable manufacturers:
 - .1 Henry - 120-19
 - .2 Foster - 30-35
- .2 Exterior, With Vapour Barrier
 - .1 Acceptable manufacturers:
 - .1 Henry - 130-11
 - .2 Foster - 65-07
- .3 Exterior, Breather Type
 - .1 Acceptable manufacturers:
 - .1 Childers - CP-10
- .4 Exterior - Aluminum Colour Finish
 - .1 Acceptable manufacturers:
 - .1 VentureClad 1579CW
 - .2 Alumaguard All-weather
- .5 Cutback Asphalt
 - .1 Acceptable manufacturers:
 - .1 Henry - 700-01
 - .2 Foster - 60-25
- 2.5 **MISCELLANEOUS PRODUCTS**
 - .1 Sealants
 - .1 Acceptable manufacturers:
 - .1 Henry - 230-39
 - .2 Foster - 30-80
 - .2 Vapour Barrier Tape
 - .1 Colour matched, foil faced vapor barrier tape.
 - .2 75 mm wide
 - .3 Vinyl backed or foil backed to suit insulation.
 - .4 Acceptable manufacturers:
 - .1 Johns Manville - Zeston Z-tape
 - .2 MacTac Canada Ltd - Vinyl Scrim or Foil Scrim Kraft
 - .3 Compac Corp
 - .4 Fattal Canvas Inc

- .3 Bands
 - .1 Stainless steel or galvanized metal, 12 mm wide with mechanical cinch locks.
- .4 Insulation Cement
 - .1 Acceptable manufacturers:
 - .1 Partek - Hilcote
- .5 Vapour Barrier Insulation Coating
 - .1 Acceptable manufacturers:
 - .1 Henry - 130-11
 - .2 Foster - 60-38
- .6 Weld Pins, Studs and Clips
 - .1 Acceptable manufacturers:
 - .1 Midwest Fasteners Inc
 - .2 Continental Studwelding
 - .3 AGM
- .7 Caulking
 - .1 Fast-drying colour matched flexible butyl elastomer-based vapor barrier sealant.

3 Execution

3.1 **APPLICATION**

- .1 General
 - .1 Perform insulation work using qualified insulating applicators, in accordance with latest trade application methods and to the Consultant's approval.
 - .2 Clean all surfaces to be insulated to remove grime, grease, oil, moisture, or other matter to ensure that insulation is applied to clean and dry surfaces.
 - .3 Apply insulation under ambient temperature conditions in accordance with insulation or adhesive manufacturer's recommendations.
 - .4 Do not apply insulation until such time as installation and testing of piping, ductwork and equipment has been inspected, verified, and accepted by General Contractor.
 - .5 Apply insulation neatly and tightly in unbroken lengths and with ends of sections firmly and squarely butted together. Lap canvas (or other specified wrapping) well over joints and cement down well with adhesive.
 - .6 At wall sleeves: Extend insulation through to make insulation continuous.
 - .7 At fire walls: Terminate insulation at wall, and pack space between wall sleeve and duct or pipe as specified in Section 23 05 01.
- .2 Treatment of Existing Insulation

- .1 Where new piping or ductwork systems connect to existing and where existing insulation is damaged through installation of new work, remove damaged sections of insulation for a minimum of 1 m and replace and finish to match existing.
- .3 Ductwork
 - .1 General
 - .1 Insulate access doors or removable panels in ductwork as separate units to permit opening or removal without damage to adjoining insulation.
 - .2 Type D1
 - .1 Fasten insulation with adhesive, applied in 150 mm wide strips at 300 mm centres.
 - .2 Tightly butt all edges and joints and seal with interior mastic and scrim foil tape.
 - .3 Tying cord may be used to temporarily hold insulation until adhesive has set.
 - .3 Type D2
 - .1 Secure insulation with welded pins and speed washer type fasteners at 300 mm centres. Provide a minimum of two rows of fasteners on each side of duct.
 - .2 In addition to mechanical fasteners, adhere insulation with adhesive applied in 150 mm strips on 450 mm centres.
 - .3 Tightly butt all edges and joints and seal with interior mastic and scrim foil tape.
 - .4 Cut off protruding ends of welded pins and cover speed washers with same tape.
 - .4 Type D3
 - .1 Install fire rated insulation in strict accordance with manufacturer's recommendations and ULC listing requirements.
 - .2 Provide the services of the manufacturer's technical representative to inspect the installation prior to inspection by the Consultant. Submit inspection certificate from the manufacturer.

3.2 INSULATION SELECTION

- .1 HVAC Ductwork
 - .1 Insulate the following systems:

System	Size	Max. Op. Temp °C (°F)	Insulation Type	Insulation Thickness mm
Conditioned air supply ducts	Exposed	65 (150)	D2	25
	Concealed		D1	38

System	Size	Max. Op. Temp °C (°F)	Insulation Type	Insulation Thickness mm
Fresh air intake plenums and ducts	Exposed Concealed	38 (100)	D2 D1	25 38
Return air ducts (as noted)	Exposed Concealed	38 (100)	D2 D1	25 38
Exterior supply and return ductwork	All	65 (150)	D2	50
Exhaust duct behind registers in high humidity areas, minimum 3 m long	Concealed	38 (100)	D1	38
Exhaust air plenums and ducts, between outside wall and motorized damper	Exposed Concealed	38 (100)	D1 D1	38 38
Fabricated steam boiler breeching and hot water boiler stacks	Round Rectangular	454 (850)	E3 E4	50 Note 1
Fire rated ducts, two hour	All	-	D3	Note 2

Note 1: Two layers of 25 mm thickness, overlapped butt joints.

Note 2: Thickness and installation in strict accordance with ULC listing requirements.

3.3 FINISH

.1 Ductwork

.1 Finish exposed ductwork in accordance with the following:

System	Equipment
D1 (round)	Canvas
D2	(Canvas) (Metal)
D3	None

.2 General

.1 Canvas installation:

- .1 Do not apply canvas to elastomeric closed cell foam insulation.
- .2 Securely paste canvas on with a two-coat application of fire resistive lagging adhesive over the entire surface. Apply canvas between coats of adhesive, while first coat is still wet. Stretch canvas tightly and smoothly with overlapping seams located where least visible. Apply second coat of adhesive immediately following application of canvas. Do not use metal bands.
- .3 Seal canvas with off-white sizing to leave a smooth non-porous surface ready to receive paint application.

.2 Outdoor ductwork:

- .1 Non-winter application: Finish with one layer of glass fabric applied between two full mop coats of outdoor mastic with all laps completely sealed.
- .2 Winter application: Finish insulated ductwork with one layer of glass fibre fabric applied between two full mop coats of exterior mastic, aluminum colour. Topcoat with aluminum coating in accordance with manufacturer's direction. Store materials in a heated space prior to application.
- .3 Do not allow mastic materials to come in contact with single ply membrane roofs.
 - .1 Clean up accidental spills immediately.
 - .2 Provide temporary drop sheets to protect the roof.

End of Section

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- 1 General
- 1.1 **SUMMARY**
 - .1 Section Includes
 - .1 Labor, Products, equipment, and services necessary to complete the Work of this section including, but not limited to, the following:
 - .1 Thermal insulation to piping, ductwork and equipment.
 - .2 Section Excludes
 - .1 The following items are not to be insulated, or are factory insulated:
 - .1 Piping:
 - .1 Compressed air piping
 - .2 Natural gas piping
 - .3 Fire protection piping (except where heat traced)
 - .4 Vertical sections of rainwater leaders (except where running exposed or concealed within high humidity areas including shower rooms, locker rooms, kitchens, etc.)
 - .5 Vertical sections of exposed sanitary drainage piping
 - .6 Condenser water supply and return piping inside of building.
- 1.2 **REFERENCE STANDARDS**
 - .1 General
 - .1 Provide insulation materials and adhesives of fire-retardant type with flame spread and smoke developed ratings not exceeding ULC, government, or municipal standards.
 - .2 Fire retardant materials with flame spread/smoke developed ratings not exceeding 25/50 when tested in accordance with CAN/ULC-S102 and complying with the requirements stated in the building code having jurisdiction.
 - .3 Identify insulation, coverings and adhesives where required by federal and/or provincial health and safety WHMIS legislation.
 - .4 Asbestos-free materials.
 - .2 Reference Standards
 - .1 Comply with the latest edition of:
 - .1 NFPA 90-A, Standard for the Installation of Air-Conditioning and Ventilating Systems
 - .2 NFPA 255, Standard Method of Test of Surface Burning Characteristics of Building Materials
 - .3 CAN/ULC-S102, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies

- .4 ASTM C-411, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation

1.3 SUBMITTALS

- .1 Samples
 - .1 Submit in accordance with Section 01 33 00.
 - .2 Before ordering insulation materials prepare sample board on which mount cross-section sample of types of insulation, including exterior jacket, properly identified for various services and equipment on project. State types of adhesives.
 - .3 Submit sample board to Consultant for review. After review and acceptance keep sample board in Consultant's Site office for duration of Project for reference. No deviation from accepted samples will be allowed.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

- .1 General
 - .1 Retain insulation materials in original cartons or containers until immediately prior to application and store in dry location.
 - .2 Keep adhesives in their original containers with manufacturer's name and catalogue number clearly stated. Protect contents against freezing.

1.5 DEFINITIONS

- .1 For the purposes of this section, the following definitions apply:
 - .1 "Conditioned supply ducts": Ductwork conveying air which has either been heated or cooled.
 - .2 "Concealed": Mechanical services and equipment located in ceiling spaces above solid drywall and T-bar ceilings; space beneath raised floors; vertical service shafts; trenches; and non-accessible chases and furred spaces.
 - .3 "Exposed": Mechanical services and equipment in all other spaces not considered to be "concealed" as defined above. Services in tunnels are to be treated as "Exposed".
 - .4 "Cold piping": Piping carrying fluids at temperatures below 16°C (60°F).

2 Products

2.1 PIPE INSULATION

- .1 Type P1
 - .1 Fiberglass: To ASTM C547
 - .2 Rigid, split formed with pressure sensitive longitudinal adhesion strip.
 - .3 Reinforced all service vapour retarder jacket:
 - .4 Operating temperatures: -40°C to +454°C (-40°F to +850°F)
 - .5 k value: 0.042 W/mC @ 93C

- .6 Acceptable Manufacturers
 - .1 Owens Corning - SSL-II
 - .2 Johns Manville - Micro-Lok with AP-T plus jacket
 - .3 Manson Alley - K with all purposed APT jacket
 - .4 Knauf Pipe Insulation with ASJ-SSI jacket
- .2 Type P2
 - .1 Inorganic mineral fiber: To ASTM C547
 - .2 Rigid, split formed, molded insulation.
 - .3 Maximum operating temperature: 648°C (1200°F)
 - .4 k value: 0.058 W/mC @ 176C
 - .5 Tie wire: 0.045 mm (16 gauge) stainless steel with twisted ends, on maximum 300 mm centres.
 - .6 Acceptable manufacturers
 - .1 Johns Manville - Thermo 12 Gold
 - .2 Calsilite
- .3 Type P3
 - .1 Closed cell elastomeric: To ASTM C534
 - .2 Preformed, with self-closing adhesion strips.
 - .3 k value: 0.04 W/mC @ 82C
 - .4 Maximum operating temperature: 82°C (180°F)
 - .5 Acceptable manufacturers:
 - .1 Armstrong - AP/Armaflex Self Seal Pipe Insulation
 - .2 Rubatex - 25-50
 - .3 Nomaco - IMC04 Polyolefin Foam
- .4 Type P4
 - .1 CFC-free rigid phenolic insulation: To ASTM C1126
 - .2 Rigid, split formed and sidewall segmented, depending on size.
 - .3 Reinforced all service low permeance vapour retarder jacket.
 - .4 Operating temperatures: -180°C to +120°C (-290°F to +250°F)
 - .5 K value: 0.019 W/mK @ 24°C
 - .6 Density: 35 kg/m³
 - .7 Acceptable manufacturers:

- .1 Kingspan - Koolphen K
- .5 Type P5 - Cold Piping Support Inserts
 - .1 CFC-free rigid phenolic insulation: To ASTM C1126
 - .2 Rigid, split formed and sidewall segmented, depending on size.
 - .3 Reinforced all service low permeance vapor retarder jacket.
 - .4 Operating temperatures: -180°C to +120°C (-290°F to +250°F)
 - .5 K value: 0.019 W/mK @ 24°C
 - .6 Density, up to NPS 10: 60 kg/m³
 - .7 Density, NPS 12 and over: 80 kg/m³
 - .8 Acceptable manufacturers:
 - .1 Kingspan - Koolphen K Pipe Support Inserts
- 2.2 **INSULATION FINISH**
 - .1 Canvas Jacket
 - .1 ULC listed plain weave cotton fabric
 - .2 Weight: 220 gm/m²
 - .3 Acceptable manufacturers
 - .1 Fattal's Thermocanvas
 - .2 PVC (Polyvinyl Chloride) Jacket
 - .1 Minimum thickness: 20 mil
 - .2 Maximum permeability: 0.09 perms
 - .3 Premoulded one-piece fitting covers
 - .4 Tape: Vinyl, pressure sensitive, colour matched
 - .5 Acceptable manufacturers:
 - .1 Johns Manville - Manville Zeston 2000
 - .2 ACWIL Insulations
 - .3 Sure Fit Systems
 - .3 Metal Jacket
 - .1 Aluminum: Stucco embossed, minimum 0.45 mm thick
 - .2 Stainless steel: Corrugated, minimum 0.25 mm thick
 - .3 Fittings: Custom made, swaged ring or lobster back style on bends, die shaped over fittings, valves, strainers, and flanges
 - .4 Bands: 13 mm wide stainless steel with mechanical fasteners

- .5 Acceptable manufacturers:
 - .1 Alcan Canada Products - Thermaclad Type 1
 - .2 Childers Products Inc - Fab straps

2.3 **ADHESIVES**

- .1 Contact Bond Cement
 - .1 Quick setting for metal surfaces
 - .2 Acceptable manufacturers:
 - .1 Henry - 200-37
 - .2 Foster - 85-75
 - .2 Lap Seal Adhesive
 - .1 For joints and lap sealing of vapour barriers
 - .2 Acceptable manufacturers:
 - .1 Henry - 230-39
 - .2 Foster - 85-75
 - .3 Contact Adhesive
 - .1 Acceptable manufacturers:
 - .1 Foster - 85-20
 - .4 Lagging Adhesive
 - .1 Acceptable manufacturers:
 - .1 Henry - 120-18
 - .2 Foster - 30-36
 - .5 Mastic Interior
 - .1 Acceptable Manufacturers
 - .1 Henry - 120-19
 - .2 Foster - 30-35
 - .6 Exterior, With Vapour Barrier
 - .1 Acceptable manufacturers:
 - .1 Henry - 130-11
 - .2 Foster - 65-07
 - .7 Exterior, Breather Type
 - .1 Acceptable manufacturers:
 - .1 Childers - CP-10

- .8 Exterior - Aluminum Colour Finish
 - .1 Acceptable manufacturers:
 - .1 USE Hickson Hydroshield Mastic 451 with "Stormking" aluminum coating.

- .9 Cutback Asphalt
 - .1 Acceptable manufacturers:
 - .1 Henry - 700-01
 - .2 Foster - 60-25

2.4 **MISCELLANEOUS PRODUCTS**

- .1 Sealants
 - .1 Acceptable manufacturers:
 - .1 Henry - 230-39
 - .2 Foster - 30-80
- .2 Vapour Barrier Tape
 - .1 Colour matched, foil faced vapor barrier tape.
 - .2 75 mm wide
 - .3 Vinyl backed or foil backed to suit insulation.
 - .4 Acceptable manufacturers:
 - .1 Johns Manville - Zeston Z-tape
 - .2 MacTac Canada Ltd - Vinyl Scrim or Foil Scrim Kraft
 - .3 Compac Corp
 - .4 Fattal Canvas Inc
- .3 Bands
 - .1 Stainless steel or galvanized metal, 12 mm wide with mechanical cinch locks.
- .4 Insulation Cement
 - .1 Acceptable manufacturers:
 - .1 Partek - Hilcote
- .5 Vapour Barrier Insulation Coating
 - .1 Acceptable manufacturers:
 - .1 Henry - 130-11
 - .2 Foster - 60-38
- .6 Weld Pins, Studs and Clips

- .1 Acceptable manufacturers:
 - .1 Midwest Fasteners Inc
 - .2 Continental Studwelding
 - .3 AGM
- .7 Caulking
 - .1 Fast-drying colour matched flexible butyl elastomer-based vapour barrier sealant.
- 3 Execution
- 3.1 **APPLICATION**
 - .1 General
 - .1 Perform insulation Work using qualified insulating applicators, in accordance with latest trade application methods and to the Consultant's approval.
 - .2 Clean all surfaces to be insulated to remove grime, grease, oil, moisture, or other matter to ensure that insulation is applied to clean and dry surfaces.
 - .3 Apply insulation under ambient temperature conditions in accordance with insulation or adhesive manufacturer's recommendations.
 - .4 Do not apply insulation until such time as installation and testing of piping, ductwork and equipment has been inspected, verified, and accepted by General Contractor.
 - .5 Apply insulation neatly and tightly in unbroken lengths and with ends of sections firmly and squarely butted together. Lap canvas (or other specified wrapping) well over joints and cement down well with adhesive.
 - .6 At wall sleeves: Extend insulation through to make insulation continuous.
 - .7 At fire walls: Terminate insulation at wall, and pack space between wall sleeve and duct or pipe as specified in Section 23 05 01.
 - .2 Treatment of Existing Insulation
 - .1 Where new piping or ductwork systems connect to existing and where existing insulation is damaged through installation of new Work, remove damaged sections of insulation for a minimum of 1 m and replace and finish to match existing.
 - .3 Piping
 - .1 General
 - .1 Neatly finish insulation at pipe hangers, supports, sensors and interruptions.
 - .2 At expansion joints in piping: Apply insulation over sleeve of 1.6 mm metal, fabricated to fit around expansion joint without restricting movement of joint.
 - .3 Provide sleeves which can be removed without damage to adjoining insulation to allow repacking and lubrication of expansion joint.

- .4 Provide sleeves minimum of 75 mm longer than expansion joint and fitted with insulation retaining flanges and with means for maintaining position of sleeve over expansion joint.
- .5 At heat traced piping: Make allowance in sizing inside diameter of insulation for tracing cable which will be provided under Electrical Contract.
- .2 Type P1
 - .1 Lap and seal all joints (longitudinal and transverse). Use vapour barrier tape on transverse joints. Locate longitudinal joints on top of pipe.
 - .2 Insulate fittings, unions, flanges, and valves with preformed block insulation or with segments cut from insulation of same type and thickness as pipe insulation.
 - .3 Form insulation on fittings and valves without voids. Secure in place with galvanized metal bands.
- .3 Type P2
 - .1 Seal all joints (longitudinal and transverse). Secure in place with metal bands at 230 mm centres. Use vapour barrier tape on transverse joints.
 - .2 Insulate fittings, and flanges with preformed block insulation or with segments cut from insulation of same type and thickness as pipe insulation.
 - .1 Exception: Steam valves NPS 2 and smaller in low pressure steam piping.
 - .2 Form insulation on fittings and valves without voids. Secure in place with metal bands.
 - .3 Finish with insulating and finishing cement.
 - .3 Insulate valves with removable "box" insulation blocks. Ensure top spindle and wheel/lever are free running and clear of insulation and covering.
 - .4 Stop insulation on each side of unions and at connections to equipment.
- .4 Type P3
 - .1 Lap and seal all joints (longitudinal and transverse). Use vapour barrier tape on transverse joints. Locate longitudinal joints on top of pipe.
- .5 Type P4 and P5
 - .1 Lap and seal all joints (longitudinal and transverse). Use vapour barrier tape on transverse joints. Locate longitudinal joints on top of pipe.
 - .2 Seal ends of insulation with mastic matching finish colour of insulation.
- .6 Drainage systems
 - .1 Apply insulation on roof drain bodies with 100% coverage of adhesive.
 - .2 Insulate above ground sanitary drainage systems (above finished ceiling areas).

- .3 Insulate above ground storm horizontal rainwater leaders, located beneath roofs.
- .7 Insulation termination points
 - .1 Terminate 75 mm from fittings.
 - .2 Bevel insulation at forty-five-degree angle away from fitting.
 - .3 Finish exposed face with insulating and finishing cement.
- .8 Insulation protection inserts - cold piping systems under 15°C (60°F)
 - .1 Place an insert between support with insulation shield and pipe on cold piping NPS 1½ and larger.
 - .2 Fabricate insert from Type P5 insulation.
 - .3 Insert length: Extending a minimum 150 mm beyond each end of insulation shield.
 - .4 Insert circumference: 360 degrees.
 - .5 Insulation shield: To Section 23 05 29
 - .6 Where insert material actual thickness is different from the actual thickness of the adjacent insulation, shave the insert to an equal thickness of the adjacent insulation.
 - .7 Bond the insulation shield to the insulation inserts with adhesive and finish and seal complete assembly with vapour barrier insulation coating to form an unbroken vapour barrier, or,
 - .8 Finish insulation insert as part of the main pipe insulation and provide two metal band clamps for each insulation shield and strap the shield to the finished pipe insulation.

3.2 **INSULATION SELECTION**

- .1 HVAC piping:
 - .1 Insulate the following systems:

System	Maximum Op. Temp °C (°F)	Pipe Size NPS	Insulation Type	Insulation Thickness mm
Equipment drain lines, safety valve vents, relief valve vents, etc.	110 (230)	All	P1	25
Dual temperature cooling/heating piping	93 (200)	All	P1, P4	38
Hot water heating piping	93 (200)	All	P1	38
Low temperature heating piping	60 (140)	Up to 4 5 and over	P1 P1	25 38
Refrigerant piping	60 (140)	All	P3, P4	19

System	Maximum Op. Temp °C (°F)	Pipe Size NPS	Insulation Type	Insulation Thickness mm
Condensate water piping (exterior)	40 (105)	All	P1, P4	38

Note 1: Two layers of 25 mm thickness, overlapped butt joints.

.2 Plumbing Piping

.1 Insulate the following systems:

System	Maximum Op. Temp °C (°F)	Pipe Size	Insulation Type	Insulation Thickness mm
City water piping	27 (80)	All	P1, P4	25
Domestic cold-water piping, including piping downstream of backflow preventers	27 (80)	All	P1, P4	25
Domestic hot and recirculating water piping, including piping downstream of backflow preventers	82 (180)	Up to 2 2½ and over	P1 P1	25 38
Storm and sanitary drainage piping	38 (100)	All	P1	25
Hot water supplies to barrier free use lavatories	82 (180)	All	P1	12

3.3

FINISH

.1 Piping

.1 Finish exposed piping in accordance with the following:

System	Pipe	Fittings, Valves, etc
P1	ASJ (Canvas) (PVC) (Metal)	(Canvas) (PVC) (Metal)
P2	(Canvas) (PVC) (Metal)	(Canvas) (PVC) (Metal)
P3	None	None
P1 Barrier Free Use	Canvas	Canvas

.2 General

.1 Canvas installation.

.1 Do not apply canvas to elastomeric closed cell foam insulation.

.2 Securely paste canvas on with a two-coat application of fire resistive lagging adhesive over the entire surface. Apply canvas between coats of adhesive, while first coat is still wet. Stretch canvas tightly and smoothly with overlapping seams located where least visible. Apply second coat of adhesive immediately following application of canvas. Do not use metal bands.

- .3 Seal canvas with off-white sizing to leave a smooth non-porous surface ready to receive paint application.
- .2 Piping insulated with elastomeric foam insulation (P3):
 - .1 Indoors and outdoors: Finish with one coat of white acrylic latex as recommended by insulation manufacturer.
- .3 Outdoor piping:
 - .1 Finish insulated piping with a field or factory applied aluminum jacket. Fasten and caulk butt joints and secure with sheet metal screws. Locate longitudinal joints on bottom of pipe.
 - .2 Alternatively, finish with two coats of outdoor type mastic (outdoor mastic - aluminum colour finish).
- .4 Do not allow mastic materials to come in contact with single ply membrane roofs.
 - .1 Clean up accidentally spills immediately.
 - .2 Provide temporary drop sheets to protect the roof.

End of Section

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- 1 General
- 1.1 **SUMMARY**
 - .1 Section Includes
 - .1 Labor, Products, equipment, and services necessary to complete the Work of this section including but not limited to the following:
 - .1 Performance testing and balancing of heating, ventilating, air conditioning and liquid systems.
 - .2 Measuring and reporting all specified space noise levels
 - .3 Measuring and reporting all specified vibration isolation levels
 - .4 Rechecking of testing and balancing during the alternate (heating/cooling) season
 - .2 This section shall be read in conjunction with Appendix A City of Toronto Corporate Building System Design Requirements. Appendix A shall take precedence where there is a conflict in this Section.
 - .2 Section Excludes
 - .1 The following systems do not require air and water balancing:
 - .1 Domestic cold water
 - .2 Domestic hot water (except balancing valve on connections to hot water recirculation piping)
 - .3 Steam and condensate systems (except steam flow meters at steam plant as part of heating equipment performance test)
 - .4 Natural gas (except natural gas metering as part of heating equipment performance test)
 - .2 The following equipment does not require air and water balancing:
 - .1 Hydronic and electric convection heaters (baseboards)
 - .2 Hydronic and electric unit heaters
 - .3 Hydronic radiant panel heating units
- 1.2 **RELATED WORK IN OTHER SECTIONS**
 - .1 Factory testing and calibrating of equipment or control systems.
 - .2 Testing and checking of equipment supplied by other divisions, except where such equipment forms an integral part of the mechanical systems.
- 1.3 **QUALIFICATIONS**
 - .1 Perform testing and balancing of air and water systems by an accredited testing and balancing firm who is a member of the Associated Air Balance Council (AABC).
 - .1 Acoustic and vibration measurements may be performed by a specialist Sub-contractor to the testing and balancing firm.

1.4 **PERFORMANCE STANDARDS**

- .1 Perform testing and balancing in accordance with the current issue of:
 - .1 Associated Air Balance Council Standards for Total System Balance.
 - .2 SMACNA "Testing, Adjusting and Balancing" guidelines.
- .2 Instruments: Recently calibrated; state date of calibration in the report.

1.5 **COORDINATION**

- .1 General
 - .1 Review with affected trades before fabrication, the location of balancing devices, test connections and access openings and report conditions which could affect optimum system performance.
 - .2 By inspection, assure that all testing, balancing, and metering devices are installed properly and in pre-selected locations.
 - .3 The Mechanical Contractor will obtain the approval of the testing and balancing firm before relocating these devices due to field conditions.
 - .4 Coordinate efforts so that items requiring replacement and/or delivery time (sheaves, motors, etc.) are tested as early as possible.
- .2 The Mechanical Contractor and/or associated Subcontractors will provide the following assistance and/or services to the testing and balancing firm.
 - .1 Schedule sufficient time so that initial testing and balancing can be completed before occupancy begins and coordinate with trades involved.
 - .2 Keep testing and balancing firm informed of any major changes made during construction and furnish same with a set of Project Drawings and reviewed Shop Drawings.
 - .3 Furnish balancing devices, test connections access openings, balancing probe inlets and plugs.
 - .4 Clean and pre-run all equipment, filters, etc. and place all heating, ventilating and air conditioning systems into full operation and continue same during each Working Day of testing and balancing.
 - .5 Provide immediate labour from pertinent mechanical trades and tools, equipment, and materials to make equipment and system alterations and adjustments as required, including control adjustments.
 - .6 Building Management System technical representative to operate the BMS during air and water balancing testing.
 - .7 Make available all equipment data (Shop Drawing performance data and operating instructions) to the testing and balancing firm.
 - .8 Refrigeration machine manufacturer service representative for performance testing of the refrigeration equipment. Testing and balancing firm witnesses and records all test results.
 - .9 Fuel fired heating equipment manufacturer service representative, or other qualified service company technical representative, for performance testing of

heating equipment. Testing and balancing firm witnesses and records all test results.

- .3 As part of the coordination effort, the Mechanical Contractor will be fully responsible for systems constructed, installed, and adjusted to provide optimum performance as required by design intent. Any re-adjusting required as the result of spot checks by the Consultant shall be done at no increase in Contract Price.

1.6 **DEFINITIONS**

.1 "Balancing"

- .1 To proportion and regulate flows within the distribution system (subsystems, branches, mains, terminals, etc.) at appropriate pressures in accordance with the design intent. This includes setting discharge volume and patterns of terminal devices, and individual return and exhaust air volumes.

.2 "Testing"

- .1 To measure, interpret and report in writing, such parameters as may be required to verify design compliance and as specified herein.

1.7 **SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00.

- .2 Submit layout drawings and report format a minimum fourteen days prior to start of air and water balancing on-site.

.1 Layout Drawings

- .1 Identify specific locations of all adjusting, balancing and permanent measuring devices, neatly marked on a set of plans for approval by the Consultant. A set of reproducible drawings will be furnished by the Consultant for this purpose.
- .2 Propose, for review by the Consultant, additional devices deemed advisable for satisfactory operation and completion of the Work of mechanical division.

.2 Report Format

- .1 Submit proposed format of initial report.
- .2 Include a complete list of instruments and tests for which they are to be used as they relate to this Project, including date of last calibration.

2 Products

2.1 **NOT APPLICABLE**

3 Execution

3.1 **REQUIRED REPORTS**

- .1 Provide the following start-up and performance testing reports:

- .1 Air and water balancing report.
- .2 Acoustic survey report

- .3 Alternate season test report
- .2 Report Format
 - .1 Prepare test forms in MS Excel or Word format.
 - .2 Include the following header information for each test report:
 - .1 Owner name
 - .2 Project name
 - .3 Contractor name
 - .4 Consultant name
 - .5 Name of test report
- .3 Submit the above tests in a hardcopy form, separately bound from the Operations and Maintenance Manuals, and in Adobe Acrobat PDF format, in accordance with Section 01 33 00.

3.2 AIR AND WATER BALANCING

- .1 Site Visits
 - .1 Visit the Site as required prior to testing and balancing systems and advise respective trades of this section's requirements for probe inlets, etc. Submit a report to the Consultant after each site visit.
- .2 Balancing Tolerances
 - .1 Balance all systems to the performance parameters indicated on Drawings and in the Specifications.
 - .2 If interpretation, clarification or additions to performance parameters are required, request such information from the Consultant.
- .3 Balancing Tolerances
 - .1 Air Flow Rates

Under 70 L/S	10% of flow
Over/at 70 L/S	5% of flow
 - .2 Water Flow Rates

Hydronic Heating	5% of flow
------------------	------------
 - .3 Heat Flow Rates

Air Coils	5% of design capacity
Heat Exchangers	5% of design capacity
Water Heaters	5% of design capacity
- .4 Drawing Review
 - .1 Review all pertinent plans, specifications, Shop Drawings, interference drawings and other documentation to become fully familiar with the systems and their specified and intended performance.

- .5 Air Systems
 - .1 Test relative barometric pressures in various building areas, as deemed necessary by the Consultant and at least in all areas served by different systems.
 - .2 Operate, test, and balance all air systems over their entire design range of operation including minimum and maximum fresh air, return air and supply air.
 - .3 Simulate full heating and cooling conditions. Record sufficient data to verify compliance with design requirements.
 - .4 Balance air systems within acceptable tolerances before water systems are balanced.
- .6 Hydronic Systems
 - .1 Operate, test, and balance all water systems over their entire design range of operation.
 - .2 Simulate full heating and cooling conditions. Record sufficient data to verify compliance with design requirements.
 - .3 Balance water systems within acceptable tolerances before air systems are balanced.
- .7 Continuous Recording
 - .1 Set-up trend logs on the Building Management System to record on a temperature and humidity levels on a twenty-four-hour basis, in areas as directed by the Consultant.
- .8 Data Required
 - .1 Submit the following data as a minimum. If Contractor's standard forms provide for additional data, also submit such additional data. Indicate if tests were not specifically made. Do not repeat design data or other values not specifically tested.
 - .2 Hydronic heating equipment (boilers, heaters, etc.)
 - .1 Manufacturer and model
 - .2 Gas and fuel oil input flow rating
 - .3 Gas and fuel oil input pressure rating
 - .4 Gas pressure regulator inlet and outlet pressure
 - .5 Entering and leaving water temperature - design and actual
 - .6 Entering and leaving water pressure - design and actual
 - .7 Water flow rate - design and actual
 - .8 Steam flow rate and pressure - design and actual.
 - .9 Combustion efficiency test at maximum rated capacity; including flue gas analysis.

- .10 Combustion efficiency test - as per Ministry of Environment Guideline A-9, corrected to 3% O₂, for fuel input ratings exceeding 10 MMBtu/h (2932 kW)
- .11 Thermal efficiency, based on ASME short form power test code, for fuel input ratings exceeding 10 MMBtu/h (2932 kW)
- .3 Motors:
 - .1 Manufacturer
 - .2 Model or serial number
 - .3 Rated amperage and voltage
 - .4 Rated horsepower
 - .5 Rated RPM
 - .6 Corrected full load amperage.
 - .7 Measured amperage and voltage.
 - .8 Calculated BHP (kW)
 - .9 Measured RPM
 - .10 Sheave size, type, and manufacturer.
- .4 Fans:
 - .1 Manufacturer
 - .2 Model or serial number
 - .3 Rated CFM (L/S)
 - .4 Rated RPM
 - .5 Rated pressures (suction and discharge)
 - .6 Measured CFM (L/S)
 - .7 Measured RPM
 - .8 Measured pressures (suction and discharge)
 - .9 Pulley size, type, and manufacturer
 - .10 Belt size and quantity.
- .5 Pumps:
 - .1 Manufacturer
 - .2 Model or serial number
 - .3 Rated GPM (L/S)
 - .4 Rated Head
 - .5 Rated pressures

- .6 Measured discharge pressure (full flow and no flow)
- .7 Measured suction pressure (full flow and no flow)
- .8 Measured gpm (L/s) at operating conditions.
- .9 Operating head
- .10 Operating RPM
- .6 Air systems (Including inlets and outlets):
 - .1 Grille, register or diffuser reference number and manufacturer.
 - .2 Grille, register or diffuser location.
 - .3 Design velocity.
 - .4 Design cfm (L/s)
 - .5 Effective (or free) area factor and size
 - .6 Measured velocity.
 - .7 Measured cfm (L/s)
- .7 Heat transfer equipment:
 - .1 Manufacturer and type
 - .2 Design inlet and outlet temperatures.
 - .3 Design pressure drop.
 - .4 Design flow rate.
 - .5 Measured inlet and outlet temperatures.
 - .6 Measured pressure drop.
 - .7 Measured flow rate.

3.3 **ACOUSTIC SURVEY**

- .1 Test Locations
 - .1 Provide acoustic noise measurements in locations agreed with the Consultant. As a minimum, the following areas are to be tested:
 - .1 Service rooms: Electrical and mechanical - one location per room.
 - .2 Open office areas: Minimum one test per 500 m²
 - .3 Enclosed office areas: Minimum 20% of all offices
 - .4 Boardrooms and meeting rooms: One location per room
 - .5 Kitchens, cafeterias, and seating areas: One location per space
- .2 Test Methods
 - .1 Test noise levels on the dBA weighting scale over eight bandwidths.

- .2 Report results in tabular and graphical plots, including NR curves for each space tested.
- .3 Conduct two tests per test location:
 - .1 Background ambient: Building ventilation and air conditioning systems turned OFF.
 - .2 Operating: Building ventilation and air conditioning systems turned ON, but building otherwise not occupied, and process equipment turned off.
- .4 Report any objectionable noise or vibration and be prepared to locate cause by instrumentation and analysis (including octave band and analysis)

3.4 **VIBRATION SURVEY**

- .1 Measure and record test results to Section 23 08 19.

3.5 **ALTERNATE SEASON TESTING**

- .1 Requirements
 - .1 Re-check testing and balancing of the heating, ventilating and air conditioning systems and water flow conditions at flow meter locations at approximately six months after initial testing and balancing has been performed and accepted, as advised by the Consultant.
 - .2 Include items which, because of their seasonal character could not be adequately completed during the initial balancing.
 - .3 Include the reading and recording of temperatures and pressures at all gauges, as well as outdoor and indoor conditions.
 - .4 Measure and record the motor amperages and drive RPM of all fans and pumps during re-checking.
- .2 Report
 - .1 Provide an addendum report to the original balancing report, in accordance with the reporting requirements described herein.

3.6 **DEFICIENCIES**

- .1 Immediately report to Consultant, any deficiencies in the systems or equipment performance resulting in design requirements being unobtainable.

3.7 **DRAFT REPORT**

- .1 On completion of the start-up, testing, adjusting, and balancing of all systems, submit to the Consultant, two typewritten copies of a full report on all tests, adjustments, and balancing performed, including the following:
 - .1 Summary of all systems
 - .2 Testing methods and instrumentation
 - .3 Air systems testing and balancing data.

- .4 Liquid systems testing and balancing data.
 - .5 Acoustic survey report
 - .6 Attachments including systems schematics with numbered terminals for referring to data above.
 - .2 After review by the Consultant and at the Consultants direction, retest up to 10% of all measurements in locations as directed by the Consultant, at no cost extra to the Contract.
- 3.8 **INTERIM REPORT**
- .1 After completion of any retesting described above, submit three typewritten copies of the interim report, in a three-hole "D" style binder, and two CD-R electronic copies in Adobe Acrobat ver.6 PDF format.
 - .2 This report is required to obtain Substantial Performance of the Contract.
- 3.9 **FINAL REPORT**
- .1 Submit to Consultant following completion of alternate season testing and balancing. Submit three typewritten copies and two CD-R Adobe PDF in the same formats as the initial report specified above.
- 3.10 **SPOT CHECKS**
- .1 Before acceptance of the air and water balancing report, the Consultant may request to witness spot-checks of the report results.
 - .2 If results indicate unusual testing inaccuracy, omissions, or incomplete balancing/adjustment, in the opinion of the Consultant, re-balance entire affected system(s) at no increase in Contract Price.
- 3.11 **ACCEPTANCE**
- .1 The Substantial Performance of the mechanical Work will be considered reached when the initial start-up and performance testing report is accepted by the Consultant and in the opinion of the Consultant all systems have been satisfactorily installed, operated, tested, balanced, and adjusted to meet the specified and intended performance.
 - .2 The Substantial Performance will not depend upon alternate season testing, however, make such relevant repairs or modifications deemed necessary during this re-checking as part of the guarantee of the Work.
 - .3 The total performance of the Mechanical Subcontract (Contract) will not be considered reached until the alternate season testing and balancing is completed, and the final report submitted and accepted by the Consultant.
- 3.12 **ADDITIONAL TESTING**
- .1 The Consultant may request such additional testing in connection with this Project as he deems necessary.
 - .2 Additional testing and balancing shall be performed at the rates quoted and costs shall be withdrawn from the Mechanical Subcontractor's (Contractor's) allowance for the testing and balancing Work as approved by the Consultant.

End of Section

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- 1 General
 - 1.1 **SUMMARY**
 - .1 Section Includes
 - .1 Labor, Products, equipment, and services necessary to complete the Work of this section.
 - .2 This section shall be read in conjunction with Appendix A City of Toronto Corporate Building System Design Requirements. Appendix A shall take precedence where there is a conflict in this Section.
 - 1.2 **GENERAL**
 - .1 Provide Work of this section in accordance with the Contract Documents, and in accordance with Section 01 18 11 Commissioning General Requirements.
 - .2 This Specification covers commissioning of mechanical systems which are part of the Work.
 - .3 Commissioning Work shall be a team effort to ensure that all equipment and systems have been completely and properly installed and function correctly to meet the design intent, and to document system performance parameters for fine tuning of control sequences and operational procedures.
 - .1 Refer to Section 01 18 11 regarding roles and responsibilities of all parties involved in the commissioning process.
 - .4 The commissioning process develops, coordinates, and documents the following:
 - .1 Equipment start-up
 - .2 Control system calibration.
 - .3 Testing and balancing
 - .4 Verification and performance testing
 - .5 Operation documentation
 - .6 Operator training
 - .5 Mechanical system installation, start-up, testing, balancing, preparation of O&M Manuals, and operator training are the responsibility of the Mechanical Contractors, with the coordination of the commissioning process the responsibility of the Commissioning Authority in conjunction with the Construction Manager.
 - .6 The commissioning program is divided into four parts:
 - .1 Part 1: Verification testing
 - .2 Part 2: Performance testing
 - .3 Part 4: Operator training
 - 1.3 **SUBSTANTIAL COMPLETION**
 - .1 Substantial completion of the Division 23 Work requires the following parts of the commissioning program to be completed and accepted by the Owner:

- .1 Part 1: Verification testing
- .2 Part 4: Operator training
- .2 Part 2 - Performance Testing may begin before Substantial Completion and extend upwards of nine months after Substantial Completion, based on seasonal conditions required to obtain test load conditions.

1.4 **WORK INCLUDED**

- .1 Commissioning Work of Division 23 includes, but is not limited to:
 - .1 Testing and start-up of equipment.
 - .2 Testing, adjusting, and balancing of hydronic and air systems.
 - .3 Cooperation with the commissioning authority in developing and implementation of the commissioning plan.
 - .4 Providing qualified personnel for participation in commissioning tests, including seasonal testing required after the initial testing.
 - .5 Providing equipment, materials, and labour as necessary to correct construction and/or equipment deficiencies found during the commissioning process.
 - .6 Providing Operation and Maintenance Manuals and As-Built Drawings to the Commissioning Authority for verification.
 - .7 Providing training and demonstrations for the systems specified in this division.
- .2 Conduct complete and thorough evaluation and documentation of the operation and performance of all components, systems, and sub-systems, including the following equipment and systems:
 - .1 Automatic temperature control
 - .2 Air handling systems
 - .3 Cooling generation systems
 - .4 Heating generation systems
 - .5 Hydronic distribution systems
 - .6 Process cooling systems.
 - .7 Compressed air systems
 - .8 Electric heating systems
 - .9 Air distribution and exhaust systems
 - .10 Domestic hot water systems
 - .11 Domestic cold-water systems
 - .12 Fire protection systems/suppression systems.
 - .13 Variable frequency drives
 - .14 Building Management Systems

- .15 Indoor air quality (IAQ) systems
- .16 Smoke venting/control systems.
- .17 IT/data AC and process cooling systems
- .18 Kitchen HVAC systems, including fire suppression systems.
- .19 Fuel systems.
- .3 Commissioning documentation includes but is not limited to:
 - .1 Progress and status reports, including deficiency lists
 - .2 Verification of pre-start and start-up procedures and results
 - .3 Performance testing procedures and results
 - .4 Training agenda and materials
 - .5 As-built records
 - .6 Final commissioning report
 - .7 Systems operating manuals
 - .8 Operation and Maintenance Manuals
- 1.5 **RELATED WORK**
 - .1 Section 23 08 13 – Start-Up and Performance Testing
- 1.6 **REFERENCE STANDARDS**
 - .1 Comply with the latest edition of the following:
 - .1 ASHRAE Guideline 1, The HVAC Commissioning Process, as amended herein.
- 1.7 **REPORTING SOFTWARE**
 - .1 Commissioning documentation to be developed and recorded using the following software:
 - .1 MS Word
 - .2 MS Excel
 - .3 MS Access
 - .4 Adobe Acrobat version 6 – for scanned documents
 - .5 Photos – scanned or digital - *.jpg format
- 1.8 **DOCUMENTATION DELIVERABLES**
 - .1 Identify documents including test documents, binder covers, etc. using equipment ID numbers provided on equipment schedules.
 - .2 Scan original signed test reports, including verification and performance test reports, manufacturers service reports, etc. in Adobe Acrobat *.pdf version 6 format. For original document chapters, provide Adobe chapter referencing.

- .3 Digital File Naming Convention
 - .1 Store documents with filenames which include the equipment type, ID number, and type of document.
 - .2 Equipment type:
 - .1 PS – Process Systems, piping, compressed air
 - .2 FP – Fire Protection
 - .3 PD – Plumbing and Drainage
 - .4 HG – Heating Generation
 - .5 CG - Cooling Generation
 - .6 HV – HVAC
 - .7 BMS – Building Management System
 - .3 Equipment ID:
 - .1 As per equipment schedules / drawings
 - .4 Document type:
 - .1 VT – Verification Test
 - .2 PT – Performance Test
 - .3 SOM – Systems Operating Manual
 - .4 TM – Training Manual/Material
 - .5 Example: A verification test report for air conditioning unit No. 1
 - .1 HV-AC1-VT.*
- .4 Submit three copies of each verification and functional performance test report, both preliminary and final issues.
 - .1 Collate final, accepted and signed test results in separate binders as follows:
 - .1 Fire protection.
 - .2 Plumbing and drainage
 - .3 HVAC systems
 - .4 Building Management Systems
- .5 Provide three CD-R or DVD-R copies of all commissioning documentation. File the documents in directories as follows:
 - .1 Primary directories: Verification / Performance / SOMS / Training
 - .2 Sub-directories: Fire / Plumbing / HVAC / BMS

1.9 **SUBMITTALS**

- .1 Report Samples

- .1 Provide sample test documentation for each type of equipment and system for review by the commissioning authority prior to the start of the verification process.
 - .1 Pre-start and start-up procedure check list form
 - .2 Verification test method and results form
 - .3 Functional performance test method and results form
 - .4 Operating and Maintenance Manual
- 2 Products
- 2.1 **TEST EQUIPMENT - GENERAL**
 - .1 Furnish all special tools and equipment required during the commissioning process.
 - .2 Submit a list of tools and equipment to be used during the commissioning process to the commissioning authority for approval.
 - .3 Utilities (water, gas, fuel oil, electrical power) will be provided by the Owner.
- 2.2 **TEST EQUIPMENT - PROPRIETARY**
 - .1 Provide any proprietary test equipment and software required by any equipment manufacturer for programming and/or start-up, whether specified or not.
 - .2 The manufacturer shall provide the test equipment, demonstrate its use, and assist in the commissioning process as needed.
 - .3 Proprietary test equipment and software shall become the property of the Owner upon completion of the commissioning process.
- 3 Execution
- 3.1 **GENERAL**
 - .1 Complete all phases of Work so that the systems can be started, tested, balanced, and Owner's acceptance procedures be undertaken.
 - .2 Participate and assist in the development of the commissioning plan by the commissioning authority, by providing all necessary information pertaining to the equipment and installation. Provide commissioning schedule information to be incorporated into the overall commissioning plan schedule.
 - .3 Acceptance procedures may begin prior to completion of a system and/or sub-system. Start of acceptance procedures before system completion does not relieve the Contractor from completing those systems in accordance with the commissioning and construction schedule.
- 3.2 **COMMISSIONING MEETINGS**
 - .1 Pre-Construction
 - .1 Participate in a pre-construction meeting of all commissioning team members, to familiarize all parties with the commissioning process, and to ensure that the responsibilities of each party are clearly understood.

.2 Construction and Post-Construction

- .1 Participate in commissioning meetings as scheduled by the commissioning authority and Construction Manager. Identify to the commissioning group problems relating to the commissioning schedule, identification of start-up issues, etc., and participate in the resolution of these problems.

3.3 **PARTICIPATION IN ACCEPTANCE PROCEDURES**

- .1 Provide skilled technicians to start-up and debug all systems within the mechanical scope of Work. Include for labour, materials, and subsistence costs for these same technicians to assist the commissioning authority in completing the commissioning program.
- .2 Provide details regarding work schedules, time commitments, work sequence programming, etc., to the commissioning authority, to permit the development and monitoring of a coordinated commissioning schedule.
- .3 Ensure the qualified technician(s) are available and present during commissioning testing to complete the tests, make adjustments and to assist in problem resolutions.
- .4 Should any equipment or system experience performance problems and/or reconstruction or replacement of components is required, include for additional technician time for subsequent retesting of systems until required system performance is achieved.
- .5 The commissioning authority reserves the right to approve proposed technicians with regard to the technical skill level required for each type of equipment and/or system, and a willingness by the individual(s) to work within the commissioning group.

3.4 **PROBLEM RESOLUTION**

- .1 In the event that additional work is required to correct systems, misapplied equipment, and/or deficient performance under varying load conditions, this work will be carried out under the direction of the Owner. Assist the Owner and commissioning authority in developing an acceptable resolution to the problem, including the resources of equipment suppliers.
- .2 The Owner and/or the Consultant has final jurisdiction over any additional work required to achieve the required level of performance.
- .3 Complete corrective Work in a timely fashion to permit the completion of the commissioning process.

3.5 **ADDITIONAL COMMISSIONING**

- .1 Additional commissioning activities may be required after completion of system performance testing. Include in the tender cost a reasonable reserve to complete this work, including assistance from manufacturers' service technicians.

3.6 **SEASONAL COMMISSIONING**

- .1 Commence initial performance testing commissioning at the completion of the installation Work and verification testing phase. Conduct performance testing, which is weather dependent, as applicable to current seasonal conditions. Complete performance testing on non-weather dependant systems in accordance with the agreed commissioning plan schedule.
- .2 For out-of-season system performance testing, conduct initial performance tests to demonstrate off-peak load performance. Schedule peak load performance testing over

the succeeding nine months to ensure all equipment is tested at peak load prior to the expiry of the construction contract warranty.

- .1 Test heating equipment/systems during winter design extremes.
- .2 Test cooling systems during summer design extremes with a fully occupied building.
- .3 Alternatively, provide temporary equipment (load banks, etc) to simulate full load conditions. Submit proposed methodology for review by the commissioning authority and Consultant.

3.7 **REPORT FORMAT**

- .1 Provide separate checklists for each piece of equipment and system tested, including interfaces, interlocks, etc.
 - .1 For checklists generated in MS Excel format, provide a separate file for each piece of equipment; do not store multiple pieces of equipment on separate worksheets in the same file.
 - .2 Each item to be checked will be recorded on a separate entry line and include the following information, reading from left to right across the entry:
 - .1 Checklist item number
 - .2 Test description.
 - .3 Test status – “Pass”, “Fail”, “Not Applicable”
 - .4 Deficiency status – “Major”, “Minor”
 - .5 Comments
 - .3 Deficiency definitions:
 - .1 “Major”: An item which if not corrected renders the equipment or system unsuitable or unsafe for use by the Owner. Major deficiencies must be corrected as a condition for achieving Substantial Completion.
 - .2 “Minor”: An item which does not impact on the operation of the equipment or system and will allow the Owner to use the system safely. Minor deficiencies may be corrected before or after Substantial Completion, but will not prevent certification of Substantial Completion of the Work.

3.8 **VERIFICATION TESTS (PART 1)**

- .1 Scope of Work
 - .1 Conduct operating tests and checks to verify that all components, equipment, systems, and interfaces between systems, operate in accordance with Contract Documents.
 - .2 Tests to demonstrate and verify all operating modes, interlocks, specified control sequences, specific responses to abnormal or emergency conditions, and verification of the proper response of the Building Automation System.

.3 Validate the results of the TAB report.

.1 Roles and responsibilities:

Verification Testing	
Organized by:	Commissioning Authority
Test sheets provided by:	Mechanical Contractors
Testing conducted by:	Mechanical Contractors
Testing recorded by:	Mechanical Contractors
Tests witnessed by:	Commissioning Authority Design Consultant (optional) Owner (optional)
Reports reviewed by:	General Contractor/Construction Manager Commissioning Authority Design Consultant
Reports accepted by:	Owner

.2 Submittals

- .1 Submit a copy of each type of equipment and system verification report for approval by the Owner prior to commencement of the verification tests.
- .2 Include any specific test requirements provided by the Owner and/or Consultant in the test reports. These requirements will be provided in MS Word or Excel format.

.3 Participants in Verification Tests

- .1 Commissioning authority: Schedules tests and assembles commissioning team members who are responsible for the implementation, witnessing and documentation of the tests.
- .2 Mechanical Contractor: Provide the services of qualified technician(s) who are familiar with the construction and operation of the system. Provide access to the Contract plans, Shop Drawings, and equipment cut sheets of all installed equipment.
- .3 Controls Contractor: Provide the services of qualified technician(s) who are familiar with the Work. Provide details of the control system, schematics, and a narrative description of control sequences of operation.
- .4 Electrical Contractor: Provide a foreman electrician familiar with the electrical interlocks, interfaces with emergency power supply, and interfaces with alarm and life-safety systems. Provide access to the contract plans, and all as-built schematics of sub-systems, interfaces, and interlocks.
- .5 Equipment Suppliers: Provide the services of manufacturers' service personnel to provide assistance with pre-start and initial start-up of the equipment, as required.

.4 Documentation and Reporting Requirements

- .1 Provide separate test records for each piece of equipment and system.

- .2 Information used to develop the check lists are to include material from the following sources:
 - .1 Manufacturers installation requirements
 - .2 Contractor's own checklists
 - .3 Design consultants' checklists.
 - .4 Owners' checklists
- .3 Checklists to include the following information:
- .4 Front cover sheet: Project name, Owner name, equipment ID and name, test date(s), and space for sign-off signatures and dates as follows:
 - .1 Mechanical Contractor: "Submitted by"
 - .2 General Contractor/Construction Manager: "Reviewed by"
 - .3 Design Consultant "Reviewed by"
 - .4 Commissioning Authority: "Reviewed by"
 - .5 Owner: "Accepted by"
- .5 Second and subsequent pages to include tests as defined below.
- .6 Equipment Checklists:
 - .1 Motor, power and drives
 - .2 Equipment piping, between equipment isolation valves
 - .3 Installation pre-start tests specific to the class of equipment.
 - .4 Equipment start-up tests specific to the class of equipment
 - .5 Electrical audit for CSA label or ESA field approval label
 - .6 Gas and fuel fired equipment audit for CSA/CGA approvals, or TSSA field approvals.
 - .7 Expansion tank installation and settings
 - .8 Operator training, including attendee names and dates, and details of manufacturers equipment demonstrations.
 - .9 Status of as-built documentation, and Operating and Maintenance Manuals reviews
- .7 Piping System Checklists:
 - .1 Hydrostatic and/or pneumatic pressure tests, including date of test, duration, starting and ending pressures, and TSSA inspection reports where required.
 - .2 Municipal plumbing inspector reports attached.
 - .3 NFPA certificates attached (sprinklers and standpipe systems)

- .4 Flushing and cleaning records, including date of cleaning, chemical treatment contractors test reports, volume of fluid in the system and amount of cleaner used.
- .5 Chemical treatment added; type and quantity, chemical treatment contractor's test reports included.
- .6 Piping installation, including supports, insulation, vibration isolation, piping identification, valve tagging, valve chains, etc.
- .7 TAB balancing report, by system
- .8 Operator training, including attendee names and dates, and details of manufacturers equipment demonstrations.
- .9 Status of as-built documentation, and Operating and Maintenance Manuals reviews
- .8 Ductwork System Checklists:
 - .1 Ductwork pressure test results
 - .2 Inspection of fire damper linkages by area/floor
 - .3 TAB balancing report, by system
 - .4 Operator training, including attendee names and dates, and details of manufacturers equipment demonstrations.
 - .5 Status of as-built documentation, and Operating and Maintenance Manuals reviews
- .9 Building Management System:
 - .1 Operating check of each I/O and control loop
 - .2 Operating check of each control sequence
 - .3 Operating check of motorized control dampers for full open and full close stroke/spring return positions
 - .4 Operating check of motorized fire dampers for full open and full close stroke/spring return positions
 - .5 Temperature and humidity survey report, identifying date and time for each reading at each transmitter/sensor device.
 - .6 Graphics display and report generation - provide display screen "snapshots."
 - .7 Operator training, including attendee names and dates, and details of manufacturers equipment demonstrations.
 - .8 Status of as-built documentation, and Operating and Maintenance Manuals reviews
- .10 Specialty Systems
 - .1 Refrigeration system compliance check to CSA B52-99, Mechanical Refrigeration Code

- .5 Instrumentation
 - .1 Provide all measurement instrumentation for conducting the verification tests. Include hand-held “HART” instrument testing units or similar test equipment.
 - .2 All instruments will have been calibrated within the six-month period prior to the start of the tests.
- .6 Verification Procedures
 - .1 The commissioning authority shall direct and witness, as required, the verification operating tests and checks for selected or all equipment and systems.
 - .2 Set the system equipment into operating mode to be tested including but not limited to:
 - .1 Normal shut-down
 - .2 Normal auto position
 - .3 Normal manual position
 - .4 Unoccupied cycle
 - .5 Emergency power operation, including transition states.
 - .6 Alarm conditions.
 - .3 Inspect and verify the position of each device and interlock identified on the checklist.
 - .4 Repeat the above tests for each operating cycle that applies to the system being tested.
 - .5 Check the operating condition of the following elements during all modes of operation of the system:
 - .1 Safety interlocks
 - .2 Alarms
 - .3 Smoke control and smoke venting interlocks.
 - .4 Life safety systems
 - .6 For failed test items, provide appropriate comments to the checklist data sheet and identify whether it is a “Major” or “Minor” deficiency.
 - .1 The Consultant retains the right to make the final decision regarding classifications of deficiencies.
 - .7 Verify the operational control of the systems through the Building Management System as follows:
 - .1 TAB airflow rates and calibrate terminal boxes in all modes of operation.
 - .2 Equipment operation in both heating and cooling modes
 - .3 Minimum outdoor air intake positions, air-side economizer cycles, and multi-set outdoor air damper positions as required for each operating sequence and mode.

- .4 Building pressurization and other specialty programs
- .8 Verify the proper responses of instrumentation and control devices (actuators) as follows:
 - .1 For each controller or sensor, record the indicated monitoring and control system reading, and the test instrument reading.
 - .2 If the initial test indicates that the test reading is outside of the control range of the installed device, check the calibration of the installed device and adjust as required. Re-test the deficient device and record the results on the checklist data sheets.
- .9 The commissioning authority shall direct and witness the field verification of the final TAB report as follows:
 - .1 Select, at random, 10% of the report data for verification.
 - .2 The TAB Contractor will be provided advance notice of the date of retesting, but not the equipment to be tested.
 - .3 The TAB to provide and use the same equipment and instruments used for collecting the original data.
 - .4 Test failure is defined as:
 - .1 For all readings other than sound, a deviation of more than 10% from the TAB report results.
 - .2 For sound pressure readings, a deviation of 3 dB at any bandwidth, not including differences in background noise readings.
 - .5 A failure rate greater than 10% of the selected items (1% of all TAB test results) will result in rejection of the final TAB report.
- .7 Acceptance
 - .1 The final reports will be reviewed by the Commissioning Authority and the Consultant, to determine if verification is complete and the operating systems are functioning in accordance with the Contract Documents.
 - .2 The Commissioning Authority, in conjunction with the Consultant, shall review and make final classification of all noted deficiencies. Deficiencies classified as "Major" shall be corrected before acceptance of the verification stage.
- 3.9 **PERFORMANCE TESTING (PART 2)**
 - .1 Scope of Work
 - .1 Conduct performance tests and checks to verify that all equipment and system components are providing the required heating and cooling performance (capacity) in accordance with the Contract Documents, including but not limited to:

- .1 Capability of the chilled water system to deliver the required flow rate, and water temperature at design conditions.
- .2 Capability of the hydronic and domestic water heating systems to deliver the required flow rate, and temperature.
- .3 Capacity of electric heating systems at design temperatures.
- .4 Confirm the ability of the HVAC systems to deliver the required cooling/heating services, at the design supply air temperature, required static pressure, and proper outside air ventilation rate.

.2 Roles and Responsibilities:

Functional Performance Testing	
Organized by:	Commissioning Authority
Test sheets provided by:	Mechanical Contractors
Testing conducted by:	Mechanical Contractors
Testing recorded by:	Mechanical Contractors
Tests witnessed by:	Commissioning Authority Design Consultant (optional) Owner (optional)
Reports reviewed by:	General Contractor/Construction Manager Commissioning Authority Design Consultant
Reports accepted by:	Owner

.2 Submittals

- .1 Submit detailed test procedures and methodology to the commissioning authority for review and acceptance. Include samples of data record sheets.

.3 Participants

- .1 Participants are the same as that described for the verification stage.

.4 Documentation and Reporting Requirements

- .1 Provide separate test records for each piece of equipment and system.
- .2 Checklists to include the following information:
 - .1 Front cover sheet: Project name, Owner name, equipment ID and name, test date(s), and space for sign-off signatures and dates as follows:
 - .1 Mechanical Contractor: "Submitted by"
 - .2 General Contractor/Construction Manager: "Reviewed by"
 - .3 Design Consultant: "Reviewed by"
 - .4 Commissioning Authority: "Reviewed by"
 - .5 Owner: "Accepted by"

- .2 Second and subsequent pages to include tests as defined below:
 - .1 Description of test methodology, including reference standards (SMACNA, ARI, ASME, etc).
 - .2 Permanent and temporary resource requirements to implement the test (power, temporary drains, etc).
 - .3 Summary of results.
 - .4 Test data sheets and measured data.
 - .5 Ambient temperature conditions at time of test.
 - .6 Load simulation method used, if required.
- .3 Provide a preliminary test report for review by the commissioning authority and the Consultant prior to conducting the performance test.
- .5 Instrumentation
 - .1 Refer to the instrumentation requirements for the verification stage.
- .6 Functional Performance Test Procedures
 - .1 The Commissioning Authority shall direct and witness, as required, the performance tests for selected or all equipment and systems.
 - .2 For each test, provide instrumentation required to calculate the total capacity of the system for each mode of operation under test.
 - .3 Special testing requirements:
 - .1 Test heating boiler and steam boiler performance in accordance with ASME Power Test Code 4.1 (short form), for thermal efficiency, and combustion efficiency.
 - .2 Test water chillers in accordance with ARI 590 and 591, at design conditions for full load ratings, and IPLV ratings.
- .7 Acceptance
 - .1 Any identified deficiencies will be reviewed by the Consultant in conjunction with the General Contractor/Construction Manager to determine if correction of the deficiency is part of the Contractor's or Subcontractor's contractual obligations.
 - .2 If it is determined the performance deficiency is part of the Contract Documents, the Contractor will rectify the deficiency and repeat the performance test until the required performance levels are achieved.
 - .3 If it is determined the mechanical system is constructed in accordance with the Contract Documents, and the performance deficiency is not part of the Contract Documents, the Owner will decide whether to accept the performance as is, or, direct the Installation Contractor to make changes to the system as required to obtain performance levels which meet the design intent.
 - .4 Should remedial Work to correct the not-in-contract deficiency be implemented, the Owner will decide whether all or part of the performance testing is to be repeated. If repeated, complete the retesting and submit a revised report.

.1 Scope of Work

.1 Provide systems training in addition to the requirements of Sections 21 05 00, 22 05 00 and 23 05 01.

.2 Roles and responsibilities:

Systems Operating Manuals	
Organized by:	Mechanical Contractor
Lecture material provided by:	Mechanical Contractor
Systems training provided by:	Mechanical Contractor
Resource material by:	Sub-Contractors Manufacturers Design Consultant
Training manuals reviewed by:	Commissioning Authority Design Consultant
Manuals accepted by:	Owner

.2 Equipment Training

.1 Provide equipment training in accordance with Sections 21 05 00, 22 05 00 and 23 05 01.

.2 The manufacturer's representative training will emphasize operating instructions and preventative maintenance.

.3 Systems Training

.1 In addition to the equipment training described above, provide additional training to describe the operational requirements and design intent of each system.

.2 Include classroom instruction, delivered by competent instructors, based upon the contents of the SOM manuals. Place emphasis on overall systems diagrams and descriptions, and design criteria and conditions.

.3 If required, obtain and pay for the services of the Design Consultant to provide the instructor services and to provide lecture material for inclusion in the training manual.

.4 Training topics to include:

.1 Types of installed systems

.2 Design intent and design criteria.

.3 Design constraints.

.4 Different operating modes - occupied, unoccupied, emergency conditions, etc.

.5 Seasonal operating modes

- .6 IAQ
 - .7 Energy efficiency
 - .8 System operation
 - .9 Automatic controls
 - .10 Service, maintenance, diagnostics and repairs.
 - .11 Use of reports and logs
 - .12 Troubleshooting
 - .5 Structure each session to start with the classroom instruction for the overall system, followed by hands-on instruction for each equipment, with the services of the manufacturers' representative as required. Demonstrate the start-up and shutdown of each system.
 - .6 Organize and schedule each training session to deliver the required instruction in an efficient and effective manner on a schedule agreed upon with the Owner. Allow for three training sessions for each topic, separated by approximately one week each, to allow for shift coverage.
 - .7 Structure each training session based on type of maintenance personnel attending the training session, i.e. plumbers, fitters, general maintenance, controls technicians, etc. Develop the proposed training plan and obtain approval from the Owner before commencing the training.
 - .8 Complete the training as close to Substantial Completion as possible, so that the Owner's operations staff are prepared to operate the system after Substantial Completion is certified.
 - .4 Training Manuals
 - .1 Provide training material hand-outs for each session. This information will be abstracted from the SOM's and shall be presented in abbreviated form (i.e. bullet points).
 - .2 Collect training material and bind into separate binders in accordance with the requirements for the SOM manuals.
 - .5 Recording of Training Sessions
 - .1 Record training sessions typical for each training topic. Provide one DVD for each training topic.
 - .2 Provide three DVD copies of each training topic, appropriately labeled.
- End of Section

- 1 General
- 1.1 **SUMMARY**
 - .1 Section Includes
 - .1 Labor, Products, equipment, and services necessary to complete the Work of this section.
- 1.2 **SUBSTANTIAL PERFORMANCE**
 - .1 Complete the Substantial Performance checklist and submit with required documentation when applying for Substantial Performance of the Work.
 - .1 Where the Work is sub-divided into separate scopes of Work, each requiring a separate Substantial Performance application, provide a separate checklist for each application.
 - .2 Prepare and submit to the Consultant a comprehensive deficiency list of items to be completed or corrected, as part of the application for a review by the Consultant to establish Substantial Performance of the Work, or designated portion of the Work.
 - .1 Failure to include an item on the list does not alter the Contractor's responsibility to complete the Work.
 - .3 Within five Working Days of the Consultant's review report which indicates that Substantial Performance of the Work has been achieved, provide a detailed schedule for completion and/or correction of the Work of all items described in the Contractors' and the Consultants' deficiency list.
- 1.3 **TOTAL PERFORMANCE**
 - .1 Complete the Total Performance checklist and submit required documentation when applying for Substantial Performance of the Work.
 - .2 Submit the following documentation with the application for Total Performance. Application for Total Performance cannot be submitted any earlier than the date of alternate season testing.
 - .3 The following documentation is included with this application for Total Performance, or has already been submitted to the Owner and a copy of the transmittal is included with this application.

2 SUBSTANTIAL PERFORMANCE APPLICATION CHECKLIST

Project Information		
Project Name:		
Contract:		
Contract Scope:		
Application Date:		
Signed:		
Required Documentation		
No.	Item	Included
1.	Contractor has compiled and submitted a detailed deficiency list, identifying work still to be completed, incomplete, or requires correction.	
2.	Equipment start-up reports (interim)	
3.	Authorities report (interim)	
4.	Air and water balancing reports (interim)	
5.	Acoustic survey report (interim)	
6.	Vibration survey report (interim) - <i>if specified</i>	
7.	Controls / BMS operation report (interim)	
8.	Operating and Maintenance Manuals, draft, submitted	
9.	Training, completed	
10.	Commissioning report – verification and training (if part of Contract)	
Reviewed by Consultant		
Status	<input type="checkbox"/> Reviewed <input type="checkbox"/> Incomplete or deficient - resubmit	
Signed:		
Date:		

3 TOTAL PERFORMANCE APPLICATION CHECKLIST

Project Information		
Project Name:		
Contract:		
Contract Scope:		
Application Date:		
Signed:		
Required Documentation		
No.	Item	Included
1.	Contractor submits a statutory declaration that all known deficiencies have been corrected, including latent deficiencies reported by the Owner.	
2.	Equipment start-up reports – updated and final	
3.	Authorities report – updated and final	
4.	Air and water balancing reports – updated and final	
5.	Acoustic survey report – updated and final	
6.	Vibration survey report – updated and final - <i>if specified</i>	
7.	Controls / BMS operation report – updated and final	
8.	Operating and Maintenance Manuals – updated and final	
9.	As-Built Drawings – final	
10.	Commissioning report – performance testing (if part of Contract)	
Reviewed by Consultant		
Status	<input type="checkbox"/> Reviewed <input type="checkbox"/> Incomplete or deficient - resubmit	
Signed:		
Date:		

End of Section

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- 1 General
- 1.1 **SUMMARY**
 - .1 Section Includes
 - .1 Labor, Products, equipment, and services necessary to complete the Work of this section.
- 1.2 **RELATED SECTIONS**
 - .1 Division 25: Integrated automation:
 - .1 Automatic control damper operators
 - .2 Automatic control dampers
- 1.3 **SUBMITTALS**
 - .1 Shop Drawings
 - .1 Submit Shop Drawings in accordance with Section 01 33 00.
- 2 Products
- 2.1 **DUCT WORK ACCESSORIES**
 - .1 Flexible Duct Connections
 - .1 Material:
 - .1 Heavy glass fabric double coated with neoprene and attached to 0.6 mm (24 ga) metal strips 75 mm wide.
 - .2 Fabric length between metal strips:
 - .1 Minimum 75 mm for ducts of maximum size in either dimension or diameter of 750 mm or less
 - .2 150 mm for ducts of 775 mm size and larger.
 - .2 Acceptable Manufacturers:
 - .1 Duro-Dyne "Grip-Loc Type SMFN"
 - .2 Ventfabrics "Ventglas"
 - .2 Turning Vanes
 - .1 Material: Hollow airfoil type, fabricated of same material as duct in which they are installed.
 - .2 Acceptable Manufacturers:
 - .1 Duro-Dyne
 - .3 Access Doors in Duct Work and Plenums
 - .1 Hand door:

- .1 Construction: 0.7 mm (24 ga) galvanized steel, double flanged frame and insulated door complete with insulation backing plate.
- .2 Fasteners: Zinc plated cam-lock fasteners, minimum two per door, with safety retaining chain.
- .2 Equipment and man doors:
 - .1 Minimum size, equipment: Where motors are installed within unit or duct, use an access door large enough to permit removal of motor.
 - .2 Minimum size, man door: 450 mm x 1.2 m or as shown on Drawings.
 - .3 Construction: 0.8 mm (22 ga) thick galvanized steel sheet double panel construction with approved 25 mm thick insulating filler, mounted in flanged die-formed collar flush with face of finished insulation, with flanged door frames welded in place.
 - .4 Hinges: Heavy zinc plated continuous hinge.
 - .5 Fasteners: Three heavy sash fasteners and neoprene gaskets.
- .4 Probe Inlets
 - .1 Material:
 - .1 Ventlok No. 699 or Duro-Dyne IP-1 or IP-2 Test Opening Enclosures complete with locking cap, chain, gaskets, insulating plug and extensions for insulated duct work.

2.2 **OPERATING DAMPERS**

- .1 Automatic Control Dampers
 - .1 General:
 - .1 Modulating control dampers: Opposed blades.
 - .2 Two position control dampers: Parallel blades.
 - .2 Damper blades and frames:
 - .1 Extruded aluminum 6063-T5
 - .2 Maximum blade length: 1.2 m without internal frame support.
 - .3 Maximum blade length: 1.2 m without internal frame support.
 - .4 Blade edge seals: EPDM gaskets.
 - .5 Frame side seals: Extruded TPE or cambered stainless steel.
 - .6 Frame style: Flanged to duct.
 - .7 Jack shaft: Extendable, combination of aluminum, and zinc/nickel coated steel.
 - .8 Damper leakage: 50 L/s per m² damper face area at 1 kPa differential static pressure.
 - .3 Bearings:

- .1 Thermal plastic resin copolymer, nylon, or oil impregnated bronze.
- .2 At blade axles, linkage devices, etc.
- .4 Damper blades and frame for outside exhaust and intake air applications:
 - .1 As above.
 - .2 Operating temperature: -40°C to +100°C (-40°F to +212°F).
 - .3 Thermally broken and insulated blades; expanded polyurethane foam insulation.
 - .4 Damper leakage: 21 L/s per m² damper face area at 1 kPa differential static pressure.
- .5 Acceptable Manufacturer:
 - .1 Tamco - Series 1000
 - .2 Nailor Industries - Series 2000
 - .3 Tamco - Series 9000 (exhaust and air intake applications)
 - .4 Nailor - Series 2000IBF (exhaust and air intake applications)
 - .5 Ventex Alumavent
- .2 Manual Balancing Dampers
 - .1 Rectangular duct work:
 - .1 Galvanized channel type frames, non-binding pre-lubricated type interconnecting and operating linkages.
 - .2 Blades: Minimum 1.6 mm (16 ga) thick material, opposed blade style.
 - .3 Manual operator and locking type quadrant as required for synchronous operation and setting of blades.
 - .4 Blade width: Maximum 200 mm.
 - .5 Blade length: Length coinciding with frame opening on horizontal plane to maximum length of 1.2 m.
 - .6 Locking quadrant: Galvanized steel locking quadrant with “Open – Closed” labels, 50 mm insulation stand-off.
 - .7 Acceptable Manufacturers:
 - .1 Nailor – Series 1810/1820 with HL2 quadrant
 - .2 Ventex Alumavent
 - .2 Round duct work - medium pressure butterfly damper:
 - .1 Galvanized steel frame 0.9 mm (22 ga) with stiffening beads up to 300 mm diameter; 0.9 mm (20 ga) over 300 mm duct size.
 - .2 Blade: Laminated galvanized steel 0.9 mm (22 ga), or single layer of 1.6 mm (16 ga), open and closed end stops, Celcon bearings, polyethylene blade edge seal, 13 mm diameter drive shaft.

- .3 Locking quadrant: Galvanized steel locking quadrant with "Open – Closed" labels, 50 mm insulation stand-off.
- .4 Acceptable Manufacturers:
 - .1 Nailor – Series 1000 with HL2 quadrant
- .3 Round duct work - low pressure butterfly damper:
 - .1 Galvanized steel frame 0.9 mm (22 ga) with stiffening beads up to 300 mm diameter; 0.9 mm (20 ga) over 300 mm duct size.
 - .2 Blade: Galvanized steel 0.9 mm (22 ga) up to 300 mm diameter; 0.9 mm (20 ga) over 300 mm duct size, 6 mm diameter drive shaft.
 - .3 Locking quadrant: Galvanized steel locking quadrant with "Open – Closed" labels, 50 mm insulation stand-off.
 - .4 Acceptable Manufacturers:
 - .1 Nailor – Series 1890 with HLQ-SB quadrant
- .4 Splitter damper:
 - .1 Material: Same material and thickness as ducts in which they are to be installed, minimum of 0.8 mm (22 ga).
 - .2 Form splitters of double thickness of metal and with rounded surface at air entering edge.
 - .3 Splitter length: At least one and one-half times width of smaller branch duct, but in no case less than 300 mm.
 - .4 Provide with locking type quadrant.
- .3 Volume Extractors in Duct Work:
 - .1 Use where noted on Drawings.
 - .2 Acceptable Manufacturers
 - .1 Titus Model AG225 with #3 manual operator.

2.3 **FIRE AND SMOKE DAMPERS**

- .1 Fire Dampers
 - .1 ULC labelled fire dampers of hinged, fusible link type with channel frames, blades and housing and conforming to NFPA 90A and UL555 requirements. Use "Type B" fire dampers for rectangular or square duct work and "Type C" fire dampers for round duct work.
 - .2 Dynamic dampers: Designed to close while the system fans are operating.
 - .3 Static dampers: Designed to close with no airflow through damper.

- .4 Closure link: Fusible link which can be released, tested and relatched for testing.
- .5 Construct fire dampers and frames of same material as duct in which they are installed.
- .6 Acceptable Manufacturers:
 - .1 Nailor – “D” series
 - .2 Ruskin
 - .3 Ventex Alumavent
- .2 Smoke Dampers
 - .1 ULC labelled fire dampers of airfoil parallel blade type, with extruded aluminum channel frames and sleeve housing and conforming to NFPA 90A and 92A, and UL555S, leakage class I rating at 176°C (350°F).
 - .2 Blades: Extruded aluminum airfoil blade with concealed linkage outside of airstream, with self lubricating bronze type bearings, stainless steel camber style jamb seals, and mechanically locked in extruded edge seals
 - .3 Dampers designed to operate while the system fans are operating.
 - .4 Operator: Externally mounted, factory installed 120 VAC electric actuator with spring return, fail close position. Built-in high limit thermostat switch opens at 73°C (163°F).
 - .5 Accessories: 120 VAC proof-of-closure and proof-of-open end-switch, with two SPDT switches.
 - .6 Acceptable Manufacturers: Damper
 - .1 Nailor – Series 1280
 - .2 Ruskin
 - .3 Ventex Alumavent
 - .7 Acceptable Manufacturers: Operator
 - .1 Belimo – Model FSNF-120 US
- .3 Combination Smoke and Fire Dampers
 - .1 ULC labelled fire dampers of airfoil parallel blade type, with extruded aluminum channel frames and sleeve housing and conforming to NFPA 90A and 92A, and UL 555 and UL555S, leakage Class I rating at 176°C (350°F).
 - .2 Blades: Extruded aluminum airfoil blade with concealed linkage outside of airstream, with self lubricating bronze type bearings, stainless steel camber style jamb seals, and mechanically locked in extruded edge seals
 - .3 Dampers designed to operate while the system fans are operating.
 - .4 Operator: Externally mounted, factory installed 120 VAC electric actuator with spring return, fail close position. Built-in high limit thermostat switch opens at 73°C (163°F).

- .5 Accessories: 120 VAC proof-of-closure and proof-of-open end-switch, with two SPDT switches.
- .6 Acceptable Manufacturers: Damper
 - .1 Nailor – Series 1220
 - .2 Ruskin
- .7 Acceptable Manufacturers: Operator
 - .1 Belimo – Model FSNF-120 US

2.4 **ACOUSTIC TREATMENT**

- .1 Acoustic Duct Insulation
 - .1 Material:
 - .1 Rigid coated duct liner conforming to NFPA 90A and 90B, 25 mm thick and 72 kg/m³ density.
 - .2 In duct work at velocities over 15 m/s, provide a perforated or expanded metal inner liner over acoustic insulation.
 - .2 Fasteners:
 - .1 Fasten acoustic liner to inside of duct with plate type impaling pins and self-locking washers, by Eckels Industries "Stic-Klips", "Tactoo Series T", or Continental Stud Welding weld pins and self-locking washers.
 - .2 Use fasteners or securing pins of size and length as required by insulation weight, thickness, fastener spacing and design.
 - .3 In addition to mechanical type fasteners, adhere insulation to inside of duct with Foster No. 81-99 or Henry No. 230-04 fire retardant adhesive. Seal all joints with Foster No. 30-36 or Henry No. 120-09 mastic sealant.
 - .3 Acceptable Manufacturers:
 - .1 Owens Corning
 - .2 Manson
 - .3 Knauf
 - .4 Manville

2.5 **ACOUSTIC SILENCERS (S)**

- .1 Rectangular and Elbow Silencers
 - .1 Material:
 - .1 Housing: Hot dip galvanized steel sheet, one gauge heavier than adjacent duct work but not less than 0.9 mm (20 ga).
 - .2 Duct size: External silencer dimension to match adjacent duct dimensions, unless otherwise shown.
 - .3 Inner liner: Hot dip galvanized perforated steel sheet, 0.8 mm (22 ga).

- .4 Insulation: Glass fiber or mineral wool to ASTM E-84, class 1.
- .2 Performance
 - .1 Silencers have been selected on basis of sound power levels of first listed equipment. Ensure that equipment of any other named manufacturer proposed for use has sound power levels equal to or lower than first listed equipment.
 - .2 Be responsible for reducing noise levels to below acceptable maximum without additional cost to Owner.
- .2 Circular Silencers
 - .1 Same as for rectangular silencers and as follows:
 - .1 Internal bullet: Spun head and tapered tail, with airflow straightening vanes.
 - .2 Duct size: Duct flange connection same size as adjacent duct size.
- .3 Acceptable Manufacturers
 - .1 Vibron
 - .2 Vibro-Acoustics
 - .3 Woods
- 3 Execution
 - 3.1 **GENERAL**
 - .1 Refer to and comply with applicable requirements specified in Section 23 05 01.
 - .2 Install miscellaneous steel framing, supports, braces, etc. as required to hang or support equipment and duct work as specified herein, and as shown on Drawings.
 - 3.2 **FLEXIBLE DUCT CONNECTIONS**
 - .1 Use flexible duct connections between fans and/or air handling units and connecting duct work, between unit components, in ducts at building expansion joints, and in other locations shown on Drawings.
 - .2 Install flexible connectors with fabric in folds, not drawn tight.
 - .3 Install internal guides to prevent flexible connection from collapsing on suction side of fans.
 - .4 For installation between sections of air handling units, install flexible connectors suitable for connecting to flanges of casings where so provided.
 - 3.3 **TURNING VANES**
 - .1 Provide hollow airfoil type turning vanes in duct work where shown on Drawings and in ninety degree square duct elbows, fabricated of same material as duct in which they are installed.

3.4 ACCESS DOORS

- .1 Provide access doors in duct work and for plenums to allow servicing, maintenance, and inspection of:
 - .1 Control dampers
 - .2 Fire dampers
 - .3 Smoke dampers
 - .4 Fire detectors
 - .5 Control elements
 - .6 Sprinkler heads mounted in ductwork
 - .7 Motors
 - .8 Bearings
 - .9 As shown on Drawings

- .2 Provide “Hand Doors” in duct work of sizes as follows:

Access Type	Duct Dimension	Access Door Size
One hand and sight	Less than 400 mm	300x150 mm
Two hands and sight	Between 400 mm and 500 mm	450x250 mm
Head and shoulders	Between 500 mm and 760 mm	530x356 mm
Body plus ladder	Between 760 mm and 1320 mm	635x430 mm

- .3 Provide “Equipment and Man Doors” as follows:
 - .1 In duct work with duct dimension over 1320 mm.
 - .2 In plenums.
 - .3 As shown.

3.5 BALANCING DAMPERS

- .1 Use rectangular opposed blade dampers at the following locations:
 - .1 At floor connections to riser shafts/ducts.
 - .2 In supply and return duct work where main ducts are split into two more trunks.
 - .3 At rectangular branch duct connections to main or trunk ducts.
 - .4 As shown.
- .2 Use splitter dampers only where specifically shown on Drawings.
- .3 Use medium pressure butterfly dampers at the following locations:
 - .1 At floor connections to supply air riser ducts.
 - .2 In supply and return duct work where main ducts are split into two more trunks.
 - .3 At branch duct connections to main or trunk ducts.
 - .4 At branch duct upstream of terminal box.

- .5 As shown.
- .4 Use low pressure butterfly dampers at the following locations:
 - .1 At branch connections on the downstream side of terminal boxes.
 - .2 At individual branch outlets serving grilles or diffusers.
- .5 Dampers supplied with diffusers or grilles are to be used to balance $\pm 10\%$ of indicated airflow, are NOT in lieu of branch dampers.
- 3.6 **VOLUME EXTRACTORS IN DUCT WORK**
 - .1 Use where noted on Drawings.
- 3.7 **FIRE AND SMOKE DAMPERS**
 - .1 Install fire dampers in accordance with Suppliers instructions, and with retaining angles on both sides of wall or floor and fastened to damper collars.
 - .2 Install fire dampers with adjacent access door as required to permit re-opening of damper and replacement of fusible link.
 - .3 Provide dynamic fire dampers on all systems, unless otherwise shown on Drawings and specified below.
 - .4 Provide static dampers on return air transfer openings.
- 3.8 **PROBE INLETS**
 - .1 Install probe inlets in duct work at locations as follows:
 - .1 In main supply and return ducts.
 - .2 Inlet and outlet side of fans.
 - .3 Other locations as required by testing and balancing trade, to permit testing, balancing and measurement of air quantities and static pressure in air handling systems.
 - .2 Locate probe inlets a sufficient distance from elbows or transition sections to ensure stable readings of non-turbulent air and install 75 mm from corners and at 150 mm centres across long side of duct.
- 3.9 **ACOUSTIC DUCT INSULATION AND SILENCERS**
 - .1 Install internal acoustic insulation in specific sections of duct work and/or plenums as shown on Drawings as follows:
 - .1 Adhere insulation to duct work or plenums by bedding in strips of adhesive supplemented by impaling clips or weld pins spaced at 300 mm centres with self-locking washers.
 - .2 Apply adhesive at 50% coverage, in 150 mm strips.
 - .3 Cut off ends of welded impaling pins after application of self-locking washers.
 - .4 Seal butt joints of insulation with mastic sealant applied to edges of insulation.

- .5 Coat joints and self-locking washers after installation with two coat application of mastic sealant, and with open mesh glass fabric embedded in mastic between first and second coat.
- .6 In high velocity duct work install perforated or expanded metal inner liner over acoustic lining.
- .2 Use silencers in duct work where shown on Drawings, to attenuate airborne noise generated in air distribution systems.
- .3 Fabricate cross talk silencers:
 - .1 Housing: Galvanized steel, to SMACNA pressure class 1" standard.
 - .2 Liner: Rigid coated duct liner.
 - .3 Size: As shown on drawings.
 - .4 Shape: As shown on drawings.
 - .5 Provide a sheetmetal nosing at open ends of duct to close off cut edge of liner.

End of Section

- 1 General
- 1.1 **SUMMARY**
 - .1 Section Includes
 - .1 Labor, Products, equipment, and services necessary to complete the Work of this section.
- 1.2 **REFERENCE STANDARDS**
 - .1 Comply with the latest edition of the standards referenced herein:
 - .1 Fans: Designed and constructed in strict conformity with the AMCA Standards and bearing the "Certified Rating Seal".
 - .2 Applicable sections of CSA C22.2 No. 113 for fan construction and installation.
 - .3 Occupational Health and Safety Act, O.Reg 851.
- 1.3 **SUBMITTALS**
 - .1 Shop Drawings
 - .1 Submit Shop Drawings in accordance with Section 01 33 00.
 - .2 Submit manufacturer's certified Shop Drawings to the Consultant and include:
 - .1 Complete information on fan construction and performance.
 - .2 Performance curves over full range from shut-off to free delivery.
 - .3 Drive details.
 - .4 Make, type and catalogue number of bearings.
 - .5 State hour rating of bearings when specified.
 - .2 Operation and Maintenance Data
 - .1 Submit printed operating instructions and maintenance data in accordance with Section 01 33 00.
 - .3 Maintenance Materials
 - .1 Provide and turn-over to Owner at time of Substantial Completion one V-belt set for each size used.
 - .1 Where more than one fan uses the same set size, provide only one set.
- 2 Products
- 2.1 **GENERAL REQUIREMENTS**
 - .1 Performance Ratings
 - .1 Type, size and capacity shown on Drawings for each specific application and conforming to requirements of manufacture, operation and performance as specified.

- .2 Select fan size, operating rpm and rating point on stable head flow curve with smooth characteristics.
- .3 Operating at least 20% below first critical speed when operating at maximum speed for class of construction.
- .4 Dynamically and statically balance wheels of free standing or unitary fans to acceptable tolerances relative to size and speed.
- .2 Cleaning and Metal Protection
 - .1 Thoroughly clean interior and exterior surfaces of fans including screens, at factory with approved de-greasing agent to CGBS 1-GP-181M+ Amdt-Mar-78.
 - .2 Apply a coating of red oxide or zinc chromate primer unless special protective coating is specified.
 - .1 Exception: Fans constructed of galvanized steel or aluminum.
- .3 Materials
 - .1 Fan casings: Heavy gauge steel or spun aluminum construction, as specified by model number.
 - .1 Explosion proof construction (non-sparking) where listed in schedules.
- .4 Bearings
 - .1 Service life
 - .1 To L10 life standard in accordance with latest AFBMA code.
 - .2 Unitary, axial and free-standing fans: 200,000 (60,000) (80,000) (100,000) hour service.
 - .3 Other fan bearings: 8,000-hour service.
 - .2 Type
 - .1 Grease lubricated ball or roller type fan bearings with ample thrust provision to prevent end play during normal life of bearings.
 - .2 Smaller than 36 mm diameter: Cartridge type.
 - .3 36 mm diameter and larger: Shaft adapter sleeve type bearings utilizing horizontally split pillow blocks and mechanical flinger type grease valves.
 - .4 Shafts smaller than 56 mm diameter, interference fit bearings may be used in lieu of adapter sleeve type.
 - .3 Bearings in air stream
 - .1 Well secured extended grease lubricating lines unless bearing is easily accessible through man-size access door.
 - .2 Pack bearings with low temperature grease in factory.
- .4 Axial flow fans

- .1 Conform to these Specifications except where inner cylinder mounting methods are used or dimensions do not permit it and special or flange mounted type bearings are required.
- .5 Grease fittings, for fans driven by motors 0.375 kW (1/2 HP) and larger.
 - .1 Provide bearings with Zerk or Alemite grease fittings, with provision for automatic relief of lubricant pressure to outside of fan, away from wheel and visible from maintenance location.
 - .2 Use service fittings and relief fittings easily accessible from maintenance locations and at separate and opposite sides of bearing housing.
- .5 Motors and Drives
 - .1 Motor ratings
 - .1 To Section 23 05 13.
 - .2 Type, kW (HP) rating, motor speed and electrical characteristics shown on Drawings.
 - .3 Capable of satisfactory operation over range of performance from shut-off to run-out at 110% of rated rpm at point of selection.
 - .2 Drive and belt guards: To Section 23 05 01.
- .6 Accessories
 - .1 Fans with variable inlet vanes
 - .1 Operating mechanisms to provide simultaneous adjustment of vanes.
 - .2 Motor operated mechanisms to be suitable for adaptation of motor operator provided under Division 25.
 - .3 Quick opening access doors in scroll casing.
 - .4 On DWDI fans interconnect vanes in each inlet to operate in unison.
 - .5 Provide locking device for manual operation.
 - .2 Casing drains
 - .1 Fans discharging vertically through roof: Fitted with 38 mm casing drains.
 - .3 Roof mounted fans.
 - .1 Factory mounted unfused disconnect switches wired to motor terminals.
 - .2 Conduit or wiring post running through fan housing so that wiring may be run to line side of disconnect switch from below roof without disturbing roof construction.
 - .4 Roof curbs for roof mounted fans and ventilators
 - .1 Prefabricated insulated galvanized steel sheet curbs for mounting to roof deck.

- .2 Prefabricated insulated galvanized steel sheet curbs for mounting to roof deck.
- .3 Minimum curb height: 300 mm on every side, or as dimensioned on Drawings.

2.2 **FAN TYPES**

.1 Centrifugal Fans

.1 Arrangements

Fan Type	Arrangement
Belt driven single inlet single width (SWSI) fans up to and including 915 mm wheel diameter	#1 or #2
Belt driven single inlet single width (SWSI) fans with wheel diameter larger than 915 mm diameter	#3
Belt driven double width double inlet (DWDI) fans	#3
Belt drive plenum (plug) fans, single width single inlet (SWSI) fans	#3
Direct connected double width double inlet (DWDI) fans	#7
Direct connected single inlet single width (SWSI) fans	#8
Utility sets	#10
Tubular single width single inlet (SWSI) fans	#1 or #9

.2 Fan wheels.

- .1 Backward curved or backward inclined for fan wheels less than 686 mm diameter.
- .2 Single or double thickness backward curved air foil blades for fan wheels 686 mm diameter and larger.

.3 Fan casing.

- .1 Continuous seam welded.
- .2 Inlet mounting collar.
- .3 Outlet flanged collar.

.4 Plenum (plug) fans

- .1 Safety screen enclosure around fan and motor fabricated from steel angle and expanded metal mesh.
- .2 Access covers to fan and motor shaft ends for speed measurements.

.5 In-line cabinet fans

- .1 Single wheel SWSI centrifugal fans with motor and V-belt drive.
- .2 Removable panels for access to internal parts.
- .3 Internally lined cabinet with 50 mm thick rigid acoustic insulation.
- .4 Expanded metal mesh over insulation on floor.
- .5 Motor pre-wired to external junction box.
- .6 Mounting ring or brackets for vertical or horizontal suspension from overhead structure.

- .7 Belt guard, motor, and drive.
- .8 Hanger brackets.
- .9 Inlet and outlet cones.
- .10 Quick-opening access door.
- .11 External grease and relief fittings to each bearing.
- .12 Variable inlet vanes and linkage where noted.
- .6 Ceiling cabinet fan / in-line cabinet fan
 - .1 Fan wheel.
 - .1 Centrifugal direct drive type.
 - .2 High strength polymer material.
 - .3 Forward curved.
 - .2 Motor
 - .1 Continuous duty, permanently lubricated, thermally protected.
 - .2 Resilient motor mounts to eliminate vibration.
 - .3 Casing
 - .1 Heavy gauge steel.
 - .2 Acoustic lining.
 - .3 Painted for corrosion resistance.
 - .4 Built-in backdraft damper.
 - .5 Outlet connection for round duct.
 - .6 Integral mounting flanges to allow for ceiling installation.
- .7 Tubular centrifugal fans
 - .1 Characteristics and construction as for centrifugal fan wheels.
 - .2 (Direct drive motor) (Belt drive assembly).
 - .3 Smooth rounded inlet, and stationary guide vanes.
- .2 Tube and Vane Axial Fans
 - .1 Fan
 - .1 Fabricated of welded steel with welded motor support.
 - .2 Quick-opening access door.
 - .3 External grease and relief fittings to each bearing.
 - .4 Streamlined inlet cone and discharge bell sections.
 - .5 Integral silencer casing.

- .6 Reinforced legs for floor mounted units.
- .7 Hanger brackets.
- .8 Support bracket welded to side of casing for suspended units.
- .2 Drives
 - .1 Direct driven: (Adjustable pitch) (Fixed pitch) (Fan blade with totally enclosed "air-over" motors and diameter of wheel hub at least equal to that of motor frame.
 - .2 Belt driven: (Fixed) (Adjustable) blade wheels with externally mounted open drip proof motors, internal belt fairing, external belt guards and adjustable motor mounts.
- .3 Roof Top Fans and Ventilators
 - .1 Upblast exhaust and downward supply air fans
 - .1 Suitable for mounting on curbed roof openings.
 - .2 Heavy gauge galvanized steel housing and wind band.
 - .3 Finished inside and outside with sprayed asphalt.
 - .4 Heavy gauge curb cap.
 - .5 Gravity or spring assisted steel dampers as required, with magnetic catches to dampers to prevent rattling in closed position.
 - .6 TEAO motor.
 - .7 Weatherproof protective motor cover and belt-drive.
 - .8 Supply fans complete with 25 mm throwaway filters.
 - .2 Spun aluminum dome type fans.
 - .1 Belt or direct driven as indicated in schedules.
 - .2 Spun aluminum housing.
 - .3 Hinged or completely removable hood for access to motor and fan.
 - .4 Non-overloading centrifugal fan wheel.
 - .5 Multi-blade gravity backdraft damper and aluminum 13 mm mesh bird screen.
 - .3 Gravity relief vents
 - .1 Spun aluminum cover.
 - .2 Welded aluminum curb cap.
 - .3 Galvanized bird screen.
 - .4 Exhaust air outlets complete with backdraft dampers.
 - .4 Penthouse type intake and exhaust hoods

- .1 Extruded aluminum fixed louvres with bird screens on inside.
- .2 Insulated metal roof.
- .3 Welded base to suit curbed opening and prefinished to later colour selection.
- .4 Ceiling Fans
 - .1 Multi-bladed propellers of sheet or airfoil shape.
 - .2 Permanently lubricated ball bearings suited for operation in any position.
 - .3 Direct driven, variable speed, with EC motor complete with controllers.
 - .4 Acceptable manufacturers:
 - .1 Big Ass Fans
 - .2 Altra Air (Envira North)
 - .3 MacroAir
- .5 Propeller Fans
 - .1 Wall type belt or direct driven propeller fans
 - .1 Multi-bladed propellers of sheet or airfoil shape steel within bell mouth entrance.
 - .2 Grease lubricated ball bearings suited for operation in any position.
 - .3 (Direct) (or) (belt) driven, with motor as indicated.
 - .4 Bird screen (and automatic backdraft dampers with gasketed edges).
 - .5 Wire guard on motor side.
 - .6 Support motor with substantial brackets or frame. Motors supported integrally with wire guard will not be accepted.
- .6 Acceptable Manufacturers
 - .1 Industrial Type Construction (In-line, Propeller Utility Sets, Upblast, Fume)
 - .1 Twin City Fan
 - .2 Chicago Blower
 - .3 New York Blower
 - .4 Northern Blower
 - .5 Barry Blower
 - .6 Carnes
 - .7 Aeroflow
 - .8 Aerovent
 - .9 Howden Fan Co.

- .10 American Fan Company (Flakt Woods)
- .11 Wood Fans
- .12 Canada Blower
- .2 Ceiling Cabinet Fans
 - .1 Greenheck
 - .2 Twin City
 - .3 Carnes
 - .4 Aerovent
 - .5 PennBarry
 - .6 Loren Cook
- .3 Small Propeller Fans
 - .1 Howden Fan Co.
 - .2 Greenheck
 - .3 Carnes
 - .4 American Fan Company (Flakt Woods)
 - .5 Wood Fans
- .4 Spun Aluminum Fans
 - .1 Greenheck
 - .2 Jenn Air
 - .3 Carnes
 - .4 American Fan Company (Flakt Woods)
- .5 Intake and Exhaust Hoods, Penthouses, Relief Vents
 - .1 Greenheck
 - .2 Jenn Air
 - .3 Carnes
 - .4 Loren-Cook
 - .5 American Fan Company (Flakt Woods)
- 3 Execution
- 3.1 **GENERAL**
 - .1 Fan Installation
 - .1 Install fans complete with resilient mountings and restraining snubbers in accordance with Section 23 05 48.

- .2 Provide flexible connections on inlet and outlet ductwork in accordance with Section 23 33 00.
 - .3 Align shafts, belt drive and motor, adjust belt tension and check motor rotation before start-up.
 - .4 Protect motors and fans during construction and rotate fans, by hand, every month between delivery and acceptance of building.
- .2 Air Balancing
- .1 Adjust variable pitch fan/motor sheaves during balancing to achieve specified air quantities.
 - .2 Provide sheaves and belts for final air balance.
- 3.2 **FABRICATED GOOSENECK TYPE FRESH AIR INTAKE AND EXHAUST AIR HOODS**
- .1 Fabrication: Black steel construction.
 - .2 Size, shape, and arrangement as shown on Drawings.
 - .3 Finish interior and exterior surfaces finished with rust inhibitive primer.
- End of Section

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- 1 General
- 1.1 **SUMMARY**
 - .1 Section Includes
 - .1 Labor, Products, equipment, and services necessary to complete the Work of this section.
- 2 Products
- 2.1 **DIFFUSERS, REGISTERS AND GRILLES**
 - .1 General
 - .1 Neck size, dimensions and capacity as shown on Drawings. Catalogue numbers of first named Supplier are listed on Drawings to show required type and style.
 - .2 Acoustic and airflow performance is based on catalogued information of the indicated manufacturer and model as shown on Drawings or schedules. Other named manufacturer Products must match these implied performance criteria.
 - .3 Border and frame as required to suit wall and ceiling construction.
 - .2 Linear Diffusers and Grilles
 - .1 Extruded aluminum construction, unless otherwise shown on Drawings.
 - .2 Linear supply and return diffusers to have either natural anodized aluminum finish or baked enamel finish as listed on Drawings.
 - .3 Complete with engineered distribution plenum and internal opposed blade damper. Black finish on inside of plenums.
 - .4 Curved and custom shapes and finishes as detailed on Drawings.
 - .3 Square and Circular Pattern Diffusers
 - .1 Steel construction with baked white enamel finish, unless otherwise shown.
 - .2 True imperial or metric sizes.
 - .3 Radial opposed blade damper.
 - .4 Grilles
 - .1 Steel construction with baked white enamel finish, unless otherwise shown.
 - .2 Blade orientation parallel to the long dimension.
 - .3 Opposed blade damper in black finish.
 - .5 Door Grilles
 - .1 Door grilles will be supplied and installed by general trades.
 - .6 Acceptable Manufacturers:
 - .1 E.H. Price
 - .2 Nailor Industries Inc.

- .3 Titus
- .4 Carnes
- .5 Tuttle & Bailey

3 Execution

3.1 **GENERAL**

- .1 Supply diffusers and registers to deliver indicated air quantities shown with throw to reach intended space limits without increasing the sound level of room. Provide blank-off baffles where required and equalizing deflectors on diffusers and in other locations as shown or required.
- .2 Coordinate placing of diffusers, registers and grilles in ceilings with electrical and ceiling installation trades and exact location to final approval of Consultant.
- .3 For connection to specific light-air troffers in flat ceilings provide boots to connect flexible duct to lighting fixtures.
- .4 For connection of air supply to coffered ceilings provide boots suitable for attachment to air slot on coffered ceilings as required and where shown on Drawings. Connect flexible supply air duct to neck of boot.

End of Section

- 1 General
 - 1.1 **SUMMARY**
 - .1 Section Includes
 - .1 Labor, Products, equipment, and services necessary to complete the Work of this section.
 - 1.2 **REFERENCE STANDARDS**
 - .1 Comply with the latest edition of the following:
 - .1 ANSI/ASHRAE/IESNA 90.1
 - .2 ANSI/ARI Standard 390
 - .3 CSA C22.2
 - 1.3 **SUBMITTALS**
 - .1 Shop Drawings
 - .1 Submit Shop Drawings in accordance with Section 01 33 00.
 - .2 Operation and Maintenance Data
 - .1 Submit printed operation instructions and maintenance data in accordance with Section 01 33 00.
- 2 Products
 - 2.1 **SPLIT-SYSTEM HEAT PUMP UNIT**
 - .1 Capacity, performance requirements, and configuration shall be as scheduled and specified.
 - .2 Provide fully packaged and factory tested indoor evaporator unit complete with control system, DX refrigeration system, supply air fan, filters.
 - .3 Provide fully packaged and factory tested remote outdoor condensing unit complete with built-in starter, contactors, controls, transformers, and weatherproof disconnect switch.
 - .4 Compressor to be inverter.
 - .5 Ship units fully charged with refrigerant R410A.
 - .6 Interconnect indoor evaporator unit and outdoor condensing unit with liquid and suction refrigerant lines. Refrigerant lines shall be insulated with cellular elastomer.
 - .7 Provide wired controller. Controller to be interlocked with electric heater where indicated on Drawings.
 - .8 Provide low (-20°C) ambient operation kit.
 - .9 Auto restart after power failure.
 - .10 Acceptable Manufacturers
 - .1 Mitsubishi

.2 Daikin

3 Execution

3.1 **GENERAL**

- .1 Install unit and accessories as per manufacturer's instructions.
- .2 Manufacturer to certify installation, and start-up and commission units.
- .3 Install miscellaneous steel framing, supports, braces, etc. as required to hang or support equipment and ductwork as specified herein, and as shown on Drawings.
- .4 Install and wire all accessories shipped loose with units for fully operating systems.

End of Section

- 1 General
- 1.1 **SUMMARY**
 - .1 Section Includes
 - .1 Labour, Products, equipment and services necessary to complete the Work of this section.
- 1.2 **CODES, PERMITS AND INSPECTIONS**
 - .1 Applicable Codes
 - .1 Ontario Electrical Safety Code
 - .2 Ontario Building Code
 - .3 Ontario Fire Code
 - .2 Comply with Ontario Electrical Safety Code, all local, provincial and federal laws, where applicable and with authorities having jurisdiction. Make any changes or alterations required by authorized inspector of authority having jurisdiction.
 - .3 Equipment and material must be acceptable to Electrical Safety Authority.
 - .4 Where materials are specified which require special inspection and approval, obtain such approval for the particular installation with the cooperation of the material Supplier.
 - .5 Obtain and pay for permits and inspections required for work performed.
 - .6 Supply and install warning signs, nameplates and glass covered single line diagrams as required by Electrical Safety Authority.
 - .7 Submit required documents and Shop Drawings to authorities having jurisdiction in order to obtain approval for the Work. Copies of Contract Drawings and Specifications may be used for this purpose.
- 1.3 **REFERENCE STANDARDS**
 - .1 These Specifications supplement the referenced standards.
 - .2 Where standards differ between authorities, the most rigid apply.
 - .3 Where requirements of the Specifications exceed referenced standards, the Specifications apply.
- 1.4 **COORDINATION**
 - .1 Refer to and comply with Section 01 10 00.
 - .2 Carefully examine Work and Drawings of all related trades and thoroughly plan the Work so as to avoid interferences. Report defects which would adversely affect the Work. Do not commence installation until such defects have been corrected.
 - .3 Coordinate Work of this division such that items will properly interface with Work of other divisions.
 - .4 Architectural Drawings, or in the absence of Architectural Drawings, Mechanical Drawings govern all locations.

- .5 Coordinate work of this division with Division 21 to ensure that damage does not occur to the fireproofing work of Division 21.
- 1.5 **SUBSTITUTIONS**
 - .1 When only one manufacturer's catalogued trade name is specified, provide only that catalogued trade name, material or Product.
 - .2 When more than one manufacturer's trade name is specified for a material or Product, the choice is the bidders.
 - .3 No substitution is allowed upon award of Contract.
- 1.6 **DIMENSIONS AND QUANTITIES**
 - .1 Dimensions shown on Drawings are approximate. Verify dimensions by reference to Shop Drawings and field measurement.
 - .2 Quantities or lengths indicated in Contract Documents are approximate only and shall not be held to gauge or limit the Work.
 - .3 Make necessary changes or additions to routing of conduit, cables, cable trays, and the like to accommodate structural, mechanical and architectural conditions. Where raceways are shown diagrammatically run them parallel to building column lines.
- 1.7 **EQUIPMENT LOCATIONS**
 - .1 Devices, fixtures and outlets may be relocated, prior to installation, from the location shown on the Contract Drawings, to a maximum distance of 3 m, without adjustment to Contract Price.
 - .2 Switch, control device and outlet locations are shown diagrammatically.
- 1.8 **INSTALLATION DRAWINGS**
 - .1 Prepare Installation Drawings for equipment, based upon approved Vendor Drawings, to check required code clearances, raceway, busway and cable entries, sizing of housekeeping pads and structure openings. Submit Installation Drawings to Consultant for review.
- 1.9 **"AS BUILT" RECORD DRAWINGS**
 - .1 Refer to and comply with Section 01 33 00.
 - .2 Maintain a set of Contract Drawings on site and record all deviations from the Contract Documents. **As a mandatory requirement, recording must be done on the same day deviation is made. Be responsible for full compliance with this requirement.**
 - .3 Mark locations of feeder conduits, junction and terminal boxes and ducts or conduits run underground either below the building or outside the building.
 - .4 Where conduit and wiring are underground or underfloor, furnish field dimension with respect to building column lines and inverts with respect to finished floor levels or grades.
 - .5 Record deviations from branch circuit numbers shown on Drawings.
 - .6 Prepare diagrams of interconnecting wiring between items of equipment including equipment supplied by Owner and under other Specification sections.
- 1.10 **SINGLE LINE DIAGRAM**

- .1 Reproduce this diagram in drawing form under glazed frame and mount in main switchgear room. Provide a copy of this diagram to the Consultant and include in the Maintenance Manuals.

1.11 **TEST REPORTS**

- .1 For each check and test performed prepare and submit a test report, signed by the Test Engineer, and where witnessed, by the Consultant.
- .2 Include record of all tests performed, methods of calculation, date and time of test, ambient conditions, names of testing company, Test Engineer, witnesses; also calibration record of all test instruments used together with manufacturers name, serial number and model number.
- .3 Include calibration record, percentage error and applicable correction factors.
- .4 Submit a certified test report from each manufacturer, signed by the certifying inspector, confirming correct installation and operation of each Product and part of Work. Include name of certifying inspector, date and times of inspection, ambient conditions.

1.12 **SHOP (VENDOR) DRAWINGS AND PARTS LISTS**

- .1 Refer to and comply with Section 01 33 00.
- .2 Submit for review, manufacturer's or vendor's drawings for all Products being furnished except cable (up to 1000V), wire and conduit. Include rating, performance, specification sheets, descriptive literature, schematic and wiring diagrams, dimensional layouts and weights of components as well as complete assembly.
- .3 Drawings for equipment assemblies, such as switchgear and unit substations, must include the entire assembly on a single drawing having a minimum size of 420 mm x 594 mm.

1.13 **FACTORY WITNESS TESTS**

- .1 Prior to Consultant attendance at factory for witness testing, perform the following:
 - .1 Successfully conduct test to be witnessed.
 - .2 Following successful testing, inform the Consultant, in writing, that tests to be witnessed have been successfully performed.

1.14 **OPERATING AND MAINTENANCE MANUALS**

- .1 Refer to and comply with Section 01 33 00 and related sections.

1.15 **AREA CLASSIFICATION**

- .1 _____

2 Products

2.1 **APPROVALS AND QUALITY**

- .1 Provide new materials bearing certification marks or labels acceptable under Ontario Electrical Safety Code.
- .2 Equipment must bear, on manufacturer's label, certification mark or label acceptable under Electrical Safety Authority.

- .3 Provide units of same manufacture where two or more units of same class or type of equipment are required.
- .4 Manufacturer's names are stated in this Specification to establish a definite basis for tender submission and to clearly describe the quality of Product that is desired for the Work.

2.2 **STANDARD SPECIFICATIONS**

- .1 Ensure that the chemical and physical properties, design, performance characteristics and methods of construction of all Products provided comply with latest issue of applicable standard Specifications issued by authorities having jurisdiction, but such standard Specifications shall not be applied to decrease the quality of workmanship, Products and services required by the Contract Documents.

2.3 **SPRINKLER PROOF EQUIPMENT**

- .1 Ensure that electrical equipment installed in electrical rooms and other areas containing sprinklers is constructed such that exposure to water from the sprinkler heads does not impair the effectiveness of the enclosed equipment.
- .2 Provide a separate cover or roof on all 2285 mm high equipment. Provide an overhang at the front, rear and sides to effectively prevent the entrance of water either at the top or through projecting faceplates, meters, etc.
- .3 Where penetrations are made in drip shields, flash and seal using manufacturer's approved caulking to maintain drip shield integrity.
- .4 Ensure that enclosure louvres are of outdoor design such that falling water or water running down the sides will not enter the enclosure.
- .5 Where enclosure openings in the top or sides are required for outgoing conduits, provide waterproof conduit fittings.
- .6 Provide panels and transformers with hoods.
- .7 Provide sprinkler proof busways.
- .8 In electrical rooms containing sprinklers provide wall mounted equipment such as pull boxes, junction boxes, splitter troughs, wireways, auxiliary gutters, cable troughs and disconnect switches located below the level of the sprinkler heads with the following accessories:
 - .1 Gaskets on doors and drip shields on equipment, panelboards, panels and enclosures.
 - .2 Louvres facing outward and downward where openings are required for heat dissipation. Expanded metal screening is not acceptable.

2.4 **HOUSEKEEPING PADS**

- .1 Provide 100 mm high concrete pads under floor mounted electrical equipment. Extend pads 50 mm outside the equipment perimeter.

2.5 **FIRE BARRIERS**

- .1 Where electrical material or devices pass through fire rated separations, make penetrations and provide fire barrier seals with a fire resistance rating equivalent to the rating of the separation.

- .2 Prior to installation, submit for review, proposed fire barrier seal materials, method of installation and ULC system number.
- .3 Acceptable Manufacturers:
 - .1 A/D Fire Protection Systems
 - .2 Dow Corning
 - .3 Fire Stop Systems
 - .4 IPC Flamesafe Firestop
 - .5 Nelson Electric
 - .6 3M
 - .7 Tremco
- 2.6 **MISCELLANEOUS METAL FABRICATIONS**
 - .1 Provide miscellaneous structural supports, platforms, braces, brackets and preformed channel struts necessary for suspension, attachment or support of electrical equipment in accordance with Section 05 50 00.
- 2.7 **SILICONE**
 - .1 Products and materials containing silicone are not permitted.
- 2.8 **EQUIPMENT COLOUR CODING**
 - .1 Exterior finish paint colour for switchgear, control panels, panelboards and devices on emergency and UPS systems:
 - .1 Emergency systems: Red
 - .2 UPS systems: Blue
- 2.9 **PRODUCTS FURNISHED BY OWNER**
 - .1 Refer to Sections 01 10 00.
 - .2 Carefully examine the Vendor or Manufacturers' Drawings and provide any incidental and miscellaneous materials, mounting hardware and supports required for complete systems.
- 3 Execution
- 3.1 **MANUFACTURER'S ATTENDANCE**
 - .1 Provide manufacturer's representatives to initially start-up each part of the Work, as specified, to check, adjust, calibrate and balance as applicable all components including controls and field wiring. Provide these services for such period and for as many visits as necessary to achieve complete working order in the subject Work.
- 3.2 **FIELD INSPECTION**
 - .1 Provide Field Engineer for inspection and certification of equipment during installation, testing and commissioning as required.
- 3.3 **PAINTING**

- .1 Touch up finishes on electrical equipment found to be marred on completion of the Work using same colour and type of finish as originally used.
- .2 Prime paint field fabricated metalwork.
- .3 Other painting will be provided under Section 09 91 00.

3.4 **CORE DRILLING**

- .1 Core Drilling Procedure
 - .1 Examine locations to be core drilled where:
 - .1 Diameter is greater than 25 mm
 - .2 Multiple drillings required and where the distance between centres is less than ten times the diameter of the hole
 - .2 Examine by most suitable method including:
 - .1 X-ray
 - .2 Ferro scan
 - .3 Cable detection
 - .3 Examine from both sides of the structure to be drilled.
 - .4 Examine proposed core drilling locations to determine:
 - .1 Possible interference with
 - .1 Services
 - .2 Structural components
 - .2 Possible presence of asbestos tile or other asbestos based material. Report any occurrence or suspected occurrence to the Consultant immediately.
 - .5 Select locations as suitable for core drilling and label them:
 - .1 Uniquely number each drilling location and core so that markings will be legible after drilling
 - .2 Mark each core with a north pointing arrow where drilling a slab or upward pointing arrow where drilling a wall
 - .6 Without interfering with or damaging any services or structural elements, drill pilot holes sufficient to verify location of potential obstructions or for alignment purposes.
 - .7 Use impact drill when drilling holes of 25 mm diameter or less. For holes of greater diameter use core drill.
 - .8 Prepare report showing intended core drill locations including printouts and X-ray images. Prior to drilling submit the report to Consultant for approval.
 - .9 Proceed with core drilling only after approval has been received from Consultant.
 - .10 Confine drilling operation to time-of-day as stipulated by Consultant.

- .11 Position suitable warning notices of a type acceptable to Consultant and exercise caution to ensure safety and protection of personnel and property during drilling especially from effects of water, dust damage, or falling objects below the slab or behind the wall being drilled.
- .12 Stop drilling immediately, and report to Consultant, if contact is made with foreign objects such as reinforcing steel (rebar), electrical conduit, water pipes, drainage pipes.
- .13 Cover open holes with secured covers to guard against fall through of objects.
- .14 Provide necessary firestopping, temporary or otherwise, sufficient to firestop holes that would be otherwise open during hours that the location is unattended. Coordinate placement of firestopping with Consultant.
- .15 Store all cores or core fragments on site and make them available for inspection by Consultant. Dispose of the cores or core fragments after permission is received from Consultant.

End of Section

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1 General

1.1 **SUMMARY**

.1 Section Includes

- .1 Labour, Products, equipment and services necessary to complete the Work of this section.
- .2 This section shall be read in conjunction with Appendix A City of Toronto Corporate Building System Design Requirements. Appendix A shall take precedence where there is a conflict in this Section.

1.2 **REFERENCES**

.1 Conform to latest issues, amendments and supplements of following standards:

- .1 CISC/CPMA 2.75 - Canadian Institute of Steel Construction/
Canadian Paint Manufacturers Association, A
Quick Drying Primer For Use on Structural
Steel
- .2 CAN/CGSB-1.40-M - Primer, Structural Steel, Oil Alkyd Type
- .3 CAN3-C21.1-M - Control Cable - 600V
- .4 CAN3-C21.2-M - Control Cable for Low Energy Circuits 150V
and 300V
- .5 CAN/CSA C22.2 No. 18 - Outlet Boxes, Conduit Boxes, and Fittings
- .6 CAN/C22.2 No. 26 - Wireways, Auxiliary Gutters and Associated
Fittings
- .7 CSA C22.2 No. 30-M - Explosion-Proof Enclosures for Use in Class I
Hazardous Locations
- .8 CSA C22.2 No. 38-M - Thermoset Insulated Wires and Cables
- .9 CSA C22.2 No. 40-M - Cutout, Junction and Pull Boxes
- .10 CSA C22.2 No. 42-M - General Use Receptacles, Attachment Plugs
and Similar Wiring Devices
- .11 CSA C22.2 No. 45-M - Rigid Metal Conduit
- .12 CSA C22.2 No. 49 - Flexible Cords and Cables
- .13 CAN/CSA C22.2 No. 51-M - Armoured Cables
- .14 CSA C22.2 No. 52-M - Service-Entrance Cables
- .15 CSA C22.2 No. 56 - Flexible Metal Conduit and Liquid-Tight
Flexible Metal Conduit
- .16 CSA C22.2 No. 62 - Surface Raceway Systems
- .17 CSA C22.2 No. 65 - Wire Connectors
- .18 CSA C22.2 No. 75-M - Thermoplastic Insulated Wires and Cables

.19	CSA C22.2 No. 76-M	-	Splitters
.20	CSA C22.2 No. 79	-	Cellular Metal and Cellular Concrete Floor Raceways and Fittings
.21	CSA C22.2 No. 80	-	Underfloor Raceways and Fittings
.22	CSA C22.2 No. 83-M	-	Electrical Metallic Tubing
.23	CAN/CSA-C22.2 No. 85-M	-	Rigid PVC Boxes and Fittings
.24	CAN/CSA C22.2 No. 94-M	-	Special Purpose Enclosures
.25	CSA C22.2 No. 123-M	-	Aluminum Sheathed Cables
.26	CSA C22.2 No. 124-M	-	Mineral-Insulated Cables
.27	CSA C22.2 No. 126-M	-	Cable Tray Systems
.28	CSA C22.2 No. 127	-	Equipment Wires
.29	CAN/CSA-C22.2 No. 131-M	-	Type Teck 90 Cable
.30	CSA C22.2 No. 138-M	-	Heat Tracing Cable and Cable Sets for Use in Hazardous Locations
.31	CSA C22.2 No. 159-M	-	Attachment Plugs, Receptacles and Similar Wiring Devices for Use in Hazardous Locations: Class I, Groups A, B, C, and D; Class II, Group G, in Coal or Coke Dust, and in Gaseous Mines
.32	CSA C22.2 No. 174-M	-	Cable and Cable Glands for Use in Hazardous Locations
.33	CSA C22.2 No. 182.1	-	Industrial Type, Special Use Attachment Plugs, Receptacles, and Connectors
.34	CSA C22.2 No. 182.2-M	-	Industrial Locking Type, Special Use Attachment Plugs, Receptacles, and Connectors
.35	CSA C22.2 No. 182.3-M	-	Special Use Attachment Plugs, Receptacles, and Connectors
.36	CSA C22.2 No. 208-M	-	Fire Alarm and Signal Cable
.37	CSA C22.2 No. 211.2-M	-	Rigid PVC (Unplasticized) Conduit
.38	CSA C22.2 No. 211.3	-	Rigid Fiberglass Reinforced Epoxy (RE) Conduit and Associated Fittings
.39	CSA C22.2 No. 214-M	-	Communications Cables
.40	CSA C22.2 No. 222-M	-	Type FCC Under-Carpet Wiring System
.41	CSA C22.2 No. 227.1	-	Electrical Nonmetallic Tubing
.42	CSA C22.2 No. 227.2	-	Flexible Liquid-Tight Nonmetallic Conduit
.43	CSA C22.2 No. 227.3-M	-	Flexible Nonmetallic Tubing
.44	CSA C22.2 No. 230-M	-	Tray Cables

- .45 CSA C22.2 No. 232-M - Optical Fiber Cables
- .46 SSPC - Steel Structures Painting Council, "Steel Structures Painting Manual, Vol. 2"

1.3 **SUBMITTALS**

- .1 Consultant reserves the right to require Contractor to submit samples of any materials to be used in this Project.

2 Products

2.1 **WIRE - LOW VOLTAGE UP TO 1000V SERVICE**

.1 Conductors

- .1 ASTM Class B, soft drawn, electrolytic copper

- .2 Stranded

.2 Insulation

- .1 CSA type RW90 XLPE (-40°C)

- .1 Heat and moisture resistant

- .2 Low temperature, chemically cross-linked thermosetting polyethylene material

- .3 600 V rated

- .4 For maximum 90°C (194°F) conductor temperature

- .5 For installation at minimum -40°C (-40°F) temperature

- .6 To CSA C22.2 No. 38

- .2 CSA type RWU90 XLPE (-40°C):

- .1 Heat and moisture resistant

- .2 Low temperature, chemically cross-linked thermosetting polyethylene material

- .3 1000 V rated

- .4 For maximum 90°C (194°F) conductor temperature

- .5 For installation at minimum -40°C (-40°F)

- .6 To CSA C22.2 No. 38

- .3 CSA type T90 NYLON (-10°C):

- .1 Heat resistant

- .2 Flame retardant

- .3 Thermoplastic PVC material with extruded nylon cover

- .4 600 V rated

- .5 For maximum 90°C (194°F) conductor temperature dry and 75°C in wet locations
- .6 For installation at minimum -10°C (14°F)
- .7 To CSA C22.2 No. 75-M
- .4 CSA type TEW:
 - .1 Heat resistant
 - .2 600 V rated
 - .3 For maximum 105°C (221°F) conductor temperature
 - .4 To CSA C22.2 No. 127
- .5 CSA type SEW-2
 - .1 Heat resistant
 - .2 600 V rated
 - .3 For maximum 200°C (392°F) conductor temperature
 - .4 To CSA C22.2 No. 127
- .3 Acceptable Manufacturers
 - .1 Alcan Cable
 - .2 Alcatel Canada Wire
 - .3 Pirelli Cables
- 2.2 **CABLE - LOW VOLTAGE UP TO 1000V SERVICE**
 - .1 CSA Type AC90 XLPE (-40°C)
 - .1 Conductors
 - .1 ASTM Class B, soft drawn, electrolytic copper
 - .2 Solid for sizes #10 AWG and smaller
 - .3 Stranded for sizes #8 AWG and larger
 - .2 Insulation
 - .1 Heat and moisture resistant
 - .2 Low temperature, chemically cross-linked thermosetting polyethylene material
 - .3 600 V rated for sizes #10 AWG and smaller
 - .4 1000 V rated for sizes #8 AWG and larger
 - .5 For maximum 90°C (194°F) conductor temperature
 - .6 For installation at minimum -40°C (-40°F) temperature

- .7 To CSA C22.2 No. 38
- .3 Construction
 - .1 Two, three or four insulated conductors
 - .2 Bare ground conductor
 - .3 Overall interlocking aluminum armour
 - .4 To CSA C22.2 No. 51
- .4 Acceptable Manufacturers
 - .1 Alcan Cable
 - .2 Alcatel Canada Wire
 - .3 Pirelli Cables
- .2 CSA Type TECK90 (-40°C)
 - .1 Conductors
 - .1 ASTM Class B, soft drawn, electrolytic copper
 - .2 Stranded
 - .2 Insulation
 - .1 Heat and moisture resistant
 - .2 Low temperature, chemically cross-linked thermosetting polyethylene material
 - .3 600 V or 1000 V rated
 - .4 For maximum 90°C (194°F) conductor temperature
 - .5 For installation at minimum -40°C (-40°F) temperature
 - .6 CSA type RW90 XLPE
 - .7 To CSA C22.2 No. 38
 - .3 Construction
 - .1 One or more insulated conductors
 - .2 Bare, stranded, copper ground conductor for multi-conductor cables
 - .3 Bare, solid, served copper ground conductors for single conductor cables
 - .4 Fillers with binder tape to produce a circular cross-section for multi-conductor cables
 - .5 Power cables
 - .1 One, two, three or four conductors
 - .2 Conductors 1000 V rated

- .6 Control cables
 - .1 Two or more conductors
 - .2 Conductors 600 V rated
- .7 Composite cables
 - .1 Three power conductors
 - .2 Three #14 AWG control conductors
 - .3 Conductors 600V rated
- .8 Extruded PVC inner jacket over conductor assembly
- .9 Interlocking aluminum armour over inner jacket
- .10 Extruded PVC overall jacket over armour
 - .1 FT4 flame test rated
 - .2 Colour black unless otherwise indicated
- .11 Cable assembly for installation at minimum -40°C (-40°F) temperature
- .12 To CSA C22.2 No. 131 and CSA C22.2 No. 174
- .4 Acceptable Manufacturers
 - .1 Alcan Cable
 - .2 Alcatel Canada Wire
 - .3 BICC Phillips
 - .4 Pirelli Cables
- .3 CSA Type RA90 XLPE (-40°C)
 - .1 Conductors
 - .1 ASTM Class B, soft drawn, electrolytic copper
 - OR
 - .2 CSA type ACM aluminum alloy
 - .3 Stranded
 - .2 Insulation
 - .1 Heat and moisture resistant
 - .2 Low temperature, chemically cross-linked thermosetting polyethylene material
 - .3 600 V rated
 - .4 For maximum 90°C (194°F) conductor temperature
 - .5 For installation at minimum -40°C (-40°F) temperature

- .6 CSA type RW90 XLPE
- .7 To CSA C22.2 No. 38
- .3 Construction
 - .1 Single conductor
 - .2 Continuous, corrugated aluminum sheath of minimum cross-sectional area to comply with electrical code table 16
 - .3 Extruded PVC overall jacket over armour
 - .1 FT4 flame test rated
 - .2 Colour black unless otherwise indicated
 - .4 Cable assembly for installation at minimum -40°C (-40°F) temperature
 - .5 To CSA C22.2 No. 123 and CSA C22.2 No. 174
- .4 Acceptable Manufacturers
 - .1 Alcan Cable
 - .2 Alcatel Canada Wire
 - .3 BICC Phillips
- .4 CSA Type TC, Tray Cable (-40°C)
 - .1 Conductors
 - .1 ASTM Class B, soft drawn, electrolytic copper
 - .2 Stranded
 - .2 Insulation
 - .1 Heat and moisture resistant
 - .2 Low temperature, chemically cross-linked thermosetting polyethylene material
 - .3 600 V rated
 - .4 For maximum 90°C (194°F) conductor temperature
 - .5 For installation at minimum -40°C (-40°F) temperature
 - .6 CSA type RW90 XLPE to CSA C22.2 No. 38
 - .3 Construction
 - .1 Two or more insulated conductors
 - .2 Bare, stranded, copper ground conductor
 - .3 Fillers with binder tape to produce a circular cross-section
 - .4 Jacket

- .1 PVC
- .2 FT4 flame test rated
- .3 Low acid gas rated to CSA C22.2 No. 0.3
- .4 Black colour
- .5 To CSA C22.2 No. 230
- .4 Acceptable Manufacturers
 - .1 Alcatel Canada Wire
 - .2 BICC Phillips
 - .3 Pirelli Cables
- .5 CSA Type MI
 - .1 Conductors
 - .1 ASTM Class B, soft drawn, electrolytic copper
 - .2 Solid
 - .2 Insulation
 - .1 Powdered magnesium oxide
 - .2 600 V rated
 - .3 Construction
 - .1 Solid conductor
 - .2 Insulation around the conductor compressed to form a solid, homogeneous mass between the conductor and the metal sheath throughout the entire length of cable
 - .3 Soft annealed seamless copper sheath over insulation
 - .4 Extruded PVC overall jacket over sheath
 - .1 FT4 flame test rated
 - .2 Colour black unless otherwise indicated
 - .5 To CSA C22.1 No. 124-M
 - .4 Acceptable Manufacturer
 - .1 Pyrotenax
- .6 EMF-Free Power Cable
 - .1 Conductors
 - .1 ASTM Class B, soft drawn, electrolytic copper
 - .2 Stranded central conductor

- .3 Solid, served concentric return conductors, equivalent to central conductor
- .4 Conductor size and number of runs to suit feeder ratings as shown on drawings
- .2 Insulation
 - .1 Heat and moisture resistant
 - .2 Ethylene propylene rubber (EPR)
 - .3 Minimum 600 V rated
 - .4 For maximum 90°C (194°F) conductor temperature
 - .5 For installation at minimum -40°C (-40°F) temperature
 - .6 To CSA C22.2 No. 38
- .3 Construction
 - .1 Single conductor with served wire return conductor (coaxial)
 - .2 PVC inner-jacket over return conductor
 - .3 Interlocking aluminum over inner jacket
 - .4 Overall PVC jacket
- .4 Power filters
 - .1 Filter parameters to suit the feeder characteristics (rating, length, etc.)
 - .2 EEMAC type 1 enclosure
- .5 Engineered system
 - .1 Provide EMF-free power cables and power filters as a complete engineered system from the manufacturer
- .6 Acceptable Manufacturer
 - .1 United Wire & Cable (ZeroFlux® Power Cable)

2.3 **MODULAR WIRING (LIGHTING SYSTEMS)**

- .1 Distribution Boxes
 - .1 Steel, EEMAC 1 enclosure, minimum size 300 mm x 300 mm x 100 mm
 - .2 Modular connectors, five-wire, female
 - .3 Terminal block for incoming wiring
 - .4 Stranded copper wiring between terminal block and modular connectors
- .2 Extension/Tap Cables
 - .1 Armoured type cable, #10 or #12 AWG, copper conductors rated 600 V, 90°C (194°F) insulation

- .2 Modular connectors, five-wire, one male at one end and twin female at other end or splitters to maintain circuit continuity on removal of luminaire drop cable
 - .3 Luminaire Drop Cables
 - .1 Service cord, type SEO or armoured cable, three-wire, stranded copper conductors rated 600V, 105°C (221°F) insulation, colour phase identification on jacket (phase A, red; phase B, black; phase C, blue)
 - .2 Modular connector, male
 - .3 Prewired to luminaires
 - .4 Modular Connectors
 - .1 Rated 347 V, 20 A
 - .2 Rated to connect or disconnect an individual luminaire under load
 - .5 Acceptable Manufacturers
 - .1 Flex Systems (Flex) 3+
 - .2 Lithonia Reloc
 - .3 Holophane Holoflex
 - .4 Cooper MWS
- 2.4 **CABLE CONNECTORS**
- .1 Connectors for Type AC90 Cable
 - .1 Steel or malleable iron
 - .2 Insulated throat
 - .3 Acceptable manufacturers
 - .1 Efcor 1000B series
 - .2 Elliott 65200 series
 - .3 Thomas & Betts 3110 series
 - .2 Connectors for Type TECK90 Cable
 - .1 Copper free aluminum body
 - .2 Steel or copper free aluminum fittings and locknut
 - .3 Certified for use in hazardous locations Classes I, II, and III
 - .4 Class I hazardous location sealing fitting
 - .5 Acceptable manufacturers
 - .1 Thomas & Betts "STE" series
 - .2 Crouse-Hinds type TMC
 - .3 Commander/Iberville type TEK

- .3 Connectors for Type RA90 Cable
 - .1 Copper free aluminum body
 - .2 Steel or copper free aluminum fittings
 - .3 Acceptable manufacturers
 - .1 Alcatel Canada Wire
 - .2 Crouse-Hinds, type TMC
- .4 Connectors for Type TC, Tray Cable
 - .1 Copper free aluminum body
 - .2 Steel or copper free aluminum fittings and locknut
 - .3 Acceptable manufacturers
 - .1 Thomas & Betts, Tray-Star, HLT series
 - .2 Crouse-Hinds, type TMC

2.5 **WIRE AND CABLE CONNECTORS**

- .1 Copper compression type wire and cable terminations for #8 AWG and larger conductors, colour keyed, sized to suit. Long barrel NEMA 2 hole lugs for sizes #1/0 AWG and larger.
 - .1 Acceptable Manufacturers
 - .1 Thomas & Betts series 54000
 - .2 Ideal Powr-Connect
 - .3 Burndy Hylug
 - .2 Twist type splicing connectors, copper, sized to suit, with nylon or plastic shroud for tee connections in #10 AWG and smaller conductors.
 - .1 Acceptable Manufacturers
 - .1 Thomas & Betts spring type
 - .2 Ideal Twister
 - .3 Marr Marrette
 - .3 Conductor compression splice for #10 AWG or smaller.
 - .1 Acceptable Manufacturers
 - .1 Thomas & Betts STA-Kon series
 - .2 Ideal Splices
 - .3 Burndy

2.6 **HEAT SHRINKABLE TUBING INSULATION, HEAVY WALL**

- .1 Acceptable Manufacturers
 - .1 Thomas & Betts, Shrink-Kon series

- .2 Ideal Thermo-Shrink, TS-46
- .3 Raychem tubing WCSM
- .4 3M cable sleeve ITCSN

2.7 **MOTOR LEAD CONNECTION KITS, 600 VOLT**

- .1 Connection kits for low voltage motors.
- .2 Acceptable Manufacturers
 - .1 3M, motor lead splice kit, pigtail, 5300 series
 - .2 Raychem, motor connection kit, MCK, type V

2.8 **MOTOR LEAD CONNECTION KITS, 5000 VOLT**

- .1 Connection kits for 4000 V motors.
- .2 Acceptable Manufacturers
 - .1 3M, motor lead splice kit, pigtail, 5320 series
 - .2 Raychem, motor connection kit, MCK-5, type V

2.9 **CONDUIT AND FITTINGS**

- .1 Rigid Steel Conduit
 - .1 To CSA C22.2 No. 45-M
 - .2 Rigid thickwall galvanized steel threaded conduit
- .2 Coated Steel Conduit
 - .1 Corrosive resistant coated rigid thickwall steel threaded conduit, CSA approved.
 - .2 Acceptable Manufacturers
 - .1 Rob Roy Plastibond PVC coated
 - .2 Columbex Green Guard II epoxy polyester coated
- .3 Rigid PVC Conduit
 - .1 To CSA C22.2 No. 211.2-M
 - .2 Rigid PVC conduit
- .4 Flexible Steel Conduit
 - .1 To CSA 22.2 No. 56
 - .2 Liquid-tight flexible steel conduit with PVC cover
- .5 Non-Metallic Flexible Conduit
 - .1 Non-metallic extra flexible PVC conduit
 - .2 Acceptable Manufacturers
 - .1 Carlon, Carflex X-Flex

- .2 Hubbell, Polytuff Black
- .6 Rigid Steel Conduit Fittings
 - .1 To CAN/CSA C22.2 No. 18
 - .2 Galvanized or polymer coated cast steel fittings
 - .3 Expansion fittings, watertight with integral bonding jumper suitable for linear expansion and 19 mm deflection in all directions
 - .4 Sealing condulets for hazardous areas
 - .5 Corrosive resistant coated cast steel fittings for corrosive resistant conduit
- .7 Rigid PVC Conduit Fittings
 - .1 To CSA C22.2 No. 85-M
 - .2 Rigid PVC fittings of same manufacture as rigid PVC conduit
- .8 Liquid Tight Flexible Steel Conduit Fittings
 - .1 Watertight connectors with nylon insulated throat
 - .1 Acceptable Manufacturers:
 - .1 T & B Series 5331 with Sealing O-ring Series 5262
 - .2 Commander/Iberville Series 6300-IT with nitrile O-ring
- 2.10 **EMT AND FITTINGS**
 - .1 EMT
 - .1 To CSA C22.2 No. 83-M
 - .2 EMT galvanized cold rolled steel tubing
 - .2 EMT Fittings
 - .1 Compression type, steel
 - .1 Gland compression connectors with insulated throats
 - .2 Compression couplings
 - .3 Acceptable manufacturers:
 - .1 T & B Series 5123 & 5120
 - .2 O-Z/Gedney type ZTC series
 - .3 Commander/Iberville Series 5600-IT and 5700
 - .2 Set screw type, steel, concrete-tight
 - .1 Connectors with insulated throats
 - .2 Couplings
 - .3 Acceptable manufacturers

.1 Commander/Iberville Series 5400 and 5500

2.11 **CABLE TRAY**

- .1 Cable Trays and Fittings
 - .1 To EEMAC F5-1
 - .2 To CAN/CSA C22.2 No. 126-M
- .2 Ladder Type
 - .1 Class C1
 - .2 Aluminum (Steel, hot dip galvanized after fabrication)
 - .3 Side height, 100 mm(150 mm)
 - .4 Rung spacing, 300 mm
- .3 Ventilated Type
 - .1 Class C1
 - .2 Aluminum (Steel, hot dip galvanized after fabrication)
 - .3 Side height, 100 mm(150 mm)
- .4 Solid Type
 - .1 Class C1
 - .2 Aluminum (Steel, hot dip galvanized after fabrication)
 - .3 Side height, 100 mm(150 mm)
- .5 Centre Rail Type
 - .1 Class C1
 - .2 Aluminum
 - .3 Rung spacing 150 mm, 225 mm, 300 mm
 - .4 Loading depth 75 mm, 100 mm, 150 mm
 - .5 Rung width 25 mm minimum
- .6 Acceptable manufacturers for ladder, ventilated and solid types:
 - .1 B-Line
 - .2 Canadian Electrical Raceways
 - .3 Canstrut
 - .4 Electrotray
 - .5 Pilgrim
 - .6 Pursley
 - .7 Unistrut

.7 Acceptable manufacturers for centre rail type:

.1 Wiremold, Spec Mate CA series

.2 B-Line, Cent-R-Rail

2.12 **WIREWAY**

.1 To CSA C22.1 No. 94-M.

.2 Steel with hinged cover to give uninterrupted access.

.3 Elbows, tees, couplings and hanger fittings manufactured as accessories for wireway supplied.

.4 Acceptable Manufacturers:

.1 Amalgamated Electric

.2 Canadian Electrical Raceways

.3 Schneider Square D

.4 Pilgrim

.5 Pursley

2.13 **SURFACE RACEWAY**

.1 Surface metal raceway, snap-in divider to form two compartments for power and voice/data, with removable cover.

.2 Elbows, couplings, end caps, device brackets and faceplates for power, data and voice, and fittings manufactured as accessories for wireway supplied. 120 V power receptacles and mounting only for voice/data.

.3 Acceptable manufacturer:

.1 Wiremold with following components:

.1 4000 series, ivory colour

.2 Device mounting plate, V4049-G and faceplate 5507-G colour grey

.3 Duplex receptacles, 120V, 15A, Leviton Decora plus, colour grey 16262-GY

.4 Duplex receptacle, 120V, 20A, P & S Sierraplex, colour grey, 26342-GRY

2.14 **CELLULAR FLOOR SYSTEM**

.1 Standards

.1 Raceways and fittings to CSA C22.2 No. 79.

.2 Activation kits and components CSA approved.

.2 Trench duct: Steel construction, intermittent bottom, adjustable compartment dividers, removable covers, external levelling screws, void closures, coupling mechanisms, end closures, elbows and coverplate lifting device.

- .3 Preset inserts: Steel construction, triple service access with grommetted openings for access to low tension and power cells.
- .4 Activation kits: Pedestal fitting, multiplex service, two duplex power convenience receptacles, two data receptacles, two telephone jack outlets, and fittings to connect to preset inserts.
- .5 Acceptable Manufacturer
 - .1 Walker: Trenchduct type VA, preset inserts NRG-Bloc series and activation kits M6 series

2.15 **FASTENINGS, SUPPORTS AND SLEEVES**

- .1 Fastenings
 - .1 Galvanized steel straps, beam clamps and threaded rods
- .2 Sleeves
 - .1 Schedule 40 steel pipe, minimum I.D. 13 mm larger than outside diameter of conduit or cable passing through.
- .3 Strut
 - .1 Continuous slotted channel
 - .2 Twelve gauge pre-galvanized steel
 - .3 41.2 mm x 41.2 mm minimum
 - .4 Acceptable manufacturers:
 - .1 B-Line
 - .2 Pilgrim
 - .3 Pursley
 - .4 Unistrut

2.16 **SPLITTER BOXES**

- .1 Code gauge (galvanized) sheet steel enclosure EEMAC Type (1) (4) (12) welded corners and formed hinged cover suitable for locking in closed position.
- .2 Cast steel enclosure EEMAC 7 (9) with gasketed bolt on cover for hazardous locations.
- .3 Copper (aluminum) main and branch lugs to match required size and number of incoming and outgoing conductors.
- .4 At least three spare terminals on each set of lugs in splitters less than 400 A.

2.17 **JUNCTION BOXES**

- .1 Galvanized steel EEMAC Type 1 (4) (12) size as required by code for number and size of conduits, conductors and devices, complete with covers, corrosion resistant screws, terminal blocks and mounting rails.
- .2 Screw-on sheet steel covers to match enclosure for surface mounting boxes.
- .3 Covers with 25 mm minimum extension around for flush-mounted junction boxes.

- .4 Galvanized steel barriers as required.
- 2.18 **TERMINAL BLOCKS - SURGE PROTECTION**
 - .1 Terminal blocks, rail mounted, with surge voltage protection, rated for circuit voltage.
 - .2 Acceptable Manufacturers
 - .1 Phoenix Contact Termitrab SLKK5 (Termitrab SLKK5-F) (TT-SLKK5-S).
- 2.19 **PULL BOXES**
 - .1 Galvanized sheet steel welded construction, EEMAC Type 1, (4) (12).
 - .2 Screw-on galvanized sheet steel covers for surface mounting boxes.
 - .3 Covers with 25 mm minimum extension around, for flush mounted pull boxes.
 - .4 Galvanized steel barriers as required.
- 2.20 **CONDUIT BOXES - GENERAL**
 - .1 Boxes for EMT
 - .1 Galvanized pressed steel
 - .2 Boxes for Rigid Steel Conduit
 - .1 Galvanized cast iron alloy FS boxes with mounting feet for surface mounted switches and receptacles
 - .2 Gasketed cover plate for exterior location
 - .3 For corrosive resistant coated conduit: Cast boxes with same finish as conduit
 - .3 Boxes for Rigid PVC Conduit
 - .1 PVC boxes
- 2.21 **OUTLET BOXES - SHEET STEEL**
 - .1 Pressed steel single and multi-gang flush device boxes, minimum size 100 mm x 50 mm x 38 mm. 100 mm square outlet boxes where more than one conduit enters one side, with extension rings as required.
 - .2 100 mm square or octagonal outlet boxes.
 - .3 119 mm square outlet boxes with extension and plaster rings as necessary for flush mounting devices in gypsum board, plaster or panelled walls.
- 2.22 **MASONRY BOXES**
 - .1 Pressed steel masonry single and multi-gang boxes for devices flush mounted in exposed masonry walls with extension and plaster rings as required.
- 2.23 **CONCRETE BOXES**
 - .1 Pressed steel concrete type boxes for flush mount in concrete with extension and plaster rings as required.
- 2.24 **OUTLET BOXES - FITTINGS**

- .1 Bushings and connectors with nylon insulated throats.
- .2 Knock-out fillers to prevent entry of foreign materials.
- .3 Double locknuts and insulated bushings for sheet steel metal boxes.

2.25 **WIRING DEVICES - SWITCHES**

- .1 Specification grade, general purpose AC switches, manual toggle operated, (white), (ivory) and (brown) colour, 15 A, 20 A, 120-277 V, 347 V, single pole, double pole, three-way, four-way switches as required.
- .2 Acceptable Manufacturers:
 - .1 Hubbell - HBL1201 Series: HBL1221 Series: HBL18201 Series: HBL 18221 Series
 - .2 P & S - 15AC Series: 20AC Series: 370000 Series
 - .3 Arrow Hart - 1891 Series: 1991 Series: 18201 Series: 18221 Series
- .3 Specification grade, general purpose AC switches, manual rocker operated, (white), (ivory) colour, 15 A, 20 A, 120-277 V, 347 V, single pole, double pole, three-way, four-way switches as required.
- .4 Acceptable Manufacturers
 - .1 Bryant, 120-277V, Fashion Series 9000
 - .2 Hubbell, 120-277V, Style Line 2100 Series
 - .3 Leviton, 120-277V and 347V, Decora Plus 5600 Series
 - .4 Pass & Seymour, 120-277V and 347V, Sierraplex Decorator, 2600 and 2600000 Series

2.26 **WIRING DEVICES - DIMMER SWITCHES**

- .1 Dimmer switches: solid state, full range with slider type handle on-off switch, (white), (ivory) rated to suit circuit load, 1000 watts minimum, 120 volts.
- .2 Acceptable Manufacturers:
 - .1 P & S
 - .2 Lutron

2.27 **WIRING DEVICES - OCCUPANCY SENSORS**

- .1 W1 Automatic wall switch, passive infrared, (120V) (277V) (347V), adjustable time delay thirty seconds to thirty minutes, 180 degrees coverage, minimum 300 sq.ft. hand motion at desktop, adjustable light sensor (21-2150 lux), white.
 - .1 Wattstopper WS-250 Series
- .2 W2 Automatic wall switch, passive infrared, (120V) (277V) (347V), adjustable time delay five minutes to thirty minutes, manual or auto on, 180 degrees coverage, minimum 300 sq.ft. hand motion at desktop, white.
 - .1 Wattstopper PW-100 Series

- .3 W2B Automatic wall switch, passive infrared, (120V) (277V) (347V), adjustable time delay five minutes to thirty minutes, manual or auto on, dimmer, 180 degrees coverage, minimum 300 sq.ft. hand motion at desktop, white.
- .1 Wattstopper PW-100D-I-U
- .4 W3 Automatic wall switch, dual technology, (120V) (277V) (347V), adjustable time delay five minutes to thirty minutes, manual or auto on, 180 degrees coverage, minimum 300 sq.ft. hand motion at desktop, white.
- .1 Wattstopper DW-100
- .5 W4 Outdoor PIR Occupancy sensor lighting control to mount internal to task lighting fixtures. 360 degree High Bay lens (20'-40'), 7.5' wire lead length, 24VDC; IP65.
- .1 Leviton OSF20-ILW
- .6 DT1 Ceiling mounted dual technology, 2000 sq.ft. coverage at 180 degrees, corner mounting bracket, adjustable time delay, adjustable sensitivity, built-in light level sensor (20 to 2150 lux), (120V/20A) (277V/20A) (347V/15A) power packs/slave packs as required, white.
- .1 Wattstopper DT-200
- .7 DT2 Ceiling mounted dual technology, 1000 sq.ft. coverage at 360 degrees, adjustable time delay, adjustable sensitivity, built-in light level sensor (100 to 3200 lux), (120V/20A) (277V/20A) (347V/15A) power packs/slave packs as required, white.
- .1 Wattstopper DT-300
- .8 C1 Ceiling mounted ultrasonic, 2000 sq.ft. coverage at 360 degrees, temperature and humidity resistant receivers, logic key/on bypass, adjustable time delay fifteen seconds to fifteen minutes, (120V/20A) (277V/20A) (347V/15A) power packs/slave packs as required, white.
- .1 Wattstopper W-2000A
- .9 C2 Ceiling mounted ultrasonic, 1000 sq.ft. coverage at 360 degrees, temperature and humidity resistant receivers, logic key/on bypass, adjustable time delay fifteen seconds to fifteen minutes, (120V/20A) (277V/20A) (347V/15A) power packs/slave packs as required, white.
- .1 Wattstopper W-1000A
- .10 C3 Ceiling mounted ultrasonic, 500 sq.ft. coverage at 360 degrees, temperature and humidity resistant receivers, logic key/on bypass, adjustable time delay fifteen seconds to fifteen minutes, (120V/20A) (277V/20A) (347V/15A) power packs/slave packs as required, white.
- .1 Wattstopper W-500A
- .11 C4 Ceiling mounted passive infrared, 300 sq.ft coverage, corner mounted, optional ON override through logic key/ON bypass, adjustable time delay thirty seconds to thirty minutes, (120V/20A) (277V/20A) (347V/15A) power packs/slave packs as required, white.
- .1 Wattstopper WPIR

.12 CH Ceiling mounted ultrasonic, 90 lin.ft. hallway coverage, temperature and humidity resistant receivers, logic key/on bypass, adjustable time delay fifteen seconds to fifteen minutes, (120V/20A) (277V/20A) (347V/15A) power packs/slave packs as required, white.

.1 Wattstopper W-2000H

2.28 **WIRING DEVICES – TIME SWITCHES**

.1 T1 (120V) (277V) digital time switch, zero crossing, pushbutton programming, adjustable time-out setting five minutes to twelve hours, flash and beep warnings, time scroll for temporary override of pre-set time-out, reset feature to return to pre-set timeout setting, electroluminescent, white.

.1 Wattstopper TS-400

.2 T2 24 V low voltage digital time switch, local power packs as required to suit load, zero crossing, pushbutton programming, adjustable time-out setting five minutes to twelve hours, flash and beep warnings, time scroll for temporary override of pre-set time-out, reset feature to return to pre-set timeout setting, electroluminescent, white

.1 Wattstopper TS-400-24.

2.29 **WIRING DEVICES - RECEPTACLES FOR GENERAL SERVICE**

.1 Receptacles: Specification grade suitable for back and side wiring, complete with grounding terminal. Colour as required for type of area for straight blade devices and black colour for twistlock devices.

.2 Receptacles of one manufacturer.

.3 Acceptable Manufacturers:

.1	15A, 125V, (5-15R) Single Straight Blade	-	Arrow Hart 5261 Leviton 5261 Hubbell 5261 Pass & Seymour 5261
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.2	15A, 125V, (5-15R) Duplex Straight Blade	-	Arrow Hart 5262 Leviton 5262 Hubbell 5262 Pass & Seymour 5262
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.3	20A, 125V, (5-20R) Single Straight Blade	-	Arrow Hart 5361 Leviton 5361 Hubbell 6331 Pass & Seymour 5361
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.4	20A, 125V, (5-20R) Duplex Straight Blade	-	Arrow Hart 5392 Leviton 5362 Hubbell 5392 Pass & Seymour 5362
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.5	15A, 125V, (5-15R) Duplex GFCI, Straight Blade	-	Arrow Hart GF5242AH Leviton 6599-W Hubbell GF-5252 Pass & Seymour 1591
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.6	15A, 125V, (5-15R) Duplex Isolated Ground, Straight Blade	- - - -	Arrow Hart IG5262AH Leviton 5262-IG Hubbell IG-5262 Pass & Seymour IG6200
.7	20A, 125V, (L5-20R) Single locking, 2 pole, 3 wire, grounding	- - - -	Arrow Hart 6200 Leviton 2310 Hubbell 2310ACN Pass & Seymour L520-RCN
.8	20A, 250V, (L6-20R) Single locking, 2 pole, 3 wire, grounding	- - - -	Arrow Hart 6210 Leviton 2320 Hubbell 2320ACN Pass & Seymour L620-RCN
.9	30A, 250V, (L6-30R) Single locking, 2 pole, 3 wire, grounding	- - - -	Arrow Hart 6340 Leviton 70630-FR Hubbell 2620CAN Pass & Seymour L630RCN
.10	30A, 250V, (L15-30R) Single locking, 3 pole, 4 wire, 3 phase, grounding	- - - -	Arrow Hart 6520 Leviton 2720 Hubbell 2720ACN Pass & Seymour L1530-RCN
.11	20A, 277V, (L7-20R) Single locking, 2 pole, 3 wire, grounding	- - - -	Arrow Hart 6220 Leviton 2331 Hubbell 2330ACN Pass & Seymour L720R
.12	20A, 347V (L24-20R) Single locking, 2 pole, 3 wire, grounding	- -	Leviton 3721 Pass & Seymour L3720-RCN
.13	15A, 125V (5-15R) Quad straight blade, 2 pole, 3 wire grounding	- - -	Bryant 1254 Hubbell 415 series Pass & Seymour 1254
.14	15A, 347V, (24-15R) Quad straight blade, 2 pole, 3 wire grounding	- - -	Bryant 3474W Hubbell 415347WC Pass & Seymour 3474W
.15	15A, 125V, (5-15R) Duplex straight blade	- - - -	Arrow Hart 26262 Leviton Decora Plus Hubbell 2152 series Pass & Seymour 885
.16	15A, 125V (5-15R) Duplex straight blade, 2 pole, 3 wire grounding, surge suppression, indicator light, blue (ivory) colour	- -	Arrow Hart 5250 Hubbell 5260
.17	15A, 125V (5-15R) Duplex straight blade, 2 pole, 3 wire grounding, isolated ground, surge suppression, indicator light, blue (ivory) colour	- -	Arrow Hart IG5250 Hubbell IG5262

- .1 Stainless steel Type 302 alloy, vertically brushed, 0.8 mm thick cover plates.
- .2 Nylon, smooth, high impact strength.
- .3 Pressed steel, galvanized.
- .4 Cast covers for cast boxes with gaskets.
- .5 Cover plates of same manufacture as devices.

.1

2.31 **PLYWOOD BACKBOARDS**

- .1 Plywood backboards, good one side, 1220 mm x 2440 mm x 19 mm unless indicated otherwise. Treat with primer and two coats of fire retardant paint.
- .2 Mount plywood on vertical strapping, on 40 mm centres to provide 10 mm clearance between wall and rear of plywood. Treat strapping similar to plywood.

2.32 **FINISH**

- .1 Equipment enclosure finish: Baked grey enamel, ANSI 49 or ANSI 61.

3 Execution

3.1 **WIRE AND CABLE**

- .1 Install wiring in raceways unless noted otherwise.
- .2 Minimum wire sizes:
 - .1 Power and lighting - No. 12 AWG
 - .2 Control - No. 14 AWG
 - .3 Fire alarm - No. 18 AWG

- .3 Wire and cable application and type:

Application	Type
.1 Lighting branch circuit where connection to luminaire is AC90 cable	T90 nylon
.2 Receptacle branch circuit	T90 nylon
.3 Ceiling boxes to luminaires in suspended ceiling	T90 nylon or AC90 cable
.4 Wiring under raised floor used as plenum	AC90 cable or wire in flexible metal conduit
.5 Wiring inside high temperature equipment	TEW or SEW-2
.6 Branch circuits other than those covered above	RW90
.7 Equipment feeders, circuits	RW90
.8 Underground and under slab raceways, duct banks, direct burial	RWU90

- .4 Type AC90 cable length limitations:

- .1 Ceiling box to luminaire: 1.2 m maximum in non-accessible ceilings;
1.8 m in accessible ceilings
- .2 Junction box to outlet: 3.6 m maximum
- .5 Load current limitations:
 - .1 Conductors rated for more than 90°C: 90°C (194°F) code ampacity rating
 - .2 Motor connection: 75°C (167°F) code ampacity rating
- .6 EMF-Free Power Cables
 - .1 Install the EMF-free power cable system in complete accordance with the manufacturer's written instructions.
 - .2 Provide a manufacturer's representative on site during installation of the system.
 - .3 At completion of the work, provide a letter from the manufacturer indicating that the system was installed to the manufacturer's satisfaction and that it is ready for use.
 - .4 Provide manufacturer's commissioning report to include the manufacturer's standard readings and specifically the following readings taken at three locations, determined by the Consultant; 1 m from the feeder and distance from the feeder where the EMF is 0.5 micro Teslas.
 - .1 Background AC and steady state (DC) EMF readings (feeder de-energized)
 - .2 EMF readings at full load, balanced $\pm 5\%$
 - .3 EMF readings near full load with 20% $\pm 5\%$ unbalance
 - .5 Acceptance Criterion
 - .1 The installation will be deemed not acceptable if the ac EMF is in excess of 0.5 micro Teslas above the background EMF at any point along the feeder not within 2 m of either end for all load conditions
- 3.2 **MODULAR WIRING**
 - .1 Install and connect modular wiring.
- 3.3 **CONNECTORS**
 - .1 Install compression terminations and splices in accordance with manufacturer's written instructions.
 - .2 Make splices in junction boxes.
 - .3 Make connections in lighting circuits with twist type splicing connectors.
 - .4 Terminate and splice conductors No. 8 and larger at terminal blocks in junction boxes.
 - .5 Seal terminations and splices exposed to moisture, corrosive conditions or mechanical abrasions with heavy wall heat shrinkable insulation.
 - .6 Install fixture type connectors and tighten. Replace insulating cap.
- 3.4 **MOTOR LEAD CONNECTION KITS, 600 VOLT**

- .1 Install motor lead connection kits for low voltage motors.

3.5 **MOTOR LEAD CONNECTION KITS, 5000 VOLT**

- .1 Install motor lead connection kits for 4000 V motors.

3.6 **CONDUIT AND EMT - GENERAL**

- .1 Run parallel or perpendicular to building lines.
- .2 Group raceways wherever possible. Support on channels.
- .3 Install expansion joints as required.
- .4 Run raceways in web portion of structural steel columns and beams.
- .5 Do not drill structural members to pass through.
- .6 Locate raceways behind infrared or unit heaters with 1.5 m clearance.
- .7 Locate raceways not less than 125 mm clear where parallel to steam or hot water lines with a minimum of 75 mm at crossovers.
- .8 Do not install horizontal runs in masonry walls.
- .9 Use metallic raceway where temperatures exceed 75°C (167°F) or where enclosed in thermal insulation.
- .10 EMT and non-metallic conduits to contain insulated green ground wire.
- .11 Install 6 mm diameter nylon pull cord in empty raceways.

3.7 **CONDUIT AND FITTINGS**

- .1 Minimum conduit sizes:
 - .1 Surface installation 21 trade size conduit
 - .2 Embedded in concrete 27 trade size conduit
 - .3 Directly buried 53 trade size conduit

- .2 Conduit application and type:

Application	Type
.1 Corrosive areas	rigid steel corrosion resistant coated
.2 Hazardous areas	rigid steel
.3 Outdoor areas	rigid steel
.4 Embedded in concrete, other than grade slab	rigid steel (PVC)
.5 In or below grade slab	PVC
.6 Exposed in unfinished areas up to 3 m above finished floor. Use EMT above 3 m	rigid steel

-
- .7 Connection to motors and equipment subject to vibration liquid tight flexible steel conduit
 - .8 Final connection to dry type transformer flexible steel conduit
 - .9 Whip connection to modular furniture non-metallic extra flexible PVC
 - .3 Use field threads on rigid conduit of sufficient length to draw conduits up tight.
 - .4 Do not bend coated steel conduit. Use elbows for deflections.
 - .5 Do not install conduit in or under slab.
 - .6 Use factory "ells" where ninety degree bends are required for 27 trade size and larger conduits.
 - .7 Bend conduit offsets cold. Do not install crushed or deformed conduits and avoid trapped runs in damp or wet locations. Prevent the entrance of water and lodging of concrete, plaster, dirt, or trash in conduit, boxes, fittings, and equipment during course of construction.
 - .8 Where conduit joints occur in damp or wet locations, make joints watertight by applying an approved compound on the entire thread area before assembling. Draw up all conduit joints as tightly as possible.
 - .9 Cap exposed empty conduits which do not terminate in outlets, panels, cabinets, etc., with standard galvanized plumber's pipe caps.
 - .10 Plug empty conduits which terminate flush with floors or walls with flush coupling and brass plug.
 - .11 Install conduit sleeves for all exposed conduits and cables passing through walls, ceilings, or floors, and fill void between sleeve and conduit with caulking. If fire-rated caulking is required by code, use same class as walls, ceilings or floors.
 - .12 Terminate conduit stubbed up through concrete floor for connection to free standing equipment with a coupling flush with finish floor, and extend rigid conduit to equipment, except where required, use flexible conduit from a point 150 mm above floor.
 - .13 Install double locknuts and bushings on all rigid conduit terminations into threadless openings. Increase length of conduit threads at terminations sufficiently to permit bushing to be fully seated against end of conduit.
 - .14 Mechanically bend steel conduit.
 - .15 Install sealing condulets in conduits at hazardous area boundaries.
 - .16 Conduits in Poured Concrete
 - .1 Locate to suit reinforcing steel. Secure firmly to prevent movement during pour.
 - .2 Clear each conduit with mandrel and brush before concrete sets.
 - .3 Protect conduits from damage where they stub out of concrete.
 - .4 Install sleeves where conduits pass through slab or wall.
 - .5 Provide oversized sleeve before membrane is installed where conduits pass through waterproof membrane. Use cold mastic between sleeve and conduit.

- .6 Encase conduits completely in concrete; provide 50 mm minimum concrete cover.
- .7 Replace with exposed conduit, any conduit run found to be obstructed after concrete sets.

3.8 **EMT AND FITTINGS**

- .1 Minimum EMT size: 21 trade size conduit.
- .2 EMT Application
 - .1 Exposed in unfinished areas, above truss level and for drops in column web to 3 m above finished floor. Use rigid steel conduit below 3 m.
 - .2 In block walls and stud partitions.

3.9 **CABLE TRAY**

- .1 Install cable tray systems.
- .2 Provide barriers where required by code.
- .3 Support cable trays from structural members. Support cable tray on both sides or on cantilever brackets to provide continuous open access to one side of the tray as required. Coordinate support locations and weight per support with building structure. Provide any additional support fastenings required.
- .4 Provide the following minimum clearances:
 - .1 300 mm vertical between top of tray and equipment or structure above.
 - .2 300 mm vertical between trays.
 - .3 600 mm horizontal on access side of tray.
- .5 Ensure that sharp burrs or projections are removed to prevent damage to cables and injury to personnel.
- .6 Install cables individually.
- .7 Lay cables into cable tray. Use rollers where necessary, to pull cables.
- .8 For maintained spacing, secure cables in cable tray at 3 m centers for horizontal runs with black coloured tie wraps and at 1.5 m centres for vertical runs with aluminum clamps supplied by tray manufacturer.
- .9 Maintain power cables greater than one diameter minimum spacing unless shown otherwise.
- .10 Firestop Fire Barriers (Refer to Section 26 05 01).
 - .1 Frame openings in walls, and floors for width and depth required for cable tray to run through with 50 mm clear all around.

3.10 **WIREWAYS**

- .1 Install per manufacturer's recommendations.
- .2 Keep number of elbows, offsets and connections to a minimum.
- .3 Install barriers where required by code.

- .4 Install gutters to full length of equipment.

3.11 **SURFACE RACEWAYS**

- .1 Install per manufacturer's recommendations.

3.12 **CELLULAR FLOOR SYSTEM**

- .1 Install trench duct, preset inserts and activation kits including activation power and data receptacles and telephone jack outlets.
- .2 Tack weld trench duct to non-cellular decking, and tack weld trench duct void closures.
- .3 Seal voids at preset inserts, cellular raceway butt joints and void closures with sealing compound.

3.13 **FASTENINGS AND SUPPORTS**

- .1 Provide supports and fastenings for the Work of this division. Do not use supports or equipment provided by other trades.
- .2 Equipment fastenings and supports shall conform to manufacturers recommendations.
- .3 Do not attach to, or suspend any electrical Product or service from the roof deck, mechanical ductwork or piping.
- .4 Do not use wire lashing or perforated strap to support or secure raceways or cable.
- .5 Support rods for any suspended item must not be attached to or extended through steel pan type roofs or through concrete slab roofs.
- .6 For surface mounting of two or more raceways or cables use channels.
- .7 Where there is no wall support for raceways and cables dropped vertically to equipment, provide channel properly secured to floor and structure.
- .8 Hang supports from structural members. Where location does not permit direct support from structure provide necessary brackets, frames, channels secured to structural members.
- .9 Fasten exposed conduit and cables to building construction or support systems using straps. Use beam clamps on exposed steelwork.
- .10 Masonry, tile and plaster surfaces: Use lead anchors.
- .11 Poured concrete: Use expandable inserts. Low velocity powder activated fastenings may be used only in poured concrete.
- .12 Steel structures: Use clips, spring loaded bolts, cable clamps, designed as accessories to basic channel members.
- .13 Do not use powder activated fasteners in, tile, precast concrete or steel structure.
- .14 Do not install conduits or cables on the bottom chord of joists or trusses.
- .15 Use beam clamps of the two-bolt design and of such type that the rod load is transmitted only concentrically to the beam web centreline. The use of "C" and "I" beam side clamps will not be allowed.
- .16 Where the roof or floor framing consists of open web or long span steel joists and/or trusses, ensure that hangers are located at or within 150 mm of the joist or truss top or

bottom chord panel points, otherwise provide additional structural steel as required where hanger spacing does not coincide with joist or truss spacing. Design suspension assembly such that the hanger load is transmitted only concentrically to the supporting joist or truss. The use of "C" and "I" beam clamps, brackets, etc., will not be allowed.

- .17 Locate secondary structural steel members between joists or trusses at or within 150 mm of top or bottom chord panel points. Where the secondary structural steel member cannot be located at or near a joist or truss panel point, provide additional diagonal structural steel web member/members designed for the applicable load to the nearest panel point in the opposite chord member. Diagonal hangers which will induce lateral stresses in the chord members of the joist will not be permitted. Submit Shop Drawings of the suspension assembly indicating the location of suspension or support points, the maximum load at each suspension point, location and size of hangers, brackets and intermediate framing members when required, and also details of connection to building structure.

3.14 **SPLITTER BOXES**

- .1 Install splitters as indicated and mount plumb, true and square to the building lines.
- .2 Extend splitters full length of equipment arrangement.

3.15 **JUNCTION BOXES**

- .1 Install junction boxes in inconspicuous but accessible locations. Secure to structure.
- .2 Install terminal blocks on mounting rails, for termination of each wire and cable regardless of size.
- .3 Only one voltage source is permitted in a junction box.
- .4 Install barriers to separate different auxiliary systems.

3.16 **TERMINAL BLOCKS - SURGE SUPPRESSION**

- .1 Install surge suppression terminal blocks.

3.17 **PULL BOXES**

- .1 Install pull boxes in inconspicuous but accessible locations. Secure to structure.
- .2 Install pull boxes so as not to exceed 30 m of conduit run between pull boxes.
- .3 Only one voltage source is permitted in a pull box.
- .4 Install barriers to separate different auxiliary systems.

3.18 **OUTLET AND CONDUIT BOXES**

- .1 Install conduit outlet boxes for conduit up to 32 mm and pull boxes for larger conduits.
- .2 Support boxes independently of connecting conduits.
- .3 Seal boxes during construction to prevent entry of debris, dust and dirt.
- .4 For flush installations mount plaster rings to box, flush with wall surface to permit wall finish to come within 6 mm of opening.
- .5 Provide correct size of openings in boxes for conduit, armoured cable connections. Reducing washers will not be acceptable.

- .6 Install switches and other controls close to door lock or latch jambs and other openings, maintaining a minimum of 100 mm from trims of doors (except where installed in door frames of metal partitions) check door swings.

- .7 Install 100 mm square or octagonal outlet boxes for lighting fixture outlets.

3.19 **MASONRY BOXES**

- .1 In block walls use deep boxes to provide clear space around knockout for AC90 cable entry.

3.20 **WIRING DEVICES - SWITCHES**

- .1 Install single throw switches with handle in up position when switch is closed.
- .2 Install switches in gang type outlet box when more than one switch is required in a location.
- .3 Mount toggle switches at height indicated.
- .4 Install switch colours as follows:

	Area	Colour
.1	Gypsum board, plaster or panelled	(white) (ivory) (brown)
.2	Office	(white) (ivory) (brown)
.3	Factory, service	brown (ivory)

3.21 **WIRING DEVICES - DIMMER SWITCHES**

- .1 Install each dimmer switch in outlet box at locations indicated.
- .2 Mount dimmer switches at height indicated.

3.22 **WIRING DEVICES - RECEPTACLES**

- .1 Install receptacles vertically, use gang type outlet box where more than one receptacle is required in a location.
- .2 Where split receptacle has a portion switched, mount vertically and switch upper portion.
- .3 Coordinate with architectural and interior design drawings for final positioning and mounting heights of power and voice/data receptacles. Where there is disagreement between electrical and architectural drawings, take the architectural drawings as correct.
- .4 Maintain clearances between receptacle outlet boxes and millwork as stipulated on the drawings.
- .5 Align and evenly space outlet boxes that are mounted as a group.
- .6 Install receptacle colours as follows:

	Area	Colour
.1	Gypsum board, plaster or panelled	(white) (ivory) (brown)
.2	Office	(white) (ivory) (brown)
.3	Factory, service, exterior	brown

3.23 **WIRING DEVICES - COVER PLATES**

- .1 Protect stainless steel cover plate finish with paper or plastic film until painting and other work is finished.
- .2 Install suitable common cover plates where wiring devices are grouped.
- .3 Do not use cover plates designed for flush outlet boxes on surface-mounted boxes.
- .4 Provide plaster ring where necessary.
- .5 Install cover plates as follows:

Area	Cover Plate Type
.1 Gypsum board, plaster or panelled	stainless steel (nylon) (white) (ivory)
.2 Factory, service	galvanized steel
.3 Exterior	cast cover

3.24 **CONTROL DEVICES**

- .1 Install as indicated.

3.25 **PLYWOOD BACKBOARDS**

- .1 Install plywood backboards.

3.26 **FIELD FABRICATED METAL WORK**

- .1 Clean and prime paint field fabricated metal work.
- .2 After fabrication deburr, scrape, grind smooth, wire brush with power brush and degrease metal work.
- .3 Prime paint steel with one coat of CISC/CPMA 2.75 oil alkyd primer.
- .4 Prime paint aluminum as follows: Wash with detergent solution and wipe down with SSPC-SP1 solvent. Apply Glidden #Y-5229 primer to 1.5 mils DFT.
- .5 For brass and bronze alloy materials, prepare as for aluminum but apply one coat of CAN/CGSB-1.40-M zinc chromate primer.

End of Section

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- 1 General
- 1.1 **SUMMARY**
 - .1 Section Includes
 - .1 Labour, Products, equipment and services necessary to complete the Work of this section.
- 1.2 **GENERAL**
 - .1 Modifications, demolition and installation of services within this building require utmost care due to vital operation of systems involved. Removal and installation of systems require constant communication with Consultant.
- 1.3 **CO-ORDINATION BETWEEN NEW AND EXISTING INSTALLATIONS**
 - .1 Provide interfacing components between new and existing systems as necessary for proper performance and operation.
- 1.4 **EXISTING SERVICES**
 - .1 Ensure existing services remain undisturbed and energized except where indicated to be disconnected.
 - .2 Disconnect and remove abandoned wiring materials and devices.
 - .3 Cut raceways flush where embedded in structure.
 - .4 Retain abandoned embedded outlet boxes and close with pressed steel cover plates.
 - .5 Make safe all circuit wiring left for future use.
- 1.5 **INTERRUPTION OF SERVICES**
 - .1 Obtain Consultant's written approval before interrupting any service. Long outages are not acceptable.
 - .2 Provide temporary services to maintain continuity in the event that services must be interrupted.
- 1.6 **PREMIUM TIME**
 - .1 Include cost of premium time in Tender Price for work during nights, weekends or other time outside normal working hours necessary to do the Work and maintain electrical services in operation.
- 2 Products
- 2.1 **USE OF EXISTING MATERIAL AND EQUIPMENT**
 - .1 Unless noted otherwise, existing panels, boxes and wiring materials may be reused if acceptable to inspection authority.
 - .2 Unless noted otherwise, provide additional equipment of same type and manufacture to supplement existing equipment.
 - .3 Reused luminaires: Furnish new lamps.
- 3 Execution

3.1 **EXISTING MATERIAL AND EQUIPMENT**

- .1 Equipment to be reused or relocated: Test for proper operation, and repair as necessary.
- .2 Repair or replace existing equipment which is damaged in process of relocation.
- .3 Reused luminaires: Install lamps, clean fixtures and touch up damaged finish.
- .4 Relocate existing junction, pull or terminal boxes which become inaccessible due to new mechanical ductwork or equipment.

3.2 **DEMOLITION**

- .1 Demolish existing work, where indicated, and remove from site.
- .2 Execute all demolition work so as to create minimum vibration or dust within and outside the building. Obtain Consultant's approval of methods before proceeding.

3.3 **WORK IN EXISTING TENANT FACILITIES**

- .1 Coordinate Work in tenant facilities with tenant. Ensure that no interruptions and/or interferences occur with tenant's normal operation.
- .2 Be responsible for any damage created in existing tenant facilities when installing equipment and materials.

3.4 **PENETRATIONS IN EXISTING STRUCTURE**

- .1 Perform cutting, patching and repairing. Before proceeding obtain Consultant's approval.
- .2 Where necessary to penetrate existing floors, walls, ceiling, roof or structural members provide sleeve and follow Consultant's instructions.
- .3 Restore surfaces to same finish and condition as existed prior to penetration.
- .4 Core Drilling Procedure
 - .1 Examine locations to be core drilled where:
 - .1 Diameter is greater than 25 mm
 - .2 Multiple drillings required and where the distance between centres is less than ten times the diameter of the hole
 - .2 Examine by most suitable method including:
 - .1 X-ray
 - .2 Ferro scan
 - .3 Cable detection
 - .3 Examine from both sides of the structure to be drilled.
 - .4 Examine proposed core drilling locations to determine:
 - .1 Possible interference with
 - .1 Services
 - .2 Structural components

- .2 Possible presence of asbestos tile or other asbestos based material. Report any occurrence or suspected occurrence to the Consultant immediately.
- .5 Select locations as suitable for core drilling and label them:
 - .1 Uniquely number each drilling location and core so that markings will be legible after drilling
 - .2 Mark each core with a north pointing arrow where drilling a slab or upward pointing arrow where drilling a wall
- .6 Without interfering with or damaging any services or structural elements, drill pilot holes sufficient to verify location of potential obstructions or for alignment purposes.
- .7 Use impact drill when drilling holes of 25 mm diameter or less. For holes of greater diameter use core drill.
- .8 Prepare report showing intended core drill locations including printouts, X-ray images. Submit the report for approval, to Consultant, prior to drilling.
- .9 Proceed with core drilling only after approval has been received from Consultant.
- .10 Confine drilling operation to time-of-day as stipulated by Consultant.
- .11 Position suitable warning notices of a type acceptable to Consultant and exercise caution to ensure safety and protection of personnel and property during drilling especially from effects of water, dust damage, or falling objects below the slab or behind the wall being drilled.
- .12 Stop drilling immediately, and report to Consultant, if contact is made with foreign objects such as reinforcing steel (rebar), electrical conduit, water pipes, drainage pipes.
- .13 Cover open holes with secured covers to guard against fall through of objects.
- .14 Provide necessary firestopping, temporary or otherwise, sufficient to firestop holes that would be otherwise open during hours that the location is unattended. Coordinate placement of firestopping with Consultant.
- .15 Store all cores or core fragments on site and make them available for inspection by Consultant. Dispose of the cores or core fragments after permission is received from Consultant.

3.5 **SALVAGE MATERIALS**

- .1 Remove from site materials in renovated areas that are not to remain or be reused, unless noted as remaining property of Owner.

End Of Section

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- 1 General
- 1.1 **SUMMARY**
 - .1 Section Includes
 - .1 Labour, Products, equipment and services necessary to complete the Work of this section.
- 1.2 **APPROVALS**
 - .1 Identification subject to prior approval of Consultant.
- 2 Products
- 2.1 **WIRE AND CABLE MARKERS**
 - .1 Wire and Cable Diameter Less Than 13 mm
 - .1 Acceptable manufacturer
 - .1 Wieland Z type
 - .2 Cable Diameter 13 mm and Larger
 - .1 Acceptable manufacturer
 - .1 Wieland K type
 - .3 Non-Circular Wire
 - .1 Acceptable manufacturer
 - .1 Raychem Shrinkmark sleeves
- 2.2 **CONDUIT AND ELECTRICAL METALLIC TUBING MARKERS**
 - .1 Stick-On Marker

	Raceway Size	Minimum Character Height
.1	¾" - 1¼"	15 mm
.2	1½" - 2"	19 mm
.3	Over 2"	32 mm

 - .2 Acceptable Manufacturers
 - .1 Brady, vinyl cloth, black on orange, type B-500
 - .2 Panduit, vinyl cloth, black on yellow, type PCL
 - .3 Wieland, mylar, black on yellow, type NL
- 2.3 **CABLE TRAY MARKERS**
 - .1 Stick-On Marker
 - .1 Acceptable Manufacturers

- .1 Brady, vinyl cloth, black on orange, 48 mm character height, type B-500
- .2 Safety Supply Canada, conduit and voltage markers, style A, 48 mm character height
- .3 Panduit, vinyl indoor/outdoor, black on yellow, 50 mm character height, type PVL
- .4 Wieland, black on yellow, 50 mm character height, Electrocode NL

2.4 **BUSWAY MARKERS**

- .1 Stick-On Marker
 - .1 Acceptable Manufacturers
 - .1 Brady, vinyl cloth, black on orange, 48 mm character height, type B-500
 - .2 Safety Supply Canada, conduit and voltage markers, style A, 48 mm character height
 - .3 Panduit, vinyl indoor/outdoor, black on yellow, 50 mm character height, type PVL
 - .4 Wieland, black on yellow, 50 mm character height, Electrocode NL
 - .2 Laminated plastic, black letters on white background, 75 mm character height.
 - .3 Suspended sign, rigid vinyl, black on yellow, 75 mm character height.
 - .1 Acceptable Manufacturers
 - .1 Panduit
 - .2 Safety Supply Canada
 - .4 Typical identification: "12-1-1, 600A, 3P, 4W".

2.5 **PANELBOARD IDENTIFICATION**

- .1 Engraved laminated plastic, black lettering on white background, 6 mm character height.
- .2 Typical two-line identification for lighting panel:
 - "Lighting Panel C, 120/208V, 3 ph, 4W"
 - "Supplied from panel BB"
- .3 Directories: Typewritten identification of breaker number, ampere rating and connected equipment.

2.6 **SWITCHBOARD IDENTIFICATION**

- .1 Engraved laminated plastic, black lettering on white background, 15 mm minimum character height.
- .2 Typical identification: "Switchboard AAA, 347/600V, 3 ph, 4 w"; for branch feeders "Power Panel B.

2.7 **MOTOR STARTER, CONTACTOR AND DISCONNECT SWITCH IDENTIFICATION**

- .1 Engraved laminated plastic, black lettering on white background, 6 mm character height.

.2 Typical identification: "Pump S4, 208V, 3 ph".

2.8 **MAGLOCK/FIRE ALARM PULL STATIONS IDENTIFICATION**

.1 Engraved laminated plastic, red lettering on white background, 25 mm character height.

.2 Identification: "EMERGENCY EXIT UNLOCKED BY FIRE ALARM OR BY SECURITY SYSTEM".

2.9 **WARNING SIGNS**

.1 Outdoor: Metal, porcelain enamel finish. Indoor: Rigid vinyl.

.2 Typical identification: "Danger - High Voltage".

.3 Acceptable Manufacturers

.1 Outdoor: Safety Supply Canada

.2 Indoor: Safety Supply Canada, Panduit

2.10 **MARKER TAPE, SERVICE AND PHASE IDENTIFICATION**

.1 Acceptable Manufacturer

.1 3M, Scotch Code Tape, type STD with SDR colour refills or 3M Scotch 35 colour tape.

3 Execution

3.1 **SYSTEMS IDENTIFICATION**

.1 Identify outlet boxes for various systems with distinctive paint colour. Apply a small area of paint to inside of outlet, junction and pull boxes and panels. In suspended ceiling areas, apply paint to inside and outside of junction boxes. System colours:

System	Normal	Emergency	UPS
120/208 volt	black	black/red	black/blue
347/600 volt	orange	orange/red	orange/blue
Fire alarm	red		
Intercom	brown		
Low voltage control	black		
PA and sound	light green		

3.2 **POWER COMPANY SERVICE IDENTIFICATION**

.1 Identify service conductors with coloured marker tape as follows:

.1 Phase A - red

.2 Phase B - black

.3 Phase C - blue

.4 Neutral - white

.5 Ground - green

3.3 **WIRE AND CABLE IDENTIFICATION**

- .1 Identify power, control, lighting and receptacle wires with continuous colouring as follows:
 - .1 Phase A - red
 - .2 Phase B - black
 - .3 Phase C - blue
 - .4 Neutral - white
 - .5 Ground - green
 - .6 Isolating ground - green and yellow
 - .7 Control - red
 - .8 Interlock - yellow
 - .9 D.C. - blue
- .2 For larger wire sizes available only in black, install coloured wire marker tape in accordance with above coding.

3.4 **WIRE AND CABLE IDENTIFICATION**

- .1 Cables Bearing Identification Numbers on the Drawings
 - .1 Install identification markers at each end of cable run.
- .2 Control/Indication Conductors
 - .1 Install conductor identification markers at switchgear, motor control centres and motor starter terminal blocks and at remote devices.
 - .2 Identification in accordance with the Drawings and reviewed Shop Drawings.
- .3 Lighting and Receptacle Branch Circuits
 - .1 Install conductor identification markers at panel, outlet box connections to lighting fixtures and device outlet boxes.
 - .2 Typical identification if fixture or device is connected to panel A, circuit 5: A-5.
- .4 Low Voltage Lighting Control
 - .1 Install conductor identification marker at relay phase conductors. Typical identification if connected to panel A, circuit 5: A-5.
 - .2 Install conductor identification marker on conductors between control locations and relay panels. Identify in accordance with reviewed Shop Drawings.
- .5 Data, Voice and Fibre Optic Cables
 - .1 Label horizontally distributed cabling at the following locations:
 - .1 Both ends of cable run
 - .2 Entrance and exit of cable pathway (i.e. cable trays, zone conduits, etc.)
 - .2 Label riser/backbone distribution cables at the following locations:

- .1 Both ends of cable run
- .2 Entrance and exit of cable pathway (i.e. cable trays, zone conduits, etc.)
- .3 1.5 m above finished floor in communication closets and equipment rooms
- .4 At entrance and exit of a sleeve or slot in communication closets and equipment rooms

.3 Use the following colour codes for labels:

Function	Colour
Auxiliary and miscellaneous circuits	Yellow
Common equipment	Purple
Customer side of network interface	Green
First level backbone	White
Horizontal cabling to workstations	Blue
Interbuilding backbone	Brown
Key telephone systems	Red
Network side of network interface	Orange
Second level backbone	Gray

Note: Common equipment refers to PBX equipment, host computer, LANs and multiplexer. Miscellaneous refers to maintenance alarms, security, paging systems, and other system and circuits not an integral part of common equipment. Colour codes to ANSI/TIA/EIA-606.

.6 Fire Alarm and Miscellaneous Systems

- .1 Install identification on conductors at panels, remote devices and system connections. Identify in accordance with reviewed Shop Drawings.
- .2 Install maglock/fire alarm pull station identification adjacent to each door equipped with a maglock.

3.5 **CONDUIT AND ELECTRICAL METALLIC TUBING (EMT) IDENTIFICATION**

- .1 Where Drawings indicate conduit and EMT identification numbers/letters, install identification markers at each end of run and at pull box locations.

3.6 **CABLE TRAY IDENTIFICATION**

- .1 Install markers indicating system, voltage, or voltages for trays with barriers, and identification number at intervals of 20 m maximum, at branches and termination locations.

3.7 **BUSWAY IDENTIFICATION**

- .1 Install stick-on markers indicating busway identification number and rating at cable tap boxes and thereafter at intervals of 30 m maximum.
- .2 Install suspended identification signs at start of run and at intervals of 30 m maximum.

3.8 **PANELBOARD IDENTIFICATION**

- .1 Install identification plates, using adhesive, on outside of panel.
- .2 Install directory.

- .3 Identify main bus as follows:
 - .1 Phase A - red
 - .2 Phase B - black
 - .3 Phase C - blue
 - .4 Neutral - white
 - .5 Ground - green

3.9 **SWITCHBOARD IDENTIFICATION**

- .1 Install identification plates for panel and branch feeders.

3.10 **MOTOR STARTER, CONTACTOR AND DISCONNECT SWITCH IDENTIFICATION**

- .1 Install identification plates using self-tapping screws.

3.11 **IDENTIFICATION AFTER FINISH PAINTING**

- .1 Behind access doors at shaft plenums: identify busways, feeder cables and feeder conduits.

3.12 **EQUIPMENT WARNING SIGNS**

- .1 Install "Danger - High Voltage" signs.
- .2 When equipment is supplied from more than one source install red warning signs to this effect.

3.13 **PATCH PANEL AND FACEPLATE IDENTIFICATION**

- .1 Identify each jack at each wall or furniture outlet with a label supplied by the faceplate manufacturer. Each jack identification designation to match the respective cable identification designation.
- .2 Identify each jack at each patch panel jack with labels, front and back, supplied by the patch panel manufacturer. Each jack identification designation to match the respective cable identification designation.
- .3 In addition to an alphanumeric label use manufacturer's matching colour coded icons, which conform to ANSI/TIA/EIA-606, to identify individual jacks on faceplate and patch panels.

End of Section

- 1 General
- 1.1 **SUMMARY**
 - .1 Section Includes
 - .1 Labour, Products, equipment and services necessary to complete the Work of this section.
- 1.2 **REFERENCES**
 - .1 Canadian Standards Association: CSA
 - .2 C22.3 No. 1
 - .3 C22.2 No. 0.3-M
 - .4 C22.3 No. 2
 - .5 C22.2 No. 04-M
 - .6 C22.2. No. 41
 - .7 American Society for Testing and Materials: ASTM
 - .8 National Electric Testing Association Inc.: NETA
- 1.3 **SUBMITTALS**
 - .1 Submit certified test reports in accordance with Section 26 05 01.
- 2 Products
- 2.1 **MATERIALS**
 - .1 Furnish all materials, instrumentation, etc. required to execute testing and commissioning as specified, including manufacturers testing and commissioning.
 - .2 Calibrate test instruments and for each instrument record identifying numbers, date of calibration and percentage of error (if any) on appropriate test reports.
 - .3 Furnish megger test instruments as follows:

Megger Voltage	System Voltage
500 V	up to 250 V (low voltage)
1000 V	277 V to 1000 V (low voltage)
- 3 Execution
- 3.1 **CO-ORDINATION OF ELECTRICAL PROTECTIVE DEVICES**
 - .1 Following receipt of Shop Drawings, obtain from manufacturers time-current curves of all protective devices.
 - .2 Coordinate setting of relays, rating of fuses and trip elements of circuit breakers, so that the protective device immediately ahead of any fault operates before any upstream protection and establish selective coordination throughout the system.

- .3 Prepare a complete set of curves showing time current characteristics for all breakers and fuses from main switchboard main circuit down to 208/120 V panels.

3.2 **PRE-TEST INSPECTION AND CLEANING**

- .1 Check that all dust, debris, surplus materials and tools, have been removed from equipment.
- .2 Inspect all parts of the power distribution systems at each voltage level for completeness, check and set circuit protective devices, fuses, breaker relays, trips, and all ancillary devices in accordance with the reviewed coordination studies, approved drawings and manufacturer's instructions.
- .3 Check phase sequence throughout the systems and application of colour codes to equipment and cables.
- .4 Verify all cable sizes, equipment ratings, trip settings conform to Specifications and coordination study.

3.3 **TESTING GENERAL**

- .1 Test the electrical installation including all safety devices as the Work progresses and on completion.
- .2 Without adjustment to the Contract Price:
 - .1 Repair, rework or replace any equipment, material or workmanship which fails specified tests.
 - .2 Perform such additional tests and re-tests as may be directed by the Consultant and/or Owner's Representative.
- .3 Energize each voltage level of the system immediately after testing is complete.
- .4 In case this is not feasible verify all fuse sizes and trip settings and repeat megger tests of each feeder and equipment with circuit breakers and switches open, immediately before energization.
- .5 Distribution Panels and Panelboards
 - .1 Check bolted connections bus to bus, and bus to cable lug with torque wrench, to manufacturer's values. Mark with adhesive tape or label when satisfactory.
 - .2 Measure contact resistance on low voltage fusible and non fusible switches, circuit breakers, contactors and auxiliary equipment. Acceptable values:

	Microhms
Low voltage - up to 250 V	500
Low voltage - 277V to 1000V	500
 - .3 Megger test insulation resistance phase to phase and phase to ground of fusible switches, circuit breakers, contactors, buswork, auxiliary equipment. Acceptable values:

	Megohms
Low voltage, up to 250V	1
Low voltage, 277V to 1000 V	50

Duration of each test: one (1) minute

- .4 Check ground bus and ground path for continuity, and connection to all non-current carrying metalwork. Maximum acceptable reading 0.1 ohms.
- .5 Check for physical faults: Damaged or dirty insulators, alignment of contacts, switchblades, operating mechanism, clearances, barriers, mounting.
- .6 Operate circuit breakers, switches, contactors, three times.
- .7 Operate equipment through design functions, including remote control operation, actuation of alarm and indication devices, mechanical and electrical operation and operation from protective relays.
- .8 Check 600V circuit breakers for trip and target operation. Test long time, short time, instantaneous and ground fault trips. Trip settings shall conform to values selected in the coordination study. Verify pickup and time values. Compare actual trip time with manufacturer's specifications and present in tabular form.
- .9 Balance loads on all panelboards. Use Shop Drawing information for all equipment loads.

3.4 **LOW VOLTAGE SWITCHBOARDS UP TO 1000 VOLT SERVICE**

- .1 Visually inspect components and complete assembly, check wiring and interconnections.

3.5 **LOW VOLTAGE STARTERS, CONTACTORS UP TO 1000 VOLT SERVICE**

- .1 Visually inspect components and the complete assembly.
- .2 Check each contactor and starter for switch or breaker operation, fuse or breaker rating, contactor size and operation, auxiliary contact operation.
- .3 Check starter overloads with motor nameplate ratings.
- .4 Check controls and starters and contactors operation on load.
- .5 Check motor rotation.

3.6 **DISTRIBUTION TRANSFORMERS UP TO 1000 VOLT SERVICE**

- .1 Set taps for nominal voltage output from secondary with initial loads applied.
- .2 Check for clear airflow through enclosure.
- .3 Check that connections are not stressed.

End of Section

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- 1 General
- 1.1 **SUMMARY**
 - .1 Section Includes
 - .1 Labour, Products, equipment and services necessary to complete the Work of this section.
- 1.2 **REFERENCES**
 - .1 Conform to latest issues, amendments and supplements of following standards:
 - .1 CAN3-C155-M - Shunt Capacitors for AC Power Systems
 - .2 CSA C9-M - Dry-Type Transformers
 - .3 CSA C22.2 No. 4-M - Enclosed Switches
 - .4 CSA C22.2 No. 5.1M - Moulded Case Circuit Breakers
 - .5 CSA C22.2 No. 27 - Busways
 - .6 CSA C22.2 No. 31-M - Switchgear Assemblies
 - .7 CSA C22.2 No. 39 - Fuseholder Assemblies
 - .8 CSA C22.2 No. 47 - Air-Cooled Transformers (Dry Type)
 - .9 CSA C22.2 No. 106-M - HRC Fuses
 - .10 NEMA BU1.1 - General Instructions for Proper Handling, Installation, Operation, and Maintenance of Busway Rated 600 Volts or Less
 - .11 ANSI/UL 1449 4th edition - Surge Protective Devices
 - .12 ANSI/UL 1283 5th edition - Electromagnetic Interference Filters
 - .13 ANSI/IEEE C62.41 - Surge Voltages in LowVoltage AC Power Circuits
- 2 Products
- 2.1 **DISTRIBUTION PANELS**
 - .1 Description
 - .1 Distribution panel comprising two basic units: Main circuit breaker and distribution circuit breakers.
 - .2 Construction
 - .1 Steel, indoor, sprinkler proof enclosure, type as specified in Section 26 05 02, dead front, free standing. Suitable for mounting against a wall. Facilities for lifting into position and bolting to floor.
 - .2 Provisions for addition of future sections at both ends.
 - .3 Bus
 - .1 All bus, copper.

- .2 Neutral bus, full capacity where indicated.
- .3 Bus short circuit rating: 65 kA, 3 phase, rms, symmetrical, unless indicated on Drawings.
- .4 Ground bus, 6 mm x 25 mm extending full length of switchboard, solderless connector at each end suitable for No. 2/0 AWG copper grounding cable.
- .4 Main Circuit Breaker
 - .1 Circuit breaker, electronic trip, molded case, full function 100% rated where indicated, three-pole, quick make, quick break, trip free, provision for padlocking in off position.
- .5 Distribution Unit
 - .1 Circuit breakers, molded case, standard function 80% rated, three-pole, quick make, quick break, trip free, thermal magnetic or solid state trip elements. Provision for padlocking in "off" position.
 - .2 Spaces to be fully bussed for addition of future breakers.
- .6 Cable Entry
 - .1 Top cable entry through removable aluminum plates.
- .7 Surge protective Device (SPD)
 - .1 SPD with connection to switchboard bus via circuit breaker with features as follows:
 - .1 Hybrid filter consisting of thermally protected metal oxide varistors and a parallel filter circuit.
 - .2 High energy transient voltage suppression, surge current diversion and high frequency attenuation of wave shapes in Category C environment as defined in ANSI/IEEE C62.41.
 - .3 Surge current rating, based on 8 x 20 μ s wave shape, as follows:
 - .1 Per mode: 125 kA minimum
 - .2 Per phase: 250 kA minimum
 - .4 Filter noise attenuation: 50 dB minimum, normal mode, from 10 kHz to 100 MHz.
 - .5 Normal protection modes: line to line (and line to neutral for four-wire systems). Common protection modes: line to ground (and neutral to ground for four-wire systems).
 - .6 Fusing for each protection mode.
 - .7 Status LED indication of each phase.
 - .8 Trouble light.
 - .9 Auxiliary contact for remote annunciation of system integrity.
 - .10 Transient surge counter.

- .11 UL1449 4th edition and UL1283 5th edition listed, CSA or CUL approved.
- .12 Acceptable manufacturers for SPD
 - .1 Eaton
 - .2 Schneider
 - .3 Siemens
- .13 Electrical parameter monitoring system
- .8 Sub-metering system
- .9 Nameplate
 - .1 Nameplate, engraved laminated plastic, black lettering on white background as follows:
 - .1 Switchboard identification, 15 mm minimum character height
- .10 Finish
 - .1 ANSI 49 light grey enamel finish.
- .11 Acceptable Manufacturers
 - .1 Schneider
 - .2 Siemens
 - .3 Eaton
- 2.2 **PANELBOARDS - CIRCUIT BREAKER TYPE**
 - .1 Panelboards to be product of one manufacturer.
 - .2 Enclosures: Steel, type as specified in Section 26 05 01.
 - .3 Bus: Copper, half capacity ground bar and full or double capacity neutral bar as indicated, braced for interrupting capacity as indicated.
 - .4 Circuit breakers: Bolt-on, quick-make, quick-break, thermal and magnetic trips, trip indicating, trip free handle. Common operating handle on multipole breaker.
 - .5 Integral surge protective device, where indicated, with features as follows:
 - .1 Connection to panelboard bus via circuit breaker.
 - .2 Hybrid filter consisting of thermally protected metal oxide varistors and a parallel filter circuit.
 - .3 High energy transient voltage suppression, surge current diversion and high frequency attenuation of wave shapes in Category B environment as defined in ANSI/IEEE C62.41.
 - .4 Surge current rating, based on 8 x 20µs wave shape, as follows:
 - .1 Per mode: 80 kA minimum
 - .2 Per phase: 160 kA minimum

- .5 Filter noise attenuation: 50 dB minimum, normal mode, from 10 kHz to 100 MHz.
- .6 Normal protection modes: Line to line (and line to neutral for four-wire system).
Common protection modes: Line to ground (and neutral to ground for four-wire system)
- .7 Fusing for each protection mode.
- .8 Status LED indication of each phase.
- .9 UL1449 4th edition and UL1283 5th edition listed, CSA or CUL approved.
- .6 Door: Hinged lockable door.
- .7 Keys: Two keys per panelboard; key panelboards alike.
- .8 In addition to CSA requirements, manufacturer's nameplate to indicate panel withstand fault current.
- .9 Lock-on devices: For circuits supplying continuously operating equipment. Minimum quantity 10% of 15A, 20A and 30A rated breakers.
- .10 Spaces: Fully bussed for future breakers with removable filler plates.
- .11 Breaker arrangement: Locate breakers at specific circuit number locations shown on panelboard schedule sheet.
- .12 Acceptable Manufacturers
 - .1 Schneider
 - .2 Eaton
 - .3 Siemens

2.3 **DRY TYPE TRANSFORMERS - UP TO 600V**

- .1 Dry-type transformers: Type ANN, copper windings, insulation Class H, 150°C rise.
- .2 Enclosure: Steel, sprinkler proof enclosure type as specified in Section 26 05 01.
- .3 Taps: Full capacity four - 2½%, two above and two below normal.
- .4 Impedance: Minimum 3% and maximum 6%.
- .5 Vibration isolators: Internal noise and vibration isolating pads.
- .6 Mounting brackets: Floor and wall standard.
- .7 Acceptable Manufacturers:
 - .1 Eaton
 - .2 Hammond
 - .3 Schneider

2.4 **MANUAL MOTOR STARTERS**

- .1 Enclosure: Steel, sprinkler proof enclosure type as specified in Section 26 05 01.
- .2 Overload relay and heater element in each phase, manual reset.

- .3 Heavy duty type single phase toggle switch, and three phase pushbutton type, quick-make quick-break switching mechanism.
- .4 Pilot light: Heavy duty, transformer, push to test, red.
- .5 Provision for padlocking in OFF position.
- .6 Acceptable Manufacturers:
 - .1 Allen-Bradley
 - .2 Eaton
 - .3 Schneider
 - .4 Siemens

2.5 **MAGNETIC MOTOR STARTERS**

- .1 Enclosure: Steel, sprinkler proof enclosure type as specified in Section 26 05 01.
- .2 NEMA type combination magnetic motor starters, fusible disconnect type with overload relay and heater element in each phase.
- .3 Rating: Minimum size-1.
- .4 Door mounted accessories:
 - .1 Pushbuttons or three-position HOA selector switches, heavy duty oil tight type.
 - .2 Pilot lights: Heavy duty, transformer, press to test, red.
 - .3 Lens colour: Running - red; stopped - green; alarm/malfunction - amber.
- .5 Control transformer: 120V secondary, fused, sized to suit control circuit load plus 50VA.
- .6 Auxiliary contacts: Minimum one spare N/C, one spare N/O interchangeable, in addition to seal-in contact.
- .7 For control voltage from an external source:
 - .1 Provide terminals, covered with hard insulating guard.
 - .2 Apply a lamacoid warning plate on the outside of the starter cover describing the source of outside control power.
- .8 Acceptable Manufacturers:
 - .1 Allen-Bradley
 - .2 Eaton
 - .3 Schneider
 - .4 Siemens

2.6 **CONTACTORS**

- .1 Enclosure: Steel, sprinkler proof enclosure type as specified in Section 26 05 01.
- .2 NEMA type, heavy duty, designed for the application, e.g. lighting contactors for lighting circuits.

- .3 Auxiliary contacts, minimum two N/O and two N/C.
- .4 Control transformer, fused primary and secondary, 120 volt output.
- .5 Hand/Off/Auto (HOA) control selector switch and red pilot light, "press to test" type.
- .6 Acceptable Manufacturers:
 - .1 Allen-Bradley
 - .2 Eaton
 - .3 Schneider
 - .4 Siemens

2.7 **CONTROL STATIONS**

- .1 Pushbutton and selector switches: heavy duty, oiltight.

2.8 **FUSIBLE AND NON FUSIBLE DISCONNECT SWITCHES**

- .1 Enclosure: Steel, sprinkler proof enclosure type as specified in Section 26 05 01.
- .2 Switches: Quick-make, quick-break, heavy duty, short circuit rating 100,000A rms sym. Provision for locking in off position with up to three padlocks.
- .3 Viewing window: For viewing blades.
- .4 Electrical interlock: Mechanically operated from switch mechanism, rated 120 VAC, 15A, one N/O and one N/C contact at non-fusible switches local to motors
- .5 Except as noted otherwise, furnish and install non-fusible safety switches on all electrically powered equipment to isolate equipment from power supply.
- .6 Acceptable Manufacturers:
 - .1 Schneider
 - .2 Eaton
 - .3 Siemens

2.9 **FUSES**

- .1 HRC fuses to CSA C22.2 No. 106-M.
- .2 Time delay fuses as follows:
 - .1 Fuses up to 600V, up to 600A HRCI-J, Form I: Class J Bussman JHC, Gould Shawmut AJT.
 - .2 Fuses above 600A HRC-L, Form I: Class L Bussman KLU, Gould Shawmut A4BT.
- .3 Provide spare fuses of each type and size in use as follows:
 - .1 600A and below: Six.
 - .2 Above 600A: Three.
- .4 Submit a list of spare fuses to Consultant for approval.

2.10 **METERING CABINET**

- .1 Steel enclosure NEMA 1, sprinkler proof, sized 900 mm x 900 mm x 300 mm deep. Code gauge steel complete with hinged door, lock and latch and removable back plate to meet utility requirements.
- .2 Acceptable Manufacturers:
 - .1 Hammond

2.11 **RELAYS**

- .1 Totally enclosed plug-in type relay with four form-C contacts, operating coil to suit required voltage. Complete with mounting socket.
- .2 Acceptable Manufacturers
 - .1 Allen-Bradley
 - .2 Schneider
 - .3 Eaton

2.12 **AC INVERTER SYSTEM**

- .1 Description: Inverter, batteries, battery charger, contactors and controls for supply of emergency AC power to a normally energized load of circuit breaker controls.
- .2 References
 - .1 Comply with:
 - .1 CSA C22.2 No. 107.1-M – Commercial and Industrial Power Supplies
 - .2 ANSI/UL924 – Emergency Lighting and Power Equipment
- .3 Enclosure
 - .1 Steel enclosure type to comply with Section 26 05 01, floor mounting, front lockable doors. Common enclosure for inverter, battery, charger and controls.
 - .2 Finish ASA 61 grey.
- .4 Rating
 - .1 Input: 120 V, single phase, 60 Hz
 - .2 Normal output: 120 V, single phase, 60 Hz
 - .3 Load: facility for normally on loads, size to suit circuit breaker control transformer in main switchboard.
 - .4 Operating time: Thirty minutes with full nameplate capacity rating at end of thirty minutes continuous operation up to end of ten year battery design life expectancy.
 - .5 Features
 - .1 Input failure sensing
 - .2 Auto test

- .3 Contactors to transfer from normal to inverter power
 - .4 Automatic battery disconnection at low battery voltage
 - .5 AC output circuit breaker
 - .6 Output voltmeter
 - .7 Inverter on/off control switch
 - .8 Inverter trip LED
 - .9 Manual bypass pushbutton
 - .6 Inverter
 - .1 Frequency regulation: $\pm 1\%$
 - .2 Voltage regulation: $\pm 10\%$ for 10-100% load
 - .3 Output: sinusoidal wave form with total harmonic distortion of less than 10%.
 - .7 Battery: Sealed, lead calcium gas recombination type, ten year design life expectancy
 - .8 Battery charger:
 - .1 Capable of full battery recharge within twenty-four hours of full discharge.
 - .2 Automatic equalize cycle, constant trickle charge
 - .3 Regulation: $\pm 0.5\%$ output for $\pm 10\%$ input variation
 - .4 DC voltmeter and charge rate ammeter.
 - .5 LED indicators for "ON" float and high charge modes.
 - .6 LED indicators common alarm with cut-off switch for AC failure, high battery voltage, low battery voltage and charger failure
 - .9 System Diagnostics
 - .1 Diagnostics to provide report to satisfy Ontario Building Code test requirements.
 - .2 Communication port RS485 and interface to provide monthly diagnostic report to Owner's computer.
 - .10 Acceptable Manufacturers
 - .1 Lumacell
 - .2 Or accepted equal
- 3 Execution
- 3.1 **GENERAL**
- .1 Protect equipment from dust, debris, moisture, and physical damage, with sealed envelope of plastic or other impervious material until building is enclosed and cleaned and equipment is energized.

.2 Protect from condensation by maintaining at suitable temperature above 0°C.

.3 Finish equipment enclosures to ANSI 49 or ANSI 61, baked grey enamel.

3.2 **PANELBOARDS**

.1 Locate panelboards, secure, plumb true and square to structure.

.2 Mounting Methods

.1 Exterior walls and interior combustible walls: mount on continuous slotted channel strut with 41 mm clear between back of panel and wall. Where practical, group panelboards on common frame.

.2 Interior non-combustible walls: mount against wall.

.3 Where panelboards are flush mounted, provide three 25 mm empty conduits from each panelboard into ceiling space above.

.4 Identify load circuits on panel directory complete with name and location.

.5 Where panelboards are equipped with fused switches, install fuses immediately prior to energization. Record fuse rating on breaker or switch cover.

3.3 **DISTRIBUTION TRANSFORMERS**

.1 Support from building structure on trapezes or L brackets. Locate to provide free flow of cooling air.

.2 Loosen isolation pads until no compression is visible.

.3 Make final connection with flexible metal conduit.

.4 Leave slack in cables and flexible conduit, to avoid stress on connections.

3.4 **MOTOR CONTROL EQUIPMENT**

.1 Secure equipment plumb true and square to structure.

.2 Check nameplate rating of motor to select overload relay heater elements; install heater elements.

.3 Check operation of starters and correct motor rotation. Coordinate with Mechanical Division.

.4 Provide plastic covers to exclude dirt and dust until starters are energized.

3.5 **DISCONNECT SWITCHES**

.1 Install local to equipment on adjacent wall, column, or other suitable mounting surface. Where necessary provide free standing rigid continuous slotted channel strut frame.

.2 Where mounted on masonry walls, allow minimum of 6 mm clear space between enclosure and masonry wall.

3.6 **FUSES**

.1 Store fuses in a moisture free location until ready to energize.

.2 Install fuses immediately prior to energization.

- .3 Prior to acceptance of the Work, clearly mark manufacturer's labels on inside cover of each fusible unit, with ampere rating and catalogue symbol of replacement fuses to be used.

3.7 **METERING CABINET**

- .1 Install cabinet in accordance with utility requirements.

3.8 **AC INVERTER SYSTEM**

- .1 Install AC inverter system
- .2 Commission inverter system under supervision of inverter system and battery system manufacturer's representatives.

End of Section

- 1 General
- 1.1 **GENERAL**
 - .1 Comply with the requirements of Division 1 – General Requirements and Section 26 05 01 (16010) General Electrical Provisions
- 1.2 **SUBMITTALS**
 - .1 Comply with the requirements of Division 1 – General Requirements Section - Submittals.
 - .2 In addition, provide UPS size calculation and load list.
- 2 Products
- 2.1 **COMPUTER ROOM, UNINTERRUPTIBLE POWER SUPPLY**
 - .1 Provide a single-phase, on-line UPS that meets the following minimum criteria:
 - .2 The system shall consist of a battery charger, static inverter, a bank of storage batteries, maintenance by-pass and all required accessories.
 - .3 Output will be 120VAC single-phase supply, filtered.
 - .4 Include a bumpless-transfer (wrap-around/Maintenance Bypass Switch) circuit to enable the receptacle panel (load power distribution panel) to be transferred to utility power without impacting the operation of the SCADA Servers or Ethernet Switches.
 - .5 Have an N+1 redundancy for battery and power (inverter) modules.
 - .6 Include a 10/100BASE-T Ethernet interface and windows-based management software for monitoring and alarming UPS status.
 - .7 Be capable of detecting and reporting battery or power module failure, battery voltage, current and temperature.
 - .8 Battery modules shall be hot-swappable.
 - .9 The batteries to be supplied shall be sealed maintenance-free lead acid.
- 2.2 **MANUFACTURERS**
 - .1 Eaton
 - .2 Or accepted equivalent.
- 2.3 **CONFIGURATION**
 - .1 95 The Esplanade
 - .1 Product
 - .1 Eaton 9PXM series, 12 kVA N+1 (5 - 4kVA power modules), 240 minutes battery run time at full load, c/w UPS cabinet, external battery cabinets, wall mount external by-pass switch
 - .2 UPS rack to be seismic rated c/w bolt down brackets.

2.4 **UPS MODES OF OPERATION**

- .1 Normal: The input converter and output inverter shall operate in an on-line manner to continuously regulate power to the critical load. The input and output converters shall be capable of full battery recharge while simultaneously providing regulated power to the load for all line and load conditions within the range of the UPS specifications.
- .2 Battery: Upon failure of the AC input source, the critical load shall continue being supplied by the output inverter, which shall derive its power from the battery system. There shall be no interruption in power to the critical load during both transfers to battery operation and retransfers from battery to normal operation.
- .3 Recharge: Upon restoration of the AC input source, the input converter and output inverter shall simultaneously recharge the battery and provide regulated power to the critical load.
- .4 Static bypass: The static bypass shall be used to provide transfer of critical load from the inverter output to the bypass source. This transfer, along with its retransfer, shall take place with no power interruption to the critical load. In the event of an emergency, this transfer shall be an automatic function.
- .5 Maintenance bypass: The system shall be equipped with an external make-before-break rack or wall mount maintenance bypass to electrically isolate the UPS during routine maintenance and service of the UPS. The maintenance bypass enclosure shall completely isolate both the UPS input and output connections.

2.5 **BATTERY**

- .1 The UPS battery shall be of modular construction made up of swappable, fused, battery modules. Each battery module shall be monitored for voltage and temperature for use by the UPS battery diagnostic, and temperature compensated charger circuitry.
- .2 The battery jars housed within each removable battery module shall be of the valve regulated lead acid (VRLA) type.
- .3 The UPS shall incorporate a battery management system to continuously monitor the health of each removable battery module. This system shall notify the Owner in the event that a failed or weak battery module is found.

2.6 **WALL MOUNT MAINTENANCE BYPASS**

- .1 The rack or wall mount maintenance bypass shall provide power to the critical load from the bypass source, during times where maintenance or service of the UPS is required. The maintenance bypass shall provide a mechanical means of complete isolation of the UPS from the critical output distribution.
- .2 As a minimum, the maintenance bypass shall contain the following features and accessories:
 - .1 Appropriately rated switches to fully isolate the UPS during times where maintenance is required. As a part of this design there shall be a UPS input switch designated as Q1, a UPS output fused switch designated as Q2, and a wrap-around maintenance bypass switch designated as Q3. Minimum 1A/1B auxiliary contacts for the purpose of relaying status information of each switch actuator to the UPS shall be provided, along with a means of locking out the switches to inhibit operation of the bypass transfer pair. The bypass shall be available for a 208 volt input.

- .2 The bypass shall have a full length hinged front door, with locking mechanism; to allow access to the switches.
- .3 The bypass shall bear a full mimic diagram inside the hinged front door. Also associated with the mimic panel shall be indicating lights, capable of depicting proper operation of maintenance bypass circuit breaker and UPS output circuit breaker.

2.7 SOFTWARE AND CONNECTIVITY

- .1 Network adaptor: The Network Management Card shall allow one or more network management systems (NMS) to monitor and manage the UPS in TCP/IP network environments. The management information base (MIB) shall be provided in DOS and UNIX "tar" formats. The SNMP interface adaptor shall be connected to the UPS via Ethernet Port.
- .2 Unattended shutdown: The UPS, in conjunction with a network interface card, shall be capable of gracefully shutting down one or more operating systems.

2.8 REMOTE SYSTEM MONITORING

- .1 The following three methods of remote UPS monitoring shall be available:
 - .1 Web monitoring: Remote monitoring shall be available via a web browser such as Internet Explorer.
 - .2 RS-232 monitoring: Remote UPS monitoring shall be possible via either RS-232 or contact closure signals from the UPS.
 - .3 Simple Network Management Protocol (SNMP): Remote UPS monitoring shall be possible through a standard MIB II compliant platform.

3 Execution

3.1 UNINTERRUPTIBLE POWER SUPPLY

- .1 Power interruptions shall be kept to a minimum. Power interruptions must be coordinated with the owner and all other trades by this contract. Application for the power interruptions must be submitted to the Owner at least seven days prior to the requested shut down date.
- .2 The Contractor shall provide a complete UPS System with all associated cables as required for a fully functional system.

3.2 TESTING

- .1 See Division 1 – General Requirements, Section - Start-Up, Testing and Commissioning.

3.3 TRAINING

- .1 See Division 1 – General Requirements, Section - Start-Up, Testing and Commissioning.

End of Section

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- 1 General
- 1.1 **SUMMARY**
 - .1 Section Includes
 - .1 Labour, Products, equipment and services necessary to complete the Work of this section including, but not limited to, the following:
 - .1 Lighting equipment as per the luminaire schedule and as specified herein.
 - .2 Refer to architectural reflected ceiling plans for exact location of luminaires.
 - .3 Check latest ceiling finish schedule in areas where recessed luminaires are specified to ensure that luminaires have suitable ceiling trim for particular ceiling finish.
- 1.2 **SUBMITTALS**
 - .1 Submit Shop Drawings in accordance with Section 01 33 00.
 - .2 Submit certified copies of photometric test data, for each luminaire type, prepared by independent testing laboratory. Photometric data to include total input watts, candlepower summary, candlepower distribution, zonal lumen summary, luminaire efficiency, coefficient of utilization table, lamp type, ballast type and manufacturer, and lumen rating in accordance with IESNA testing procedures.
 - .3 Submit samples as directed by Consultant for the following luminaire types:
- 1.3 **REFERENCES**
 - .1 Refer to the latest issue of the following standards:
 - .1 CSA C22.2 No. 9-M - General Requirements for Luminaires
 - .2 CSA C22.2 No. 66 - Specialty Transformers
 - .3 CSA C22.2 No. 141-M - Unit Equipment for Emergency Lighting
 - .4 ANSI/IEEE C62.41 - IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits
 - .5 CSA C860 - Performance of Internally Lighted Exit Signs
- 1.4 **CODES AND STANDARDS**
 - .1 All wiring to be in accordance with the Ontario Electrical Safety Code.
 - .2 Provide only equipment bearing a label acceptable to the Electrical Safety Authority (ESA) to indicate that the equipment has been tested to applicable CSA standards.
- 2 Products
- 2.1 **LUMINAIRES**
 - .1 General
 - .1 Furnish luminaires in accordance with CSA C22.2 No. 9.
 - .2 Furnish medium screw base lampholders of nickel or brass in accordance with CSA C22.2 No. 43.

- .3 Furnish mogul screw base lampholders of porcelain and nickel in accordance with CSA C22.2 No. 43.
- .4 Furnish lamp bases for gas tube lamps in accordance with CSA C22.2 No. 34.
- .5 Luminaire finishes shall resist chipping, crazing, discolouration.
- .6 Luminaires to contain no asbestos.
- .7 Furnish luminaires with flanges and gaskets to eliminate light leaks.
- .2 Exit Light Luminaires
 - .1 Aluminum housing, stencil face, knock-out chevrons, unless otherwise noted in luminaire schedule.
 - .2 150 mm high red letters.
 - .3 Universal ceiling, end-to-wall, surface back-to-wall mounting or recessed mounting if indicated.
 - .4 Connection for emergency 12 V source where indicated.
 - .5 LED type with diffusing lens.

2.2 **EMERGENCY BATTERY UNITS**

- .1 Supply voltage 120 (277) (347) V ac.
- .2 Output voltage 12 V dc.
- .3 Batteries: Sealed lead acid calcium alloy grid type sized to operate the lamp load to 91% of initial voltage for thirty minutes unless otherwise specified in luminaire schedule.
- .4 Battery charger: Solid state, multi-rate, voltage/current regulated, sized to restore battery to full charge in twelve hours.
- .5 Low voltage disconnect: Solid state, modular, operates at 80% battery voltage.
- .6 EEMAC 1 code gauge steel housing unless otherwise specified in luminaire schedule.
- .7 Auxiliary equipment:
 - .1 "AC power ON"
 - .2 "Fast charge" pilot light
 - .3 Voltmeter
 - .4 Test switch
 - .5 Five minute time delay relay
 - .6 Cord and plug (120 V only)
- .8 Lamp heads: Mounted as indicated, 360 degree horizontal and 180 degree vertical adjustment, type and wattage as specified in luminaire schedule.
- .9 Acceptable manufacturers: As specified in luminaire schedule.

3 Execution

3.1 **INSTALLATION - GENERAL**

- .1 Provide supports for luminaires. Support single units from luminaire studs in outlet boxes. For continuous row fluorescent type, provide support for each end plus at least one for each channel section, or additional as required. Swivel mount stems. Provide concrete inserts at points of luminaire support in unfinished areas where a concrete slab serves as ceiling. Provide support from concrete floor and roof steel above ceiling as applicable.
- .2 Align luminaires in rows, maintain required heights, and install luminaires clear of other work.
- .3 Clean and relamp existing luminaires being removed and installed in new locations.
- .4 Keep luminaires covered and protected from construction dust and debris until building is broom clean and free of suspended dust clouds.
- .5 Do not lamp luminaires until ready for testing and use. Obtain Owner's approval before lamping. Install lamps in lampholders.
- .6 When installation is complete, demonstrate operation to satisfaction of Owner.
- .7 Standard octagonal boxes may be supplied where conduits feeding luminaires in finished areas are exposed on ceiling if hanger canopies entirely cover outlet boxes and are neatly notched for conduit. Otherwise, provide cast conduit outlet boxes with a diameter larger than canopies.
- .8 Attach boxes or hickies directly to poured concrete with 6 mm minimum diameter bolts and lead expansion anchors where luminaires are suspended directly from concrete slabs. Use 8 mm minimum bolts through precast slabs, welded to 100 mm x 100 mm minimum, 3.5 mm plate above slabs.
- .9 Do not mount luminaires above pipes, ducts or equipment. In event of unavoidable tight locations, provide hangers to clear obstructions. Check layouts of other trades on job and plan cooperatively. Luminaires in any room shall hang at one height. Obtain approval before any changes are made to layouts shown.
- .10 Provide continuous 12 mm x 38 mm channel above ceiling, where luminaires are suspended or mounted on furred ceilings. Fasten luminaires to channel with two 6 mm minimum diameter studs with minimum 1220 mm on centre.
- .11 Where two 1220 mm surface or suspended fluorescent luminaires occur in tandem, an 2440 mm body may be used. Where two single lamp luminaires occur in tandem, a common lamp ballast may be used.
- .12 Verify catalogue number of luminaires with description prior to ordering, and check for final ceiling finish in areas where recessed luminaires are called for in order to provide ceiling trim, flanges and mounting brackets to suit particular construction used where luminaires are installed.
- .13 Support luminaires in an approved manner to comply with the Ontario Electrical Safety Code and the Ontario Building Code.
- .14 Provide steel luminaire studs, brackets and hangers. Where luminaires are hung on chain hangers, provide chain of closed link type capable of supporting ten times luminaire weight. Use U-bolts for chain ends; S-hooks are not acceptable.

3.2 INSTALLATION - INDUSTRIAL

- .1 For industrial luminaires suspended from ceiling outlet boxes, provide 13 mm rigid combination conduit stems, luminaire stud, and self-aligning hangers. In other locations, except as otherwise detailed or required, provide ceiling or wall outlet boxes with 9.5 mm, no-bolt luminaire studs. Provide special hangers for support of any luminaire which weighs more than 23 kg.
- .2 In high vibration areas, mount luminaires with cushion hangers.
- .3 Where specified, provide safety restraint device (safety chain or safety cord) of minimum length as recommended by the manufacturer.
- .4 The manufacturer to certify that the safety restraint device has been drop tested for the actual luminaire and restraint length.

3.3 INSTALLATION - EMERGENCY AND EXIT LIGHTS

- .1 Exit sign installation shall meet all requirements of the authorities having jurisdiction.
- .2 Install emergency battery units where shown. Support on brackets supplied by manufacturer.
- .3 Aim heads to properly illuminate exit path.

3.4 INSTALLATION - CEILINGS

- .1 Suspend luminaires mounted from or in a suspended T-bar ceiling directly from building structure, independent of the T-bar system, to ULC, Local Fire Marshal's Office, Ontario Building Code, Electrical Safety Authority (ESA) and Consultant's approval.
- .2 In non-accessible ceilings wire with not more than 1200 mm of AC90 or RW90 XLPE wire in flexible conduit to adjacent outlet boxes placed above finished ceiling within reach of the luminaire openings.
- .3 In accessible ceilings wire with not more than 1.8 m of AC90 or RW90 XLPE wire in flexible conduit to adjacent outlet boxes, locations as shown on the Drawings.
- .4 Provide suitable trim for all luminaires installed in drywall ceilings or within lay-in or snap-in tiles.

3.5 INSTALLATION - POLES

- .1 Wire down inside of lighting poles with No. 10 AWG RW90 plus No. 10 AWG insulated ground wire and secure to clips. Provide strain relief at the top of the pole so that the weight of the wiring down to the bottom of the pole does not place a strain on the wiring terminations. Install fuse holders and fuses.
- .2 Assemble arms and luminaires securely to pole. Provide lamps in lampholders.
- .3 Erect pole plumb and true on base. Along roadways, orient pole handhole on the side opposite the roadway unless otherwise indicated.
- .4 Connect underground ground wire and pole ground wire at ground lug in pole.
- .5 Leave slack in wires to allow connector and ground wire to be pulled out of handhole 150 mm clear of pole without disconnecting.

3.6 FLOODLIGHTS

- .1 Aim floodlights at night to satisfaction of Consultant.

- .2 Provide support from the building structure where floodlights are supported from buildings. Make support and wiring penetrations of the building envelope waterproof.

End Of Section

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- 1 General
 - 1.1 **SUMMARY**
 - .1 Labour, Products, equipment and services necessary to complete the Work of this section including, but not limited to, the following:
 - .1 Control Devices
 - .1 Distributed dimming control systems
 - .2 Central dimming control system
 - .2 Input Devices
 - .1 Occupancy, vacancy sensors
 - .2 Sensor power packs
 - .3 Daylight sensors
 - .4 Multi Sensors
 - .5 Touchscreens
 - .6 Wallstations
 - .3 End Devices
 - .1 Relays
 - .2 Digital to Analog converters
 - .3 0-10V to Reverse phase converters
 - .4 LED drivers
 - .4 Software and Integration
 - .1 BMS integration
 - .2 LAN/VLAN integration
 - .3 Partition controls
 - .4 DMX integration
 - .5 ASCII integration
 - .6 Programming software
 - .7 Emergency lighting control (if applicable)
 - 1.2 **REFERENCES**
 - .1 American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE)
 - .1 C62.41-1991 - Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.
 - .2 ASTM International (ASTM)

- .1 D4674 -02a Standard Test Method for Accelerated Testing for Color Stability of Plastics Exposed to Indoor Fluorescent Lighting and Window-Filtered Daylight.
- .3 Canadian Standards Association (CSA).
 - .1 CSA C22.2 # 14 Industrial Control Equipment
 - .2 CSA C22.2 # 184 Solid-State Lighting Controls
 - .3 CSA C22.2 # 156 Solid-State Speed Controls
- .4 International Electrotechnical Commission.
 - .1 (IEC) 801-2 Electrostatic Discharge Testing Standard.
 - .2 IEC/EN 60669-2-1 Switches for household and similar fixed electrical installations - electronic switches.
- .5 International Organization for Standardization (ISO)
 - .1 9001:2000 – Quality Management Systems.
- .6 National Electrical Manufacturers Association (NEMA)
 - .1 WD1 (R2005) - General Color Requirements for Wiring Devices.
- .7 Underwriters Laboratories, Inc. (UL):
 - .1 489 (2002) - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.
 - .2 508 (1999) - Standard for Industrial Control Equipment.
 - .3 1472 (1996) - Solid-State Dimming Controls.
 - .4 924 (2003) - Emergency Lighting and Power Equipment.
- .8 National Fire Protection Association (NFPA)
 - .1 701 (2004) Standard Methods of Fire Tests for Flame Propagation

1.3 **COORDINATION REQUIREMENTS**

- .1 Coordination
 - .1 Coordinate the placement of lighting control panels
 - .2 Coordinate the placement of sensors, wallstations and other user input devices
 - .3 Coordinate the placement of daylight sensors to achieve optimal daylight dimming
- .2 Prewire meeting: Conducted on-site with lighting control system manufacturers or designated representative prior to commencing work as part of the manufacturer's standard practice and startup services. Manufacturer to review with the installer:
 - .1 Installation of lighting control panels and locations
 - .2 Lighting control network wiring
 - .3 Network IT requirements

- .4 Low voltage wiring requirements
- .5 Lighting control integration requirements
- .6 Lighting control system integration network wiring and connectivity
- .7 Installer responsibilities
- .8 Startup and training schedule and actions

1.4 **SUBMITTALS**

- .1 Submit under provisions of Section 01 33 00.
- .2 Specification Conformance Document: Indicate whether the submitted equipment:
 - .1 Meets specification exactly as stated.
 - .2 Meets specification via an alternate means and indicate the specific methodology used.
- .3 Shop Drawings; include:
 - .1 Load schedule indicating actual connected load, load type, and voltage per circuit, circuits and their respective control zones, circuits that are on emergency, and capacity, phase, and corresponding circuit numbers.
 - .2 Schematic of system.
- .4 Product Data: Catalog specification sheets with performance specifications demonstrating compliance with specified requirements.
- .5 Project Record Documents: Installer to record actual installation location and settings of lighting control panels and components.

1.5 **QUALITY ASSURANCE**

- .1 Manufacturer: Minimum 10 years' experience in manufacture of architectural lighting controls.
- .2 Manufacturer's Quality System: Registered to ISO 9001:2000 Quality Standard, including in-house engineering for product design activities.
- .3 Central dimming control system:
 - .1 Meets UL, cUL, and/or CSA Standards specifically for the required loads. Provide evidence of compliance upon request.

1.6 **PROJECT CONDITIONS**

- .1 Do not install equipment until following conditions can be maintained in spaces to receive equipment:
 - .1 Ambient temperature: 0° to 40° C (32° to 104° F).
 - .2 Relative humidity: Maximum 90 percent, non-condensing.
 - .3 Lighting control system must be protected from dust and sprays during installation.

1.7 **WARRANTY**

- .1 Provide manufacturer's warranty covering 5 year 100 percent parts to repair and replace defective equipment.
 - .1 Systems that do not provide 100 percent parts at no extra charge for the first 5 years of installation shall not be acceptable.
 - .2 Provide manufacturer's additional warranty options to customer where required.
 - .1 Provide warranty options beyond initial 5 year period as an additional purchased service.
- 1.8 **COMMISSIONING**
- .1 Provide factory-certified field service engineer to a site visit to ensure proper system installation and operation under following parameters:
 - .1 Qualifications for factory-certified field service engineer:
 - .1 Certified by the equipment manufacturer on the system installed.
 - .2 Make a visit upon completion of installation of central dimming control system:
 - .1 Verify connection of power feeds and load circuits.
 - .2 Verify connection Wallstation controls.
 - .3 Verify proper connection iCAN link.
 - .4 Download system panel data to dimming panels.
 - .5 Check dimming panel load types and currents and remove by-pass jumpers.
 - .6 Verify system operation control by control, circuit by circuit.
 - .7 Obtain sign-off on system functions.
 - .8 User to be trained on system operation
- 1.9 **MAINTENANCE**
- .1 Make ordering spare parts available to end user.
 - .2 Make new replacement parts available for minimum of ten years from date of manufacture.
 - .3 Provide factory direct technical support hotline.
 - .4 Provide on-site service support where required.
 - .5 Offer renewable service contract on yearly basis, to include parts, factory labor, and annual training visits to customer if desired.
- 1.10 **DELIVERY, STORAGE AND FIELD CONDITIONS**
- .1 Ensure products are delivered as shipped, including pallet assembly and packaging has not been damaged in shipment.
 - .2 Store products in a clean, dry location in manufacturers original packaging.
 - .3 Store products in an environment that meets products ambient and storage temperature per products specification sheets.

- .4 Store products in an environment that meets products relative humidity of less than 90 percent, non-condensing as outlined on the product specification sheets.

1.11 **SYSTEM DESCRIPTION AND OPERATION**

- .1 The Lighting Control and Automation system as defined under this section covers the following equipment:
 - .1 Distributed dimming control system – Simplified factory assembled dimming and switching solutions that meet typical applications and simplify low voltage wiring to help a space meet the latest IECC, ASHRAE and Title 24 energy codes.
 - .2 Centralized dimming control system – Factory assembled dimming and switching solutions that allow for applications to scale from small to enterprise while providing simplified low voltage wiring to allow for system completion faster. This system includes third party integration and features to simplify complex application designs.
 - .3 Occupancy Sensors – PIR, DT and ULT Auto adjusting, NEMA WD7 compliant occupancy or vacancy sensors.
 - .4 Wallstations – Smart device that are fully programmable, pre-engraved digital pushbutton wallstations and dimmers.
 - .5 Scene Wallstation – Smart device that are fully programmable, pre-engraved digital pushbutton scene wallstations, dimmers and programmable scene buttons.
 - .6 Daylight Photosensor – Smart device that is a multi-zone open loop daylight sensor with two-way active infrared (IR) communications, which can provide dimming control for daylight harvesting.
 - .7 Touchscreens – Full color touchscreen that can be programmed to control any area on the lighting control network. Shall include multiple screens with templates for simplified programming as well as password protected screen locking features.
 - .8 3rd Party Integration – Interface shall be provided to allows for 3rd party integration via serial or Ethernet into the iLumin Plus lighting system using standard ASCII commands
 - .9 BAS Integration – BACnet interface shall be available to allow BAS systems to detect and control area status.
 - .10 Demand Response – OpenADR or other demand response input shall be connected to one or more iLumin Plus panels. The DR signal will trigger a response to the lighting and is fully programmable based on a single area or the entire network.
 - .11 iLumin Plus communication network – iCANnet CANbus wiring using Belden 1502 or 1502P network wire to create the iLumin Plus system lighting control network.
 - .12 2 wire topology free polarity free low voltage network – 18AWG or 14AWG twisted pair wire (purple and purple) is preferred for connecting user interface devices to the iLumin Plus lighting control panels. This simplifies the design, installation and controls allowing the installer and designer to get off the job faster.

- .2 Minimum lighting control performance required, unless local energy code is more stringent.
 - .1 Occupancy/vacancy requirements - Provide occupancy/vacancy sensors as indicated on drawings and sequence of operation.
 - .2 Daylight Zones – Primary sidelit or toplit areas within an enclosed space shall be controlled separately and automatically by a multi-level photocontrol device.
 - .3 Provide smooth and continuous daylight dimming for areas marked on drawings. Daylighting control system may be designed to dim electric light to the lowest light level.
 - .4 Provide the ability to adjust the high end and low end trim of the dimmers to ensure the lighting automatically provides energy saving even when daylighting calls for full illumination.
 - .5 Provide the ability for the dimmers and the relays to function separately. Systems where the 0-10V dimmers and relays are tied together reduce design capabilities and shall not be acceptable.
 - .6 Provide the ability to provide occupancy status to a Building Automation System.
 - .7 Shall be capable of automatically responding to a Demand Response Signal and adjusting the lighting level. (Required for California Title 24 2013)

- 2 Products
 - 2.1 **MANUFACTURERS**
 - .1 Acceptable Manufacturers:
 - .1 Cooper Lighting Solutions
 - .2 Douglas Controls
 - .2 Basis of design product: Cooper iLumin Plus system or subject to compliance and prior approval with specified requirements of this section, one of the following:
 - .1 Cooper iLumin Plus system
 - .2 Douglas Controls
 - .3 Substitutions:
 - .1 No substitution will be accepted prior to award of Contract.
 - .2 All proposed substitutions (clearly delineated as such) must be submitted in writing for approval by the design professional
 - .3 Proposed substitutes must be accompanied by a review of the specification noting compliance on a line-by-line basis.
 - .4 Provide complete engineered shop drawings (including power wiring) with deviations for the original design highlighted in an alternate color to the engineer for review and approval prior to rough-in.

- 2.2 **GENERAL**
 - .1 Provide system hardware that is designed, tested, manufactured, and warranted by a single manufacturer.

.2 Architectural Lighting Controls: Ten-year operational life while operating continually at any temperature in an ambient temperature range of 0° C (32°F) to 40° C (104°F) and 90 percent non-condensing relative humidity.

.3 Designed and tested to withstand electrostatic discharges up to 12,000 V without impairment per IEC 801-2.

2.3 **ILUMIN PLUS PANELS**

.1 Mechanical:

.1 Meets UL, cUL, and/or CSA Standards specifically for the required loads. Provide evidence of compliance upon request.

.2 Delivered and installed as a factory assembled panel listed to UL508.

.3 Field wiring accessible from front of panel without need to remove dimmer or relay assemblies or other components.

.4 Panels passively cooled via free-convection, unaided by fans or other means.

.2 Electrical:

.1 Electrolytic capacitors to operate under the component manufacturer's maximum temperature rating when device is under fully-loaded conditions in 40° C (104° F) ambient temperature.

.2 Design and test dimmers/relays to withstand line-side surges without impairment to performance.

.1 Panels: Withstand surges without impairment of performance when subjected to surges of 6,000 volts, 3,000 amps per ANSI/IEEE C62.41 and per IEC 61000-4-5 surge requirements.

.2 Other power handling devices: Withstand surges without impairment of performance when subjected to surges of 6,000 volts, 200 amps per ANSI/IEEE C62.41.

.3 Utilize air gap off, activated when user selects "off" at any control to disconnect the load from line supply.

.4 Power failure memory and dimmer/relay recovery:

.5 When power is interrupted and subsequently returned, lights will automatically return to same levels (dimmed setting, full on, or off) prior to power interruption.

.6 In 3 phase panels loss of power to any phase should not effect operation or control dimmers on any other phase.

.3 Performance:

.1 Shall be UL listed to relevant standards (UL508A, UL916, cULus)

.2 Shall be capable of mixed voltages 120/277VAC 50/60Hz

.3 Shall be capable of mixed sources including normal and emergency power

.4 Shall include a panel SCCR rating of 25kA

.5 Shall be capable of providing a mixed module solution panel including relays, dimmers and DALI controls.

- .6 Shall be capable of meeting the latest IECC, ASHRAE and Title 24 energy codes
- .7 Shall support three enclosure sizes
 - .1 Small Enclosure
 - .1 Shall support up to two modules
 - .2 Medium Enclosure
 - .1 Shall support up to four modules and PC connection module
 - .2 Shall include configurations with Ethernet connection to building LAN or VLAN
 - .3 Large Enclosure
 - .1 Shall support up to eight modules and PC connection module
 - .2 Shall include configurations with Ethernet connection to building LAN or VLAN
 - .4 Relay Module: (SCMR1220)
 - .1 Up to 48 relays in large enclosure
 - .2 Each relay module shall support up to twelve 20A fully rated relays
 - .1 Shall include heavy duty 20A @40C relays
 - .3 Rated life of relay: Minimum 1,000,000 cycles.
 - .4 Load switched in manner so that there is no arcing at mechanical contacts when power is applied to and removed from load circuits.
 - .5 Fully rated output continuous duty for inductive, capacitive, and resistive loads.
 - .6 Relay controller shall include the capability for DMX input control with base address
 - .7 Relay controller shall include the capability for DALI input control
 - .8 Relay controller shall include alert dry contact input for hardware override of all relay.
 - .5 Dimmer Module: (SCMH1200)
 - .1 Up to 48 Low Voltage Dimming (0-10V) channels in large enclosure
 - .2 Each dimmer module shall support up to twelve 0-10V channels; Meet following requirements:
 - .3 Capable of controlling any 0-10V source.
 - .4 0-10V dimmers shall include a fail to full output safety feature by default
 - .5 Provide isolated 0-10V output signal conforming to IEC 60929.

- .1 50mA sink current per channel via IEC 60929.
- .2 50mA source current per channel
- .6 0-10V controller shall include the capability for DALI input control
- .6 DALI: (SCMD4)
 - .1 Up to 16 DALI buses in medium enclosure
 - .2 Each DALI module shall support up to four DALI buses
 - .3 Shall include dedicated test/override buttons for each DALI bus
 - .4 Shall include a separate power supply for each DALI bus
 - .1 Shall provide 16V nominal, 250mA max current per bus
 - .2 Shall support 64 standard DALI devices per bus
 - .5 DALI controller shall include the capability for DMX input control with base address
 - .6 DALI controller shall include the capability for DALI input control
 - .7 DALI controller shall include alert dry contact input for hardware override of all relays
- .7 Ethernet: (EG2)
 - .1 Shall provide a single ethernet port for connection to the building LAN or VLAN
 - .2 Shall be capable of facilitating a LAN or Wi-Fi connection to the iLumin Plus system
 - .3 Shall include an integral web server
 - .4 Shall provide the capability for mobile devices to override the lighting system via scene or channel slider commands
 - .5 Shall provide the capability for 3rd party integration via ASCII control strings
 - .6 Shall provide the capability for bridging the iLumin Plus network across LAN or VLAN connections

2.4 INPUT DEVICES

- .1 WALLSTATIONS & TOUCHSCREENS
 - .1 Product: DALI Wallstation
 - .1 Electronics:
 - .1 Use 18AWG – 14AWG wiring for low voltage communication to SCMD4 module
 - .2 Functionality:
 - .1 Upon button press, LEDs to immediately illuminate.

- .2 Each button shall be programmable to control any area, scene, channel
- .3 Color: White
- .4 Provide color matching faceplates with concealed mounting hardware where specified.
- .5 Engrave wall stations with appropriate button, zone, and scene descriptions as specified.
- .2 Product: Ineo Wallstation
 - .1 Electronics:
 - .1 Use iCANnet wiring for low voltage communication to ensure reliable data communication in high electrical noise environments.
 - .2 Functionality:
 - .1 Upon button press, LEDs to immediately illuminate.
 - .2 Each button shall be programmable to control any area, scene, channel
 - .3 Color: White
 - .4 Provide color matching faceplates with concealed mounting hardware where specified.
 - .5 Engrave wall stations with appropriate button, zone, and scene descriptions as specified.
- .3 Product: [TSC-30]
 - .1 Communication: iCANnet protocol.
 - .2 Power: From the 9V external power supply (included)
 - .3 Connections: Five (5) wires Belden 1502 or 1502P
 - .4 Mounting: Wallbox (included)
 - .5 VGA 320x240 pixel resolution, 65,000 colors available
 - .6 3.5" diagonal backlit LCD touchscreen
 - .7 Shall allow up to 250 pages to be stored in memory
 - .8 Groups: The set of fixtures controlled by a given touchscreen shall be completely configurable through software and can span entire iLumin Plus network.
 - .9 Shall support individual zone level adjustment and save scene controls
- .2 ADDRESSABLE MULTI-SENSOR
 - .1 Product: [MST-6], [MTS-12],
 - .1 Communication: DALI protocol.

- .2 Power: From the DALI bus.
 - .3 Maximum Current Draw: 3.75 mA.
 - .4 Connections: Two (2) wires (16/18AWG, FT6, non-twisted, non-shielded, non-polarized and plenum rated) connected to the DALI communication bus.
 - .5 Sensing Technologies: Occupancy, daylight and temperature.
 - .6 Daylight Sensing Range: 0-400 lux.
 - .7 Daylight Sensing Coverage: Light input within 60° cone.
 - .8 Occupancy Detection Technology: Passive infrared.
 - .9 Occupancy Detection Coverage Area: 600 sq. ft. or 1,200 sq. ft.
 - .10 Occupancy Detection Angle: 360°.
 - .11 Mounting: Junction box or ceiling tile.
 - .12 Groups: The set of fixtures controlled by a given multi-sensor shall be completely configurable through software and can span iLumin Plus network.
 - .13 Timers: All times shall be configurable through the web software and shall not require any manual configuration of settings prior to installation. Timer values can range from 1 second to 24 hours
 - .14 Shall be capable of occupancy forwarding to send occupancy status to other areas within the system
- .2 Product: [NC3-C]
- .1 Communication: iCANnet protocol.
 - .2 Power: From the iCANnet bus.
 - .3 Connections: Five (5) wires Belden 1502 or 1502P
 - .4 Sensing Technologies: Occupancy, daylight
 - .5 Daylight Sensing Range: 0-400 lux.
 - .6 Daylight Sensing Coverage: Light input within 60° cone.
 - .7 Occupancy Detection Technology: Passive infrared.
 - .8 Occupancy Detection Coverage Area: 250 sq. ft.
 - .9 Occupancy Detection Angle: 360°.
 - .10 Mounting: ceiling tile.
 - .11 Groups: The set of fixtures controlled by a given multi-sensor shall be completely configurable through software and can span entire iLumin Plus network.
 - .12 Timers: All times shall be configurable through the web software and shall not require any manual configuration of settings prior to installation. Timer values can range from 1 second to 24 hours

- .13 Shall be capable of occupancy forwarding to send occupancy status to other areas within the system
- .14 Capable of sending a command to turn HVAC on and off
- .3 ADDRESSABLE SENSOR POWERPACK
 - .1 Product: [FLT-SP-MV-DC2], [FLT-SP-MV-DC1], [FLT-SP-347-DC2], [FLT-SP-347-DC1], [FLT-SP-240-DC2], [FLT-SP-24-DC1]
 - .1 Communication: DALI protocol.
 - .2 Power: 347VAC.
 - .3 Maximum Current Draw: 2 mA.
 - .4 Maximum number of sensors: Up to five (5) PIR or DT sensors are connected and report to the system as a single address.
 - .5 Connections: Two (2) wires (16/18AWG, FT6, non-twisted, non-shielded, non-polarized and plenum rated) connected to the DALI communication bus.
 - .6 Sensor connections: Five (5) wires (16/18AWG, FT6, non-twisted, non-shielded, non-polarized and plenum rated) connected to sensor for controls and addressing
- .4 CEILING MOUNTED SENSORS
 - .1 Product: [OAC-DT-2000-R], [OAC-DT-1000-R], [OAC-P-1500-R], [OAC-U-2000-R]
 - .1 Provide all necessary mounting hardware and instructions.
 - .2 Sensors shall be Class 2 devices.
 - .3 Connect up to five (5) sensor to the DALI Powerpack for power and signal back to the iLumin Plus system
 - .4 Device calibration and features:
 - .1 Sensitivity – 0-100% in 10% increments.
 - .2 Time delay – 1-30, self-adjusts to 10 min based on room occupancy.
 - .3 Test mode – Fifteen second time delay.
 - .4 Detection technology – PIR, Ultrasonic or Dual Technology activation and/or re-activation.
 - .5 Walk-through mode.
 - .6 Ultrasonic and Dual Technology Sensors utilize two independent sensor detection circuits simultaneously to ensure optimum performance, regardless of location or proximity to walls and structures.
 - .7 Ultrasonic and Dual Technology Sensors utilize Variable Drive Circuitry (VDC) in cases of over saturation from misapplication, which automatically adjusts the

volumetric output without reducing detection capability. Systems that reduce detection coverage area shall not be acceptable.

- .8 Automatically and continually self-adjust ultrasonic frequency to ignore specific frequency, continuous noise from airflow to prevent detuning which can lead to inadvertent lights out. Sensors that require detuning shall not be acceptable.
 - .5 Device Status LEDs including:
 - .1 PIR Detection
 - .2 Ultrasonic detection
 - .6 Manual override of controlled loads
 - .7 Where specified, sensor packaging shall be 100% recycled [made entirely from post-consumer waste (100% post-consumer fiber content) as well as, 100% recyclable].
 - .8 Sensors shall be RoHS compliant.
- .5 WALL/CORNER MOUNTED SENSORS
- .1 Product: [OAWC-P-120W-R], [OAWC-P-009L-H-R], [OAWC-DT-120W-R],
 - .1 Provide all necessary mounting hardware and instructions.
 - .2 Sensors shall be Class 2 devices.
 - .3 Connect up to five (5) sensor to the DALI Powerpack for power and signal back to the iLumin Plus system
 - .4 Device calibration and features:
 - .1 Sensitivity – 0-100% in 10% increments.
 - .2 Time delay – 1-30, self-adjusts to 10 min. based on room occupancy.
 - .3 Test Mode – Fifteen second time delay.
 - .4 Detection technology – PIR, Ultrasonic or Dual Technology activation and/or re-activation.
 - .5 Walk-Through Mode.
 - .6 Automatically and continually self-adjust ultrasonic frequency to ignore specific frequency continuous noise from airflow to prevent detuning which can lead to inadvertent lights out. Sensors that require detuning shall not be acceptable.
 - .5 Device Status LEDs including:
 - .1 PIR Detection
 - .2 Ultrasonic detection

- .6 Manual override of controlled loads.
- .7 Where specified, sensor packaging shall be 100% recycled [made entirely from post-consumer waste (100% post-consumer fiber content) as well as, 100% recyclable].
- .8 Sensors shall be RoHS compliant.

2.5 **END DEVICES**

.1 **ADDRESSABLE RELAYS AND DRIVERS**

- .1 Product: [FLT-DAC-DALI-DC1], [FLT-DAC-DALI-DC2]
 - .1 0-10V Addressable Dimming Modules
 - .2 Communication: DALI protocol.
 - .3 Power: From the DALI bus.
 - .4 Maximum Current Draw: 3.75 mA.
 - .5 Communication Connections: Two wires (16/18AWG, FT6, non-twisted, non-shielded, non-polarized and plenum rated) connected to the DALI communication bus.
 - .6 Power Ratings: Up to 4A Ballast 120/277/347 VAC.
 - .7 Dimming Control: 0-10V, 50 mA max current sink.
 - .8 Mounting: Fixture or conduit (90° elbow and mounting clips included).
 - .9 UL 924 Listed component.
- .2 Product: [FLT-HPRS-DALI]
 - .1 Communication: DALI protocol.
 - .2 Power: From the DALI bus.
 - .3 Maximum Current Draw: 3.75 mA.
 - .4 Enclosure: Standard outlet box or NEMA 250, Type 1, unless otherwise indicated.
 - .5 Communication Connections: Two (2) wires (16/18AWG, FT6, non-twisted,
 - .6 non-shielded, non-polarized and plenum rated) connected to the DALI communication bus.
 - .7 Power Ratings: Up to 20 A at 347 VAC.
 - .8 Field relays shall be capable of controlling plug loads.
 - .9 Mounting: Junction box.

2.6 **INTEGRATION AND ACCESSORIES**

.1 **BAS INTEGRATION**

- .1 Product: [FPA-W34-1130] BMSPRO 2 - BACnet Interface

- .1 The iLumin Plus network shall permit data protocol translation through a building automation interface Gateway. The BACnet Gateway shall permit BACnet communication protocol to operate individual areas, scenes or channels and read the status. The iLumin Plus network shall respond efficiently to the requested information from the BACnet network.
 - .2 The BMSPro2 provides up to 10,000 points of control and can communicate to multiple panel types.
 - .3 The BMSPro 2 requires a dedicated EG2 interface for connectivity either installed in an iLumin Plus panel or as a separate accessory.
 - .4 Provide PIC list definition and object model to other system manufacturers.
- .2 LAN/VLAN INTEGRATION
- .1 Product: [EG2-NA] Ethernet Gateway
 - .1 Shall provide a single ethernet port for connection to the building LAN or VLAN
 - .2 Shall be capable of facilitating a LAN or Wi-Fi connection to the iLumin Plus system
 - .3 Shall include an integral web server
 - .4 Shall provide the capability for mobile devices to override the lighting system via scene or channel slider commands
 - .5 Shall provide the capability for 3rd party integration via ASCII control strings
 - .6 Shall provide the capability for bridging the iLumin Plus network across LAN or VLAN connections
 - .7 Provide ability for bi-direction communication by means of Ethernet communication to system by means of user-supplied PC, digital audiovisual, or BAS equipment. Control to be located on the same Local Area Network.
 - .8 Allow for custom communication command strings to be entered in to software to allow lighting control system to control other devices
- .3 SERIAL INTEGRATION
- .1 Product: [SI-2-NA] RS232 Interface
 - .1 Communication: iCANnet protocol.
 - .2 Power: From the iCANnet bus.
 - .3 Connections: Five (5) wires Belden 1502 or 1502P
 - .4 Mounting: Junction box
 - .5 Provide ability for bi-direction communication by means of RS232 serial communication to system by means of user-

supplied PC, digital audiovisual, or BMS equipment. Control to be located within 50 feet (15 meters) of RS232 source.

- .6 Allow for custom RS-232 command strings to be entered in to software to allow lighting control system to control any other device

.4 PARTITION CONTROL;

.1 Product: [UIG-NA], [UIM-NA]

- .1 Communication: iCANnet protocol.
- .2 Power: From the iCANnet bus.
- .3 Connections: Five (5) wires Belden 1502 or 1502P
- .4 Inputs: Four (4) digitally optically isolated inputs
- .5 Mounting: Junction box
- .6 partitioning: Shall provide partitioning and room join capabilities using either a button press, input, or IR wall partition sensors
- .7 Low Voltage Input: Shall provide the capability for contact closures to integrate between lighting controls and other systems.
 - .1 The contact closure input device will accept both momentary and maintained contact closures.

.2 Product: [IRTR]

- .1 Infrared Transmitter & Receiver
- .2 Provide the ability to sense the presence or absence of partitions.
- .3 Requires the connection to a UIG-2-NA or UIM-NA

.5 NETWORK ACCESSORIES

.1 Product: [LCNJ]

- .1 Communication: iCANnet protocol.
- .2 Power: From the iCANnet bus.
- .3 Connections: Five (5) wires Belden 1502 or 1502P
- .4 Mounting: Junction box
- .5 Shall allow direct access to the iLumin lighting control network while in the space being modified.

.2 Product: [BN-2-NA]

- .1 Network Bridge
- .2 Communication: iCANnet protocol.
- .3 Power: From the iCANnet bus.

- .4 Connections: Five (5) wires Belden 1502 or 1502P
- .5 Mounting: Junction box
- .6 Shall allow the network to extend more than 1000m/3200 feet.
- .7 Shall permit the connection of multiple networks allowing up to 65,000 devices on one system.

2.7

SOFTWARE

- .1 ICANsoft Suite
 - .1 Product: [SW-2]
 - .1 Software shall support multiple functions to setup entire enterprise iLumin Plus system
 - .1 DALI addressing tool
 - .2 Device editor for system programming and scheduling
 - .3 iCANsoft editor for system programming and scheduling
 - .4 Smartphone configuration tool for mobile applications
 - .5 Touchscreen configuration tool
 - .6 Panel editor for floor plan control
 - .2 Software shall support multiple diagnostic tools for troubleshooting the iLumin Plus system
 - .1 Network monitor
 - .2 Flash tool for updating system device firmware
 - .3 Device simulator
 - .3 Shall include with user-friendly software suitable for operation on computer workstations which serve as central control stations for the selection and operation of lighting scenes
 - .4 Clients shall interface with the software via Eaton Lighting Systems iCANsoft application
 - .2 Execution

2.8

INSTALLATION

- .1 Install equipment in accordance with manufacturer's installation instructions.
- .2 Provide complete installation of system in accordance with Contract Documents.
- .3 Define each dimmer's/relay's load type, assign each load to a zone, and set control functions.
- .4 Provide equipment at locations and in quantities indicated on Drawings. Provide any additional equipment required to provide control intent.
- .5 100 digital devices (Source Controllers, User Interfaces, etc) may reside on a single network segment with a network length not to exceed 3000 feet. Additional network

segments shall be accomplished by the employment of a network bridge up to 65000 devices. Network segments shall be terminated at the end of each segment.

- .6 Devices to be connected via Daisy Chain topology.
- .7 Network wire recommended is Belden#1502R or 1502P (plenum) or similar. Wire shall meet color code requirements to insure proper installation of the network polarity.
- .8 All panels are "masters" and may be added to the network in any location and any amount as long as network installation guidelines are met.
- .9 Panels are designed to function independently from external control devices.

End of Section

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IDEN. No	AREA	CONTROLS	SEQUENCE
1	Corridors	Local low voltage switches Occupancy sensors Low voltage relays Time of day schedule	ON: 50% by time of day schedule; remaining 50% by occupancy sensor when space is occupied ADJUST: Reduced to 50% when space is not occupied, increased to 100% when occupied OFF: by time of day schedule OVERRIDE: local manual switches to override ON when scheduled OFF
2	Washrooms; Janitor Room	Local low voltage switches Low voltage relays Vacancy sensors	ON: manual by local switches OFF: vacancy sensors
3	Private Offices	Local dimming type wall switch sensor or vacancy sensor & dimming switch as indicated on drawings Photocells where Primary and/or Secondary sidelighting is available Low voltage relay	ON: 100% manual by local wall dimmers/dimming sensor ADJUST: Local dimmer; photocell where daylighting is available OFF: vacancy sensor
4	Open Offices; Copy/Print Rooms	Local dimming switches preset for 50% ON, 100% ON, OFF (no additional manual adjustment) Photocells where Primary and/or Secondary sidelighting is available Vacancy sensor Low voltage relays	ON: manual by local dimming switches ADJUST: Local dimmer (2 levels only); photocell where daylighting is available OFF: by switch or vacancy sensor
5	Meeting Rooms, Conference Rooms, Multipurpose rooms	Local dimming switches Photocells where Primary and/or Secondary sidelighting is available Vacancy sensor Low voltage relays	ON: manual by local dimmer switches ADJUST: Local dimmers; photocell where daylighting is available OFF: vacancy sensor, and manual override by local dimmer switches
6	Mechanical, Electrical, Comms. Rooms	Local low voltage switch Low voltage relay	ON: Manual by local control OFF: Manual by local control or schedule
7	Lobby, Vestibule	Local low voltage switch Occupancy sensor Photocell where daylighting is available Low voltage relays Time of day schedule	ON: 50% Auto on by schedule; remaining 50% by occupancy sensor when space is occupied ADJUST: Dimmed to 50% by occupancy sensor when not occupied; dimmed by photocell in response to daylighting OFF: time of day schedule OVERRIDE: local manual switch to override ON when scheduled OFF
8	Storage up to 1000 sq ft	Local wall switch or sensor switch Vacancy sensors Low voltage relays	ON: Manual on using local switch; OFF: Auto off using vacancy sensors when space is not occupied
9	Exterior	photocell Low voltage relays time-of-day schedule	ON/OFF: by time of day schedule and photocell REDUCE: dimmed by time of day schedule

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-
- 1 General
- 1.1 **INTRODUCTION**
- .1 This document describes the Structured Cabling Improvements project to be undertaken at 95 The Esplanade, Toronto, Ontario.
- 1.2 **DEFINITION**
- .1 Client – Toronto Water.
- .2 Consultant – Arcadis
- .3 Contractor - TBD.
- 1.3 **GENERAL**
- .1 Reference standards and codes are listed in Section 27 00 00, Paragraph 1.6 of this specification.
- .2 These documents have been prepared by the Consultant for the specific use on this project and may not be reproduced in whole or in part without the express written consent of the Consultant. These documents may not be used for any other purpose and are considered confidential for the use of preparing a tender response.
- .3 These tender documents shall remain the property of the Client and the Consultant at all times.
- .4 All information provided in these documents shall be read in conjunction with all other sections of this specification (Division 27), the contract drawings, and any additional general information as prepared by the Consultant or others when issued.
- .5 The Contractor shall report any discrepancies between drawings and all applicable specifications to the Consultant immediately. In case of any discrepancies, the most stringent clause will apply.
- .6 The Contractor is to verify the exact locations of all items shown and must verify with the Consultant all new locations prior to installation. It shall be the responsibility of the Contractor to provide the Consultant detailed layouts of all rooms and locations of installation prior to installation for approval. All costs, including other trades as applicable, associated with changes resulting from non- approved installation will be the responsibility of the Contractor.
- .7 Minor changes in locations (e.g. up to 3 metres in any direction) may be required by the Consultant in order to coordinate site conditions with other divisions and the Consultant reserves the right to make these changes with no additional cost to the Client.
- 1.4 **PROJECT DESCRIPTION**
- .1 As part of a structured cabling improvement project, the project is installing horizontal and backbone cabling, cabinet/rack/access closets, power, cable pathways/conduits, equipment and service entrances
- .2 The purpose of these specifications and drawings is to provide guidelines for the Contractor with information and guidelines based on the industry standards outlined in Section 1.6.
- 1.5 **RELATED SECTIONS**
- .1 Drawings and general provisions of the contract, including general and supplementary conditions apply to this section.
- .2 It follows the Construction Specifications Institute's Master Format and consists of the following sections:
- .1 26 05 01 Common Work Results for Electrical
- .2 27 05 26 Communication System Ground and Bonding

- .3 27 05 53 Identification for Communications Systems.
- .4 27 10 00 Communications Structured Cabling.
- .5 27 11 16 Testing for Communications Systems

1.6

REFERENCES

- .1 Toronto Water Structured Cabling Standard for Commercial Buildings.
- .2 Toronto Water Telecommunication Room Standard.
- .3 TIA-568-series (568.0-E; 568.1-E; 568.2-D; 568.3-E) Telecommunications Cabling Standards
- .4 TIA-606 -D - Administration standard for telecommunications infrastructure (2012).
- .5 TIA-607-D - Generic telecommunications bonding and grounding (earthing) for customer premises (2015).
- .6 C22.2 NO. 214-08 (R2013) - Communications cables (Bi- national standard, with UL 444) (2013).
- .7 C22.2 NO. 232-09 (R2014) - Optical fibre cables (2014).
- .8 CAN/CSA-C22.2 NO. 0-10 (R2015) - General requirements - Canadian Electrical Code, part II (2015).
- .9 CAN/CSA-C22.2 NO. 182.4-M90 (R2015) - Plugs, Receptacles, and Connectors for Communication Systems (2015).
- .10 TIA-569-E - Telecommunications Pathways and Spaces.
- .11 TIA-526-14-C - Optical Power Loss Measurements of Installed Multimode Fibre Cable Plant; Modification of IEC 61280-4-1 edition 2, Fibre-Optic Communications Subsystem Test Procedures- Part 4-1: Installed cable plant- Multimode attenuation measurement (2015).
- .12 TIA-526-7-A - Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant, Adoption of IEC 61280-4-2 edition 2: Fibre-Optic Communications Subsystem Test Procedures – Part 4- 2: Installed Cable Plant – Single-Mode Attenuation and Optical Return Loss Measurement (2015).
- .13 TIA-598-D - Optical Fibre Cabling Coding (2014).
- .14 BICSI TDMM - Telecommunications Distribution Methods Manual, 14th Edition.
- .15 TIA-1152 - Requirements for field test instruments and measurements for balanced twisted-pair cabling (2009).
- .16 TIA-455-244 - Standard test procedure for fibre optic fibres, cables, transducers, sensors, connecting and terminating devices, and other fibre optic components (2011).
- .17 ICEA S-83-596-2011 - Indoor Optical Fibre Cables (2011).
- .18 ICEA S-87-640-2011 - Fibre Optic Outside Plant Communications Cable (2011).
- .19 ICEA S-90-661-2012 - Category 3, 5, & 5e Individually Unshielded Twisted Pair Indoor Cable for Use in General Purpose and LAN Communication Wiring Systems (2012).
- .20 TIA-604-10-B - FOCIS 10b fibre optic connector intermateability standard - type LC (2008).
- .21 CSA C22.1-15 - Canadian electrical code, part I (23rd edition), safety standard for electrical installations (2015).
- .22 NEMA WC 63.1-2005 - Performance Standard for Twisted Pair Premise Voice and Data Communications Cables (2005).
- .23 O. Reg. 213/07, Division C, ss. 2.1.1.1., 2.1.2.1. - The Ontario Fire Code (2007).

- .24 UL 444 Edition 4 - Communications Cables (2010).
- .25 ANSI Z136.2 - Safe Use Of Optical Fiber Communication Systems Utilizing Laser Diode And LED Sources (2012).
- .26 ANSI/EIA/TIA-455-50B - Light Launch Conditions For Long-Length Graded-Index Optical Fiber Spectral Attenuation Measurements (1998).
- .27 ANSI/TIA/EIA-455-59A - Measurement of Fiber Point Discontinuities Using an OTDR (2000).
- .28 ANSI/TIA/EIA-455-60A - Measurement of Fiber or Cable Length Using an OTDR (2000).
- .29 ANSI/TIA/EIA-455-61A - Measurement of Fiber or Cable Attenuation Using an OTDR (1989).
- .30 TIA-TSB-4979 - Practical Considerations for Implementation of Multimode Launch Conditions in the Field (2013).
- .31 IEC-61300-3-35 - Basic Test and Measurement Procedures Standard for Fiber Optic Interconnecting Devices and Passive Components (2015).
- .32 ANSI/TIA-942-A - Telecommunications Infrastructure Standard for Data Centers (2014).
- .33 ANSI/TIA-942-A-1 - Telecommunications Infrastructure Standard for Data Centers, Addendum 1 – Cabling Guidelines for Data Center Fabrics (2013).
- .34 ANSI/BICSI-002 - Data Center Design and Implementation Best Practices (2014).
- .35 EIA/ECA-310-E - Cabinets, Racks, Panels, and Associated Equipment (2005).
- .36 TSB-162-A - Telecommunications Cabling Guidelines for Wireless Access Points (2013).
- .37 ANSI/TIA-862-B - Structured Cabling Infrastructure Standard for Intelligent Building Systems (2016).
- .38 TIA -5017 – Telecommunications Physical Network Security Standard (2016).
- .39 In the event of conflict, the most stringent and recent requirements shall apply to the codes and standards above.
- .40 The Contractor shall perform all work according to Federal, Provincial, and Municipal codes, rules, regulations, and ordinances governing the work, and as fully part of the specifications as if herein repeated or hereto attached.
- .41 If the Contractor should note items in the drawings or the specifications, construction of which would be code violations, promptly call them to the attention of the Client's representative in writing.

1.7

INSPECTION

- .1 Allow the Consultant access to work. If part of work is in preparation at other locations other than the place of work, allow access to work wherever it is in progress.
- .2 Give timely notice requesting inspection if project on any level is designated for special tests, inspections or approvals by the Consultant instructions, or by law.
- .3 Notify appropriate agency and Consultant in advance of requirement for tests so that arrangements can be made.
- .4 Submit samples and/or materials required for testing, as specifically requested in specifications. Submit with reasonable promptness and with necessary components in order so that assessment is made in a timely fashion.
- .5 Provide labour and facilities to obtain and handle samples and materials on site.
- .6 Provide sufficient space to store and cure test samples.

- .7 If special tests, inspections or approvals must be made, work on the project must come to a halt until such special tests, inspection or approvals have been made. Reports of special tests and/or inspection:
 - .1 Must be submitted in PDF format.
 - .2 Must be copied and distributed to the Subcontractor being inspected or tested or manufacturer or fabricator of material being inspected or tested.
- .8 The Consultant may order any part of the project be examined should they suspect to be not in accordance with Contract Documents. If, upon examination such work is found not in accordance with Contract Documents, correct such work and pay cost examination and correction. If such work is found in accordance with Contract Documents, Contractor shall pay cost of examination and replacement.
 - .1 Allow inspection/testing agencies access to project, both off site and on site.
 - .2 Co-operate to provide reasonable facilities for such access.
- 1.8 **EQUIPMENT AND SYSTEMS**
 - .1 Each item of equipment and each system:
 - .1 Includes a description of unit or system, and component parts.
 - .2 Give function, normal operation characteristics, and limiting conditions.
 - .3 Includes performance curves, with engineering data and tests, and complete nomenclature and commercial number of replacement parts.
 - .4 Panel board circuit directories must provide electrical service characteristics, controls and communications.
 - .5 Must include colour coded wiring diagrams.
 - .6 Must outline operating procedures including; start-up, break-in, and routine operating instructions and sequences. This includes; regulation, control, stopping, shut-down, and emergency instructions.
 - .7 Include routine procedures and guide for trouble-shooting, disassembly, repair, and reassembly instructions.
 - .8 Provide servicing schedule.
- 1.9 **SUBMISSION PROCESS**
 - .1 Prepare instructions and data using personnel experienced in maintenance and operation of described products.
 - .2 Copy will be returned after final inspection, with Consultant's comments.
 - .3 Revise content of documents as required prior to final submittal.
 - .4 Submit to the Consultant three (3) copies of operating and maintenance manuals in English and three (3) electronic version on USB Drive.
 - .5 Submission to include soft copy in PDF format. PDF is to be bookmarked and organized in the same manner as hard copy.
 - .6 Submissions are to be formatted as follows:
 - .1 Organize data in the form of an instruction manual.
 - .2 Binders: vinyl, hard covered, 3 'D' ring, loose leaf 219 x 279 mm with spine and face pockets.
 - .3 If multiple binders are used, correlate data in consistent groupings.
 - .4 Identify contents of each binder on spine.

- .5 Cover: Identify each binder with type or printed title 'Project Record Documents'; list title of project and identify subject matter of contents.
- .6 Arrange content by systems, process flow, under Section numbers and sequence of Table of Contents.
- .7 Provide tabbed fly leaf for each separate product and system, with typed description of product and major component parts of equipment.
- .8 Text: Manufacturer's printed data, or typewritten data.
- .9 Drawings: provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages. Always folded such that the drawing number and Project Title are visible.
- .7 Closeout Submittals include:
 - .1 As-built, samples, and specifications.
 - .2 Cabling test results and cabling test results compliance sheet.
 - .3 Site acceptance test document.
 - .4 Equipment and systems.
 - .5 Product data, materials, finishes and related information.
 - .6 Operation and maintenance data.
 - .7 Training document.
 - .8 Spare parts, special tools and maintenance materials.
 - .9 Active equipment manufacturer product warranty documents (UPS/ATS etc).
 - .10 Belden or Panduit structure cabling system 25- year warranty certificate.
 - .11 City approval of Satisfaction – signing off.
- .8 Contents must include:
 - .1 Table of Contents:
 - .1 Provide title of project;
 - .2 Date of submission;
 - .3 Names, addresses and telephone numbers of Contractor with name of responsible parties;
 - .4 Schedule of products and systems, indexed to content of volume.
 - .2 For each product or system:
 - .1 List names, addresses and telephone numbers of subcontractors and suppliers, including local source of supplies and replacement parts.
 - .2 Product Data: mark each sheet to clearly identify specific products and component parts, and data applicable to installation; delete inapplicable information.
 - .3 Drawings: supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams.
 - .4 Typewritten Text: as required to supplement product data. Provide logical sequence of instructions for each manufacturer's instructions specified in Section 01 45 00 – Quality Control.

1.10 **SCHEDULE**

- .1 The Contractor shall be responsible to meet the project schedule as provided by the Consultant and/or the Client.
- .2 Work is generally to be performed during regular work hours unless noted otherwise in this document.
- .3 The Contractor is to include for all necessary overtime labour in order complete the project. The Contractor shall be responsible for providing labour in order to complete the work within the schedule with no additional cost to the Client.
- .4 The Contractor shall supply a project plan using Microsoft Project software detailing the schedule of installation in coordination with the overall project schedule.
- .5 At and near the completion of the project, the Contractor will be responsible for providing project documentation for the Client's further use. This will include:
 - .1 Temporary As-Builts five (5) days prior to cutover.
 - .2 Contact Info for Cutover Technician 5 days prior to cutover.
 - .3 As-Built Test Results 10 days after cutover.
 - .4 As-Built Drawings 10 days after cutover.
- .6 All documents and information are to be provided as further detailed in these specifications and delivered to the Consultant.

1.11 **TENDER SUBMISSIONS**

- .1 The tender closing details are to be provided by the Consultant and are considered part of these specifications.
- .2 All submissions received after the closing time will be considered non-compliant and disqualified from further evaluation.
- .3 All submissions shall be valid for a period of 90 days from date of closing and include all applicable taxes.
- .4 Bidders finding discrepancies or omissions in these documents, or who have any question regarding the meaning, interpretation or intent shall contact the Consultant in writing or via email or fax. All questions and clarifications will be issued to all bidding Contractors. Questions received by the Consultant within 72 hours of the closing date will not be answered. Please contact:

Att'n.: Faraz Bolourian
Email: faraz.bolourian@arcadis.com
- .5 The Contractor shall read and be responsible for all tender documentation issued for this project and complete all applicable tender forms in their entirety to be considered compliant to this document.
- .6 The Contractor shall complete and submit the tender documents provided with this specification. Submissions must be complete with unit, itemized and separate prices requested to be in compliance with this document.
- .7 The Contractor shall sign the tender documents acknowledging acceptance of all terms, conditions and instruction contained in these specifications and drawings.
- .8 Tender submissions not found to be compliant with these specifications or drawings may be rejected by the Client for further evaluation.
- .9 It is the purpose of this tender to collect pricing for the Client and the contract may not be awarded to the lowest bidder. The Client reserves the right to accept or reject all, or part of any submission.

- .10 Tender submissions must include all labour, material, transportation, storage, insurance, bonding, inspection fees, permits, training, disposal, taxes, hoisting, and incidental costs associated with the delivery of the project.
 - .1 The Contractor is responsible for visiting the site to perform a site review to familiarize themselves with the site conditions that may affect their ability to perform the installation.
 - .2 No additional costs will be accepted by the Client for failing to complete this review.
 - .3 The Bidding Contractors may be requested to attend a Bidders site meeting. Attendance at this meeting is mandatory to familiarize the Bidders with the site conditions, review the Specifications and answer any questions.
 - .4 A bill of materials is required as part of the tender submission for evaluation by the Consultant and the Client which shall not be considered a complete material list for the purpose of the contract.
 - .5 Bidding Contractors must notify the Consultant within 72 hours prior to closing date if they intend not to bid this project.
 - .6 The Contractor may suggest alternates and include a full description, material list and a narrative of technical and financial advantages in writing. This information must accompany the required tender submission on the closing date to be considered compliant.
 - .7 Suggestions will be evaluated by the Consultant and Client and may be accepted or rejected solely on their opinion.
 - .8 Costs associated with the preparation of this tender including printing and reproduction of drawings or specifications is the sole responsibility of the bidding Contractor. Reproduction of drawings or specifications in whole or in part must be approved in advance and in writing, by the Consultant.
 - .9 Oral presentations of selected bidders may be requested for evaluation purposes at no additional cost to the Client.
 - .10 The Client assumes no responsibility to issue a contract based on this tender call and may re-issue or cancel the tender at any time.

1.12 **LABOUR**

- .1 The Contractor shall provide proof its current status as a networking contractor in Belden Partner Alliance Program (or Panduit equivalent program) and shall deliver Belden or Panduit Warranty which includes a 25-year Product Warranty and Lifetime Application Assurance for the installed Belden or Panduit Cabling System.
- .2 All contractors/technicians shall be certified with Belden or Panduit, Fluke
- .3 Networks, or BICSI to perform installations and testing/commissioning.
- .4 The Contractor shall be responsible to provide Union or Non-union labour as required on the project site and meet all requirements without any delay or cost to the Client, General Contractor or other trades.
- .5 Sub-Contractors shall not be allowed to perform all or any portion of the project unless approved in writing by the Consultant and the Client. Subcontractors must be identified at time of tender to be considered for approval.
- .6 The Contractor must be in compliance at all times with local, provincial and federal employee standards, safety acts, fire codes and other applicable legislations, codes and acts affecting the delivery of the project. The Contractor is responsible for the training and notifying their employees of any details associated with all codes, standards, acts and legislation applicable to this project.

- .7 WSIB (Workplace Safety Insurance Board) clearance certificate indicating a good standing is to be provided by the Contractor prior to acceptance of any contract.
- .8 Provide personal identification in a form acceptable to the Client for all employees attending the site for this project when requested.
- .9 Provide remedial work required to repair or replace parts or portions of work identified as defective or unacceptable. Coordinate adjacent affected work as required.
- .10 Perform remedial work by specialists familiar with materials affected. Perform in a manner to neither damage nor put at risk any portion of work.
- .11 Prevent overloading of any part of building. Do not cut, drill or sleeve any load bearing structural member, unless specifically indicated, without written approval of the Consultant.

1.13 **MANUFACTURER'S INSTRUCTIONS**

- .1 Unless otherwise indicated in specifications, install or erect products in accordance with manufacturer's instructions. Do not rely on labels or enclosures provided with products. Obtain written instructions directly from manufacturer.
- .2 Notify the Consultant in writing, of conflicts between specifications and manufacturer's instructions, so that the Consultant may establish course of action.
- .3 Improper installation or erection of products, due to failure in complying with these requirements, authorizes the Consultant to require removal and proper installation at no increase in Contract Price or Contract Time.

1.14 **QUALITY OF WORK**

- .1 Ensure quality of work is of the highest standard, executed by experienced and skilled workers in the respective duties for which they are employed.
- .2 Notify the Consultant if conditions make it impractical to produce the required results.
- .3 Do not employ anyone unskilled in their required duties. The Consultant reserves the right to dismiss from site, workers deemed incompetent or careless.
- .4 Decisions as to standard or fitness of Quality of Work in cases of dispute rest solely with the Consultant, whose decision is final.

1.15 **INTERPRETATION AND SPECIFICATIONS OF DRAWINGS**

- .1 It is the responsibility of the Contractor to read carefully these specifications and drawings and report any discrepancies immediately to the Consultant.
- .2 All drawings and details have been prepared to illustrate the existing and new conditions of the project and are to be considered diagrammatic and represent the intent of the project.
- .3 The Contractor will ensure all components required to complete the fully operational system are installed with no additional cost to the Client or to the Consultant.
- .4 Dimensions and measurements shown in these documents must be verified by the Contractor on site prior to final installation.
- .5 Quantities and lengths identified are approximate and must not be used to gauge or limit work.

1.16 **CONTRACT**

- .1 The successful Contractor may at the Client's discretion be required to enter into a contract with the Client directly or with one of the project team.
- .2 The Contractor must submit a breakdown of the project value for the purpose of evaluating monthly draws. The breakdown must be approved by the Client to be accepted. The breakdown must include an amount of 10% for Final Documentation.

- .3 Monthly progress draws must be submitted to the General Contractor for approval by the Client.
- .4 This specification, associated drawings, addendum, tender instructions, and the successful Bidders response will all be considered as part of the contract.
- .5 All contemplated changes, change notices and addendums to these contract documents must be in written form and issued by the Client, to be considered valid with this contract.
- .6 No verbal authorizations or interpretations will be recognized.
- .7 Holdback will be applied to this project as follows:
 - .1 Standard Holdback applied by General Contractor at a rate of 10%
 - .2 Final Documentation Holdback – the Consultant reserves the right to not approve payment (10%) for final documentation not delivered and approved complete, in accordance to this document.

1.17 **CODES AND PERMITS**

- .1 The Contractor must comply with all local, provincial and federal codes and apply for permits required and applicable. Costs for permits and all documentation required to obtain these permits shall be included in the tender amount.
- .2 Special inspections and “Right of Way” permits must be coordinated with vendors and service providers and be included in the tender amount.
- .3 Copies of all applications, supporting documents and responses to be issued to the Consultant at time of application or receipt and included in the Project Manual.

1.18 **WASTE COLLECTION AND DISPOSAL**

- .1 Separate and salvage materials suitable for reuse and/or recycling from general waste stream.
- .2 Provide on-site facilities for collection, handling and storage of predicted quantities of reusable and/or recyclable materials.
- .3 Locate containers in such a manner that they facilitate deposit of materials without hindering daily operations.
- .4 Collect, handle and store on site and transport off site. Salvaged materials, salvaged for reuse and/or recycling must be stored and transported separately. Transport to authorized reuse/recycling locations only.
- .5 Separate non salvage materials from salvage items. Transport and deliver non salvageable items to licensed disposal facility.
- .6 Burying, burning or selling waste materials on-site is prohibited.
- .7 Disposal of liquid waste into waterways or sewers is prohibited.
- .8 Unless otherwise stated, materials for removal become Contractor’s property.
- .9 Clean up work, storage and waste collection areas as work progresses.
 - .1 Remove waste material and debris from site and deposit at waste container at the end of each working day.
 - .2 Store volatile waste in covered metal containers, and remove from premises at end of each working day.

1.19 **COORDINATION**

- .1 The Contractor shall provide an installation schedule and make all changes associated with coordination with other trades and to accommodate unforeseen site conditions at no additional cost to the Client.

- .2 Contractor shall maintain two (2) sets of drawings and specifications, for record drawing purposes.
- .3 Record changes and at completion of project submit one marked to the Consultant.
- .4 Prepare interference drawings and sketches for presentation to the Consultant to review any anticipated conflicts with other trades.
- .5 Prepare detailed layouts of equipment rooms prior to installation for review by the Consultant. Layouts must indicate other major pieces of equipment being supplied by other trades.
- .6 The Contractor shall be responsible for attending coordination meetings as requested by the General Contractor or Project Manager for the coordination of locations and services. The Project Manager selected must be assigned for the duration of the project and may only be changed with the written consent of the Consultant.
- .7 The Contractor, in addition to coordination of meetings, shall attend weekly site meetings and be prepared to provide current project progress status, anticipated completion of future tasks and information on outstanding delivery items.
- .8 Access to the site must be in compliance to all rules, regulations, safety standards and security procedures established for the project or building. Fees for after- hours access shall be considered included in the tender amount. No additional cost will be accepted by the Client for these requirements.
- .9 Cutting and patching of all surfaces as applicable to the Telecommunications- Security installation will be the responsibility and performed by the Contractor. All work must be performed to the standards set by the codes and standards contained herein.
- .10 Cutting and patching of all structural members must be approved by the Architect prior to work starting.
- .11 No metal cutting/drilling that creates metal filings is to be carried out in the raised floor data centre areas. The contractor is required to use at minimum HEPA vacuums.
- .12 Work causing excess noise or disturbance to the operation of the Client's or surrounding businesses is to be performed at agreed times and in coordination with each party. All damages caused for work performed not in compliance with this item shall be the responsibility of the Contractor.

1.20 **TEMPORARY SERVICE**

- .1 The Contractor shall provide all required materials, labour, tools and transportation of products/equipment to meet the temporary requirements of the project in coordination with other trades and the General Contractor at no additional cost to the Client.
- .2 All hoisting, mechanical lifts and special scaffolds shall be the responsibility of the Contractor and at no additional cost to the Client.
- .3 All power supplies, extension cords and equipment cords shall be the responsibility of the Contractor and shall be installed in good working order and in accordance to all codes, standards and building regulations

2 Products

2.1 **GENERAL**

- .1 All equipment and products supplied must be new and free of all manufacturer defects and delivery or installation damage.
- .2 All equipment and products supplied shall meet all manufacturer listed characteristics as identified in the latest manufacturer catalogue.

- .3 All products shall meet all applicable codes and standards and bare the UL/ULC label, be CSA approved and meet FCC/CRTC Regulations.
- .4 All products must be provided in accordance with local, provincial and national fire ratings for the installation on this project.
- .5 Acceptable manufacturers and part numbers provided as benchmarks where applicable.
- .6 All products and the system solution related to the Telecommunications systems are to be approved by the Consultant.
- .7 Please note that any and all references to Belden products and/or Part numbers is provided strictly as a reference product. Panduit is acceptable provided it meets the fit, form and function of the reference product.

2.2 **APPROVED MANUFACTURERS**

- .1 All backbone fibre optic cables, connectors, patch cords, patch panels, cassettes and adaptors shall be from Corning.
- .2 All Category 6A modular jacks, faceplates, UTP patch cords and Category 6A cables shall be from Belden or Panduit.
- .3 Where cross connect punch down is required at Entrance Facility for termination of all voice backbone cables, it shall be from Belden or Panduit.
- .4 All free standing Telecommunication Enclosures in the Equipment Room / Telecom Room shall be from Chatsworth Products, Inc. (CPI).
- .5 All fire-stopping EZ-PATH components shall be from Specified Technologies Inc.
- .6 For UPS, Eaton shall be the manufacturer. PDU (power distribution Unit) shall be Vertiv.
- .7 For rack-mount Automatic Transfer Switch (ATS), Eaton shall be the manufacturer.

2.3 **CERTIFICATION**

- .1 Separate each warranty or bond with index tab sheets keyed to Table of Contents listing.
- .2 The Contractor shall currently be an authorized and certified installer of the manufacturer of the structured cabling systems being tendered in order to provide the manufacturer's 25-year warranty. The Contractor will provide a letter of authorization from the manufacturer with their bid stating that they are in good standing with the manufacturer's certification program.
- .3 Subcontractors shall not be acceptable to provide warranty unless pre-approved by the Consultant at time of tender. Subcontractors will not be approved after tender is awarded.
- .4 The Contractor shall provide a written 2-year warranty inclusive of all parts and labour for the end to end solution.
- .5 The Contractor shall also state and agree in writing to provide response for any warranty request within 24 hours during this warranty period.
- .6 Verify documents are in proper form, contain full information, and are notarized.
- .7 Co-execute warranty submittals when required.
- .8 Retain warranties until time specified for submittal.

2.4 **SUBSTITUTIONS**

- .1 Manufacturer Substitution of any part other than those specified in this standard is strictly prohibited without the written consent of Toronto Water PCS /Divisional Network Service (DNS) Division.
- .2 The procedure for substitution approval will include the written submission by the Contractor and include the following:

- .1 Original benchmark product.
 - .2 Proposed product being substituted.
 - .3 Reason for substitution.
 - .4 Shop drawings indicating all technical specifications.
 - .5 Financial advantage.
 - .6 Schedule delivery date.
 - .7 Foreseeable delay of product supply/arrival.
 - .8 Written approval from certifying system manufacturer.
- .3 Based on the review of the information requested above, the Client and/or the Consultant reserve the right to reject any proposed substitution without delay or cost to the project or the Client.
- .4 In the event of foreseeable delay of availability of products, notify the Consultant of such, in order to substitute in a timely manner to ensure quality of work is not affected by any delays.
- .5 In the event of failure to notify the Consultant at commencement of work and should it result in work being delayed, the Consultant reserves the right to substitute a more readily available product of similar character, at no increase in Contract Price or Contract Time.

2.5

SHOP DRAWINGS

- .1 The Contractor will provide 3 copies and 1 digital copy of manufacturer prepared shop drawings identifying complete technical specifications for each product being supplied as part of the end to end solution including fire stopping, pathways and other miscellaneous products.
- .2 The Contractor must submit shop drawings within fourteen (14) days of contract award. Shop drawings are to be stamped and signed "For Review" complete with date submitted.
- .3 Accompany submissions with transmittal letter, in duplicate, containing:
 - .1 Date.
 - .2 Project title and number.
 - .3 Contractor's name and address.
- .4 Manufacturers shop drawings showing various model or styles must be labeled with identification arrows showing which items are being proposed. Arrows must be reproducible through standard photocopying.
- .5 Shop Drawings must be approved by the Consultant and City TW/PCS/DNS prior to starting installation and the Contractor will be responsible for the cost of replacing of all installed product not approved.

2.6

PROJECT DOCUMENTATION

- .1 The Contractor will supply all as-built drawings showing all cable numbers on floor plans, rack elevations, backboard layouts and cable routing shall be provided at the completion of the project. Drawings must include all architectural and project changes. Provide within 10 days of completion of the project, 1 hard copy of As-built drawings for review and approval by the Consultant.
- .2 Make as-built drawing changes as requested by the Consultant at no additional cost.
- .3 The Contractor shall be responsible for maintaining a complete set of As-built marked up drawings on site for the Consultant to review at all times. Drawings must be up to date with all architectural and project changes.

- .4 Maintain a log of date, time and reason for any delays in performing the installation. Details must include names, conditions and specific reason for delay.
- .5 Upon written approval from the Consultant, prepare 3 full size copies, 3 - 11x 17 copies and 3 soft copies on USB of as-built drawings. Distribute 2 copies of all formats to the Client and 1 copy to the Consultant.
- .6 The Contractor must provide as-built drawings in the latest AutoCAD format (2010 or newer) and no hand written changes will be permitted. No additional costs for preparation or reproduction of these drawings will be accepted by the Client.
- .7 Prepare a complete test report for each cable identifying a successful test on each cable, complete with the technician's signature and date. Test reports are to be full test reports in the testing software format, with one page per cable. Provide 1 soft copy on USB of test results with appropriate viewing software to the Consultant within 5 days of project completion, for approval.
- .8 Upon written approval from the Consultant, prepare 2 hard copies and 2 soft copies to be included in the project manual.
- .9 At the completion of the project be prepared to submit 1 copy of a Project Manual in a 3-ring binder to the Consultant for review and approval. This Project Manual must include:
 - .1 The Contractor's name, contact information and lead installer/foreman's contact info.
 - .2 Letter detailing, total cost of project (including changes), square footage, number of cable drops, project highlights, Architect and Client name and contact information.
 - .3 Standard project two (2) years warranty.
 - .4 Manufacturer's Certification and warranty (extended 25-year cabling system warranty) documentation.
 - .5 Approved shop drawings.
 - .6 One (1) hard copy and one (1) soft copy of approved test results.
 - .7 Final bill of materials.
 - .8 Maintenance and/or operation manuals for all equipment.
 - .9 Connectivity database if applicable.
 - .10 WHIMS data sheets on all applicable materials including fire-stopping.
 - .11 11x17 copy of approved as-built drawings.
- .10 Once approved prepare two (2) additional copies of manuals and deliver to the Client.
- .11 The Consultant's copy of the manual will not be returned and retained for future use.
- .12 Final documentation not provided within 30 days of project completion and with reasonable notification, may result in the commissioning of another agent to prepare such documents. Costs for this work will be deducted from all Holdback amounts available to the Contractor.

2.7 **MATERIAL HANDLING**

- .1 The Contractor is responsible for the delivery of all materials to site and transportation to the work place in accordance with all safety regulations and procedures.
- .2 Delivery and Acceptance Requirements: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.
- .3 Storage and Handling Requirements: Store and handle materials in accordance with manufacturer's instructions.

- .4 Keep materials in manufacturer's original, unopened containers and packaging until installation.
 - .1 Store materials in clean, dry area indoors.
 - .2 Protect materials during storage, handling, and installation to prevent damage.
 - .3 Must follow manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning.
- .5 The Contractor shall provide his own hoisting facilities regardless of height required to perform the work as specified.
- .6 The Contractor to make arrangements and schedule all hoisting with the Client and the General Contractor.
- .7 Provide lockable storage for all tools and materials required to complete the installation throughout the duration of the project. Once the project is complete, the Contractor shall remove all tools and excess materials within 5 business days.
- .8 The Client and its representatives shall in no way be held liable for any missing material, equipment or tools required to complete the installation.

3 Execution

3.1 **GENERAL**

- .1 The Contractor shall supply all materials, labour, tools and equipment to provide a complete warranted installation as outlined in the contract documents and suitable to the approval of the Client, the Consultant and inspection bodies having jurisdiction.
- .2 The Contractor shall be responsible for installing and providing pulling strings, ropes and fishing walls wherever conduit is not installed or conduit is installed without these provisions.
- .3 Provide continuity of all existing services while completing the specified installation. Losses due to interruption of services will be the responsibility of the Contractor.
- .4 Arrange for all shutdowns two (2) weeks prior in writing with the Project Manager and those in control of services to be disrupted. City must approve the shutdowns. All overtime costs, fees, security and other requirements shall be the full responsibility of the Contractor.
- .5 Should services be interrupted accidentally, the Contractor must provide services to resume services immediately and continue without stoppage until complete.
- .6 All costs including overtime will be the responsibility of the Contractor and no additional costs will be assigned to the Client.

3.2 **SITE CONDITIONS**

- .1 The Contractor is responsible for maintaining a clean work environment and is responsible for the removal of all debris on a daily basis. Debris and removed materials must be disposed in conformance to all local by laws and regulations. Failing to comply and after reasonable time and written notice, the Client reserves the right to hire cleaners to complete the cleaning and back charge the Contractor.
- .2 The Contractor shall be responsible for the removal and reinstallation of all floor or ceiling tiles, hatch ways or access panels. All items shall be removed and replaced on a daily basis and left in the original condition. Special caution is to be taken to not break, chip or discolour with dirt or finger prints any such items. The Contractor will be fully responsible for repair or replacement of all damaged pieces at the discretion of the Consultant and/or Client.
- .3 Actual Site Conditions must be recorded on a regular basis and must:

- .1 Be recorded by felt tip pen, maintaining separate colours for each major system, for recording information.
- .2 Record information currently with construction progress. Do not conceal work until required information is recorded.
- .3 Legibly mark Contract Drawings and Shop Drawings to record actual construction.
- .4 Legibly mark each item to record actual construction, including:
 - .1 Manufacturer, trade name, and catalogue number of each product actually installed, particularly optional items and substitute items.
 - .2 Changes made by Addenda and change orders.
- .5 Maintain manufacturer's certifications, inspection certifications, field test records, required by individual specification sections.
- .6 It is the responsibility of the Contractor to perform all cutting, patching and repair as per instructions from the General Contractor and the Client Project Managers.
- .7 The Contractor is fully responsible for storage of all temporarily removed items for the project.
- .4 Prior to final review, remove surplus products, tools, construction machinery and equipment.
- .5 All materials and installation throughout the project will remain the responsibility of the Contractor until final completion for the project is accepted by the Client. Damages to any item installed shall be replaced or repaired by the Contractor to provide a complete final installation at no additional cost to the Client.
- .6 At the completion of the project or as and when the Client requires, restore the original condition of all materials, equipment and surfaces within the work area affected by this installation.
- .7 All vehicular traffic entering the site must be coordinated with the General Contractor and no parking or compensation for paid parking will be provided by the Client.

3.3 **SAFETY**

- .1 The Contractor shall adhere to all safety laws, rules and regulations issued by the authorities having jurisdiction, General Contractor, Project Manager and the Client.
- .2 The Contractor shall attend all Safety Program meetings requested by the Project Manager.
- .3 Provide adequate protection in public and work areas to pedestrian and other trade traffic using approved safety barriers, caution tape and signage.
- .4 At all times, maintain clear fire exits, emergency routes and access to emergency equipment including fire hose cabinets, fire extinguishers and stand pipe connections.
- .5 Smoking and combustion of any materials is strictly prohibited on all sites.
- .6 Provide information to all employees of emergency and fire safety plans for the work site and facility.
- .7 Provide protection as required by the authorities having jurisdiction to all employees for work performed in typically inaccessible or concealed spaces.
- .8 If an approved subcontractor is used, provide information and ensure all safety specifications herein are met.

3.4 **SITE ADJUSTMENTS**

- .1 Locations or all equipment, outlets or devices prior to installation may be revised to within three (3) meters without any additional cost or change request.

.2 Portions of the project may be at any time identified in writing to be "On Hold". Work in these areas is not to be started, continued or completed until further direction is received.

.3 No additional cost will be accepted by the Client for areas put On Hold.

3.5

STANDARD PROJECT TWO (2) YEARS WARRANTY

.1 Per City standard Construction Agreement, the Contractor shall provide at minimum 2-years standard project warranty after the project final sign off/acceptance, or the warranty period that is defined in the contract documents.

.2 For a period of twenty-four (24) months following Final Acceptance, the contractor shall provide a qualified technician/electrician to fix identified the contractor supplied and installed components related issues.

.3 The Contractor will be given twenty-four (24) hours notice as to their requirement on-site.

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1 General

1.1 **INTRODUCTION**

- .1 It is essential in today's installations to have a properly installed grounding and bonding system because of all the sensitive electronic components being connected together in a network.
- .2 A telecommunications grounding and bonding system consists of grounding busbars, bonding backbones, and other bonding conductors.
- .3 It provides a common ground reference for the telecommunications systems within the building and a common bonding system back to the main telecommunications room.
- .4 This section specifies a uniform telecommunications grounding and bonding infrastructure that shall be followed within the museum based on the ANSI/TIA- 607C standard.
- .5 This is to be a Design- Bid- Build project and the purpose of these specifications and drawings is to provide guidelines for the ICT Contractor based on industry standards outlined in Section 27 00 00, Paragraph 1.6.
- .6 If there are any questions, please contact the Consultant for clarification.

1.2 **SYSTEM DESCRIPTION**

- .1 Metallic pathways, cable shields, conductors, and hardware within telecommunications spaces are to be bonded to telecommunications grounding and bonding system.
- .2 All cables and related terminations, support and grounding hardware shall be furnished, installed, wired, tested, labelled, and documented by the Contractor as detailed in this section.
- .3 Product specifications, general design considerations and installation guidelines are provided in this section.
- .4 The Contractor shall meet or exceed all requirements for the cable system described in this section.
- .5 Local electrical codes shall be adhered to.
- .6 Local building codes shall be adhered to.
- .7 All communications components including, entrance lugs, entrance terminal frames, racks, cabinets, cable tray, ladder racks, metallic pathways, enclosures and other components noted on drawings shall be bonded to an independent grounding system and in accordance with local codes and standards, ANSI/TIA- 607-C, ANSI/TIA- 942-A and IEEE Std. 1100 and these specifications.
- .8 Grounding system shall include a local copper Telecommunications Grounding Busbar (TGB) (by Division 26) in each entrance facility and equipment room bonded to a Telecommunications Grounding Backbone (by Division 26).
- .9 The TGB shall be bonded directly to the Telecommunications Main Grounding Busbar (by Division 26). The TMGB shall be bonded directly to the building electrical entrance grounding system and meet all local codes and standards as noted above.
- .10 The grounding system shall be visually verifiable and adequately sized to handle expected currents safely.
- .11 All grounding conductors and busbars shall be made of copper.
- .12 The grounding system shall be intentional, visually verifiable, adequately sized to handle expected currents safely, and direct these currents away from network equipment. As such, grounding shall be purposeful in its design and installation.
- .13 Lugs, HTAPs, grounding strips, and busbars shall be UL Listed and CSA certified and made of premium quality tin-plated electrolytic copper that provides low electrical

resistance while inhibiting corrosion. Antioxidant shall be used when making bonding connections in the field.

- .14 Wherever possible, two-hole lugs shall be used. All lugs shall be irreversible compression and meet NEBS Level 3 as tested by Telcordia. Lugs with inspection windows shall be used in all non-corrosive environments so that connections may be inspected for full conductor insertion (battery rooms are an exception where windowless lugs may be used).
- .15 Die index numbers shall be embossed on all compression connections to allow crimp inspection.
- .16 Cable assemblies shall be UL Listed and CSA Certified. Cables shall be a distinctive green or green/yellow in color, and all jackets shall be UL, VW-1 flame rated.

1.3 **RELATED SECTIONS**

- .1 This section shall be read in conjunction with all other sections as listed in Section 27 00 00, Paragraph 1.5, the contract drawings. In addition, the general provisions as listed in the document preface, including supplementary conditions shall apply.

1.4 **REFERENCES**

- .1 Reference standards and codes are listed in Section 27 00 00, Paragraph 1.6 of this specification.
- .2 The Contractor shall perform all work according to Federal, Provincial, and Municipal codes, rules, regulations, and ordinances governing the work, and as fully part of the specifications as if herein repeated or hereto attached.
- .3 This document does not replace any code, either partially or wholly. The Contractor must be aware of local codes that may impact this project.
- .4 If the Contractor should note items in the drawings or the specifications, construction of which would be code violations, promptly call them to the attention of the Client's representative in writing.
- .5 All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to the most recent release when developing the proposal for installation.
- .6 In the event of conflict, the most stringent and recent requirements shall apply to the codes and standards above.

1.5 **ABBREVIATIONS**

- .1 The following abbreviations are excerpted from the ANSI/TIA-607-B standard entitled: Generic Telecommunications Bonding and Grounding (Grounding) for Customer Premises:
 - .1 TMGB – Telecommunications Main Grounding Bar.
 - .2 TBB – Telecommunications Bonding Backbone.
 - .3 TBC – Telecommunications Bonding Conductor.
 - .4 TGB - Telecommunications Grounding Busbar.
 - .5 TBBIBC – Telecommunications Bonding Backbone Interconnecting Bonding Conductor.

2 Products

2.1 **GENERAL TELECOMMUNICATIONS MAIN GROUNDING BUSBAR (TMGB)**

- .1 An insulated predrilled copper busbar listed by NRT, electro-tin plated with holes 8mm diameter for use with standard-sized lugs.

- .2 Dimensions: 6 mm thick, 100 mm wide, variable length as applicable.
- .3 Shall be insulated from its support by a minimum of 50 mm.

2.2 TELECOMMUNICATIONS GROUNDING BUSBAR (TGB)

- .1 Predrilled copper busbar listed by NRT, electro tin plated with holes 8 mm diameter for use with standard- sized lugs.
- .2 Dimensions 6 mm thick, 50 mm wide, variable length as applicable.
- .3 Shall be insulated from its support by a minimum of 50 mm.

2.3 TELECOMMUNICATIONS BONDING BACKBONE (TBB)

- .1 Cable assemblies shall be UL Listed and CSA Certified and be a minimum of 6 AWG copper conductor, green insulated.
- .2 Telecommunications Grounding and Bonding Conductor Label Kits shall be supplied and installed by the Electrical Contractor at every rack and cabinet as well as one for every Telecommunications Grounding Busbar.
- .3 The bonding conductor size shall be as follows:

TBB Length in Linear Metres Metres (Feet)	TBB Size (AWG)
Less than 4 (13)	6
4-6 (14-20)	4
6-8 (21-26)	3
8-10 (27-33)	2
10-13 (34-41)	1
13-16 (42-52)	1/0
16-20 (53-66)	2/0
20-26 (67-84)	3/0

2.4 TELECOMMUNICATIONS BONDING CONDUCTOR (TBC)

- .1 Cable assemblies shall be UL Listed and CSA Certified and be a minimum, the same size as the largest TBB copper conductor.
- .2 Shall be green insulated and marked in accordance with ANSI/TIA-607-C.

2.5 WARNING LABELS

- .1 Non-metallic warning labels in English: TIA-607-C.
- .2 Identify labels with wording "If this connector is loose, please call the building telecommunications manager or site / area supervisor".

3 Execution

3.1 GENERAL

- .1 The grounding and bonding system shall provide equipment ground connections (bonds) from the premises entrance facility and outside-plant grounding system to each

telecommunication room telecommunication ground busbar, through the racking systems to bond the network equipment.

- .2 The entire grounding link from equipment to earth should be visually verifiable except where hidden by walls, conduit or pathways.
- .3 The Contractor shall ensure that all elements of the communications bonding network are labelled according to guidelines defined in ANSI/TIA-607-B and ANSI/TIA 606-B.

3.2 **TELECOMMUNICATIONS BONDING BACKBONE (TBB)**

- .1 Bonding and grounding conductors may be insulated or un-insulated and shall not decrease in size as the grounding path moves closer to earth.
- .2 Connections (bonds) between the telecommunications grounding network and associated electrical panels shall be done by a qualified electrician in accordance with guidelines in ANSI/ANSI/TIA 607-B and applicable electrical codes.
- .3 Bonding Conductors should be continuous and routed in the shortest possible straight line path, avoiding changes in elevation and sharp bends.
- .4 TBB conductors shall be protected from mechanical damage and built so as to minimize splicing. Where splicing is unavoidable they shall be done using irreversible compression splices (C-TAPS) built to that purpose. See the "Materials" section of this document for appropriate compression splices.
- .5 Routing grounding conductors through ferrous metal conduit should be avoided, but if it is necessary due to building constraints, any grounding conductor running through ferrous conduit longer than 3 feet shall be bonded at the end using appropriately sized HTAP and Conduit grounding clamps as described ANSI/TIA 607-C-Busing appliances described for that purpose in the "Materials" section of this document.
- .6 Conductors used to bond TBB to conduit ends shall be of #6 AWG size or larger.

3.3 **CUTTING, PATCHING AND REPAIRING**

- .1 Racks and Cabinets shall be bonded into the communications bonding network with conductors of #6 AWG or larger.
- .2 Racks and cabinets shall have individual Rack Bonding Conductors (RBC) bonding to the Telecommunications Equipment Bonding Conductor (TEBC) or underfloor Supplemental Bonding Grid.
- .3 In smaller Telecommunications Rooms (3-5 racks) it is acceptable to have telecommunications equipment bonding conductors (TEBC) that go directly from each individual rack to the TGB.
- .4 Rack Bonding Conductors (RBC) or above rack row grounds (TEBC) shall be installed to maintain a minimum of 50 mm (2") separation from all other types of cable - power or communications.
- .5 Depending on size of the telecommunications room, Rack Bonding Conductors (RBC) may tap into underfloor or overhead grounding conductors, or for smaller TRs (3-5 racks or cabinets), may go directly from the rack to the wall mounted busbar.
- .6 Racks, cabinets and similar enclosures shall not be attached serially (daisy- chained) but must have individual RBC into the grounding system.
- .7 Newly installed racks and cabinets shall have vertical grounding busbars installed along one rail to provide clean bonding landing point for all rack mount equipment. Grounding busbars shall not be isolated from the rack or cabinet.
- .8 All painted components of racks/cabinets shall be assembled using serrated grounding washers and thread- forming screws to ensure electrical continuity between the different structural components of the rack/cabinet.

- .9 Larger equipment (chassis switches) with integral grounding terminals or pads shall be bonded to the vertical busbar with equipment grounding kits attached to those terminals and bonding them to the rack-mounted busbars.
- .10 Anywhere two metallic surfaces are to be bonded, contractor shall clean the contact areas of paint or oxidation using abrasive pads, and apply film of anti-oxidation compound between surfaces prior to bonding.
- .11 All cable fittings shall be of two-hole (LCC series) compression-type. Mechanical screw-lugs on racking systems will not be accepted and must be removed and replaced at contractor's expense.
- .12 All screws used to affix compression lugs to rack-mounted vertical busbars shall be of the thread forming type made specifically for electrical bonding.
- .13 Smaller equipment (servers, TOR switches) not having integral grounding pads must be bonded to the rack through the equipment mounting flanges using green thread-forming grounding screws with serrations under the head to cut through paint, coatings and oxidation that may be present on the equipment flange. Such equipment shall have minimally one grounding screw per piece of equipment.
- .14 Existing (installed) racking systems containing live active equipment may be retrofitted for Standards-compliant bonding using rack retrofitting kits.
- .15 ESD (electro-static discharge) ports and wrist straps shall be provided minimally every other rack or bay to be within reach of any active equipment. On larger 4-post racks or cabinets - ESD ports and wrist straps shall be installed on the front and back to be accessible when servicing any active equipment.
- .16 All ICT Contractor personnel servicing active equipment must be wearing a properly grounded wrist strap to dissipate ESD charges prior to touching any active equipment.

End of Section

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1 General

1.1 **SYSTEM DESCRIPTION**

- .1 The requirements of this section shall take precedence over other sections.
- .2 The labeling of Toronto Water network components, structured cabling and cable routing/containment shall comply with the TIA-606-D standard.
- .3 The codification of network components, cables and cable routing shall follow the identification standards detailed in this standard.
- .4 It describes labelling and alphanumeric numbering criteria for all racks, patch panels, and communication ports as well as grounding and bonding, fire-stopping and pathways.
- .5 At a minimum, the labelling system shall clearly identify all components of the structured cabling system: racks, cables, panels and outlets.
- .6 The labelling system shall designate the cables origin and destination and a unique identifier for each cable and component within the system.
- .7 Racks and patch panels shall be labeled to identify the location within the structured cable system infrastructure.
- .8 All labelling information shall be recorded on the as- built drawings and all test documents shall reflect the appropriate labelling scheme.
- .9 This is to be a Design – Bid - Build project and the purpose of these specifications and drawings is to provide guidelines for the Contractor based on industry standards outlined in Section 27 00 00, Paragraph 1.6.
- .10 If there are any questions, please contact the Consultant for clarification.
- .11 The Contractor will be responsible to confirm labelling schemes with the Client and the Consultant prior to preparation and installation of any labelling.

1.2 **RELATED SECTIONS**

- .1 This section shall be read in conjunction with all other sections as listed in Section 27 00 00, the Contract Drawings, and Division 26 Electrical Specification as prepared by the Electrical Consultant.
- .2 In addition, the general provisions as listed in Division 26 Electrical specifications, including supplementary conditions shall apply.

1.3 **REFERENCES**

- .1 Reference standards and codes are listed in Section 27 00 00, Paragraph 1.6 of this specification.
- .2 The Contractor shall perform all work according to Federal, Provincial, and Municipal codes, rules, regulations, and ordinances governing the work, and as fully part of the specifications as if herein repeated or hereto attached.
- .3 This document does not replace any code, either partially or wholly. The Contractor must be aware of local codes that may impact this project.
- .4 If the Contractor should note items in the drawings or the specifications, construction of which would be code violations, promptly call them to the attention of the Client's representative in writing.
- .5 All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to the most recent release when developing the proposal for installation.

- .6 In the event of conflict, the most stringent and recent requirements shall apply to the codes and standards above.

1.4 **LOCATION LABELLING SCHEMES**

- .1 **BUILDING LOCATION:**
 - .1 YTE: 95 THE ESPLANADE
- .2 **ROOM Location:**
 - .1 ER – Equipment Room / Server Room / Main Telecommunications Room
 - .2 EF – Entrance Facility

1.5 **CABINETS LABELLING**

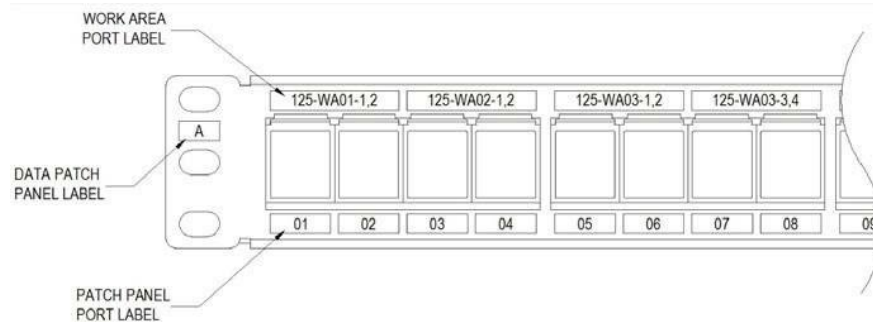
- .1 The Cabinets in the IT room on ground floor of XXX shall be tagged as follows:
YTE-ITS-COM-0100 NETWORK CABINET
YTE-SS-COM-0100 SECURITIY CLOSE
- .2 Cabinet nameplate shall conform as follows:
 - .1 Provide nameplate for each enclosure on the top left corner of the door, front and back.
 - .2 Use engraved Gravoply laminate nameplates using black letters on a white background.
 - .3 The laminate nameplates shall have a dimension of 200mm W x 35mm H.
 - .4 Minimum character height shall be 12 mm. Character lettering shall be centered on each line.
 - .5 Affix name plates on the center of cabinet bottom frame, both front and rear side (using adhesive tape present on name plate).Include device identification (tag) number as well as a descriptive name.

1.6 **COPPER PATCH PANEL LABELLING**

- .1 The horizontal Category 6A copper data patch panels in a Telecommunications Enclosure / Closet shall employ one character A, B, C, ..., Z. The rack shall be populated with patch panel/s as necessary and labeled in sequential order from top to bottom.
- .2 For example, the first copper data patch panel from the top of the rack shall be labeled A, the second shall be B, and so on.
- .3 For office areas, the minimum number of ports associated with a work area outlet shall be a group of two (2) or four (4) ports.
- .4 Labels shall be applied to patch panels in such a manner as to be readily visible and not obscured by structured cabling or patch cords.
- .5 Labels for each 4-port or 2-port, shall be laser printed, adhesive, polyester or polyolefin. Hand-written labels shall not be accepted.
- .6 Lettering shall be black on a white background. Characters are a minimum of 4 mm high.
- .7 Apply a label on the top of each group of 4 ports or 2 ports to indicate the destination of the cables terminated on the data ports (RJ).
- .8 For office areas, the label 125-WA01 would be applied on the patch panel for a group of 2 ports with destination cables to work area outlet 125-WA01. Whereas, 125 represents the

room number or assigned area number which shown in the floor plan drawing of the facility and WA01 represents the work area 01.

- .9 Apply a two-digit label immediately above each data port (RJ) indicating its destination port number on the work area outlet. For example, a group of four consecutive ports on a 24-port patch panel whose destination is port numbers 1 to 4 on a WAO would have the ports labeled 1, 2, 3, and 4.



- .10 For backbone copper Category 6A patch panel used for connection between two closets, the patch panel shall be labelled as source and destination:

Example: COM-0100-A : COM-0300-A

Indicates the backbone Category 6A cables whose source is Network Closet COM-0100, Patch Panel A, and whose destination is Server/Network Closet COM-0300, Patch Panel A.

- .11 For backbone copper Category 6A patch panel used for connection between Network Closet and Security Closet, the patch panel shall be labelled as source and destination:

Example: COM-0100-C : SECURITY-A

Indicates the backbone Category 6A cables whose source is Network Closet COM-0100, Patch Panel C, and whose destination is Security Closet SECURITY, Patch Panel A.

- .12 For backbone 25-pair Category 3 cable used for Voice communications between Network Closet and BIX Block module, the BIX Block and the patch panel at Network Closet side shall be labelled as source and destination:

Example: COM-0100-B : BIX-A01 (Network Closet side)
BIX-A01 : COM-0100-B (BIX Block side)

Indicates the 25-pair Category 3 backbone cables whose source is Network Closet COM-0100, Patch Panel B, and whose destination is BIX Block module, Connector A01.

1.7 FIBRE OPTICS PATCH PANEL LABELLING

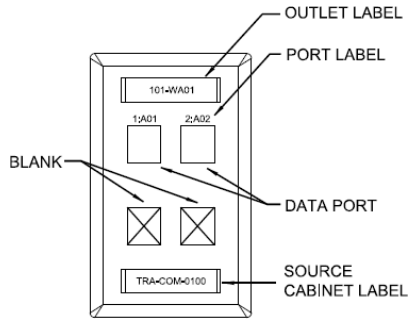
- .1 The fibre patch panel label shall be labeled as follows: FPXX where

XX is the fibre patch panel sequence i.e. 01, 02, 03 ... etc. The rack shall be populated with patch panels as necessary and labeled in sequential order from top to bottom.

- .2 For example, the first patch panel from the top of the rack would be labeled as FP01; the second is FP02 and so on.
- .3 In addition, a label shall be applied to the top of the LC duplex adapter modules associated with a single fibre cable indicating the destination of the cable.
- .4 For example, the adapter modules that terminate the fibre cable whose destination is Telecommunications Enclosure 1400 would be labeled as XYZ- 1400.
- .5 Lettering shall be black on a white background. Characters are a minimum of 4 mm high.
- .6 Terminate all 12 fibres of each fibre optic cable in Fibre Enclosures (Telecommunications Enclosure or Network Core Closet).
- .7 The ordering and color of individual fibres shall be the same for each fibre cable and compliant with ANSI/TIA-568-C.3
- .8 Labels for patch panels shall be laser printed, adhesive, polyester or polyolefin.
- .9 Hand-written labels shall not be accepted.
- .10 Labels shall be applied to patch panels in such a manner as to be readily visible and not obscured by structured cabling or patch cords.
- .11 It is recommended to use fiber panel provided label holder to install the label for the fiber adapter module/plate.

1.8 **WORK AREA OUTLET (WAO) LABELLING**

- .1 A label shall be applied to the top of each work area outlet indicating the location of this work area outlet,
Example: 125-WA01 indicates Room 125, WAO 01
- .2 A label shall be applied to the bottom of each work area outlet indicating the source cabinet of the horizontal cables,
Example: COM-0400 indicates Telecom Room B, Server Cabinet 0400.
- .3 A label shall be applied to the top of each 4-port, work area outlet indicating the source of the Horizontal cables.
Example:
1:A01 indicates WAO port 1 connected to patch panel A port 1.
2:A02 indicates WAO port 2 connected to patch panel A port 2.
- .4 Labels for each 4-port, work area outlet shall be laser printed, adhesive, polyester or polyolefin. Hand- written labels shall not be accepted. When using the faceplate provided label cover, standard white paper printed by laserprinter and manufacturer's label template is acceptable.
- .5 Lettering shall be black on a white background. Characters shall be a minimum of 4 mm high.



4-PORT WALL-MOUNT FACEPLATE

1.9 CABLE LABELLING

- .1 Use durable non-fading sleeve type wire markers to identify all network cables.
- .2 Labels for cable/wire shall be laser printed, adhesive with a print-on area and clear over laminate, polyester (indoor/outdoor). Hand-written labels will not be accepted.
- .3 Lettering shall be black on a white background. Characters shall be a minimum of 4 mm in height.
- .4 All the cable labels (both ends) shall following the detailed label scheme provide in the schedule in the design drawing and showing end to end wire mapping (source to destination and vice versa) on excel sheet and be submitted to Consultant for review and approval, before the installation.
- .5 The contractor shall complete the 'Wiring Schedule Template Sheet' attached in Appendix based on final built and reviewed by consultant and client

1.10 FIBER OPTICS BACKBONE CABLE LABELLING

- .1 The tagging convention for identification of fibre optic backbone cables shall indicate the source and destination of the cable separated by a colon.

Example: 0200-FP01-A: 1400-FP01-A

Indicates a fibre optic backbone cable whose source is Network Core Closet 2 (XYZ-0200), Fibre Patch Panel 01, adapter panel A and terminated in Telecommunications Enclosure 1400 (XYZ-1400) on the fibre patch panel 01 adapter panel A.

- .2 It is recommended to use provided label holder with the fiber patch panel to install the adapter panel labelling.
- .3 As a minimum, all fibre optic backbone cables shall be labeled at both ends of the cable, within every pull box and every 15 metres.
- .4 In addition, the fibre backbone cables shall be labeled at each transition. A transition is defined as: a change in ducting (e.g. cable tray to conduit), a change in direction of more than 45 degrees, or an entrance and exit of ducting through a wall or floor.
- .5 If the fibre cable is run in conduit then the transition labels shall be applied to the conduit.

1.11 HORIZONTAL COPPER CABLE LABELLING

- .1 The tagging convention for identification of Horizontal cables shall indicate the source and destination of the cable separated by a colon.

Example: COM-0400-A01:125-WA01-1

Indicates a horizontal cable whose source is Telecommunications Enclosure COM-0400, Patch Panel A, port 01 and whose destination is port 1, Work Area Outlet 01, in room number 125.

- .2 As a minimum, all horizontal Category 6A cables shall be labeled at both ends of the cable, within every pull box and every 15 metres.
- .3 In addition, the cables shall be labeled at each transition. A transition is defined as: a change in ducting (e.g. cable tray to conduit), a change in direction of more than 45 degrees, or an entrance and exit of ducting through a wall or floor.
- .4 If the cable is run in conduit then the transition labels shall be applied to the conduit.

1.12 **PATCH CORD LABELLING**

- .1 As a minimum, all Contractor installed Category 6A or fibre optic patch cords in the network/server closet shall be labeled at both ends of the cable.
- .2 The tagging convention for identification of patch cords shall indicate the source and destination of the cable separated by a colon. The source is the switch port and the destination is the patch panel, termination point.

1.13 **CABLE PATHWAYS LABELLING**

- .1 All ducting (cable tray or conduit) carrying fibre optic backbone cables shall be tagged as "LAN OPTIC BACKBONE".
- .2 All ducting (cable tray or conduit) carrying Category 6A backbone cables shall be tagged as "LAN COPPER BACKBONE".
- .3 All ducting (cable tray or conduit) carrying Voice 25- pair backbone cables shall be tagged as "VOICE BACKBONE".
- .4 All ducting (cable tray or conduit) carrying fibre optic from service provider Bell shall be tagged as "BELL FIBER".
- .5 All ducting (cable tray or conduit) carrying fibre optic from service provider BEANFIELD shall be tagged as " BEANFIELD FIBER".
- .6 All ducting (cable tray or conduit) carrying Horizontal cables shall be tagged as "LAN HORIZONTAL" with the source and destination network panels.
- .7 All ducting shall be labeled at each transition. A transition is defined as a change in ducting (e.g. cable tray to conduit), a change in direction of more than 45 degrees, or an entrance and exit of ducting through a wall or floor.
- .8 Use engraved Gravoply laminate nameplates using black letters on white background.
- .9 The laminate nameplates shall have a dimension of 210mm W x 50mm H.
- .10 Minimum character height shall be 12 mm. Character lettering shall be centered on each line.

2 Products

2.1 **CABLE, SURFACE MOUNT BOX AND PATCH PANEL LABELS**

- .1 All products shall meet UL 969 standards and be rated for indoor or outdoor use as applicable to the installation.
- .2 Cable labels shall be self-laminating, vinyl with white printing area and sized to allow label to wrap around 2.5 times minimum. Labels also shall be sized to suit the labelling requirement maintaining a minimum 10pt. font size.

- .3 Surface Mount Box and Patch Panel labels shall be adhesive style made of polyester with a white printing area and sized to suit the designated label location. Labels shall be printed with a minimum 10pt. font size.
- .4 Active equipment labels shall be adhesive style made of polyester with a white printing area and sized to suit the designated label location. Labels shall be printed with a minimum 6 mm (1/4") high font.
- .5 Patch Panel labels shall be adhesive style made of polyester with a white printing area and sized to suit the designated label location. Labels shall be printed with a minimum 6 mm (1/4") high font.

2.2 LABEL MANUFACTURERS

- .1 Acceptable label manufacturers:
 - .1 Panduit
 - .2 Brady
 - .3 HellermanTyton.

3 Execution

3.1 GENERAL

- .1 All labels shall be laser-printed and reliably installed. No handwritten labels shall be accepted.

3.2 CABLE LABELLING

- .1 All cabling runs shall be labeled in four (4) locations including at each end of the cable, on the corresponding faceplate and at the patch panel.

3.3 PATCH CORD LABELLING

- .1 Each patch cord shall be labelled with one label at each end within 50 mm (2") from the plug.
- .2 Patch cord labels shall be installed on clean and dry patch cords and mounted within 50mm or 2" of each end of each patch cord.

3.4 DATA PATCH PANEL LABELLING

- .1 Horizontal cabling patch panels will be sequentially tagged (A, B, C ,,,. etc.).
- .2 Ports will be sequentially numbered from the first to the last port within a single patch panel. (e.g. 01-24).

3.5 SURFACE MOUNT BOX LABELLING

- .1 All Multimedia Outlet (MMO) ports in a surface mount box shall be identified by an alphanumeric code that will coincide with the associated room, cabinet, patch panel and port.

3.6 APPENDIX – WIRING SCHEDULE TEMPLATE

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1 General

1.1 **INTRODUCTION**

- .1 This section describes the products and execution requirements relating to supplying and installing for the copper horizontal and fibre optic backbone cabling systems.
- .2 This section describes the provisioning of the following components:
 - .1 OM4 Multimode Fibre Optic Cable.
 - .2 Category 6A 4-pair UTP cables.
 - .3 Category 6A and Category 6 Twisted-pair copper patch cords.
 - .4 Patch panels, Faceplates and Modules.
- .3 The Contractor is to supply and install the fibre optic cabling backbone as described in this section.
- .4 The Contractor is to supply and install all the components of the horizontal cabling as described in this section.
- .5 Install, terminate, test, and guarantee each drop according to all applicable standards and Client's preferences.
- .6 Product specifications, general design considerations, and installation guidelines are provided in this document. Quantities of telecommunications outlets, typical installation details, cable routing and outlet types are provided in the contract drawings associated with this document.
- .7 This section describes the products and labour required to complete the communications termination elements, including modular jacks, blocks and patch panels for the communications systems work specified herein.
- .8 All cables and related terminations, support and grounding hardware shall be furnished, installed, wired, tested, labeled, and documented by the Contractor as detailed in this document.
- .9 Contractor to install and patching the City free issued network switches per the layout drawing of network cabinets and the application cut out schedules sheet. The patch cord patching between the horizontal patch panel and switch is only can be performed after the permanent link testing completed and its test report is approved by City TW DNS staff. The contractor shall not allowed to plug in the power for the switch, TW DNS staff will configure the switch, power on and enable the network after the SAT.
- .10 Contractor is to label, install, patching the City free issued WAP device per floor plan drawing and cut out schedule sheet.

1.2 **RELATED SECTIONS**

- .1 This section shall be read in conjunction with all other sections as listed in Section 27 00 00, Paragraph 1.5, and the contract drawings.
- .2 The Contractor must comply with the General Requirements of the Contract, including General and Supplementary Conditions and Division 26 Specification Sections referred to herein.

1.3 **REFERENCES**

- .1 Reference standards and codes are listed in Section 27 00 00, Paragraph 1.6 of this specification.
- .2 The Contractor shall perform all work according to Federal, Provincial, and Municipal codes, rules, regulations, and ordinances governing the work, and as fully part of the specifications as if herein repeated or hereto attached.

- .3 This document does not replace any code, either partially or wholly. The Contractor must be aware of local codes that may impact this project.
- .4 If the Contractor should note items in the drawings or the specifications, construction of which would be code violations, promptly call them to the attention of the Client's representative in writing.
- .5 All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to the most recent release when developing the proposal for installation.
- .6 In the event of conflict, the most stringent and recent requirements shall apply to the codes and standards above.

1.4 **QUALITY CONTROL**

- .1 Only new products listed in this section may be used unless otherwise submitted for approval.
- .2 Manufacturer's Qualifications: Manufacturer regularly engaged, for past 10 years, in manufacture of communications horizontal cabling of similar type to that specified.
- .3 The Contractor will be a Certified Installer of the cable manufacturer. Supporting documentation will be required as part of the submittal.
- .4 All Category 6A copper and fibre patch cords are to be manufactured and certified by the Manufacturer. Field- assembled patch cords are not permitted.
- .5 Test each optical fiber cable and UTP cable per the requirement in section 27 11 16.

1.5 **PRE-INSTALLATION MEETINGS**

- .1 The Contractor will convene a pre-installation meeting 2 weeks before the start of the installation of the horizontal cabling.
- .2 Require attendance of parties directly affecting work of this section, including Architect, Consultant, Electrical Consultant, Electrical Contractor, and Manufacturer's Representative.
- .3 Review materials, installation, field quality control, labeling, protection, and coordination with other work

1.6 **SUBMITTALS**

- .1 Comply with Section 27 00 00 – Submittal Procedures.
- .2 Shop drawings for each type of cable indicated in the following document, including, material descriptions, dimensions of the cable, rated capacities and operating characteristics along with furnished specialties and accessories.
- .3 Product Data: Submit manufacturer's product data sheets, including installation instructions verifying that materials comply with specified requirements and are suitable for intended application.
- .4 The Contractor's Project References: Submit Contractor's list of successfully completed communications horizontal cabling projects, including project name and location, name of architect, and type and quantity of communications horizontal cabling installed.
- .5 For Category 6A patch cords, include the following installation data for each type used:
 - .1 Nominal OD.
 - .2 Minimum bending radius.
 - .3 Maximum pulling tension.
- .6 For Fibre Optic patch cords, include the following installation data for each type used:
 - .1 Nominal OD.

- .2 Minimum bending radius.
- .3 Maximum pulling tension.
- .7 Source quality-control reports.
- .8 Field quality-control reports
- 1.7 **WARRANTY**
 - .1 Structured Cabling System with 25-year manufacturer warranty.
 - .2 The horizontal/backbone communications cabling system installed shall be eligible for coverage by a 25-year warranty to the Client.
 - .3 The project shall be pre-registered with Belden or Panduit Inc by Contractor as a Belden or Panduit project for the warranty. The Contractor shall provide labor, materials, and documentation in accordance with manufacturer's requirements necessary to ensure that the Client will be furnished with a 25-year warranty.
 - .4 Horizontal channels shall be completed with factory- terminated copper patch cords in order to be eligible for the applicable manufacturer's warranty.
 - .5 The installed structured cabling system shall provide a warranty guaranteeing installed channel performance at the ANSI/TIA 568-C requirements for Category 6A cabling systems or ISO 11801 requirements for Class D, Class E, and/or Class Ea.
 - .6 Standards-compliant channel or permanent link performance tests shall be performed in the field with an approved certification tester in the appropriate channel or permanent link test configuration.
 - .7 Necessary documentation for warranty registration shall be provided to the manufacturer by the Contractor (within 10 days) following 100 percent testing of cables.
 - .8 Submit test results to Manufacturer, in the certification tester's original software files.
 - .9 The Contractor shall ensure that the warranty registration is properly submitted, with all required documentation within 10 days of project completion.
 - .10 The Contractor shall ensure that the Client receives the Manufacturer-issued project 25-year cabling system warranty certificate within 60 calendar days of warranty registration.
- 2 **Products**
 - 2.1 **FIRE RATED BACKBOARD PLYWOOD**
 - .1 In the Main Electrical Room and IT Room, Fire Rated plywood shall be provided on the walls or struts such that there is proper cable penetration from behind.
 - .2 Plywood shall be void-free and either fire-rated or treated on all sides with at least two coats of fire- retardant light-colored paint.
 - .3 Have at least two walls lined with A/C grade or better, 2.4 m (8 ft) high with a minimum thickness of 19 mm (3/4 in). To reduce warping, plywood should be kiln-dried to maximum moisture content of 15 percent.
 - .4 Mount plywood 200 mm (8 in) AFF to avoid damaging the plywood. Have the plywood with the grade A surface exposed. The plywood should be securely fastened to wall-framing members to ensure that it can support attached equipment.
 - .5 All joints screw and nail holes are to be caulked and / or covered.
 - .6 The plywood is to be provided for security panels, power supplies etc. as may be required and is not intended for cabinet installation.
 - 2.2 **FLOOR STANDING CABINETS**
 - .1 Cabinets are to be supplied by the City and installed by Contractor. Refer to Contract Drawings E4001, Note 10 for pickup location.

- .2 Supply and install with all accessories to provide a complete cabinet as indicated below.
- .3 Cabinets shall have a rack mounted horizontal grounding bar.
 - .1 Approved manufacturer: Panduit
 - .2 Part Number: RGB19CN (for cage nut).
- .4 All cabinets shall be bonded to the Telecommunications Bonding System as per the standard. The bonding green cable shall be sized (Minimum AWG 6) according to distance and terminated at the nearest Telecommunications Grounding Busbar.
- .5 Two-hole mechanical lug or Compression lugs (long barrel) shall be used to connect the bonding cable, horizontal grounding bar and cabinet frame.
- .6 Cabinets shall be provided with horizontal cable managers,
 - .1 Approved manufacturer: NEATPATCH, Panduit
 - .2 2U cable manager part number: NP2. (NEATPATCH)
 - .3 1U cable manager part number: WMPFSE. (Panduit)
- .7 Cabinets shall be provided with rear internal vertical cable managers, and lacer bar.
- .8 Network Cabinet shall be provided with front vertical finger cable managers with cover/door for managing patch cables. 1-pair mounted on the front two sides of the cabinet. Cabletalk part no: CTC3-CMS-11-B.
- .9 Each cabinet shall be provided with at least one roll of Velcro cable tie for the cable and patching management.
 - .1 Approved Manufacturer: Belden or Panduit
 - .2 Part Number: AX100783 (8"L x 0.5"W, 25 per Roll)
- .10 Appropriated cooling solution shall be designed for the cabinet per installed environment and shall be reviewed by TW-DNS.
- .11 Typically, the rack mounting space is recommended reserving 4RU to 6RU empty space from cabinet top for cooling efficiency and covered by the blank panels at front.
- .12 Each cabinet shall be black with square hold rails.
- .13 Supply one box (Pack of 250) M6 Cage nuts and screws, for two cabinets, CPI CLIK-NUT®, PART NO: 76543-002.
- .14 Specified cabinet:
 - .1 The two cabinets will be free issued by City, but the contractor shall pick up from North Toronto Waster water treatment Plant (stored in the gallery near by server room).
 - .2 Address: 21 Redway Rd., Toronto, ON M4K 3H8
 - .3 Site contact: Atul Marathe atul.marathe@toronto.ca
 - .4 Tel: 416-392-6055.
 - .5 Technical contact:
Edward Guo Edward.guo@toronto.ca
Cell: 416-8897073
- .15 Electrical:
 - .1 Contractor is to provide the electrical distribution for each IT Network and Server cabinet as per the related Electrical Distribution drawings and relevant City standards.
 - .2 Bond each 19" cabinet to ground.

- .3 Provide each Network Closet/server closet and security closet cabinet (<5kw) with two (2) minimum 30A, 208 VAC, 1-ph, receptacles L14- 30R from Utility power supply and UPS power supply.
- .4 The final power supply design for the Network Closets and Server Security Closets shall refer to Electrical specification section.
- .5 The receptacles shall be mounted in such a manner as not to interfere with access to or removal of other equipment within the enclosures.
- .6 Power distribution within the enclosure shall be via vertically mounted metered power bars/PDU.
- .7 Redundant power supplies, within the same device, shall not be connected to the same UPS circuit.
- .8 All the electrical component (receptacles, power bars/PDUs, UPS etc.) shall be labelled with source circuit IDs (breaker panel etc.)
- .9 The final provided PDU (network cabinet) and Eaton ATS power bar (security cabinet) power input cord plug shall match with the cabinet power supply receptacle type, otherwise, additional power plug adapter shall be provided.
- .16 Power Distribution Unit (PDU – Power Bar)
 - .1 PDU (network cabinet) and Eaton ATS power bar (security cabinet) power input cord plug shall match with the cabinet power supply receptacle type, otherwise, additional power plug adapter shall be provided.
 - .2 Input Power:
 - .1 Network and Security Cabinet Closet: 100-120V/173-208V, 1-ph, 30A;
 - .3 Input wiring: 10ft pluggable power cord
 - .4 Output Outlet: NEMA 5-20R, C13, C19
 - .5 Outlets: 18 Outlets (minimum)
 - .6 Approved Manufacturer: Vertiv, APC or approved equal.
 - .7 Part number: MPH21413 (1-ph)
 - .8 The Vertiv MPH2 rack PDU shall be managed three-phase power distribution unit that shall be monitoring along with receptacle control.
 - .9 Typically two (2) Vertiv MPH2 units shall be mounting in vertical, zero-U configuration in network cabinet. It is recommended to mount two PDUs on one side at the rear of cabinet. Related PDU mounting bracket shall be provided.
 - .10 The output receptacles support equipment requiring connection with NEMA 5-20R and IEC60320-C13 plugs.
 - .11 Confirm with City if the PDU can be free issued or not.
- .17 Depend on power load and PDU type, two EATON rack mount Automatic Transfer Switch shall be provided for the network cabinet for those single source power supply equipment (switch, routers).
 - .1 Approved manufacturer: Eaton
 - .2 Part number:
 - .1 EATS120 (ATS, 20A, 120VAC)
 - .2 EATS220 (ATS, 16A, 100-240VAC)
- .18 Network /Server Cabinets (rear) shall be provided with under cabinet 17" LED light, 15w, UL listed with power adapter/power cord, magnetic mounted.

- .1 Approved manufacturer: Eaton or approved equivalent.
- .2 Part number: REED1715 or approved equivalent.
- .19 Slide tray for laptop
 - .1 Each network cabinet shall be provided one x 1RU rack mounted slide tray for network laptop user.
 - .2 Approved manufacturer: Eaton or approved equivalent
 - .3 Part number: EARS19281U10 or approved equivalent
 - .4 The slide tray shall be mounted according to the rack elevation diagrams.

2.3 **WORK AREA OUTLETS FOR OFFICE AREA**

- .1 All modular jacks, faceplates and furniture inserts, surface mounted box shall be Belden or Panduit and performance rated to Category 6A.
- .2 Provide one 4-port, single-gang, work area outlet in each work area for termination of the horizontal Category 6A cables with faceplates or decora module frames.
- .3 The outlet back box depth selection shall meet Belden requirement for their new REVConnect Category 6A jack module (or Panduit equivalent). The back boxes shall be 100mm (L) X 50 mm (W) X 54 mm (D), complete with a mud ring cover specifically designed for single gang faceplates intended for flush or surface mounting to the wall. This single gang deep outlet back box aids in the maintaining of Category 6A and higher bends radius requirements.
- .4 Where walls are not suitable or have insufficient depth, standard electrical size outlet boxes shall be used, but must ensure the box can accept 4 terminated Belden REVConnect jacks (or Panduit equivalent).
- .5 One (1) 4-port, work-area outlet shall be associated with as many ports necessary (in groups of 4 or 2) on the patch panel of the TE or TR as is provided.
- .6 Within each outlet, only two of the ports shall be terminated at the work area faceplate and patch panel unless otherwise specified.
- .7 Space shall be left in each conduit and faceplate for a third and fourth cable to be added at a later time.
- .8 In the majority of cases one (1) 4-port, work-area, outlet shall be installed within each systems furniture cubical work area partition.
- .9 In some special situations where the systems furniture is configured fully the work-area outlet shall be installed directly on the wall in the office areas.
- .10 Within systems furniture, only two of the four positions shall be terminated with work area jacks and on the patch panels unless otherwise specified.
- .11 In boardrooms and large general office areas, one single gang work area outlet shall be provided every 3.0 metres and within 1.0 metres of an electrical outlet if provided.
- .12 Approved back box manufacturer and part number:
 - .1 Manufacturer: IPEX; Appleton
 - .2 Part Number: FDS101520 or approved equivalent.
 - .1 2" x 3" device box-2-1/2" deep, gangable, Appleton part no: 1104-k; 1104-ludbar
- .13 Single Gang Back Boxes
 - .1 Single gang back boxes shall be installed on the concrete/block wall as indicated on the drawings.
 - .2 Approved manufacturer: Belden KeyConnect, or Panduit equivalent.

.3 Part Number: AX102657 (White)

2.4

FACE PLATES

- .1 Faceplates shall be modular Belden or Panduit white format opening to allow the possibility of changing connector types in the future without replacing the entire unit.
- .2 Faceplates shall be equipped with small form factor terminating connectors to fit the individual outlet's requirements
- .3 Faceplates shall be equipped with a minimum of four (4) openings for modules. Contractors are to equip the faceplate with the required amount of blank inserts as required.
- .4 The color of faceplate shall match with the decoration environment requirement.
- .5 Approved 4-Port w/ ID Windows, Single-gang faceplate manufacturer and part number:
 - .1 Manufacturer: Belden KeyConnect (same as keystone footprint), or Panduit equivalent
 - .2 Part number: AX102249 (White); CFPL4WHY
- .6 Approved faceplate port blank insert manufacturer and part number:
 - .1 Manufacturer: Belden KeyConnect, or Panduit equivalent
 - .2 Part number: AX102262 (White); CMBWH
- .7 For ceiling mounted WAP device, 2 port surface mounted box should be used:
 - .1 Manufacturer: Belden, or Panduit
 - .2 Part number: KeyConnect Side-Entry Box, 2-Port; AX102652; Mini-Com® Surface Mount Box, 2 Port, White CBX2WH-AY.

2.5

WORKSTATION FACE PLATES AND ADAPTERS – CUBICLES

- .1 Workstation outlets shall be supplied and installed for all terminations at the workstation end and as further specified below to suit the application.
- .2 Each workstation shall be equipped with minimum two (2) RJ45 Category 6A green color jacks.
- .3 Contractor shall confirm the color of outlets prior to placing order.
- .4 Contractor to confirm and ensure the Belden or Panduit modular furniture adapter match with the furniture cutout and ensure the mount is reliable and secured.
 - .1 Modular Furniture Faceplates
 - .2 Modular furniture faceplates shall be installed in all furniture outlets that have a modular furniture knockout shall consist of 4 ports.
 - .3 Each outlet shall be installed with the specified termination modules or a blank insert. No openings shall remain exposed.
 - .4 Contractor shall verify furniture modular faceplate prior to placing order.
 - .5 Approved manufacturer: Belden Keyconnect 4-port modular furniture adapter, or Panduit equivalent
 - .6 Part number: AX102901 (Black)

2.6

RJ45 CATEGORY 6A MODULAR JACKS

- .1 Belden or Panduit Eight-position modular jack (RJ45), type Category 6A to TIA- 568-C shall be green color and shall have the following minimum performance characteristics:
 - .1 Modular jack current rating: 1.5 Amperes maximum.
 - .2 Modular jack durability 1,000 mating cycles.

- .3 Modular jack contact Pressure: 100 grams minimum per contact.
- .4 Dielectric voltage strength: 1,000 V RMS at 60Hz for 1 minute.
- .5 Insulation resistance: 200 milliohms minimum.
- .6 Contact resistance 1 milliohms per contact.
- .2 The contact material of the jack in a modular jack connector shall be phosphor bronze with 50 micro inches of gold over nickel.
- .3 UTP termination modules shall be of the same Category as the UTP cabling to ensure that manufacturer end to end warranties can be attained.
- .4 UTP cables used for IP voice shall be terminated with the same specified jacks.
- .5 All UTP jack modules shall be Belden REVConnect 10GX UTP type (or Panduit equivalent) which is compatible with Belden Keyconnect (Keystone) series (or Panduit equivalent) faceplates and patch panels.
 - .1 Approved Manufacturer: Belden REVConnect 10GX UTP modular jack, or Panduit equivalent
 - .2 Part number:
 - RVAMJKUGN-S1 (Black: RVAMJKUBK-S1, White color, RVAMJKUEW-S1 color, single jack)
 - RVAMJKUGN-B24 (Black: RVAMJKUBK-B24. White: RVAMJKUEW-B24 color, Bulk pack - 24 jacks)
 - CJ6X88TGWH: CJ6X88TGBL
- .6 Field terminated Cat 6A plug (used for security IP camera end termination with Cat 6A cable):
 - Belden: RVAFPUBK-S1; RVAFPUBK-B24
 - Panduit: FP6X88MTG; FP6X88MTG-X; FPUD6X88MTG; FPUD6X88MTG-X
- .7 All unused jack module on the work area faceplate shall be covered by dust cover,
 - .1 Approved manufacturer: Belden REVConnect Dust Cover, or Panduit equivalent
 - .2 Part number:
 - RVUDCGN-B24 (Green, Bulk Pack - 24 covers); MDC-C
- .8 To distinguish the different applications, provide color-coded, snap-in icon/ID data tab for each data port (RJ) on the jack module accordingly.
- .9 The following colours will indicate typical network membership:

Color	Membership /Function	Color	Membership /Function
Red	HMI/SCADA	Blue	PLC/SCADA
Green	Business (VOIP phone & PC)	Purple	Security (iSTAR, CCTV, Intercom)
Orange	BAS (HVAC, Lighting), UPS, PDU	Yellow	Maintenance/SCADA
Black	Voice (Analog)	White	Spare
Gray	WAP (phone/data)		

- .1 Approve snap-in icon manufacturer: Belden or Panduit
- .2 Part number:

CIROR-C (Orange); CIDRD-C (Red); CIDBL-C (Black), CIDVL-C (Violet);
CIDBU-C (Blue)

RVUICPR-B24 (bulk pack): Purple Icon for Security

RVUICBK-B24 (bulk pack): Black Icon for Voice

RVUICRD-B24 (bulk pack): Red Icon for HMI /SCADA

RVUICOR-B24 (bulk pack): Orange ICON for BAS/UPS/PDU

2.7

COPPER PATCH PANEL (CPP)

- .1 All horizontal Category 6A UTP cabling shall be terminated on 1U, 24 ports, Belden or Panduit Category 6A modular patch panel.
- .2 All copper patch panels shall be black.
- .3 All modular patch panels shall be populated with Category 6A UTP modules/jacks as required.
- .4 All the patch panel shall be front accessed for the jack modules and rear with a cable manage bar.
- .5 The modular copper patch panel shall mount to standard TIA 482.6 mm (19") rack.
- .6 Contractor to refer to Belden or Panduit installation instructions provided with the patch panel for proper installation.
- .7 The patch panel termination must maintain appropriated cable slack for future troubleshooting/jack re- termination.
- .8 Approved manufacturer: Belden or Panduit
- .9 Modular (unloaded) black, Front Access, Keyconnect style Patch Panel accept REVConnect jacks, 24-port, 1U, patch panel
Part number: AX106288;
AX106291 (label holder kit); CPPL24WBLY
- .10 To distinguish the different applications, provide color-coded, snap-in icon/ID data tab for each jack module port (RJ) accordingly.

2.8

COPPER CATEGORY 6A HORIZONTAL CABLE (UTP)

- .1 Belden or Panduit or General Cable, 10GXS four-pair, 100 ohm balanced unshielded-twisted-pair (UTP) cable, appropriate flame test classification, Category 6A shall be in compliance to TIA-568-C.
- .2 All cables fully contained within conduit or areas that are not plenum rated shall use CMR/FT4 rated cable.
- .3 Any cable, regardless of length passing through a return air plenum ceiling and not in conduit shall be rated CMP/FT6.
- .4 All UTP cables shall meet requirements identified below:
 - .1 Color: Blue
 - .2 Rating: CMP/FT6 (plenum areas)
 - .3 Category 6A
 - .4 23 AWG, spool-in-a-box or spool in reel
 - .5 Small diameter < 0.265 inch
 - .6 Approved manufacturer: Belden or Panduit or General Cable
 - .7 Part number: 10GXS13D151000 ; 7141819 or 7141869 (FT6/CMP, blue, non-bonded).

- .8 For outdoor mounted security cabling systems, IP Camera, IP intercom, the CAT6A cable shall be outdoor or indoor/outdoor rated. Belden Part No: OSP6AU 0101000, or General cable Part No: 7141007.
- .5 All Category 6A horizontal cables shall be eligible for the Belden or Panduit 25 years Certification Warranty.
- .6 Cabling shall be installed and terminated as per the BICSI Installation Methods Manual, Belden or Panduit Certification training and the manufacturers' installation instructions.
- 2.9 **COPPER CATEGORY 6A PATCH CORD (UTP)**
- .1 Patch cord shall be manufactured of stranded or solid conductor cable (AWG24) slim size with 8-position, 4-pair terminations at both ends. For security, the patch cord shall be AWG24 based for better POE.
- .2 All patch cords shall be manufactured by Belden or Panduit and performance rated to Category 6A.
- .3 All patch cords shall be of the same or higher performance Category and manufacturer of the UTP horizontal cabling system that shall be warranted as part of the end to end solution.
- .4 All patch cords shall be CSA approved and minimum of FT4 rated.
- .5 All patch cords shall be manufactured and certified, 4-pair stranded/solid conductors copper cables, field assembled patch cords are not allowed.
- .6 All patch cords for data shall be gray in color. Patch cords for security shall be Purple in color.
- .7 The Contractor shall supply patch cords in the following length:
- .1 At patch panel location, provide 1 feet or 2 feet CAT6A or per patching needs long patch cords for all terminated horizontal cables unless otherwise advised by Consultant or DNS. For Analog telephone patching, 5 feet or, per patching needs shall be provided.
- .2 At workstation or work area outlet location, provide patch cords of suitable length and not longer than 5 metres (typically 2.1 metres but Project Consultant to finalize) for every terminated horizontal cable unless otherwise advised by Consultant or DNS.
- .8 Patch cords shall be installed and plug into the final device by the Contractor as per the BICSI Installation Methods Manual, Belden or Panduit Certification training and the manufacturer's installation instructions. When the device is not available, patch cords shall be plug in the WAO ports.
- .9 Contractor shall install patch cords per the cutover schedule sheet shown in design drawing. Patch all installed horizontal cable related patch panel ports to its network switch ports. To save patch cords length and provide a neat patching, typically: 2x24 Patch panel should patched to 1x48 switch which installed between patch panels, Top mounted 24 Port patch panel patched to Top section Odd # port of switch, Bottom mounted patch panel patched to lower section Even# port of switch.
- .10 Contractor shall install the City free issued WAP device and provide and plug in one (1) x 5m Category 6A UTP cord for each two port WAP outlet. Plug in can only be done after approval of the contractor submitted cabling test report by the consultant and DNS.
- .11 Approved manufacturer: Belden or Panduit
- .12 Part Numbers:
CAT6A UTP patch cords , AWG24, Purple/Violet color (used for Security only):
Belden: AT110yyx (yy: color, x: length in feet)
Panduit UTP6AXyVL (yy: color, x: length in feet)

Cat 6A UTP patch cords: Grey color, AWG 28

Belden: CAD110800x (yy: color, x: length in feet)

Panduit: UTP28XyGY (yy: color, x: length in feet)

2.10 **COPPER CATEGORY 3 BACKBONE CABLE FOR VOICE**

- .1 Category 3 rated wire and cable placed in the inside environment shall be solid, 24 AWG, twisted pair and multi-conductor.
- .2 All cables fully contained within conduit or areas that are not plenum rated shall use CMR rated cable.
- .3 Any cable, regard less of length passing through a return air plenum ceiling and not in conduit shall be rated as CMP.
- .4 Approved manufacturer: Belden or Panduit or General Cable
- .5 Color: Grey
- .6 Part Numbers:
DIW127321000 (12-Pair, Cat 3, CMR, Olive) ; Using 2 or 3, 4-pair CAT6A cable for voice backbone cable is acceptable.

2.11 **TELEPHONE PATCH PANEL FOR VOICE**

- .1 Minimum 1U 24 RJ45 UTP ports.
- .2 Approved manufacturer: Belden or Panduit
- .3 Part number:
Voice unloaded patch panel: Belden AX106288 (Front access, Keyconnect modular patch panel, Black) or Panduit CPPL24WBLY.
Label Holder Kit: AX106291
REVConnect Jack Module: Belden RV5MJKUBK-S1 ; Panduit: CJ5E88TGBL (Category 5e, Black).
- .4 For 24 port voice patch panel, only 1 pair of 25-pair cable is terminated with each jack module at pin 4&5.

2.12 **VOICE CROSS CONNECT**

- .1 Voice cross-connect is a system that consists of various sizes of BIX blocks, cable distribution accessories (such as mounded rings and strips) and a BIX tool to terminate wires at the BIX block. The voice cross- connect system is primarily composed of two parts: the mount and the connectors.
- .2 Cross-connect mount is a wall-mounted frame, generally built from 16 gauge steel. The frame feature a rectangular plastic backplate and two plastic brackets that extend from either side of the backplate to fit between two and ten connectors. The connectors shall be oriented horizontally on the mount.
- .3 The connectors are rectangular punch-down blocks used to terminate up to 25 pairs. The connectors shall have a slip-in fitting which automatically strips the wire as it is punched down, eliminating the need for pre- stripping. The connectors shall also have a pair- splitter to facilitate fast arranging of wires on the punch-down block.
- .4 Backbone cables shall be terminated on the backboard which is close to the Bell Voice BIX block(as shown on drawings) unless otherwise specified in this document.
- .5 All cables shall be terminated on IDC connectors complete with associated hardware such as mounts, cable/cross-connect wire managers, etc.
- .6 The IDC connectors shall accept 24 to 26 AWG solid copper conductors.

- .7 The IDC mounts shall accept cables from behind the connector.
- .8 Cross-connect shall be a 5-pair block and include appropriate mounting and number of designation strips and labels.
- .9 Cable management in the form of distribution rings or approved similar shall be provided between columns and rows of IDC mounts to support cross connect management in a manner recommended by the manufacturer.
- .10 Instruction sheets for products are available from Belden or Panduit.
- .11 Approved manufacturer: Belden or Panduit
- .12 Part number
50-pair BIX mount: A0284798
25-pair BIX distribution connector: A0266828 (5 pair marking) BIX Designation strip: A0270169

2.13 **INDOOR BACKBONE MULTIMODE OM4 FIBREOPTIC CABLE**

- .1 The cable is performance rated to OM3 and shall be used only if the backbone link length is less than 300 meters, otherwise, Singlemode OS2 shall be used.
- .2 Contractor to provide and install one (1) 12-strands Corning MTP-MTP OM4 pre-terminated cable between NETWORK CABINET and security cabinet.
- .3 All backbone fiber optic cables running between telecom rooms shall be fully contained within conduits.
- .4 Fiber cables shall be protected when entering the patch panel from the top cable tray with a black or Orange color flexible conduit/inner duct (plenum).
- .5 Indoor, OFNP/FT6.
- .6 50/125 micron core/cladding.
- .7 2000 MHz-km bandwidth at 850 nm wavelength (EMB).
- .8 500 MHz-km bandwidth at 1300 nm wavelength.
- .9 All fibreoptics cables shall be installed and terminated into fibre optic adapters contained in fibre optic patch panels by the Contractor as per the BICSI Installation Methods Manual, Belden or Panduit certification training and installation instructions.
- .10 Approved manufacturer: Corning
- .11 Part number:
12-Fiber OM4 MTP-MTP trunking cable, PART NO: A757512QPNAAUxxxF;

2.14 **FIBREOPTICS PATCH PANEL (FPP)**

- .1 Fibreoptics cabling shall be terminated in patch panels intended for fibre optic cable management.
- .2 Belden or Panduit Fibreoptics Rack Mount Enclosure for Telecommunication Enclosures shall be:
 - .1 1U, 19" FX UHD Rack Mount Enclosure/Housing Durable black powder coat finish
 - .2 Be equipped with cable strain relief and slack storage
 - .3 Approved manufacturer: Corning
 - .4 Part Number: CCH-01U
- .3 Belden or Panduit Fibreoptics LC Fibre Adapter Strip/frame shall be:

- .1 Loaded with TIA/EIA-604 FOCIS-10 compatible adapters that exceed TIA/EIA-568-C.3. Shall be provided at network and security cabinet fiber panel for the fiber MTP-MTP cable.
- .2 Split sleeve: Zirconia Ceramic
- .3 Adapter housing colors follow TIA/EIA-568-C.3 suggested color identification scheme.
- .4 Approved manufacturer: Corning
- .5 Part number:
12 Fiber Duplex LC/MTP cassettes, shuttered CCH modules, Corning part no: CCH-UM12-05-93Q.

2.15 **FIBREOPTICS LC-LC DUPLEX PATCH CORDS – OM4**

- .1 All patch cords shall be CSA approved and CMR (FT4) rated and stamped accordingly.
- .2 All optical fibre patch cords shall be OM4 to match with backbone fiber cable type accordingly.
- .3 All LC-LC optical fibre patch cords shall be manufactured and certified, 1-pair (duplex, 2 strands) Uniboot, OM4 50um, 2F, DFX 250 Riser, Standard Aqua Jacket. Field assembled patch cord is not allowed.
- .4 The fiber patch cords cable maximum Insertion Loss (IL) shall be no more than 3.25dB/Km.
- .5 LC patch cords connector maximum insertion loss (IL) shall be no more than 0.25dB/mated pair for OM4.
- .6 LC patch cords connector typical polish Return Loss (RL) shall be 30 dB for OM4.
- .7 The Contractor shall supply a minimum two (2) patch cords for every OM4 backbone cable:
 - .1 Provide 2x1m fiber patch cords for Security cabinet, and 1x1m, AND 1X2M Fiber patch cords for Network Cabinet
- .8 Approved manufacturer: Corning
- .9 Part number:
797902QD120001M
797902QD120002M

3 Execution

3.1 **INSTALLATION - GENERAL**

- .1 Install communications horizontal cabling in accordance with manufacturer's instructions, ANSI/TIA-568-C.0, ANSI/TIA-568-C.1, ANSI/TIA-569-D, BICSI TDMM, and NFPA 70.
- .2 Install cables after building interior has been physically protected from weather and mechanical work likely to damage cabling has been completed.
- .3 Ensure cable pathways are completely and thoroughly cleaned before installing cabling.
- .4 Inspect installed conduit, wireway, cable trays, and innerduct.
- .5 Clean additional enclosed raceway and innerduct systems furnished.
- .6 Provide protection for exposed cables where subject to damage.
- .7 Provide abrasion protection for cable or wire bundles which pass through holes or across edges of sheet metal.
- .8 Use protective bushings to protect cables.

- .9 Velcro wraps are preferred over cable ties for all cable bundles. No more than 24xCAT6A cable bundled together for ANEXT performance.
- .10 Where possible, route cables in overhead cable trays and inside wire management systems attached to equipment cabinets and racks.
- .11 Use Velcro, plastic ties or ducts to restrain cabling installed outside of wire management systems on racks or in cabinets.
- .12 Cable Trays: Do not exceed 50 percent fill.
- .13 Conduit: Do not exceed 40 percent fill.
- .14 Pull Cord: Nylon, 1/8-inch minimum.
- .15 Cable Raceways: Do not fill greater than ANSI/TIA-569-D maximum fill for particular raceway type.
- .16 Do not allow cables to rest on acoustic ceiling grids, plumbing pipes, or electrical conduits.
- .17 Bundle horizontal distribution cables in groups of no more than amount of cables designed for by cable support manufacturer, based on cable OD and weight.
- .18 Install cables above fire-sprinkler system.
- .19 Do not attach cables to fire-sprinkler system or ancillary equipment or hardware.
- .20 Install cable system and support hardware so that it does not obscure valves, fire alarm conduit, boxes, or other control devices.
- .21 Do not attach cables to ceiling grid or lighting fixture wires.
- .22 Replace before final acceptance, cables damaged or exceeding recommended installation parameters during installation.
- .23 Install patch cords for each termination using cable management in a neat and workmanship fashion acceptable to the Consultant.
- .24 Assume all Category 6A ports shall be patched.
- .25 Assume all fibre optic ports shall be patched
- .26 Install the Category 6A UTP patch cords from the network switches to the data patch panel using the horizontal and vertical wire managers.
- .27 Install the fibre patch cords from the network switches to the fibre backbone patch panel using the vertical wire managers.

3.2

WORK AREA OUTLETS

- .1 Cables shall be coiled in the in-wall or surface-mount boxes if adequate space is present to house the cable coil without exceeding the manufacturers bend radius.
- .2 In hollow wall installations where box-eliminators are used, excess wire can be stored in the wall. No more than 12" of UTP and 36" of fibre slack shall be stored in an in-wall box, modular furniture raceway, or insulated walls.
- .3 Excess slack shall be loosely configured and stored in the ceiling/cable tray above each drop location when there is not enough space present in the outlet box to store slack cable. For cubical office area, store 3 meters slacks in ceiling/cable tray for future changes.
- .4 Cables shall be dressed and terminated in accordance with the recommendations made in the TIA-568-C document, manufacturer's recommendations and best industry practices.
- .5 Pair untwist at the termination shall not exceed 3.18mm (0.125 inch).
- .6 Bend radius of the cable in the termination area shall not be less than 4 times the outside diameter of the cable.
- .7 The cable jacket shall be maintained to within 25mm (one inch) of the termination point.

3.3 HORIZONTAL CROSS CONNECT INSTALLATION

- .1 Cables shall be dressed and terminated in accordance with the recommendations made in the TIA-568-C standard, manufacturer's recommendations and best industry practices.
- .2 Pair untwist at the termination shall not exceed 3.18 mm (0.125 inch).
- .3 Bend radius of the cable in the termination area shall not less than 4 times the outside diameter of the cable.
- .4 Cables shall be neatly bundled and dressed to their respective panels or blocks. Each panel or block shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.
- .5 The cable jacket shall be maintained as close as possible to the termination point. In case of cable repair termination position change, the copper cable shall maintain enough slack (minimum 3 meters) in the cabinet and top cable tray for the patch panel termination.
- .6 Each cable shall be clearly labelled on the cable jacket behind the patch panel at a location that can be viewed without removing the bundle support ties. Cables labelled within the bundle, where the label is obscured from view shall not be acceptable.

3.4 INSTALLATION – UNSHIELDED TWISTED-PAIR CABLES

- .1 Install unshielded twisted-pair cables in accordance with manufacturer's instructions.
- .2 Install cables in continuous lengths from origin to destination, without splices, except for transition points or consolidation points.
- .3 Where transition points or consolidation points are allowed, they shall be located in accessible locations and housed in enclosure intended and suitable for the purpose.
- .4 Install unshielded twisted-pair cables so that there are no bends smaller than 4 times cable outside diameter at any point in the run and at the termination field.
- .5 Pulling Tension on 4-Pair UTP Cables shall not exceed 25 ft.lb.
- .6 Horizontal cables shall be bundled in groups of no more than 48 cables. Cable bundle quantities in excess of 48 cables may cause deformation of the bottom cables within the bundles, which will degrade the performance of those cables.
- .7 Provide following minimum separation distances between pathways for copper communications cables and power wiring of 480 volts or less:
- .8 Grounded Metal Conduit Communications Pathways:
 - .1 Electrical equipment and unshielded power lines carrying up to 2 kVA: 2-1/2 inches.
 - .2 Electrical equipment and unshielded power lines carrying from 2 kVA to 5 kVA: 6 inches.
 - .3 Electrical equipment and unshielded power lines carrying more than 5 kVA: 12 inches.
 - .4 Power lines enclosed in grounded metal conduit (or equivalent shielding) carrying from 2 kVA to 5 kVA: 3 inches.
 - .5 Power lines enclosed in grounded metal conduit (or equivalent shielding) carrying more than 5 kVA: 6 inches.

3.5 OPTICAL FIBRE BACKBONE REQUIREMENTS

- .1 The Contractor shall be responsible for a complete backbone cabling installation including and not limited to, termination fibre connectors, adaptor plates, cabling, ty-wraps, patch panels and labelling.
- .2 All fibre optic cabling shall be installed in dedicated conduit or cable tray, and protected with inner duct when in cable tray and inside of cabinet.

- .3 Backbone cabling shall be installed in pathways indicated on contract drawings and as per Section 27 05 28 of this specification.
- .4 All cables shall be neatly bundled and installed as per the manufacturer's guidelines or the standards in these specifications; whichever is more stringent.
- .5 Fibre optic cabling in racks and cabinets shall be neatly dressed using Velcro cable ties.
- .6 All cables shall continuous with no splices other than those that may be identified on drawings.
- .7 Provide a minimum of 3.0 m (10'-0") of slack at the patch panel end of each fibre optic cable. Neatly coil slack in cabinet and fasten with Velcro cable ties.
- .8 All strands of fibre optic cabling shall be terminated.
- .9 Do not kink or exceed the cable minimum bend radius for all cabling. Maintain a minimum of ten (10) times the cable diameter or 30 mm (1.2") whichever is larger for a bend radius.
- .10 Where backbone cables and distribution cables are installed in a cable tray or wireway, backbone cables shall be installed first and bundled separately from the horizontal distribution cables.
- .11 Vertical runs of cable shall be supported to messenger strand, cable ladder, or other method to provide proper support for the weight of the cable.
- .12 Large bundles of cables and/or heavy cables shall be attached using metal clamps and/or metal banding to support the cables.
- .13 Where there is the potential for excess stress on a cable(s) when pulling through conduit systems, apply a non-corrosive quick drying lubricant to the cable to facilitate pulling.
- .14 Completely remove all cable lubricant from cable jacket as cable exits the conduit system prior to termination and labelling.

3.6

OPTICAL FIBRE BACKBONE TESTING AND ACCEPTANCE

- .1 This section is to be read in conjunction with Section 27 11 16: "Testing for Communication Systems." In a case of a discrepancy, the more stringent requirement will be followed.
- .2 All cables and termination hardware shall be 100% tested for defects in installation and to verify cabling system performance under installed conditions according to the requirements of ANSI/TIA/EIA-568-B-1 Section 11.
- .3 All pairs of each installed cable shall be verified prior to system acceptance. Any defect in the cabling system installation including but not limited to cable, connectors, feed through couplers, patch panels, and connector blocks shall be repaired or replaced in order to ensure 100% useable conductors in all cables installed.
- .4 Backbone multimode fibre cabling shall be tested at both 850 and 1300 nm in both directions.
- .5 Test set-up and performance shall be conducted in accordance with ANSI/TIA/EIA-526-14 Standard, Method B.
- .6 Where links are combined to complete a circuit between devices, the Contractor shall test each link from end to end to ensure the performance of the system.
- .7 Only a basic link test is required. The Contractor can optionally install patch cords to complete the circuit and then test the entire channel. The test method shall be the same used for the test described above. The values for calculating loss shall be those defined in the ANSI/TIA/EIA Standard.

3.7

OPTICAL FIBRE BACKBONE SYSTEM DOCUMENTATION

- .1 This sub-section is to be read in conjunction with Section 27 00 00, Paragraph 2.5 "Project Documentation." In a case of a discrepancy, the more stringent requirement will be followed.

- .2 Upon completion of the installation, the Contractor shall provide three (3) full documentation sets to the Consultant for approval. Documentation shall include the items detailed in the sub-sections below.
- .3 Documentation shall be submitted within ten (10) working days of the completion of each testing phase. This is inclusive of all test results and draft as-built drawings. Draft drawings may include annotations done by hand. Machine generated (final) copies of all drawings shall be submitted within 30 working days of the completion of each testing phase. At the request of the Consultant, the Contractor shall provide copies of the original test results.
- .4 The Consultant may request that a 10% random field re-test be conducted on the cable system, at no additional cost, to verify documented findings. Tests shall be a repeat of those defined above. If findings contradict the documentation submitted by the Contractor, additional testing can be requested to the extent determined necessary by the Consultant, including a 100% re-test. This re-test shall be at no additional cost to the Owner.
- .5 Test Results documentation shall be provided in electronic format within three weeks after the completion of the project. The media shall be clearly marked on the outside front cover with the words "Project Test Documentation", the project name, and the date of completion (month and year).
- .6 The results shall include a record of test frequencies, cable type, conductor pair and cable (or outlet) I.D., measurement direction, reference setup, and crew member name(s). The test equipment name, manufacturer, model number, serial number, software version and last calibration date will also be provided at the end of the document.
- .7 Unless the manufacturer specifies a more frequent calibration cycle, an annual calibration cycle is anticipated on all test equipment used for this installation. The test document shall detail the test method used and the specific settings of the equipment during the test as well as the software version being used in the field test equipment.
- .8 The field test equipment shall meet the requirements of ANSI/TIA/EIA-568-B. The minimum level III tester shall be used to verify Category 6A cabling systems.
- .9 Printouts generated for each cable by the wire (or fibre) test instrument shall be submitted as part of the documentation package. Alternately, the Contractor may furnish this information in electronic form. The media shall contain the electronic equivalent of the test results as defined by the specification along with the software necessary to view and evaluate the test reports.
- .10 When repairs and re-tests are performed, the problem found and corrective action taken shall be noted, and both the failed and passed test data shall be documented.
- .11 The As-Built drawings are to include cable routes and outlet locations. Their sequential number as defined elsewhere in this document shall identify outlet locations.
- .12 Numbering, icons, and drawing conventions used shall be consistent throughout all documentation provided. The Owner will provide floor plans in paper and electronic (DWG, AutoCAD rel. 14) formats on which as-built construction information can be added. These documents will be modified accordingly by the Contractor to denote as-built information as defined above and returned to the Client.
- .13 The Contractor shall annotate the base drawings and return a hard copy (same plot size as originals) and electronic (AutoCAD rel. 14) form.

3.8

SYSTEM WARRANTY

- .1 A Cable Products Warranty shall provide a complete warranty to guarantee a high performance cabling systems that meet application requirements.
- .2 The guarantee shall include all cable installed in the structured cabling system.
- .3 The supply and installed and tested Belden or Panduit copper and fiber cabling system warranty, and a certificate from Belden or Panduit shall be provided by Contractor. The Cabling system shall be warranted for a period of at least 25 years.

3.9

FIELD QUALITY CONTROL

- .1 This section is to be read in conjunction with Section 27 11 16: "Testing for Communication Systems." In a case of a discrepancy, the more stringent requirement will be followed.
- .2 If any of these are in conflict, bring discrepancies to the attention of the Consultant for clarification and resolution.
- .3 Cables and Termination Hardware: Test 100 percent for defects in installation and verify cabling system performance under installed conditions in accordance with ANSI/TIA-568-C.0.
- .4 Verify all pairs of each installed cable before system acceptance.
- .5 Defects in cabling system installation, including but not limited to cables, connectors, patch panels, and connector blocks shall be repaired or replaced to ensure 100 percent useable conductors in all cables installed.
- .6 Test all cables in accordance with this specification section, ANSI/TIA-568-C.2, and ANSI/TIA-568-C.3 standards, and Manufacturer Network Solutions instructions.
- .7 Testing Unshielded Twisted-Pair Cables: (NOTE: Permanent Link Test results are required, and are the expected norm – unless patch cords that will remain installed at the work area and cross-connect are also being tested, in which case Channel Test results would be expected and accepted).
- .8 Test twisted-pair copper cable links for continuity, pair reversals, shorts, opens, and performance as specified.
- .9 Additional testing is required to verify Category 6A performance.
- .10 Test horizontal cabling using approved certification tester for Category 6A performance compliance in accordance with ANSI/TIA-568-C.2.
- .11 Only approved certification testers shall be used.
- .12 Fluke Networks Versiv/DSX-5000/DSX-8000 or VIAVI/JDSU NGC-4500 series Category 6A Cable Analyzer.
- .13 Category 6A shall conform to ANSI/TIA-568-C.2 for Category 6A to 550 MHz.
- .14 Basic Tests Required:
 - .1 Wire map.
 - .2 Length (feet).
 - .3 Insertion loss (dB), formerly attenuation.
 - .4 NEXT (Near end crosstalk) (dB).
 - .5 Return loss (dB).
 - .6 ELFEXT (dB).
 - .7 Propagation delay (ns).
 - .8 Delay skew (ns).
 - .9 PSNEXT (Power sum near-end crosstalk loss) (dB).
 - .10 PSELFEXT (Power sum equal level far-end crosstalk loss) (dB).
- .15 Test Category 6A by auto test to 550 MHz.
- .16 Provide test results in approved certification testers original software format on CD, with the following minimum information per cable:
 - .1 Circuit ID.
 - .2 Information from specified basic tests required.

- .3 Test Result: "Pass" or "Fail".
- .4 Date and time of test.
- .5 Project name.
- .6 Nominal Velocity of Propagation (NVP.)
- .7 Software version.
- .17 An occasional Asterisk-Pass (*Pass) will be accepted by Manufacturer at the manufacturer's discretion, but rework of these links should be done in an attempt to achieve clean "Pass" results prior to submission of test results.
- .18 To receive Manufacturer's Warranty for the project, submit software copy of test results, in original tester software format, to the Consultant and to Manufacturer.
- .19 Submit fully functional version of tester software for use by the Consultant in reviewing test results.
- .20 Report in writing to the Consultant immediately, along with copy of test results, failed test results that cannot be remedied through re-termination (as in the case of reversed or split pairs).

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1 General

1.1 **INTRODUCTION**

- .1 This section presents testing methodology and measurement standards for the Category 6A UTP copper and OM3/OM4 multimode fibre cabling infrastructure specified in this document.
- .2 The main standard for testing Category 6A UTP copper cable is ANSI/TIA-568- C2, and this section is based on that standard.
- .3 This is to be a Design/Build project and the purpose of these specifications and drawings is to provide guidelines for the Contractor based on industry standards outlined in Section 27 00 00, Paragraph 1.6.
- .4 If there are any questions, please contact the Consultant for clarification.

1.2 **RELATED SECTIONS**

- .1 This section shall be read in conjunction with all other sections as listed in Section 27 00 00, Paragraph 1.5, the contract drawings.
- .2 In addition, the general provisions as listed in Division 26, including supplementary conditions shall apply.

1.3 **REFERENCES**

- .1 Reference standards and codes are listed in Section 27 00 00, Paragraph 1.6 of this specification.
- .2 The Contractor shall perform all work according to Federal, Provincial, and Municipal codes, rules, regulations, and ordinances governing the work, and as fully part of the specifications as if herein repeated or hereto attached.
- .3 This document does not replace any code, either partially or wholly. The Contractor must be aware of local codes that may impact this project.
- .4 If the Contractor should note items in the drawings or the specifications, construction of which would be code violations, promptly call them to the attention of the Client's representative in writing.
- .5 All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to the most recent release when developing the proposal for installation.
- .6 In the event of conflict, the most stringent and recent requirements shall apply to the codes and standards above.

1.4 **ABBREVIATIONS AND DEFINITIONS**

- .1 There are a lot of parameters to be considered when testing cables and the jargon is somewhat daunting. The following is a list of definitions and abbreviations used in the testing of copper cable as outlined in the ANSI/TIA- 568-C2 standard:
- .2 Return Loss:
A measure of the degree of impedance mismatch between two impedances. It is the ratio, expressed in decibels, of the amplitude of a reflected wave echo to the amplitude of the main wave at the junction of a transmission line and a terminating impedance.
- .3 Insertion Loss:
- .4 This term has replaced the term "attenuation" (ATTN). It is a measure of the decrease of signal strength as it travels down the media.
- .5 NEXT Loss (Near-End Crosstalk):
A measure of the unwanted signal coupling from a transmitter at the near-end into a neighboring (non- energized) pair measured at the near-end.

- .6 PSNEXT Loss (Power-Sum Near-End Crosstalk):
A computation of the unwanted signal coupling from multiple transmitters at the near-end into a neighboring (non-energized) pair measured at the near- end.
- .7 FEXT Loss (Far-End Crosstalk):
A measure of the unwanted signal coupling from a transmitter at the near-end into a neighboring pair measured at the far-end.
- .8 ACRF (Attenuation to Crosstalk Ratio, Far-End) or ELFEXT (Equal-Level Far- End Crosstalk):
A measure of the unwanted signal coupling from a transmitter at the near-end into a neighboring pair measured at the far-end, relative to the received signal level measured on that same pair.
- .9 PSFEXT Loss (Power-Sum far-end crosstalk):
A computation of the unwanted signal coupling from multiple transmitters at the near-end into a neighboring pair measured at the far-end.
- .10 PSACRF (Power-Sum Attenuation to Crosstalk Ratio, Far- End) or PSELFEXT (Power-Sum Equal-Level Far-End Crosstalk):
A computation of the unwanted signal coupling from multiple transmitters at the near-end into a neighboring pair measured at the far-end, relative to the received signal level measured on that same pair.
- .11 Propagation Delay:
The time needed for the transmission of signal to travel the length of a single pair.
- .12 Propagation Delay Skew:
The difference between the propagation delay of any two pairs within the same cable sheath. Delay skew is caused primarily because twisted-pair cable is designed to have different twists per foot (lay lengths). Delay skew could cause data transmitted over one wire pair to arrive out of sync with data over another wire pair.
- .13 ANEXT Loss (Alien Near-End Crosstalk):
A measure of signal coupling from a near-end disturbing pair into a disturbed pair of a neighboring cable or connector pair or part thereof, measured at the near- end.
- .14 PSANEXT Loss (Power-Sum Alien Near-End Crosstalk):
A computation of signal coupling from multiple near-end disturbing pairs into a disturbed pair of a neighboring channel, cable or connector pair or part thereof, measured at the near-end.
- .15 AFEXT Loss (Alien Far-End Crosstalk):
A measure of signal coupling from a near-end disturbing pair into a disturbed pair of a neighboring cable or connector pair or part thereof, measured at the far- end.
- .16 PSAFEXT Loss (Power-Sum Alien Far-End Crosstalk):
A computation of signal coupling from multiple near-end disturbing channel pairs into a disturbed pair of a neighboring channel or part thereof, measured at the far-end.
- .17 PSAACRF (Power-Sum Alien Attenuation to Crosstalk Ratio, Far-End) or PSAELFEXT (Power-Sum Alien Equal- Level Far-End Crosstalk):
A computation of signal coupling from multiple pairs of disturbing channels to a disturbed pair in another channel measured at the far-end and relative to the received signal level in the disturbed pair at the far end.

1.5 **WORK INCLUDED**

- .1 The Contractor shall furnish all labour, materials, tools, field-test instruments and equipment required for the complete testing, identification and administration and other equipment necessary to provide test results for the horizontal voice and data and fibre backbone cabling systems.
- .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.
- .3 In order to conform to the overall project event schedule, the Contractor shall survey the work areas and coordinate cabling testing with other applicable trades.
- .4 In addition to the tests detailed in this document, the Contractor shall notify the Client or the Client's representative of any additional tests that are deemed necessary to guarantee a fully functional system. The Contractor shall carry out and record any additional measurement results at no additional charge.

1.6 **QUALITY ASSURANCE**

- .1 All testing procedures and field-test instruments shall comply with applicable requirements of:
 - .1 ANSI/TIA-1152, Requirements for Field Test Instruments and Measurements for Balanced Twisted- Pair Cabling
 - .2 ANSI/TIA-568-D-0, Generic Telecommunications Cabling for Customer Premises.
 - .3 ANSI/TIA-568-D-1, Commercial Building Telecommunications Cabling Standard
 - .4 ANSI/TIA 568-C.2, Balanced Twisted-Pair Telecommunications Cabling and Components Standards.
 - .5 ANSI/TIA-606-D, Administration Standard for Commercial Telecommunications Infrastructure, including the requirements specified by the customer, unless the customer specifies their own labeling requirements.
- .2 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 organizations or an equivalent organization:
 - .1 Manufacturer of the connectors or cable.
 - .2 Manufacturer of the test equipment used for the field certification.
 - .3 Training organizations such as BICSI.
- .3 The Client or the Consultant shall be invited to witness and/or review field- testing. They shall be notified of the start date of the testing phase five business days before testing commences.
- .4 At no cost to the Client, the Client or the Consultant will advise Contractor to select a random sample of five percent of the installed links and shall test these randomly selected links. The results obtained are to be stored in accordance with Part 3 of this document and shall be compared to the data provided by the Contractor. If more than two percent of the sample results differ in terms of the pass/fail determination, the Contractor under supervision of the Consultant shall repeat one hundred percent testing at no cost to the Client.

2 Products

2.1 **CATEGORY 6A COPPER CABLE TEST EQUIPMENT**

- .1 Approved Category 6A Test Equipment:
 - .1 JDSU: NGC-4500

- .2 Fluke Networks: DSX 5000/8000 Versiv Cable Analyzer
- .2 Category 6A test equipment shall meet the following minimum criteria:
 - .1 All test equipment of a given type shall be from the same manufacturer and have compatible electronic results output. Unless the manufacturer specifies a more frequent calibration cycle, calibration date shall be not more than a year from cable test date.
 - .2 Test adapters must be approved by the manufacturer of the test equipment. Adapters from other sources are not acceptable. For horizontal cabling, permanent link adapters shall be used.
 - .3 Baseline accuracy of the test equipment must meet or exceed TIA Level III, as indicated by independent laboratory testing.
 - .4 Test equipment must be capable of certifying Category 6A to TIA-568-C.2 standards.
 - .5 Test equipment must have a dynamic range of at least 100dB to minimize measurement uncertainty.
 - .6 Test equipment must be capable of storing full frequency sweep data for all tests.
 - .7 Test equipment must include S-Band time domain diagnostics for NEXT and return loss (TDNXT and TDRL) for accurate and efficient troubleshooting.
 - .8 Test equipment must be capable of running individual NEXT, return loss, etc., measurements in addition to auto tests. Individual tests increase productivity when diagnosing faults.
 - .9 Test equipment must make swept frequency measurements in compliance with TIA-568-C standards.
 - .10 The measurement reference plane of the test equipment shall start immediately at the output of the test equipment interface connector. There shall not be a time domain dead zone of any distance that excludes any part of the link from the measurement.
 - .11 The calibration of equipment shall be valid within one (1) year of the test date.
- 2.2 **BACKBONE CATEGORY 5E COPPER CABLE TEST EQUIPMENT**
 - .1 Approved Multipair Category 5e Test Equipment:
 - .1 JDSU: NGC-4500
 - .2 Fluke Networks: DSX 5000 Versiv Cable Analyzer
- 2.3 **FIBREOPTIC CABLE TEST EQUIPMENT**
 - .1 Approved fibreoptic test equipment:
 - .1 Fluke Networks: Versiv Main and Remote with OptoFiber Pro, CertiFiber® Pro Quad Optical Loss Test Set Module and USB Video Fiber Inspection Camera With Tip Set
 - .2 JDSU
 - .2 All test equipment of a given type shall be from the same manufacturer and have compatible electronic results output.
 - .3 Test results from the OLTS, and end-face images shall be recorded in the test instrument upon completion of each test for subsequent uploading to a PC in which the administrative documentation (reports) may be generated.
 - .4 Testing shall be performed on each cabling segment (connector to connector).
 - .5 All test equipment shall be able to perform Tier 1 testing and certification.

- .6 Test equipment that combines into one instrument an OLTS, and a fiber microscope shall be used and preferred.
- .7 Sources and meters shall automatically synchronize wavelengths to prevent calibration-related errors.
- .8 Test equipment shall employ a communications port to facilitate uploading of saved information from tester to PC.
- .9 Testing of the cabling shall be performed using high- quality test cords of the same fiber type as the cabling under test. The test cords for OLTS testing shall be between 1 m and 5 m in length.
- .10 Test equipment capable of measuring a Tx/Rx fiber pair simultaneously is recommended to enhance productivity. It is recommended that test equipment utilizing dual function main and remote units be used for bi- directional testing, eliminating the need to swap optical source and power meter.
- .11 Unless the manufacturer specifies a more frequent calibration cycle, calibration date shall not be more than a year from cable test date.
- .12 The calibration of all equipment used (main, remote, modules, adapters etc.) shall be within one (1) year of the test date. Calibration certificate shall be required and provided along with report.
- .13 Optical loss test set (OLTS) shall meet the following minimum criteria:
 - .1 Test equipment shall be capable of measuring relative or absolute optical power in accordance with TIA/EIA-526-14-C, "Optical Power Loss Measurement of Installed Multimode Fiber Cable Plant."
 - .2 Test equipment shall not include the loss or length of the test jumpers in the cable plant measurements.
 - .3 OLTS shall be able to measure the optical length of the fiber using time- of-flight techniques
 - .4 Multimode test equipment shall incorporate and provide:
 - .1 Dual LED light sources with central wavelengths of 850 nm (± 30 nm) and 1300 nm (± 20 nm)
 - .2 Output power of -20 dBm minimum.
 - .3 The launch shall meet the Encircled Flux launch requirements of ANSI/TIA-526-14-C.
 - .4 The test reference cords must demonstrate an insertion loss ≤ 0.15 dB when mated against each other.

3 Execution

3.1 **CABLE ACCEPTANCE TESTING**

- .1 This section specifies the acceptance testing requirements for structure cabling backbone fibre optic as well as horizontal UTP cabling.
- .2 Supply all labor, materials, tools, field-test instruments and equipment required for the complete testing, identification and administration of the structured cabling for each cabling link (connector to connector).
- .3 All structured cabling components (outlets, cables, patch panels and associated components etc.) shall be fully assembled and labeled prior to field-testing. Any testing performed on incomplete systems shall be redone on completion of the work at no cost to City of Toronto.
- .4 Installed Category 6A, Unshielded Twisted Pair (UTP) structured cabling system shall be tested as specified in TIA-568-C.2 for Category 6A, Unshielded Twisted Pair (UTP) using

- permanent link configuration on the testing equipment. Channel link testing shall not be accepted.
- .5 Installed Fiber-optic cable each strand connector and adapter ferrule end-faces shall be cleaned and inspected before loss testing and final connection along a link, including through any passive connections or splices along the way and shall be free of any scratches, defects and dirt as per IEC-61300-3-35.
 - .6 Installed Fiber-optic cable each strand connector and adapter Ferrule end-faces shall be Dry cleaning (such as, using "one click pen"). If that still does not clean, then try wet cleaning (such as hydrocarbon liquid, lint free wipes). Always finish with dry cleaning.
 - .7 It shall take care to accommodate the angle when cleaning APC type angled connectors.
 - .8 It is also especially important to clean loose contaminants beyond the contact point.
 - .9 Damaged connector shall be replaced.
 - .10 Installed Fiber-optic structured cabling system shall be tested as per TIA-568.0-D- Tier 1 OLTS: link attenuation testing, link length and polarity check etc.
 - .11 All of the installed cabling must be tested and successfully pass all test criteria.
 - .12 Any parameter with Asterisk (PASS*) in pass test result indicating Marginal Pass shall be considered as conditional pass (no exceptions).
 - .13 Marginal Pass result/parameter shall be identified and highlighted on the result document. The detailed diagnostic report as an aid to interpret results marked with asterisks shall be provided. A diagnostic report shall be submitted identifying the source of the marginal performance.
 - .14 City of Toronto-DNS team after reviewing cause/factor of the marginal pass will determine if the marginal pass result will be accepted and no further action is required. If any corrective actions and retest is required, that shall be done at no cost to City of Toronto and shall be done immediately.
 - .15 City of Toronto-DNS reserved the rights to demand to rectify the cause of the marginal pass result and retest. City of Toronto shall not assume any cost associated in rectifying and retest the marginal pass result/link.
 - .16 Standards referenced in this section include:
 - .1 TIA-568-C or latest: Telecommunications Cabling Standard. All standards referenced within the TIA-568-C, where applicable, constitute standard provisions of this specification.
 - .2 TIA-526-14-C: Optical Power Loss Measurement, Multimode
 - .3 TIA-526-7-A : Optical Power Loss Measurement, Single-mode
 - .4 ANSI/TIA-1152: Requirements for field test instruments and measurements for balanced twisted- pair cabling
 - .5 IEC-61300-3-35: Basic Test and Measurement Procedures Standard for Fiber Optic Interconnecting Devices and Passive Components (Automated End-Face Inspection)
 - .17 Contractors, installers and technicians shall be certified (in good/valid standing) with Belden, Corning, JDSU and Fluke Networks to review/accept and perform installations and testing/commissioning.
 - .18 Visually inspect all cables, cable reels and shipping cartons to detect possible cable damage incurred during shipping and transport. Visibly damaged goods shall be returned to the supplier and replaced at no additional cost to the City of Toronto-TW.
 - .19 All cables and termination hardware shall be 100% tested for defects in installation and to verify cabling system performance under installed conditions according to the requirements

of TIA-568-C. All pairs of each installed cable shall be verified prior to system acceptance. Any defect in the cabling system installation including but not limited to cable, connectors, feed through couplers, patch panels and connector blocks shall be repaired or replaced in order to ensure 100% useable conductors in all cables installed without cost to the City of Toronto.

3.2 **COPPER PERMANENT LINK TESTING – HORIZONTAL CABLING**

- .1 All twisted-pair copper cable links shall be tested for continuity, pair reversals, shorts, opens and performance to Category 6A. Horizontal cabling shall be tested using a minimum level III test unit for Category 6A performance compliance.
- .2 Continuity - Each pair of installed cable shall be tested using a test unit that shows opens, shorts, polarity and pair-reversals, crossed pairs and split pairs. The test shall be recorded as pass/fail as indicated by the test unit and referenced to the appropriate cable identification number and circuit or pair number. Any faults in the wiring shall be corrected and the cable re-tested prior to final acceptance.
- .3 Length - Each installed cable link shall be tested for installed length using a TDR type device. The cables shall be tested from patch panel to patch panel, block to block, patch panel to outlet or block to outlet as appropriate. The cable length shall conform to the maximum distances set forth in the TIA-568-C Standard. Cable length shall be recorded, referencing the cable identification number and circuit or pair number. For multi-pair cable, the shortest pair length shall be recorded as the length for the cable.
- .4 Horizontal twisted pair cable shall meet or exceed the permanent link, performance requirements specified in TIA-568-C.2 for Category 6A, Unshielded Twisted Pair (UTP).
- .5 All tests shall be conducted using permanent link configuration on the testing equipment.
- .6 Category 6A Cabling Alien Crosstalk Field Sampling Testing
 - .1 Cabling manufacturer (Belden or Panduit) Category 6A Cabling System Warranty requirement on Alien Crosstalk field sampling testing must be confirmed and followed.

3.3 **COPPER PATCH CORD TESTING**

- .1 All supplied and installed Category 6A patch cords shall be from manufacturer/ Belden. A Belden factory test report or certificate on their supplied Category 6A patch cord shall be provided by Contractor.

3.4 **HORIZONTAL CABLE TESTING DOCUMENTATION - COPPER**

- .1 Category 6A (UTP) Documentation - As a minimum, test reports shall include the following information for each UTP Category 6A cabling element tested:
 - .1 Wiremap results that indicate the cabling has no shorts, opens, split, reversed, or crossed pairs and end-to-end connectivity is achieved.
 - .2 Attenuation, NEXT, PSNEXT, Return Loss, ELFEXT and PSELFEXT data that indicate the worst case result, the frequency at which it occurs, the limit at that point and the margin. These tests shall be performed in a swept frequency manner from 1 MHz to highest relevant frequency, using a swept frequency interval that is consistent with TIA and ISO requirements. Information shall be provided for all pairs or pair combinations and in both directions when required by the appropriate standards.
 - .3 DC Loop Resistance is the total resistance through two conductors looped at one end of the link. This is usually a function of the conductor diameter and varies only with distance. This measurement is sometimes done to ensure there are no gross misconnections which can add significant resistance to the link.
 - .4 Length (in meters), propagation delay and delay skew relative to the limit.

- .5 Any individual test that fails the relevant performance specification shall be marked as a FAIL.
- .6 Final Test results that contain an asterisk (PASS*, FAIL*) are not acceptable to TW-DNS.
- .7 The report shall include the plot (graphical) data as well for trouble shooting.
- .8 Cable manufacturer, cable model number/type and NVP.
- .9 Tester, manufacturer, model, serial number, hardware version and software version.
- .10 Circuit ID number (Cable Tag Id) and Facility name.
- .11 Test criteria used.
- .12 Overall pass/fail indication.
- .13 Date and time of test.

3.5 **BACKBONE CATEGORY 5E MULTIPAIR TESTING – VOICE APPLICATION**

- .1 Multipair Category 5e copper backbone cable shall be tested for by Permanent link per TAI-568-C.
- .2 The testing shall be conducted from the voice patch panel in the Telecom Enclosure (TE) to the termination wiring blocks at the Entrance Facility.
- .3 For testing the multipair cabling on the termination blocks (BIX series) appropriated test adapters shall be used and shall be reviewed by the Consultant and DNS.
- .4 When only 1 or 2-pair of the multipair cable terminated with a RJ45 jack module, the continuity test is requested only.

3.6 **BACKBONE FIBREOPTIC TESTING**

- .1 All testing procedures and field-test instruments shall exceed (meet and comply with) applicable requirements of:
 - .1 ANSI Z136.2, Safe Use of Optical Fiber Communication Systems Utilizing Laser Diode and LED Sources
 - .2 ANSI/EIA/TIA-455-50B, Light Launch Conditions for Long-Length Graded-Index Optical Fiber Spectral Attenuation Measurements
 - .3 ANSI/TIA/EIA-455-59A, Measurement of Fiber Point Discontinuities Using an OTDR.
 - .4 ANSI/TIA/EIA-455-60A, Measurement of Fiber or Cable Length Using an OTDR.
 - .5 ANSI/TIA/EIA-455-61A, Measurement of Fiber or Cable Attenuation Using an OTDR.
 - .6 ANSI/TIA/EIA-526-7, Optical Power Loss Measurements of Installed Singlemode Fiber Cable Plant.
 - .7 ANSI/TIA-526-14-C, Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant; IEC 61280-4-1 edition 2, Fiber-Optic Communications Subsystem Test Procedure - Part 4-1: Installed cable plant - Multimode attenuation measurement
 - .8 TIA-TSB-4979 Practical Considerations for Implementation of Multimode Launch Conditions in the Field (Encircled Flux)
 - .9 ANSI/TIA-568.0-D, Generic Telecommunications Cabling for Customer Premises (Merged/Combined Tier 1 and Tier 2)
 - .10 ANSI/TIA-568-C.3, Optical Fiber Cabling Components Standard (MM and SM)

- .11 IEC-61300-3-35: Basic Test and Measurement Procedures Standard for Fiber Optic Interconnecting Devices and Passive Components.
- .12 ANSI/TIA-606-B, Administration Standard for Telecommunications Infrastructure
- .2 Installed Fiber-optic end-faces shall be inspected at 400X magnification as per IEC-61300-3-35. Scratched, pitted or dirty connectors shall be diagnosed and corrected at no extra cost to City of Toronto.
 - .1 End-face images shall be recorded in the memory of the test instrument for subsequent uploading to a PC and shall be reported to TW DNS.
 - .2 The End-face images shall be submitted and incorporated with the test report.
- .3 Installed Fiber-optic structured cabling system shall meet or exceed and shall be tested as per TIA-568.0-D:
 - .1 Tier 1 - OLTS (mandatory): link attenuation testing, link length and polarity check etc.
- .4 All unused fiber adapter plates and fiber jumper connectors shall be protected with dust cap/cover. All removed dust cap/cover during the testing shall be restored after the testing.
- .5 All tests shall be documented including OLTS dual wavelength attenuation measurements, optical length measurements etc.
- .6 Test link attenuation with an OLTS:
 - .1 For multimode fibre, make reference measurements in accordance with TIA-526-14-B, Annex A - Method B (One cord reference method). Measure optical loss on each fibre at 850 nm and 1300 nm. Measure loss on each fibre from each direction (bi-directionally).
- .7 Measure link length optically or calculate using cable sheath length markings.
- .8 Testing shall be performed on each cabling link (connector to connector).
- .9 Negative losses shall be retested.
- .10 Testing shall not include any active devices or passive devices within the link or channel other than cable, connectors, and splices, i.e. link attenuation does not include such devices as, optical bypass switches, couplers, repeaters, or optical amplifiers.
- .11 Multimode backbone fibre optic cabling shall meet the following loss and length criteria:
 - .1 Attenuation @ 850 nm shall be less than or equal to: fibre length (km) x 3.5 dB/km + number connector pairs x 0.75 dB + number of splices x 0.3 dB.
 - .2 Attenuation @ 1300 nm shall be less than or equal to: fibre length (km) x 1.50 dB/km + number connector pairs x 0.75 dB + number of splices x 0.3 dB.
 - .3 Length shall be less than or equal to 300 meters.
- .12 All tests performed on optical fiber cabling that use a laser or LED in a test set shall be carried out with safety precautions in accordance with ANSI Z136.2.
- .13 All structured cabling components (outlets, cables, patch panels and associated components etc.) shall be fully assembled and labeled prior to field-testing. Any testing performed on incomplete systems shall be redone on completion of the work at no cost to City of Toronto.
- .14 Field-test instruments shall have the latest software and firmware installed.
- .15 All the test results shall be recorded in the test instrument upon completion of each test for subsequent uploading to a PC in which the administrative documentation may be generated.

3.7

BACKBONE FIBREOPTICS TESTING DOCUMENTION

- .1 Fibreoptics Documentation: As a minimum, test reports shall include the following information for each fibreoptics cabling element (fibre) tested:
 - .1 400X magnified fiber connector End-face inspection images.
 - .2 Actual measured attenuation, maximum allowable attenuation (loss) and the attenuation margin at the specified wavelengths. An individual test that fails the link criteria shall be marked as FAIL.
 - .3 The length:
 - .1 OLTS measurements for each optical fiber as calculated by the OLTS tester. (mandatory)
 - .4 The overall Pass/Fail evaluation:
 - .1 OLTS measurements of the link-under-test as calculated by OLTS tester.(mandatory)
 - .5 Reference method and document test reference cord losses. Test reference cords will "wear out" with use, poor/damage cords will destroy the installation. For 1-jumper reference, the reference cord shall be verified every 288 tests. Verification performance of test reference cords to be saved and submitted.
 - .6 Number of mated connectors.
 - .7 Test limit
 - .8 Limits Version
 - .9 Number of Splices
 - .10 Bi-directional testing
 - .11 Tester manufacturer, model, serial number and software version.
 - .12 Link criteria used.
 - .13 Overall pass/fail indication.
 - .14 Date and time of test was conducted and saved in the memory of test equipment.
 - .15 Cable IDs as recorded and reported on the test instrument shall match the actual installed cable IDs of each strand, for example:
 - .1 2100-FP01-A-01:0100-FP01-F-01 (1st Fiber Strand)
 - .2 2100-FP01-A-02:0100-FP01-F-02 (2nd Fiber Strand) so on, so forth.
 - .16 Cable Type.
 - .1 SITE/Facility name: Actual site name or acronym (XXX etc.)
 - .17 Project: Actual Project Name and Contract Number
 - .18 Native File Name for e.g. (Fluke.flw) shall reflect respective TE name for e.g. (xxx-ITS-COM- 2100) where XXX is site acronym (XXX etc.)
 - .19 1st page of the printed test results shall always be Test Result Summary Page.
- .2 Any link or channel that fails the requirements shall be diagnosed and corrected. Any corrective action that must take place shall be documented and followed with a new test to prove that the corrected link or channel meets performance requirements. The final and passing result of the tests for all links and channels shall be provided in the test results documentation and shall be done at no cost to City of Toronto.

3.8 CABLE TEST RESULTS MANUAL

- .1 Contractor shall submit the test report to Consultant for review and comment. TW-DNS shall only receive the report after the review and approved comments of the Consulting Engineer. TW-DNS will provide their final review comment.
- .2 The database and test report for the complete project shall be submitted in both a hardcopy and electronic format (.pdf and native). Hand-written test reports are not acceptable. Submit electronic files on USB in a PDF and native format. This USB shall include the software tools required to view, inspect, and print any selection of the test reports at no cost to City of Toronto.
- .3 Fiber optic backbone cable test results shall be incorporated in the Toronto Water Network - Cable Test Results manual. Submit two (2) copies of the Cable Test Results manual for each facility. The manual consists of hardcopy test result reports placed into lockable 'D' ring binders with a cover and spine that clearly indicates the title of the manual. Put a USB with the electronic copies of test reports in a pocket in the Cable Test Results manual.
- .4 Test results saved within the field-test instrument shall be transferred into a Windows™-based database utility (for example, Fluke LinkWare software) that
- .5 allows for the maintenance, inspection and archiving of the test records. These test records shall be uploaded to the PC unaltered, i.e., "as saved in the field-test instrument". The file format, CSV (comma separated value), does not provide adequate protection of these records and shall not be used.
- .6 The test results documentation shall be available for inspection by the City of Toronto or City of Toronto assigned Engineering Consultants during the installation period and shall be passed to the City of Toronto assigned Engineering Consultants within 5 working days of completion of tests on cabling served by a telecommunications room or of backbone cabling. The installer shall retain a copy to aid preparation of as built information.
- .7 The Contractor (Project manager) must sign hardcopy reports before submitting it to Consultant (RCDD).

3.9 COMPLIANCE SHEET

- .1 A compliance sheet shall be prepared for every project by Toronto Water - DNS. The general minimum criteria is summarized as below, but not limited to:

1	Test equipment with latest software and test limit version	11	
2	Test equipment with latest test limit version	12	Test results based on LED or Encircled Flux for OM3/OM4 MM
3	Tester manufacturer, model, serial number, software version and Calibration date.	13	
4	Test results submitted in PDF and native format	14	MM testing at 850nm and 1300 nm wavelength
5	Test result cable ID in compliance	15	
6	Permanent Link testing and Patch Cord testing performed on copper (Category 5e/6A)	16	Bi-directional testing done

7	Test result cable type (copper and fiber) in compliance	17	Accurate quantity of adapters and splices
8	Correct reference cable used (Correct Jumper method used)	18	Project: Actual Project Name and Contract Number used
9	SITE: Actual site name or acronym used	19	Test Record Native File Name have reference to TE name (xxx-ITS-COM-2100)
10	Fiber Optic Tested using: Tier 1 - OLTS (mandatory) Tier 2 – OTDR (optional, if applicable and requested)	20	400x Magnified End- face images complete report is provided

3.10

SITE ACCEPTANCE TEST (SAT)

- .1 Prior to SAT, it is mandatory that City of Toronto assigned Engineering Consultant / Contract Administrator shall verify if installed structured cabling system (end to end) is ready qualify for acceptable SAT and any other criteria as may be described in the project tender, the Installation and Layout drawings. This can be achieved by conducting a Pre-SAT between City of Toronto assigned Engineering Consultant / Contract Administrator and contractor / installer.
- .2 SAT date shall be established (no exceptions) only after, City of Toronto assigned Engineering Consultant / Contract Administrator have comprehensively reviewed and approved all copper and fiber cabling testing, follow-up with TW- DNS final review and approval.
- .3 Contractor shall develop and provide all the required drawings and documents, SAT document (check list) and provide it to City of Toronto assigned Engineering Consultant / Contract Administrator at least four (4) weeks prior to the test for review.
- .4 City of Toronto assigned Engineering Consultant / Contract Administrator shall review all the required drawings and documents, SAT document (check list), Certificate of Conformance (CoC) - Grounding and Bonding System and then shall submit to TW-DNS for final review and approval, at least two (2) weeks prior to SAT date.
- .5 The Contractor shall conduct the test when directed by the Contract Administrator. Contract Administrator shall monitor the SAT and record the results. TW-DNS shall witness the test only.
- .6 The SAT plan shall be sealed by the Installation Project Manager RCDD, followed by the RCDD Consultant.
- .7 A Site Acceptance Test (SAT) will NOT test functionality of the system or its components. Site Acceptance Tests will evaluate the workmanship and verify installation for installed structured cabling system (end to end) under the project against the Installation and Layout drawings.
- .8 The SAT shall be completed only when all items in the checklist have been witnessed and installed by the Contract Administrator/Project Manager, Consultant and TW-DNS as being in conformance with the design as specified.
- .9 Any noted or identified non-compliant items shall be made compliant at no cost to the City of Toronto.
- .10 The term "free-issue" refers to equipment supplied by the City but installed and patched by contractor per the layout drawing and application patching schedule. The Network Switching and Routing Equipment will be freely issued by the City. The network equipment will be configured, tested by Toronto Water PCS DNS staff. The horizontal cabling patching

and end device connection must be successfully past the performance field testing and SAT.

- .11 The fiber backbone cabling patching with Switch shall be done by TW DNS staff.
- .12 SAT of Equipment Room / Telecom Room
 - .1 Each facility shall have one or more equipment room / telecom room, which house the server and network core/service provider closets. Each equipment / telecom room shall undergo a witnessed SAT.
 - .2 The Consultant is responsible for the equipment / telecom room UPS, lighting panel, HVAC and any ER/TR modifications noted in the tender drawings and specifications. The extent of ER/TR modifications varies for each facility.
 - .3 In addition to the above, the ER/TR SAT shall include the evaluation of the server and core closet installation, fiber/copper cabling products and equipment, cable managers, labelling, power supplies to each closet and external cable management (e.g. cable tray) as well as cooling and grounding. For the purpose of the ER/TR SAT the server and core closets shall be empty except for the installation of receptacles to receive the UPS.
- .13 Work area outlet installation and labelling and cabling pathway shall be inspected during SAT.

3.11 **WARRANTY**

- .1 The installed Category 6A and OM3/OM4 fiber cabling System shall be covered by the cabling system Warranty, issued by cabling manufacturer (Belden or Panduit). and delivered by the manufacturer certified cabling Contractor. To qualify for System Warranties, the installed cabling system shall fully comply with all relevant manufacturer design and application guidelines.
- .2 Testing and certification of the Building Network Distribution Cabling System shall be by the Contractor and shall include the provision of a manufacturer Warranty covering performance, products and installation.
- .3 The Warranty shall cover the full repair and/or replacement of any component failing or failure to meet the design requirements within one (1) year.
- .4 Extended 25-year Structure Cabling System Manufacturer Warranty.
- .5 Warranty shall be delivered by the Contractor in coordination with cabling manufacturer to the Client's Project Manager with the Testing and Certification documents. The project site shall receive manufacturer's plaque. All coordination regarding warranty and handing over of the manufacturer's plaque is the responsibility of the Contractor.
- .6 The manufacturer shall warrant the project for twenty five (25) years against application assurance and extended product manufacturing defects.
- .7 The Contractor/manufacturer shall warrant installation against all product installation defects and that all approved cabling components meet or exceed the specified requirements for a period of twenty five (25) years following acceptance.
- .8 The Contractor/manufacturer shall warrant that all permanent fibre optic links meet or exceed the performance requirements of TIA-568-C.3 for multimode fibre.
- .9 The Contractor/manufacturer shall warrant that all permanent twisted-pair links meet or exceed the performance requirement of TIA/EIA-568-C.2 for Category 6A, unshielded twisted pair.
- .10 The Contractor must provide complete end to end mapping of all connectivity at the end in both hard and softcopy formats. This includes but not limited to horizontal data / voice cable number, copper and fibre backbone cable and active equipment ports.

- .11 Within ten (10) days after testing, the contractor shall provide the Project Manager with documentation, which shall include cable test results, a marked-up copy of the as-built cable network drawing and an electronic copy of the completed installation in AutoCAD or as per City's CAD guidelines.
- .12 The Contractor shall provide a manufacturer written certificate, plaque and warranty that the structured cabling platform is installed and fully operating in accordance with this standard and manufacturers specification.
- .13 The warranty must guarantee that the design or installation negligence on the part of the Cabling Contractor shall not negate or void any portion of the certified system. The manufacturer must guarantee that all material, components and labour are covered in this circumstance for the full certification period of twenty five (25) years. It must also guarantee that in the event a Cabling Contractor is no longer able to service the warranty, the full certification remains valid and is responsibility of the manufacturer.
- .14 If a warranty issue arises for the cabling, the Warrantor must make arrangements to undertake the repair or replacement of warranty issues within 24 hours of notification. This may require the repair/replace of cabling components outside regular working hours at no additional cost.
- .15 The Cabling Contractor shall forward the Structured Cabling Platform certification request form(s) to the proper authority and ensure that a Plaque and Certificate is issued to the Customer / Project Site along with the Structured Cabling Platform user manual. The successful bidder shall provide a certification number within two weeks of award of this project. Please note that the Plaque/Certificate must have the Customer name / Project name on the Plaque/Certificate.
- .16 The Cabling Contractor shall provide letter(s) of Certification within two weeks of substantial completion of the project to the Customer. This document will include the following: verification of the performance of the installed system, identification of the installation by location and project number and a copy of the warranty.
- .17 Upon request and at no additional cost to the client the Cabling Contractor must provide a manufacturer's technical representative to conduct an on-site visit to ensure complete technical compliance.
- .18 The Cabling Contractor must supply a copy of an unexecuted warranty statement (at the time of bidding) including all related terms and conditions. This copy shall be the Standard to which the warranty will be held. No changes shall be accepted unless it is deemed to benefit the client. Any proposed changes to the warranty must be submitted in writing to the consultant and client for review. The changes will then be accepted or declined by the Client at their discretion. This is to remain valid for the entire warranty period.
- .19 All cable Cabling Contractor technicians on site must be trained by the manufacturer of the Structured Cabling Platform being installed.
- .20 Any defective or improperly installed products shall be replaced, or correctly reinstalled at no cost to the Client.

3.12 **AS-BUILT DRAWINGS**

- .1 The drawings shall include cable routes and outlet locations.
- .2 Outlet locations shall be identified by their sequential number as defined elsewhere in this document.
- .3 Numbering, icons and drawing conventions used shall be consistent throughout all documentation provided.
- .4 For an existing infrastructure upgrade, the Client may provide floor plans in paper and electronic (AutoCAD & PDF) formats on which as-built construction information can be added.

- .5 These documents shall be modified accordingly by the Contractor to denote as-built information as defined above and returned to the Client.
- .6 The Contractors shall annotate the base drawings and return a hard copy (same plot size as originals) and electronic (AutoCAD & PDF) form. The drawings shall follow City CADD standard.

3.13 **FINAL ACCEPTANCE**

- .1 Once all work has been completed including all documentation submissions, the client will notify the satisfaction to the Consultant in writing of formal acceptance of the system.
- .2 Consultant must warrant in writing that 100% of the installation meets the design requirements as specified.
- .3 Contractor must warrant in writing that 100% of the installation meets the requirements specified in the tender documents.
- .4 Acceptance shall be subject to completion of all work, successful post-installation testing which yields 100% PASS rating and receipt of full documentation as specified.
- .5 The client may agree to allow certain cable runs to exceed acceptable standardized performance criteria. If required these cable runs will be exempt from meeting the specified standards. However, the Contractor will still be required to test these cable runs to validate component and installation performance.
- .6 Documentation: The Contractor shall submit the following documentation for final acceptance:
 - .1 Toronto Water Network — Cable Test Results Manual.
 - .2 Cable Acceptance Test (CAT) – Compliance Sheet.
 - .3 Site Acceptance Test (SAT).
 - .4 As-built Drawings and Documents (ADD).
 - .5 Consultant Review and Comments (CRC).
 - .6 Certificate of Conformance (CoC) – Grounding and Bonding System.
 - .7 Manufacturer Warranty Certificates.
 - .8 TW-DNS Approval of Satisfaction (IAS) – Signing off.

End of Section

APPENDIX A

City of Toronto
Corporate Building System Design Requirements



Corporate Building System Design Requirements

September 2024

Prepared by City of Toronto Corporate Real Estate Management & Arup

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Introduction

The objective of the development of the City of Toronto Corporate Building System Design Requirements (Design Requirements) is to establish a standardized framework for the design and construction of building system replacements. The Design Requirements are intended to promote consistency in design practice across the city's portfolio and apply to the design or procurement of all major building systems and components for new or existing city-owned buildings, wherever applicable. It is intended to provide clarity to both municipal staff, external consultants, and contractors.

This document is intended for use by **Contractors**. Refer to *COT - Corporate Building System Design – Consultants* for design consultant' specific requirements.

Goals and Objectives

City of Toronto has identified the following thirteen objectives aimed at enhancing operations and performance of their portfolio. These objectives serve as guiding principles aimed at optimizing the performance and functionality of the city's diverse portfolio.

1. Standardize building components and systems
2. Optimize lifecycle costs
3. Perform building commissioning
4. Leverage existing systems
5. Integrate with BAS
6. Minimize energy and water use
7. Increase building resilience
8. Incorporate onsite renewable energy generation
9. Minimize or eliminate greenhouse gas emissions
10. Minimize embodied carbon of materials
11. Minimize adverse effects on natural and built environments
12. Provide healthy indoor environments for occupants
13. Use environmentally preferable products

Guide to the Corporate Building System Design Requirements

This document outlines the requirements that are to be applied to all future renovation and new build projects undertaken by the City of Toronto. These requirements have universal application to City of Toronto projects, spanning major and minor capital projects, site projects, and initiatives driven by specific city targets such as TransformTO, ModernTO, as well as any asset-specific Net Zero Transition Plans. While applicable to both new construction and existing buildings, the primary focus of the Standard Documentation is on existing buildings, aiming to address the gap in guidance for retrofits and equipment replacement.

These requirements will be used for all City of Toronto owned and operated projects inclusive, but not limited to:

- Major capital projects - all new building construction projects and major renovations for regularly scheduled capital projects that include mechanical and electrical system upgrades or replacement, envelope improvements, and room reconfiguration
- Minor capital projects - project examples may include minor space renovation, alteration or system upgrade or replacement (i.e., replacement of a single mechanical, electrical, or furniture system), operation and maintenance projects
- Site projects - project examples may include stormwater management, soft and hard landscaping, irrigation, or exterior lighting
- Projects outside of regular capital planning driven by City of Toronto initiatives

Projects are required to take into account both current and future building needs, ensuring that subsequent renovations and retrofits remain in harmony with the original intent of the building. While emergency replacement projects are encouraged to align with these standards whenever feasible, it is acknowledged that limitations may arise in such situations. It's important to note that these requirements were not specifically formulated to address emergency replacement scenarios. This framework is designed to be applicable to a diverse range of building types within the City of Toronto's corporate portfolio, including:

- Community Centers & Arenas
- Office buildings
- Service Facilities (Boathouse, greenhouse, animal shelters, etc.)
- Emergency Services (Police, Fire, EMS)
- Yards (Warehouse, maintenance, industrial, etc.)

While the requirements are applicable to leased facilities where possible, separate guidelines have not been developed to address specific nuances related to leased facilities.

Project Adherence

The requirements have been developed by the Corporate Real Estate Management (CREM). It is imperative that all applicable projects, as outlined above, must adhere to them, and COT project teams are responsible for determining any requirements that can be excluded based on project specifics. The requirements are not meant to eliminate innovation and design thought, but to clearly define City of Toronto's expectations on project outcomes. Deviations from these requirements are only allowed through specific direction or exemption granted by the CREM team.

Organization

The document is organized by NMCS division titles. Within divisions, requirement statements will be organized by General Objectives, Functional Requirements, Performance Requirements, and Prescriptive Requirements. General Objectives and Functional Requirements will capture Owner's Project Requirements and to outline the goals of a project and expectations for how it be used and operated. They will lay out the foundation for a successful project delivery as defined by the owner and building users. They will be used during the pre-design phase of an existing building or new construction project in collaboration with the facilities design team. Each building system section will contain specification statements to outline requirements of given design, product, or material in the form of Performance Requirements and Prescriptive Requirements. These will in whole or in part form the basis for and inform any project-specific design specification package produced by designers and consulting engineers.

The **General Objectives** outlined in this document will encompass statements that reflect the City's overarching policies and priorities concerning its corporate buildings portfolio. These objectives align with and support the City's broader set of 13 overarching objectives, aimed to improve performance of its real estate assets. These General Objectives will serve as a reference point for decision-making and project planning, ensuring that all projects within the corporate buildings' portfolio are consistent with the City's direction. Additionally, they will inform when certain project types require feasibility studies, investigations, or enabling works that might be necessary for project execution.

The **Functional Requirements** contained in this document will be statements related to the desired purpose or objective of a building system or component within the context of the whole building as a system. The Functional Requirement statements translate applicable General Objectives to the building system or component level and define additional characteristics as appropriate such as the following list.

- Heat, air, and moisture control objectives
- Commissioning outcomes
- Maintenance objectives
- Durability and lifespan
- Indoor environmental quality objectives
- Provision of cooling (e.g., for new or for where it doesn't exist)
- Integrate with existing systems/components etc.
- Climate adaptation & resilience
- Thermal autonomy/Passive survivability
- Backup system / redundancy requirements
- Renewable energy generation
- Provision of temporary shelter (e.g., during severe cold and heat events)
- Etc.

The **Performance Requirements** outlined in this document provide a clear description of the expected performance characteristics necessary to achieve specific General Objectives and Functional Requirements. Performance requirements will focus on how the building system and its components should perform once integrated, rather than specifying the exact composition or construction of individual components. Unlike prescriptive requirements, which dictate precise methods and materials, performance requirements concentrate on the desired outcomes and functionality of the system and offer a more flexible approach. Performance requirements have a broader scope, encouraging innovation and flexibility in design and construction. They empower

designers and builders to explore various solutions to meet the desired performance levels, fostering creativity and adaptability. Where asset-specific Net Zero Transition Plans have not been developed, the Performance Requirements can serve to form a pathway to this eventual goal. Performance Requirement statements define characteristics which may be related to:

- Energy efficiency
- Operational GHG emissions
- Embodied emissions of materials
- Building Façade performance
 - Air tightness of materials and assemblies
 - Thermal performance of materials and assemblies
 - Bulk and vapour water management
 - Glazing characteristics
- Etc.

The **Prescriptive Requirements** contained in this document are prescriptive statements related to *material, component, or system* selection that serve to standardize these items across the City's portfolio where possible. These statements will be added where needed to support related Performance/Functional Requirements or greater policy objectives and will be informed by industry best practice and past experience of Corporate Real Estate Management staff and other stakeholders. The Prescriptive Requirements may include statements related to:

- Commissioning requirements
- Preferred materials, components, or systems
- Materials, components, or systems to avoid

Codes and References

The Corporate Building System Design Requirements are intended to be read in conjunction with the applicable codes, regulations, and existing suite of City of Toronto documents and policies. There may also be additional specific design requirements that are applicable to the project, which consultants should obtain and abide to in addition to these regulations. The design standards do not relieve the design team of its professional responsibility, due diligence, duty of care, or legal liability of complying with any codes, regulations, bid, and construction documents. Where the technical design standards differ from the applicable codes and regulations, codes and regulations should always take precedent. The Standard Documentation incorporates and references various existing City of Toronto documents and policies, including:

- Fire and Life Safety Specifications
- Building Automation Systems Specification
- Security Specification
- Shelters Specification
- Cabling Standard
- City of Toronto Official Plan
- Energy Performance Best Practices
- Accessibility Design Guidelines
- Conservation of Historic Places
- ModernTO - Workplace design standards
- Best Practices for Effective Lighting
- Bird Friendly Guidelines
- 'Greening' Surface Parking Lots
- Building Charter
- Toronto Water Servicing and Metering Manual

08 00 00 Openings

Applicable Codes and Standards

The project shall be designed, installed, commissioned, and operated in accordance with the latest versions at the time of design, of the relevant local and international standards, codes, guidelines, and regulations. Refer to the following documents:

- NECB, "National Energy Code of Canada for Buildings"
- ASHRAE 90.1, "Energy Standard for Sites and Buildings Except Low-Rise Residential"
- OBC SB-10, "Energy Efficiency Requirements"
- GANA Publications: GANA's "Laminated Glazing Reference Manual" and GANA's "Glazing Manual."
- AAMA Publications: AAMA GDSG-1, "Glass Design for Sloped Glazing," and AAMA TIR-A7, "Sloped Glazing Guidelines."
- IGMA Publication for Sloped Glazing: IGMA TB-3001, "Guidelines for Sloped Glazing."
- IGMA Publication for Insulating Glass: IGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."
- NFRC 100, "Procedure for Determining Fenestration Product U-Factors"
- NFRC 200, "Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and VLT"

1.0 General Openings

1.1 General Requirements

- .1 The Contractor's design, materials and workmanship shall comply with all current codes and reference standards listed herein. Comply with all appropriate national and local government regulations and obtain all necessary approvals from the statutory authorities. Where a recommendation or suggestion occurs in the referenced standards, such recommendation or suggestion shall be considered mandatory. In the event of conflict between referenced standards, this specification or within a document itself, the more stringent standard or requirement shall govern.
- .2 Contractor to design, detail, coordinate and document the Contract Work using performance requirements and design criteria developed by the design team.
- .3 This specification together with the Related Sections and Architectural Drawings define the scope of work including:
 - a. Mandatory geometry of visible facade surfaces.
 - b. Performance parameters.
 - c. Coordination of geometry of Contract Work to new and existing building conditions including related required surveys for fabrication.
 - d. Minimum acceptable standards and establish a regime for verification of the design, fabrication and installation processes.
- .4 Contractor shall ensure that all people engaged in the design, fabrication and installation of the Contract Work are adequately trained, proficient and experienced.
- .5 Employ a Registered Professional Engineer in Ontario who is specifically experienced in projects similar to the systems referenced in this Section in material, design and extent to provide design and engineering services, prepare, stamp and certify the Contract Work.

- .6 The contractor's engineers shall provide evidence of their design methodology, including assumptions with respect to material strength, load factors, material factors, robustness, and post fracture behavior within the furnished calculations.
- .7 The contractor's engineers shall prepare and stamp mock-up drawings and calculations as well as submittal drawings and calculations.
- .8 Engage NFRC accredited engineer to prepare, stamp and certify any thermal reports for fenestration products.

Bid Submittals:

- .9 Bid Submittals shall be submitted prior to Award to the CM, Owner and Architect for review and approval. Submittals shall comply with the general requirements of this Section in addition to the specific requirements outlined in each associated system section.
- .10 Design team to develop a list of submittals required for evaluating tender returns including but not limited to:
 - a. Provide Proposal Drawings
 - b. Proposed work schedule
 - c. Product Samples
 - d. Organization Chart
1. Bid submittals must provide project experience demonstrating the capability to complete the Contract Work for each of the following (Submit prior to award):
 - e. Installer.
 - f. Material Suppliers / Fabricators / Manufacturers.
 - g. Testing agency.
 - h. Welding Certificates.
 - i. Energy Performance Certificates

Action Submittals

- .11 Provide calculations and drawings signed and sealed by a Registered Professional Engineer in Ontario
- .12 Shop drawings: submit shop drawings of fenestration products showing design loads, frame reinforcing, insulating glass makeup, installation clearances, expected building deformations, as well as shimming and anchorage requirements for the expected design loads for that location. Shop drawings shall bear the seal of a professional engineer registered in specified region.
- .13 Calculations shall be provided concurrently with the relevant system Shop Drawings.
- .14 Contract shall provide at minimum the following information along with any information requested by the design team:
 - a. Product Data
 - b. Hardware Product Data
 - c. Product Test Reports
 - d. Environmental Product Declarations
 - e. Re-glazing method and procedure
 - f. Quality Control Plan
 - g. Warranties
 - h. Maintenance Manual

Sustainability Submittals

- .15 Life-cycle Assessment: Evaluate product's environmental impact from creation to disposal, following ISO 14044 standards.

- .16 Environmental Product Declaration (EPD): A report verified by third parties, based on life-cycle assessments per product category rules, including both product-specific and industry-wide versions.
 - a. Product-Specific Declaration: For products with a detailed life-cycle assessment available to the public and covering at least from creation to delivery.
 - b. Industry-Wide EPD: For products with generic, third-party certified environmental impacts recognized by the program operator, following ISO standards.
 - c. Product-Specific Type III EPD: Similar to the product-specific declaration but with third-party certification and external verification, also following ISO standards.
2. Recycled Content: Recycled content shall be defined in accordance with the International Organization for Standardization document, ISO 14021 – 1999 - Environmental label and declarations – Self declared environmental claims (Type II environmental labeling). Recycled content products contain postconsumer and/or pre-consumer material.

Samples Requirements

- .17 Provide the following samples for design team and owner's review:
 - a. Framing Samples
 - Provide samples specified inclusive of all coatings, finishes, gaskets, hardware and fasteners from manufacturers able to meet the Project's design intent and performance requirements.
 - b. Glass Samples
 - Provide 305 mm x 305 mm samples of each glass type shown of all coatings, frit patterns and interlayers from manufacturers able to meet the Project's design intent and performance requirements.
 - Label samples to indicate product, characteristics, and locations in the work.

Warranty

- .18 Guarantee shall state that the Contract Work is in accord with Drawings and Specifications, as amended by any changes authorized by the Architect, free from defects in materials and workmanship and weather tight for a minimum period of ten (10) years, (twenty (20) years for finish, twenty-five (25) manufacturer warranty for framing, gaskets, seals and assembly components) from the date of acceptance of the Contract Work by the Owner. Contractor shall agree to repair or replace defective materials and workmanship to "like new condition", including such exploratory work, required to determine the cause, during the guarantee period, at no additional cost to the Owner. Failure modes include warping, cracking, shrunken glazing beads, failure of gaskets, dislocation, or disappearance of weatherstrips, detectable water penetration through joints in the product and operational difficulties such as inability or increased difficulty to operate products.
- .19 The Contractor shall be responsible for damage to the building and furnishings occasioned by defective materials or workmanship or damage as part of repairs to the Contract Work.
- .20 The Contractor shall include with his bid proposals, copy(s) of proposed warranty(s).

- .21 Sealed glazing units to have a minimum warranty period of twenty (20) years against failure of glazing unit seals and deposits on interior glass faces detrimental to vision.
- .22 Hardware for doors and windows to have a minimum warranty period of twenty (20) years against breakage, premature wear and/or operational difficulties such as inability or increased difficulty to operate products, including an increase in operating force beyond the values in AAMA/WDMA/CSA 101/I.S.2/A440 Table 6.

1.2 Functional Requirements

Design Principals

- .1 Contract Work shall, as specified:
 - a. Withstand and accommodate the stresses and movements induced by the specified cambers, estimated deflections, relative deflections and the long term movements associated with the settlement of the foundations, or any other movements of the structure, changes in temperature, moisture content and chemical changes.
 - b. Include suitable allowances for the specified construction tolerances.
 - c. Withstand the specified deleterious and degrading effects of radiation from the sun, weathering, atmospheric pollution, vandalism, vermin, fungi and other growths for the required service life described herein without maintenance in excess of routine cleaning and minor repairs.
 - d. Have a resistance to combustion and fire spread appropriate to each part.
 - e. Prevent casual and unlawful entry into the building.
 - f. Cleaning and maintenance of the Contract Work shall be carried out easily, without interfering with the function of the building.
 - g. Panels, glazing beads, structural silicone assemblies and decorative capping pieces shall remain securely held and gaskets shall not be displaced.
- .2 Failure shall include the inability of the Contract Work to meet the performance requirements set forth in this and all Related Sections in addition to the following:
 - a. Noise or vibration created by wind and thermal and structural movements.
 - b. Secondary glass damage and/or damage due to falling components of the Work of this Contract.
 - c. Staining of adjacent components or wetting of interior building components.
- .3 All elements outside of the vapor barrier plane shall be of materials suitable for external conditions and shall not deteriorate as a result of weathering.
- .4 Where dissimilar metals interface separators shall be included to prevent bimetallic corrosion.
- .5 Where flexible or sheet vapor control materials are connected together or to other systems they shall be lapped and continuously sealed with chemically compatible materials and mechanically restrained.
- .6 Site-applied sealant shall not be acceptable as part of the primary weather sealing system unless shown on the Architectural Drawings or noted within this Section.
- .7 Paints, coatings, adhesives and sealants must not contain methylene chloride and perchloroethylene. Paints and coatings must meet Canadian Volatile Organic Compound (VOC) Concentration Limits for Architectural Coatings Regulations (SOR/2009-264). Adhesives and sealants must meet SCAQMD Rule 1168, effective July 1, 2005
- .8 Smoke seals and fire stops shall be provided as required by the governing Building Code.

- .9 All façade component materials to be non-combustible and shall not exhibit sustained flaming according to NFPA 268.
- .10 Component materials shall not give off toxic fumes.
- .11 Composite metal sheet products to be 'FR' rated
- .12 Materials used in the Contract Work shall be designed not to be attacked or infested by micro-organisms, fungi, insects or other vermin.
- .13 Recycle and/or salvage at least 75% of construction, demolition and packaging debris (by weight or volume)

Quality Assurance

- .14 Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.
- .15 Glass Testing Agency Qualifications: A qualified independent testing agency accredited according to the NFRC CAP 1 Certification Agency Program.
- .16 Source Limitations for Glass and Glass Accessories: Obtain Glass and Glass accessories from one source for each product indicated below for all associated façade systems unless approved by the Architect:
 - a. Primary glass.
 - b. Fabricated Glass, including Glass which is coated, heat treated, laminated, fritted or printed, and formed or slumped Glass
 - c. Glazing gaskets.
 - d. Glazing accessories.
- .17 Glazing Publications: Comply with published recommendations of Glass product manufacturers and organizations below, unless more stringent requirements are indicated.
 - a. GANA Publications: GANA's "Laminated Glazing Reference Manual" and GANA's "Glazing Manual."
 - b. AAMA Publications: AAMA GDSG-1, "Glass Design for Sloped Glazing," and AAMA TIR-A7, "Sloped Glazing Guidelines."
 - c. IGMA Publication for Sloped Glazing: IGMA TB-3001, "Guidelines for Sloped Glazing."
 - d. IGMA Publication for Insulating Glass: IGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."
- .18 Safety Glass: Comply with the applicable requirements of the laws, codes, ordinances and regulations of Federal and Municipal authorities having jurisdiction, wherever requirements conflict, the more stringent shall be required. Obtain approvals from all such authorities.
- .19 Retain the following line item 1. only if impact testing is specified for the project.
- .20 Fire-Protection-Rated Glazing Labeling: Permanently mark fire-protection-rated Glazing with certification label of a testing agency acceptable to authorities having jurisdiction. Label complying with NFPA 80 shall indicate manufacturer's name, test standard, whether Glazing is for use in fire doors or other openings, whether or not Glazing passes hose-stream test, whether or not Glazing has a temperature rise rating of 250 deg C, and the fire-resistance rating in minutes according to NFPA 252 or 257 as applicable.
- .21 Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of IGCC.

Field Testing:

- .22 Field Testing in the field by independent inspection agency retained by the Owner as indicated herein.
- .23 Testing shall be performed after completing the installation of the Contract Work and before the installation of interior finishes has begun.
- .24 Where modifications are necessary to the fenestration/window assembly or wall interfaces to achieve the required performance, the contractor shall undertake required modifications to the manufacturing or installation process to the satisfaction of the Building Envelope Consultant.
- .25 Include cost of field testing in the contract price. The Contractor will pay for any re-testing required as a result of failures. For renovation projects, the Owner may choose to have the consultant to engage the testing firm independently.
- .26 Field Quality Control: Testing and inspecting of representative areas of the Contract Work shall take place as installation proceeds to determine compliance of installed assemblies with specified requirements.
- .27 Contract Work will be considered defective if it does not pass tests and inspections.
- .28 Repair or remove and replace Work that is considered defective, does not meet requirements or that is damaged by testing; replace to conform to specified requirements. Retesting will be performed to determine compliance of replaced or additional work with specified requirements.
- .29 The costs for all testing will be responsibility of the Contractor. These costs include, but are not limited to: access, equipment, labor, materials and the Independent Testing and Inspection Agency required to complete retesting.
- .30 All costs associated with the additional tests because of failures that are the result of contractor deficiencies will be charged to the Contractor, including consultant costs of monitoring the retests.
- .31 Water Spray Test
 - a. Carry out hose testing on 10% of the Contract Work as designated by Architect.
 - b. Selected installed fenestration products shall be tested for water penetration resistance in accordance with ASTM E 1105. The test Procedure shall correspond to the method of test used to qualify the product for water penetration resistance under AAMA/WDMA/CSA 101/I.S.2/A440. The Water Penetration Resistance Test Pressure shall be as indicated in this specification. The test chamber shall be installed so as to test both the product and the interface joint to the adjacent wall. The pass/fail criteria for the test shall be as defined in CSA A440S1 Clause 5.4.
- .32 On-Site Chamber Testing
 - a. Perform Quantitative Air Testing according to ASTM E783 at an air pressure differential of 300 Pa.
 - b. Perform testing according to ASTM E1105 at a minimum static air pressure differential of or 20% design load or Driving Rain Wind Pressure as per code extrapolated over building height, whichever is greater, but not less than 720 Pa.
 - c. Testing shall be performed at three (3) different locations for each wall type shown in the Architectural Drawings.
 - d. Testing shall include at least one (1) specimen of each fenestration type.
 - e. Each test area shall be at least one (1) bay wide, but not less than 30 feet, by one (1) story tall.
 - f. Perform tests prior to 10, 35 and 70 percent completion of the Contract Work.
- .33 Structural Testing

- a. A minimum of 1% but no less than 5 anchors of each anchor type shall be tested, as indicated by the Design Team.
- b. In case of failure or anomalies during the embed testing, an additional 5% but no less than 5 anchors of each anchor type shall be tested.
- c. Perform testing for each anchor type embedded into concrete or reinforced masonry to ASTM E488 prior to installation of the exterior envelope.
- d. Testing of welds at structurally critical conditions shall be performed by an inspection agency retained by the Owner. Testing/Inspection Agency to perform shop and field weld inspection and tests in accordance with the weld quality and standards of acceptance of ANSI/AWS D1.1 – Structural Welding Code.

1.3 Performance Requirements

- .1 All fasteners and connectors shall be designed for the cladding seismic load as given, applied at the center of mass of the panel.
- .2 The air / vapor barrier shall be designed to resist the maximum design wind load.
- .3 No reinforcement or other obstructions shall be cut without the approval of the Architect or Structural Engineer.
- .4 The operable windows, sliding glass doors and swing doors are to comply with the maximum operating force of 22 N per the 2010 ADA and the ANSI A117.1-2009 requirements and tested in accordance to AAMA 513.

Structural

- .5 Coordinate all loads imposed on the building structure with the project Structural Engineer.
 - a. Gravity Loads: Support its self-weight and transmit this weight safely back to the supporting structure without overloading or permanently displacing any of its components.
 - Wind Loads: as per the code.
 - Live Loads: as per the Codes but not less than guard loads as per code and maintenance load as applicable
 - b. Seismic Loads: as per the codes
 - c. Thermal Loads: as per code including NBC Part 4 commentaries for solar heat gain and night-time-sky heat loss.

Movement

- .6 The Contract Work shall accommodate the movements developed by the building structure without any reduction in the performance below the minimum levels required herein. These shall include but are not limited to:
 - a. Movements due to design gravity and live loads.
 - b. Movements under repeated cycles of the design wind loads.
 - c. Movements due to seismic loads.
 - d. Changes in dimension and shape arising from specified building movements, including settlement, shrinkage, elastic shortening, floor beam deflections, creep, wind sway, twisting and racking and thermal and moisture movement. These shall include the movements due to any joint in the supporting structure or building frame.
- .7 Provide the following when all tolerances are accommodated and the most onerous combination of movements occur (including wind and seismic sway):
 - a. Sufficient edge cover on all glazed units and panels to maintain weathering and structural performance around their perimeter.

- b. Clearance to edges of all glass panes or panels of at least 3.2 mm everywhere around their perimeter.
- .8 All seismic actions and movements shall be coordinated with the Structural Engineer. Cladding systems shall withstand the effects of earthquake motions based on the Seismic Design Parameters as given in the Geotechnical Engineer's report(s) or as determined from and governing code.

Deflection

- .9 The Contract Work shall accommodate thermal deflections and movements resulting from the following maximum change (range) in ambient and surface temperatures. Changes in dimension resulting from changes in temperature in any of its parts, its supporting framework and brackets shall not result in any reduction in the specified performance.
- .10 Base engineering calculation on surface temperatures of materials due to both solar heat gain and night-time-sky heat loss. As per AAMA 501.5, all system components shall noiselessly withstand thermal movements and shall not buckle, distort, crack, cause failure of glass, and / or joint seals, or develop undue stresses on the finished surfaces, materials, fixing assemblies or building structure.
- .11 The Contract Work shall accommodate deflections and / or movements resulting from moisture without any reduction in the specified performance. This shall include:
 - a. Changes in the moisture content of Contract Work components, including those due to wetting as a result of rain.
 - b. Expansion of absorbed or retained moisture due to freezing.
 - c. Changes in the moisture content of the supporting structure and interfacing construction
- .12 The Contractor shall avoid in their design and detailing the introduction of locked-in stresses that may be detrimental to the performance of the Contract Work during the service life.
- .13 The stresses that are referred to are those that can develop in an individual panel, if the various fasteners and connections that secure that panel in position are so rigid that they do not allow for thermal or other movement in that panel.

Energy Performance

- .14 Contract Work and components shall have certified energy performance ratings as determined by the standards referenced by Code.
- .15 The Contract Work shall wherever possible incorporate the use of thermal breaks.
- .16 The design environmental conditions to be determined by the design team as applicable to the project:
 - a. Exterior extreme annual dry bulb temperature and coincident wind speed
 - b. Interior design dry bulb temperature, relative humidity and interior air film coefficient
- .17 System Thermal Transmittance (U-factor)
 - a. Enclosure system performance values for new construction and complete system replacements are to be substantiated via detailed energy simulation and heat balance modeling.
 - b. Enclosure system performance values are to meet TEDI targets as per Toronto Green Standard (TGS) by building type.
 - c. The Contract Work shall have a U-factor of not more than specified, accounting for all frame effects, as calculated in accordance with NFRC 100.
 - d. Meet Toronto Green Standard (TGS) as applicable.

- e. New Built and additions more than 100 sqm: 25% improvement above code (OBC)
- .18 Linear Transmittance Loss at Interfaces
 - a. Detail interfaces are to be designed with a maximum linear transmittance of 0.2 W/m·K. Considered “mitigated” per BETB Guide
- .19 Condensation Resistance
 - a. Provide systems whose internal condensation and drainage systems will prevent uncontrolled condensation inboard of the vapor barrier plane, under the most onerous environmental conditions specified in this section.
- .20 Static pressure air infiltration/exfiltration
 - a. Maximum air leakage through the Contract Work areas of the project shall be the lesser of the requirements determined according to Code or the following:
 - b. For non-operable portions of the Contract Work the maximum air infiltration rate shall be no more than 0.15 L/s/m² when tested at 300 Pa as per ASTM E283.
 - c. For operable portions of the Contract Work the maximum air infiltration rate shall be no more than 0.5 L/s/m² when tested at 300 Pa as per ASTM E283.

Weatherproofing

- .21 The Contract Work, including all joints between it and other elements of Contract Work, shall prevent leakage of water into the interior of the building from the weathering line of the assembly, under the action of wind pressure kinetic energy, gravity, surface tension, or capillary action. It shall also prevent water entering into those parts of the Contract Work that would be adversely affected by the presence of water.
- .22 All joints within the Contract Work shall maintain their water tightness under the loads and movements specified herein.
- .23 The weathering principles incorporated within the Contract Work and interfacing with adjacent elements of Contract Work shall be compatible with the weathering principles adopted by the adjacent elements.
- .24 Detailing and waterproofing must ensure that water from ponding or reservoirs will be directed away from the Contract Work such that water will not build up a pressure head or impose forces onto the façade seals and components.
- .25 Detailing must ensure that water that is collected within elements of the contract work is positively drained to the outside of the Contract Work.
- .26 The primary drainage of water along edge seals of insulated glazed units is not permitted unless written confirmation is provided by the unit manufacturer stating that the design life, required service life and warranty, of the unit is unaffected.
- .27 The Contract Work shall incorporate elements and details to provide for a continuous vapor barrier system.
- .28 Elements to the exterior of the vapor barrier plane shall be designed to be suitable to be in exterior conditions and shall be designed to experience weathering without any loss in performance as specified.
- .29 No element of the Contract Work shall be encapsulated between two vapor barrier planes.
- .30 Vapor control elements shall maintain their performance and properties for the expected service life of the system.
- .31 Where vapor control elements will be exposed to the interior conditions during construction, suitable materials shall be selected to ensure the elements are not

easily damaged during the installation of the Contract Work or adjacent constructions.

- .32 Materials that are considered easily damaged include but are not limited to foil facing attached to other products, including insulation.

Operable panels:

- .33 Windows, side hinged doors and sliding glass doors (hereafter called the fenestration products) shall conform to AAMA/WDMA/CSA 101/I.S.2/A440 and CSA A440S1, and have the following minimum tested performance ratings:
- a. Performance Class – to be selected according to the intended building usage:
 - b. Performance Grade — For Part 9 buildings, Performance Grades should be selected according to the Canadian Supplement CSA A440S1. For Part 3 buildings the architect may determine Performance Grades that will be used together with Performance Class to prequalify and select products. Performance Grade shall not be less than PG35.
 - c. Water Penetration Resistance Test Pressure — to be determined in accordance with CSA A440S1, but in no case shall it be less than 290 Pa for buildings up to four storeys, or 510 Pa for buildings taller than four storeys. For patio doors on four storey buildings and higher shall be at minimum 330 Pa, lower requirements shall require Consultant's approval. AAMA/WDMA/CSA 101/I.S.2/A440 requires products supplied with screens to be laboratory tested for water penetration resistance both with screens and without screens.
 - d. Air Infiltration/Exfiltration Level: A-3 for operable windows; "Fixed" for non-operable windows.

1.4 Prescriptive Requirements

Brackets and Anchorage

- .1 The design of brackets and anchorage shall allow for adjustments by 1 inch in small increments in and out, up and down and side to side in the position of the Contract Work supports relative to other constructions to accommodate the full variations in the underlying construction and fabrication tolerances.
- .2 Shimming required to accommodate local variations in construction tolerances only. The maximum allowable shim dimension shall be stated in the shop drawings.
- .3 Concrete and masonry inserts shall be hot-dip galvanized cast-iron, malleable-iron, or steel inserts as required by ASTM A123 / A123M or ASTM A153/A153M.
- .4 Submit Schedule S-B Assurance of Design and Schedule S-C Assurance of Field Review for fenestration product design and anchoring on completion of the installation

Stainless Steel Fittings

- .5 Comply with requirements of ASTM A582, for type listed on the Contract Drawings.

Sealants and Adhesives

- .6 Prepare surfaces that will contact sealants and / or adhesives according to the manufacturer's written instructions to ensure compatibility and adhesion.
- .7 Preparation includes, but is not limited to, cleaning and priming surfaces.

Gaskets

- .8 Gaskets jointed by bonding with adhesive are not accepted as a substitute for molded frame gaskets. In the event that adhesive bonded joints are required to be formed, this shall be brought to the attention of the Architect for review before such work is carried out.
- .9 All gasket frames should be normally manufactured to a small but predetermined oversize tolerance, to ensure that when seated into position, the lineal lengths and corners of the gaskets are in slight compression.
- .10 Gaskets/dry weather seals shall not be installed in a pre-stretched condition.
- .11 Gaskets shall be accessible for inspection/replacement.
- .12 Gaskets and seals used to achieve the required weather and airtightness shall be selected in accordance with ASTM C716 to fully accommodate the range of dimensional tolerances associated with fabrication and installation of the Work.
- .13 The gaskets shall be free of mold flash.
- .14 Extruded rubber gaskets shall comply with ASTM C509.
- .15 Dense compression gaskets shall be molded or extruded of profile and hardness required to maintain watertight seal, made from Silicone complying with ASTM C1115.
- .16 Soft compression gaskets shall be extruded or molded, closed-cell, integral-skinned silicone gaskets complying with ASTM C509, Type II, black; of profile and hardness required to maintain watertight seal.

Flashing

- .17 Provide corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials constructed with one of the following waterproof materials:
 - a. Stainless steel, ASTM A240/A240M of thickness recommended by manufacturer
 - b. Coated aluminum
 - c. One of the following membrane materials:
 - Flexible ethylene-propylene diene monomer (EPDM)
 - Silicone sheet
- .18 At movement joints, use slip-joint linings, spacers, and sleeves of material and type recommended by manufacturer.

Insulation

- .19 Unfaced, mineral-wool board insulation:
 - a. Shall comply with ASTM C612; with maximum flame-spread and smoke-developed indexes of 15 and zero, respectively, per ASTM E84.
 - b. Shall pass ASTM E136 for combustion characteristics.
- .20 Fasteners shall be designed to fully restrain insulation against all design loads.
- .21 Fastener materials shall be suitable for the environmental conditions the insulation will be exposed to.
- .22 Adhesively attached, spindle-type anchors shall utilize plate welded to projecting spindle and shall be capable of holding insulation of specified thickness securely in position indicated with self-locking washer in place.
- .23 Anchor adhesive shall have demonstrated capability to bond insulation anchors securely to substrates indicated without damaging insulation, fasteners, and substrates.
- .24 Where insulation must be locally reduced in thickness, high performance insulation shall be provided to match the overall performance of the surrounding insulation.

Fasteners

- .25 Fastener design shall be no less than the most stringent standards as required by Code and its reference standards, or the following requirements:
 - a. Fastener design for aluminum components shall be as per the Aluminum Association Aluminum Design Manual (AA-ADM).
 - b. Allowable loads for fasteners shall be the lesser of the fastener manufacturers' requirements or per AAMA TIR A9 with the most recent amendments.
 - c. When utilizing a fastener that is not included in any of the above references, available standards or design guides, a minimum factor of safety of 2 shall be used for permissible load design of anchoring assemblies.
- .26 Fastener design shall account for any reduction in safe working loads due to their spacing, location in areas of tension, near edges or proximity to cast in inserts/existing fasteners, or thickness of shims.
- .27 All exterior fasteners or fasteners in wet areas shall be of a suitable grade of stainless steel. Weather coatings for corrosion resistance may only be used with the approval of the Architect.
- .28 Where post drilled or site fasteners are used for connections to the external structural steel frame, the integrity of the steel corrosion protection system shall not be compromised.
- .29 The general requirement for torquing of bolts shall be highlighted in the shop drawings and tightening torque values are to be clearly stated.

Tolerances

- .30 Fabrication Tolerances: Metal cutting tolerances for framework shall be:
 - a. ± 1.6 mm on length of vertical members
 - b. ± 0.8 mm on length of horizontal members
 - c. ± 0.4 mm on the length and width of spandrel panels, backpans and aluminum sheets.
 - d. ± 0.8 mm on length of diagonal of spandrel panels, backpans and aluminum sheets and not more than ± 1.6 mm in difference in the length between the two diagonals.
- .31 Installation Tolerances: Install Contract Work to comply with the following maximum tolerances:
 - a. Plumb: 3.2 mm in 3 m; non-cumulative.
 - b. Level: 3.2 mm in 6 m; non-cumulative.
 - c. Alignment: End to end or edge to edge offset of adjoining consecutive element to 1.6 mm.
 - d. Location and Plane: Limit variation from plane to 1 3.2 mm in 3.6 m; 12.7 mm over total length.
 - e. Diagonal Measurements: Limit difference between diagonal measurements to 3.2 mm
 - f. Tolerances shall not be cumulative.

2.0 Glazing**2.1 General Requirements**

- .1 For all heat-treated Glazing, including samples, provide measurement data for roller wave, bow and edge dip.
- .2 For all coated Glazing, including samples, provide measurement data for color ASTM C1376 and ASTM D2244.

- .3 For argon-filled insulated glazing units, provide documentation confirming initial argon fill percentage.
- .4 Submit written evidence of insulating glass certification to ASTM E 2190. The certification must apply to the insulating glass makeup used in the fenestration products.
- .5 For solar-control low-e-coated Glass, provide documentation demonstrating that manufacturer of coated Glass is certified by coating manufacturer.
- .6 Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.
- .7 Protect exterior Glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to Glass surface. Remove no-permanent labels and clean surfaces.
- .8 Protect Glass from contact with contaminating substances resulting from construction operations. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by Glass manufacturer.
- .9 Remove and replace glass that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, and vandalism, during construction period.
- .10 Glass shall be delivered to the site bearing the manufacturer's label, complete with glazing instructions where applicable.
- .11 Comply with insulating Glass manufacturer's written recommendations for venting and sealing units to avoid hermetic seal ruptures due to altitude change.
- .12 Inspect each unit of glass immediately before installation. Do not install units which are improperly sized or have damaged edges, scratches or abrasion or other evidence of damage.
- .13 Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that exterior and interior surfaces are readily identifiable. Do not use materials that will leave visible marks in the completed work.
- .14 Follow manufacturers recommendations for cleaning and preparation of glazing units prior to installation

2.2 **Functional Requirements**

- .1 Adjust glazing channel dimensions as required by project conditions during installation to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.
- .2 Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.
- .3 Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless more stringent requirements are recommended by glass manufacturer. Place blocks to allow water passage to weep holes. Set blocks in thin course of silicone sealant.
- .4 Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
- .5 Provide spacers for glass lites where length plus width is larger than 1270 mm.
 - a. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face

- clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
- b. Provide 3 mm minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.
- .6 Provide edge blocking to prevent glass lites from moving sideways in glazing channel, sized and located to comply with the glass manufacturers recommendations and the requirements in referenced glazing publications.
 - .7 Set glass lites with proper orientation so that coatings face exterior or interior as specified.
 - .8 Glazing shall not be used to provide lateral support to framing members.
 - .9 Provide laminated glass where as required by regional code and under the following conditions:
 - a. Vertical glazing with unsupported edges.
 - b. Horizontal glazing.
 - c. Sloped glazing greater than 15° from vertical.

2.3 Performance Requirements

Structural Performance

- .1 Design Glass, including comprehensive engineering analysis according to ASTM E1300 by a qualified professional engineer.
- .2 Probability of breakage specified in ASTM E1300 standard is 0.008. Probability of Breakage for Sloped Glazing shall be designed for a probability of breakage not greater than 0.001.
- .3 Failure shall include, but is not limited to:
 - a. Glass breakage; inclusive of spontaneous Glass breakage and any secondary breakage caused by the failure of other Glass or components.
 - b. Cracking, crazing, flaking, discoloration of coatings on Glass.
 - c. De-lamination of laminated Glass units.
 - d. Loss of transparency of laminated Glass.
- .4 In addition to the reference-listed requirements and any specific load cases required by Code for glazing, the following combinations shall also be used in the design of sloped Glazing. The most stringent of the below or what is specified in the Code shall be used:
 - a. Outward design wind pressure minus the weight of the Glass. Base design on Glass type factors for short-duration load.
 - b. Inward design wind pressure plus the weight of the Glass plus half of the design snow load. Base design on Glass type factors for short-duration load.
 - c. Half of the inward design wind pressure plus the weight of the Glass plus the design snow load. Base design on Glass type factors for long-duration load.
- .5 Design Glass to resist thermal stresses induced by differential shading.
 - a. Thermal stress analysis for each exterior Glass type shall be provided for each building elevation or facet of the façade as appropriate.
 - b. The analysis shall clearly indicate all the expected service temperature ranges and the effects of partial and full shading on the Glass.
 - c. Append to the thermal stress analysis a statement from the Glass manufacturer that based upon this analysis the resulting thermal stresses will not increase the specified "statistical probability of breakage".

- .6 Internal loads on Insulating Glass Units (IGUs) shall be considered. This shall include the altitude of the building as well as the combined effects of temperature, altitude, atmospheric pressure, together with the other specified loads, shall be considered in the design of insulating Glass units.
- .7 The contractor shall account for the expected temperature, max/min glass temperature, and the max/min frame temperature in their calculations and fabrication as shown in the related skylight system specifications.
- .8 Contractor shall provide calculations that climatic loads have been accounted for and will not cause serviceability issues.

Movement Performance

- .9 The Glazing shall accommodate the movements specified and developed by the associated facade system and its related sections without any reduction in the performance below the minimum levels required herein.
- .10 Maximum Lateral Deflection:
 - a. For Glass supported on all four edges, limit center-of-glass deflection at design wind pressure or suction to not more than 1/90 times the short-side length or 25 mm, whichever is less.
 - b. Insulated Glazing units shall be limited to an edge of Glass deflection not exceeding L/175 of the Glass edge length (L) for each individual Glazing lite
 - c. For horizontal glazing, deflection shall be limited to ensure that deflected shape maintains positive slope of minimum 2.5 degrees to avoid ponding.
- .11 The Glazing shall accommodate the following thermal movements without any reduction in the specified performance:
 - a. Allow for thermal movements resulting from the maximum change (range) in ambient and surface temperatures of the associated facade system. Base engineering calculation on surface temperatures of materials due to both solar heat gain and night-time-sky heat loss.
 - b. Use associated façade system's environmental conditions for analysis.
 - c. Due to changes in the temperature of the supporting structure and interfacing construction.

Energy Performance

- .12 Glazing shall have certified energy performance ratings in accordance with the standards required by Code.
- .13 Thermal Transmittance (U-value)
 - a. Glazing shall achieve the system U-value requirements provided in the System Schedule.
 - b. Glazing U-value shall be determined as per NFRC 100.
- .14 Solar Heat Gain Coefficient (SHGC)
 - a. Glazing SHGC value shall be determined as per NFRC 200.
- .15 Visible Light Transmittance (VLT)
 - a. Glazing shall achieve the system VLT requirements provided in the System Schedule.
 - b. Glazing VLT shall be determined as per NFRC 200.
- .16 Condensation Resistance
 - a. Provide glazing that will not condense on the inside face of the Glazing per the requirements of the associated façade system.
 - b. Provide insulated glazing units that shall not exhibit frost or condensation within the air space at a temperature equal or above the minimum exterior temperature as per the specified environmental conditions.

Daylight Quality Performance

- .17 Spectral transmission data: Contractor to submit for review by the Owner spectral transmission data of each glass type for the complete IGU resulting from physical testing performed by an independent laboratory. Exported data from Window or other computer analysis programs are not acceptable. Spectral transmission shall be in a maximum of 5 nm increments from 320nm through 780nm.
- .18 UV – Transmission Requirements: Transmission at 400nm should be less than half of that at 550nm. Transmission at 320nm and at 380nm should be less than 1/100th of that at 550nm. Total transmission of UV proportion of light shall be less than 10 microW/lm for filtered daylight.

2.4 Prescriptive Requirements

- .1 Tape Glazing
 - a. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.
 - b. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.
- .2 Gasket Glazing (Dry)
 - a. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.
 - b. On exterior and interior of units use weather strip and gasket material that has been fabricated into units with molded or vulcanized corners wherever possible. Where lineal gasket material must be used, miter cut and bond units at corners with sealant recommended by gasket manufacturer.
 - c. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.
 - d. Install gaskets so they protrude past face of glazing stops.
- .3 Sealant Glazing (Wet)
 - a. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.
- .4 Structural Silicone Glazing
 - a. Glazing with structural silicone sealant shall be accomplished in the shop, unless otherwise approved by the Architect prior to Award of Contract. Units shall not be moved until structural silicone seal has achieved full cure.
 - b. Examine joints indicated to receive structural silicone sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance. Proceed with installation only after unsatisfactory conditions have been corrected.
 - c. Structural-Sealant Glazing: Comply with recommendations in ASTM C1401, "Guide for Structural Sealant Glazing."
 - d. Provide certification that structural sealant manufacturer has reviewed the details, bite size and adjacent finishes to which sealants will be bonded and finds same suitable for the purpose intended in accordance with his published literature and in accordance with the ASTM C1401 standards. This shall include a written analysis of stress due to loads and environmental conditions.
 - e. Install sealants by proven techniques to comply with the following and at the same time backings are installed:

- f. Place sealants so they directly contact and fully wet joint substrates.
 - g. Completely fill recesses provided for each joint configuration.
 - h. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- .5 Glazing Surface Films
- a. Solar Films
 - To be selected from manufacturers full line
 - Clear and non – low – reflective
 - >90% UV Block
 - High heat rejection
 - Scratch resistant
 - b. Safety and Security Films
 - To be selected from manufacturers full line
 - Clear and non / low – reflective
 - >90% UV Block
 - High heat rejection
 - Scratch resistant
 - c. Bird Control Films
 - Application of film for prevention of bird strike is considered a secondary or retrofit solution with preference for etched glass following the same Flap Standards (below)
 - To be selected from manufacturers full line
 - Refer to the following Flap Canada Standard For Visual Markers:
 - Marker Density – separate visual markers by spaces no more than 10 cm apart vertically or 5 cm horizontally. To help make your marker pattern less visible to people, while perhaps helping to keep smaller birds safe, such as hummingbirds and kinglets, windows should not have reflective openings larger than 5 X 5 cm.
 - Marker Surface – apply visual markers to exterior surface (first surface) of glass to disrupt the illusion of a safe, natural environment reflected in the glass.
 - Marker Contrast – make markers stand out in contrast to transparent or reflective exterior surfaces under varying daylight conditions.
 - Marker Size – the dimension of a marker to be no less than 0.64 cm.
 - Marker Coverage – markers are to cover entire exterior glass surfaces up to 20 metres above grade or to the top of the mature tree canopy, whichever is greater.
 - d. Decorative Films
 - To be selected from manufacturers full line
 - Etch mark is not acceptable for frosted film
 - Use 3M Dusted Crystal or equal for frosted film
 - Scratch resistant

3.0 Storefront & Curtain Wall

3.1 General Requirements

- .1 Supply and install storefront framing and doors, including deflection channels, sill tracks, sill flashings, glass, glazing and hardware
- .2 Submit certified copies of laboratory test reports from an approved independent testing agency to demonstrate storefront system compliance with air infiltration and water penetration resistance requirements.

- .3 The Contract Work typically adopts a fully framed and mechanically pressure capped / structurally glazed / custom steel / custom / standard / aluminum framed curtain wall / storefront glazing system.

3.2 **Functional Requirements**

This system shall be:

- .1 Designed as dry / structurally glazed and factory / site installed onto a custom profile extruded aluminum unitized curtain wall system / stick built steel mullion and transom assembly / modified / off the shelf glazing system to afford the project the most cost effective solution.
- .2 Mechanically restrained glazing and panels shall have the pressure cap be separated from the face of the glazing by gaskets. Decorative pressure cap covers shall be mechanically attached to the pressure caps.
- .3 Pressure equalized to the back of the glazing pocket / innermost gasket line of the aluminum extrusion:
 - a. Coupled vertical mullion and horizontal stack joint extrusions shall incorporate a minimum of two sets of engaging extrusions to define both an inner and outer pressure equalized chambers.
 - b. The inner set of engaging legs, inboard of the inner pressure equalized chamber, shall define the air and vapor seal of the system.
 - c. Secondary, uncoupled, vertical and horizontal extrusion members shall be pressure equalized to the inner chamber of the coupled extrusions.
- .4 Incorporate a secondary drainage system behind the weathering seals that drains to the outside via a baffled weep path. This system shall:
 - a. Allow complete drainage of water from rebates to outside.
 - b. Eliminate standing water on/or around the edge of insulated glazed units, panes and panels.
 - c. Allow ventilation of the edges of the glazed units.
- .5 Incorporate a continuous internal air seal and vapor barrier that shall also act as second line of defense against water ingress.
- .6 Include sub sills, sub jambs and sub heads sealed back to the main structure as required to achieve a fully continuous air seal.
- .7 Incorporate thermal isolation devices / thermal breaks wherever possible to minimize thermal bridging.
- .8 Be capable of being re-glazed from outside / inside of the building.
- .9 Incorporate supports for one / two sets of blinds as indicated the Architectural Drawings.
- .10 Be sealed with gaskets / sealant at joints between horizontal and vertical framing members.

3.3 **Performance Requirements**

Structural:

- .1 Structural design: Allow for deflection of building structure. Ensure no structural loads are imposed on storefront framing or doors. Engage Registered Professional Engineer to review structural design and attachment to building structure, seal shop drawings, carry out field reviews, and submit sealed letter of assurance stating that the installation conforms to sealed shop drawings

- .2 Access and maintenance loads shall be coordinated with the maintenance equipment manufacturer / project Maintenance Access Consultant. Loads shall not be less than Code or the following, whichever is greater and shall be applied to any external or internal surface of the Contract Work which is subject to access for maintenance purposes:
- a. A vertical uniformly distributed load of 0.6 kPa, and a concentrated load of 1110 N acting on a 152.4 mm diameter contact area applied to any gutters, copings or flat and near flat surfaces with horizontal projections greater than 6 in.
 - b. A 510 N load applied horizontally through a 152.4 mm diameter contact area on any vertical or near vertical façade surface required to support a ladder.
 - c. Ultimate load of 2670 N in any direction at building maintenance equipment restraint points.
 - d. Where maintenance and safety ropes are to be draped over elements of the Work, design those elements to support, without damage, the anchorage load limits provided by the maintenance equipment manufacturer, applied over the length of contact of the cladding.

Movement:

- .3 Thermal Movements: Allow for thermal movements resulting from the maximum change (range) in ambient and surface temperatures:
- a. Temperature Change (Range): 49 deg C, ambient; 82 deg C, material surfaces.
 - b. Test Interior Ambient-Air Temperature: 24 deg C.
- .4 Coordinate all building movement assumptions with the project Structural Engineer and as per the Structural Drawings and/or Report(s).

Deflection:

- .5 Provide Contract Work that accommodates the dimensional construction tolerances of building structure and other adjacent constructions.
- .6 Under design loads and their combinations the deflections of elements shall be less than either the requirements of Code or as follows, whichever is lesser:
- a. Normal to the face of the wall plane:
 - Elements supporting insulated glazing: less than $L/175$, whereby L is less than or equal to 4 m and L is the length of the supported edge of the glazing.
 - Elements supporting insulated glazing: less than $L/240+6.35$ mm, whereby L is greater than 4 m and L is the length of the supported edge of the glazing.
 - Elements supporting plaster, masonry or brittle items: less than $\text{span}/500$
 - Non-glass spandrel elements: $\text{span}/90$.
 - b. Parallel to the face of the wall plane, limited to the lesser amount of either:
 - That which reduces glazing bite to less than 75 percent of the design dimension.
 - That which reduces edge clearance between framing members and glazing or other fixed components to less than 3.2 mm.
 - c. Cantilevered elements shall be designed to deflect less than $2L/175$, where L represents the length of the cantilevered element.
 - d. Operable units and adjacent framing shall be designed to accommodate in service deflections with a minimum of 1.6 mm, clearance between fixed and operable portions of the framing.

Energy:

- .7 Water penetration resistance: no uncontrolled water penetration when tested to ASTM E 331 at a test pressure of 290 Pa.
- .8 Thermally broken, the grid members shall have a condensation resistance equal to or better than the area along the bottom of a 25 mm sealed glass unit with standard metal spacer edge construction

3.4 Prescriptive Requirements

- .1 Operable Units
 - a. Install operable units level and plumb, securely anchored, and without distortion.
 - b. Adjust weather-stripping contact and hardware movement to produce proper operation.

4.0 Aluminium Punched Windows**4.1 General Requirements**

- .1 The Contract Work typically adopts a fully framed and mechanical Aluminum standard fixed windows system with exterior glazing bead.

4.2 Functional Requirements

This system shall be:

- .1 Designed as and site installed onto a extruded aluminum framing assembly off the shelf system to afford the project the most cost effective solution.
 - a. Mechanically restrained glazing and panels shall have the glazing bead be separated from the face of the glazing by gaskets.
- .2 Subframe to be pressure equalized to the back of the glazing pocket / innermost gasket line of the framing by providing two sets of gaskets.
- .3 Incorporate a secondary drainage system behind the weathering seals that drains to the outside via a baffled weep path. This system shall:
 - a. Allow complete drainage of water from rebates to outside.
 - b. Eliminate standing water on/or around the edge of insulated glazed units, panes and panels.
 - c. Allow ventilation of the edges of the glazed units.
- .4 Incorporate a continuous internal air seal and vapor barrier that shall also act as second line of defense against water ingress.
- .5 Include sub sills, sub jambs and sub heads sealed back to the rough opening as required to achieve a fully continuous air seal.
- .6 Incorporate thermal isolation devices / thermal breaks wherever possible to minimize thermal bridging.
- .7 Be capable of being re-glazed from outside of the building.

4.3 Performance Requirements

Deflection

- .1 Under design loads and their combinations the deflections of elements shall be less than either the requirements of Code or as follows, whichever is lesser:
 - a. Normal to the face of the wall plane:
 - Elements supporting insulated glazing: less than $L/175$, whereby L is the length of the supported edge of the glazing.
 - b. Parallel to the face of the wall plane, limited to the lesser amount of either:
 - That which reduces glazing bite to less than 75 percent of the design dimension.
 - That which reduces edge clearance between framing members and glazing or other fixed components to less than 3.2 mm.
 - c. Cantilevered elements shall be designed to deflect less than $2L/175$, where L represents the length of the cantilevered element.
 - d. Operable sash and adjacent framing shall be designed to accommodate in service deflections with a minimum of 1.6 mm, clearance between fixed and operable portions of the framing.

4.4 Prescriptive Requirements

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5.0 Skylight Systems

5.1 General Requirements

- .1 The Contract Work adopts a structurally glazed aluminum framed and toggle clipped skylight glazing system.

5.2 Functional Requirements

- .1 Designed as structurally glazed and factory installed onto an extruded aluminum channel, which is toggle clipped to an extruded aluminum rafter and purlin support system which is stick-built on site.
- .2 Pressure equalized to the back of the innermost gasket line of the aluminum extrusion:
 - a. Incorporate a nested secondary drainage system behind the weathering seals that drains to the exterior via a baffled weep path.
 - b. Allow complete drainage of water from rebates to outside.
 - c. Eliminate standing water on/or around the edge of insulated glazed units, panes and panels.
 - d. Allow for weeping and ventilation of the edges of the glazed units.
 - e. Provide nested condensation gutters along sides of rafters and purlins which drain to a condensation reservoir / evaporation tray at the base of the skylight system.
- .3 Incorporate thermal isolation devices / thermal breaks wherever possible to minimize thermal bridging.
- .4 Be capable of being re-glazed from outside the building.
- .5 Be sealed with sealant at joints between horizontal and vertical framing members.

- .6 The Contract Work adopts an interior two-sided pressure cap glazed skylight system.
- .7 Designed as a pressure cap skylight system with pressure plates on vertical joints only which fasten non-insulating laminated glazing panels to an extruded aluminum rafter and purlin support system which is stick-built on site
- .8 Pressure equalized to the back of the innermost gasket line of the aluminum extrusion:
 - a. Incorporate a nested secondary drainage system behind the weathering seals that drains to the “exterior” (top side of sloped glazed wall).
 - b. Allow complete drainage of water from rebates to exterior.
 - c. Eliminate standing water on/or around the edge of glazed panels.
 - d. Allow for weeping and ventilation of the edges of the glazed panels.
 - e. Provide nested condensation gutters along sides of rafters and purlins which drain to a condensation reservoir / evaporation tray at the base of the skylight system.
- .9 Be capable of being re-glazed from the “exterior” (top side of sloped glazed wall).
- .10 Be sealed with sealant at joints between horizontal framing members.
- .11 The following performance requirements are not relevant for this interior skylight system:
 - a. Visual and performance mock-up and testing requirements
 - b. Energy and thermal performance

5.3 Performances Requirements

Structural Performance

- .1 Access and maintenance loads shall not be less than Code or the following, whichever is greater and shall be applied to any external or internal surface of the Contract Work which is subject to access for maintenance purposes:
 - a. A vertical uniformly distributed load of 1.91 kPa, and a concentrated load of 1335 N acting on a 152.4 mm diameter contact area applied to any gutters, copings or flat and near flat surfaces with horizontal projections greater than 6 in.
 - b. A 510 N load applied horizontally through a 152.4 mm diameter contact area on any vertical or near vertical façade surface required to support a ladder.

Deflection Performance

- .2 Provide Contract Work that accommodates the dimensional construction tolerances of building structure and other adjacent constructions.
- .3 Under design loads and their combinations, the deflections of elements shall be less than either the requirements of Code or as follows, whichever is lesser:
 - a. Normal to the face of the wall plane:
 - Elements supporting insulated glazing: less than $L/175$, whereby L is the length of the supported edge of the glazing.
 - b. Parallel to the face of the wall plane, limited to the lesser amount of either:
 - That which reduces glazing bite to less than 75 percent of the design dimension.
 - That which reduces edge clearance between framing members and glazing or other fixed components to less than 3.2 mm.
 - c. Cantilevered elements shall be designed to deflect less than $2L/175$, where L represents the length of the cantilevered element.
 - d. Glass

- Deflection shall be limited to ensure that deflected shape maintains positive slope of minimum 2.5 degrees to avoid ponding.

Fire Performance

- .4 All façade component materials to be non-combustible and shall not exhibit sustained flaming according to NFPA 268.
- .5 Component materials shall not give off toxic fumes.
- .6 The Skylight Contractor shall coordinate as necessary with the Electrical Contractor and with the Construction Manager responsible for the grounding systems as required by Code for the building and shall agree appropriate connection points with him for review by the Architect.
- .7 All metallic framework elements and supporting structures of the facade shall be electrically continuous for the purposes of grounding. Provide bonding of the framework to the grounding system. Ensure all non-conductive thermal breaks are electrically continuous.

5.4 Prescriptive Requirements

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6.0 Doors and Frames

6.1 General Requirements

- .1 Submittals: prior to fabrication clearly indicating manufacturer, door frame, elevations, dimensions, fastening, reinforcing, thickness, hardware, reinforcement details, opening requirements for glazing, quality of materials, shop finishes, fabrication details, installation requirements and wall condition/ anchorage details. Include schedule identifying each unit, with door marks and numbers relating to numbering on drawings and door schedule of the Architect.
- .2 Ensure the overall heat transfer coefficient (U-value) of opaque doors does not exceed 2.04 W/(m²K) for swinging and non-swinging doors in Zones 5, 6 and 7, representing a 10% improvement from the Ontario Building Code SB-10 (2012).
- .3 Ensure air leakage at doors does not exceed the requirements listed in Table 5 below from CSA A440-08 Table 9.

6.2 Functional Requirements

Metal Doors

- .1 Doors and frames to exit stairs and service rooms and suite entrance frames from public corridors must conform to Canadian Steel Door and Frame Manufacturer's Association (CSDFMA), Manufacturing Specifications for Steel Doors and Frames
- .2 Fire-Rated Door Assemblies complying with NFPA 80 are listed/labeled by ULC/WH (Warnok Hersey) acceptable to authorities having jurisdiction for fire protection ratings indicated. Materials not less than the thickness specified herein, unless a greater thickness is specified in the rating requirements
- .3 Exterior doors must meet the requirements of AAMA/WDMA/CSA 101/IS2/A440-NAFS and CAN/ CSA A440S1 – Canadian Supplement. Provide minimum ratings as specified by the building envelop consultant.

Wood Doors

- .4 Wood doors must conform to the Quality Standards Illustrated (QSI) for Architectural Woodwork as published by the Architectural Woodwork Manufacturers Association of Canada (AWMAC).
- .5 Wood products are recommended to have certification according to the requirements of one of the four internationally recognized third-party audited certification systems: Forest Stewardship Council (FSC), CSA CAN/CSA Z809, Sustainable Forestry Initiative (SFI), Program for Endorsement of Forest Certification Systems (PEFC) or other product programs mutually recognized by PEFC.
- .6 Products used are considered to be local available and have high recycle content. Comply with requirements in NFPA-80 for fire-rated doors. Conform to CAN/ULC S104 for fire rated doors. Fabricate non-rated doors in accordance with QSI requirements.
- .7 Glazed door lites must meet the requirements of AAMA/WDMA/CSA 101/IS2/A440-NAFS and CAN/ CSA A440S1 – Canadian Supplement. Provide minimum ratings as specified by the building envelop consultant.
- .8 All wood doors and frames shall be guaranteed by the manufacturer for a period of not less than three (3) years after the substantial completion against stile, rail, core show-through or deformation in the surfaces as determined under AWMAC.

6.3 Performance Requirements*Intentionally left blank***6.4 Prescriptive Requirements***Intentionally left blank*

23 00 00 Heating, Ventilating and Air-Conditioning (HVAC)

Applicable Codes and Standards

- Ontario Building Code
- Ontario Fire Code
- Canadian Standards Association (CSA) Standards
- Ontario Electrical Safety Code
- ASHRAE 62.1 – Ventilation for Acceptable Indoor Air Quality
- ASHRAE 90.1 – Energy Standard for Buildings Except Low-Rise Residential Buildings
- ANSI/ASHRAE Standard 55 – Thermal Environmental Conditions for Human Occupancy
- ANSI/ASHRAE Standard 111 – Measurement, Testing, Adjusting and Balancing of Building HVAC Systems
- ANSI/ASHRAE Standard 183 – Peak Cooling and Heating Load Calculations in Buildings Except Low-Rise Residential Buildings
- ANSI/ASHRAE Standard 189.1 – Standard for Design of High-Performance Green Buildings Except Low-Rise Residential Buildings
- SMACNA – HVAC Duct Construction Standards Metal and Flexible

1.0 Design and System Requirements

1.1 General Requirements

- .1 For all new and major retrofits of mechanical systems, building heating and cooling systems must align with the goals of TransformTO Net Zero Strategy. Non fossil fuel-based systems, (e.g., heat pump technology, electric based equipment), shall be used as the primary source of building heating and cooling unless shown not to be technically feasible.
- .2 Mechanical option analysis must consider a lifecycle cost analysis, payback period, estimated reductions of energy consumption, and estimated reductions in greenhouse gas emissions.
- .3 For renovation projects, consideration should also be given to the existing equipment, systems and overall condition of the building before selecting the heating system and equipment.
- .4 The selection of the systems shall take into account system operation and maintenance with the aim of simplicity.
- .5 The Owner shall provide the signoff for the conceptual design prior to the commencement of the working drawings. This is to ensure that the passive design strategies have been considered and implemented and that the proposed mechanical systems are within the capability of the service team who will operate and run the facility.

1.2 Functional Requirements

- .1 Provisions shall be in place for heat recovery when simultaneous heating and cooling is required. Provisions for free cooling shall be in place when winter cooling is required.
- .2 Design engineer to provide energy efficient heating and cooling systems that incorporate energy recovery wherever possible.

1.3 Performance Requirements

- .1 External design conditions shall be based on the current Ontario Building Code, Appendix SB-1:
 - a. Summer: 2.5% July dry bulb and wet bulb temperatures and wind velocity of 2.3 m/s.
 - b. Winter: 1% January design temperature and wind velocity of 4.6 m/s.
- .2 Internal design conditions shall be based on project specific requirements or otherwise as per the following:

Space Type	Temperature	Humidity
Office/Conference Rooms	Summer 24°C ± 2°C Winter 22°C ± 2°C	30% - 60% RH
Public Spaces	Summer 24°C ± 2°C Winter 22°C ± 2°C	30% - 60% RH
Kitchens/Kitchenettes	Summer 24°C ± 2°C Winter 22°C ± 2°C	30% - 60% RH
Washrooms	Summer 27°C ± 2°C Winter 20°C ± 2°C	Uncontrolled
Mechanical Rooms	Summer 38°C ± 2°C Winter 10°C ± 2°C	Uncontrolled
Electric Rooms	Summer 30°C ± 2°C Winter 10°C ± 2°C	Uncontrolled

- .3 Hydronic heat supply water temperature shall be maximum of 57.2°C (135°F).
- .4 Hydronic cooling supply water temperature shall be no less than 6.1°C (43°F).
- .5 All spaces shall be ventilated based on project specific requirements, but in no case, less than that required by ASHRAE 62.1 – Latest Version.
- .6 Demand Control Ventilation (DCV) based on occupancy shall be provided to comply with ASHRAE 90.1

1.4 Prescriptive Requirements

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2.0 Common Works Mechanical:

2.1 General Requirements

- .1 Mechanical equipment schedules shall appear on the drawings including all performance, sizing, and selection data.
- .2 A thermal zoning diagram showing thermal zones must be created on new construction projects or projects with major HVAC retrofits. This should be completed during the schematic design stage and submitted to the City of Toronto for review prior to proceeding to the design development stage of the project.
- .3 Exterior grade-mounted equipment is not permitted. Any exterior grade-mounted equipment that cannot be avoided shall require City of Toronto approval, and if approved, will be placed in a lockable architectural enclosure to hide it from view and protect it from damage.
- .4 Major mechanical equipment, with the exception of air-cooled chillers, condensing units, cooling towers, fluid coolers, and exhaust fans serving washrooms, kitchen and fume hoods, shall not be located outdoors or on the roof. All major equipment shall be located in mechanical rooms.
- .5 Heating equipment shall be placed on emergency power to protect buildings from freezing during power outages. This includes all equipment required to keep the heating systems active while on emergency power.
- .6 No mechanical services are to run through electrical rooms unless specifically serving the electrical room.
- .7 Main mechanical rooms shall have a wash sink with hot and cold water.
- .8 Mechanical rooms and janitor closets with chemical treatment shall be provided with an eyewash station.
- .9 Mechanical rooms shall have floor drains strategically placed to avoid running drains across floor.
- .10 Mechanical rooms should not be located adjacent to sound sensitive areas, such as offices, conference rooms, libraries.
- .11 Mechanical rooms shall be provided with double doors with removable mullions to facilitate maintenance and equipment replacement.
- .12 Roof mounted equipment, and the path leading to the equipment, must be protected from the roof edge with guardrails when within 3 metres (10 feet) of the edge. Ladders are not permitted to access roof mounted equipment.
- .13 Mechanical rooms shall have sufficient space to allow for replacement and proper servicing of equipment. Clear paths must be maintained to all doors. Provisions must be in place to remove major equipment such as chillers and boilers such as roof hatches or removable roof or wall sections.
- .14 Mechanical rooms shall have both mechanical supply and exhaust ventilation systems and shall be maintained at a negative pressure with respect to adjacent rooms and corridors.
- .15 Noise from mechanical equipment shall be attenuated within the mechanical rooms as necessary to achieve the noise criteria (NC) project specific requirements or industry good practice such as for offices, and conference rooms.
- .16 Above grade mechanical rooms shall have waterproof floors.
- .17 Mechanical rooms and outdoor service spaces shall be provided with 110v outlets for portable service equipment.
- .18 Mechanical rooms shall be provided with adequate lighting for servicing.

- .19 Equipment sizing shall be based on ASHRAE's Load Calculation Manual or similar methodology.
- .20 The chosen system shall be discussed and explained to the building owner/operator during the schematic design phase.

2.2 **Functional Requirements**

- .1 The scope of mechanical retrofit work must be established at the very beginning of the design process. Projects involving major retrofit scope for building envelope and mechanical systems are required to conduct a whole-building ventilation and overheating assessment and implement measures to mitigate and make acceptable ventilation and indoor comfort conditions.
- .2 System redundancy shall be built into heating and cooling systems:
 - a. Heating and cooling pumps shall be installed in minimum duty / standby pairs.
 - b. A minimum of two (2) boilers shall be installed to meet peak demand.
 - c. A minimum of two (2) chiller compressors shall be installed to meet peak demand.
 - d. A minimum of four (4) central heat pumps shall be installed in geo-exchange systems including one redundant heat pump (N+1)

2.3 **Performance Requirements**

- .1 Refer to Division 25 00 00 Integrated Automation for all controls requirements.
- .2 New buildings and building retrofits are to be capable to track total energy consumed per fuel source on a minimum hourly basis.
- .3 Private offices and rooms for new buildings and major building retrofits shall have a minimum of one thermostat to a maximum of two occupants that are adjustable by users and that indicate the set point and room temperatures. Public areas shall have thermostats that are not adjustable by users.

2.4 **Prescriptive Requirements**

- .1 Only non-CFC and non-HCFC-based refrigerants are permitted in the HVAC or refrigeration equipment.
- .2 If the building's HVAC&R base system contains CFCs, a commitment to phasing out CFC-based refrigerants must be in place. Base building systems are those that contain 0.23 kilograms (0.5lbs) of refrigerant or more. If the project building uses district cooling, the central chilled water plants system must not use CFC-based refrigerants. If it currently does, the central plant must commit to phasing out CFC-based refrigerants.
- .3 Select refrigerants with no or low ozone-depleting potential (ODP) and global warming potentials (GWP). Consider selection based on available equipment, energy efficiency, budget and other factors.
- .4 Select equipment with a long service life to reduce the potential amount of refrigerant leaked into the environment that occurs during installation and decommissioning of equipment.

3.0 Operation and Maintenance of HVAC Systems

3.1 General Requirements

- .1 The clearance requirements for regular maintenance of all major equipment must be clearly shown on a layout drawing.
- .2 The equipment removal intent must be clearly shown on a layout drawing, and/or referenced architectural or structural plan, if it is not standard through doors.
- .3 At conclusion of project, provide to City of Toronto the following:
 - a. Operation and maintenance manuals for all systems and equipment
 - b. As-built drawings in the following electronic format: PDF and 3D Revit (BIM). Where project has been developed in 2D AutoCad, provide 2D AutoCad
 - c. Spare parts, including but not limited to:
 - One set of packing for each pump.
 - One casing joint gasket for each size pump.
 - One head gasket set for each heat exchanger.
 - One glass for each gauge glass.
 - One filter cartridge or set of filter media for each filter or filter bank in addition to final operating set
 - Specialty tools required to service equipment as recommended by manufacturers.
- .4 The service contracts are to follow the manufactures recommended annual maintenance recommendations and running inspections throughout the service terms. They shall include one major annual maintenance visit and a minimum of three running inspections each throughout the year. All findings and work completed shall be recorded in a report format and issued to the owner. All warranty items shall be resolved by the Contractor.

3.2 Functional Requirements

- .1 All systems installed must be readily accessible, able to be isolated, and replaced without the need for demolition or assisted lifts when possible.
- .2 All main mechanical equipment with accessible components over 1.5 meters above finished floor shall be provided with permanent platform for access to components.
- .3 All floor mounted equipment shall be installed on concrete housekeeping pads. Housekeeping pads shall be as required to facilitate operation of equipment but not less than 100mm high.

3.3 Performance Requirements

- .1 Equipment to comply with ASHRAE 90.1 for minimum equipment efficiencies.

3.4 Prescriptive Requirements

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4.0 Motors

4.1 General Requirements

- .1 Motors shall have standard voltage ratings consistent with project distribution voltages.
- .2 Motors 0.37 KW (1/2 hp) and larger to be 3 phase power three phase, 60 hertz.
- .3 Motors smaller than 0.37 kW (1/2 hp) to be single phase, 60 hertz, 120V and shall have built in thermal protection.
- .4 Motors shall be tested in accordance with NEMA standard MG1 1 and name plate shall indicate the index letter.
- .5 Motors shall be designed and manufactured to operate with $\pm 10\%$ voltage and $\pm 5\%$ frequency variations of the nameplate ratings.
- .6 Motors shall be rated for 1.15 service factor in 40°C (104°F) ambient environment.

4.2 Functional Requirements

- .1 All ball bearing motors shall be equipped with lubricating type bearings and provided with one (1) grease fitting per bearing and one (1) removable plug per bearing in the bottom of the grease sump to provide for flushing and pressure relief when lubricating. Motors shall be permanently marked that bearings are lubricating type bearings. Where motor grease fittings are not accessible, extend 1/8" steel or copper tubing from fitting to an accessible location.

4.3 Performance Requirements

- .1 All motors above 0.37 kW (1/2 hp) shall be the low loss - high efficiency type, in accordance with ASHRAE 90.1-Latest Edition.

4.4 Prescriptive Requirement

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5.0 Mechanical Identification

5.1 General Requirements

- .1 Each piece of equipment (e.g., pumps, water heaters, tanks, etc.) shall be identified with a limacoid to identify its equipment schedule identification (e.g., Pump P-1, Water Heater WH-1, Storage Tank ST-1, etc.).
- .2 All control, drain, and test connection valves shall be provided with signs indicating their purpose.
- .3 Piping contents shall be classified by colour and identified by name.
- .4 Colour coding shall be in conformance with CAN/CGSB-24.3 and ANSI A131 as follows:

Table 1 - Pipe and Valve Identification

Pipe Marker Legend	Valve Tag Legend	CGSB Hazard Classification	Background Colour	Text Colour
Raw Water	RAW	Low	Green	White
River Water	RIV.W	Low	Green	White
Sea Water	SEA.W	Low	Green	White
City Water	CI.W	Low	Green	White
Cold Water	C.W.	Low	Green	White
Distilled Water	DI.W	Low	Green	White
Demineralized Water	DE.W	Low	Green	White
Condenser Water Supply	COND.W.S.	Low	Green	White
Condenser Water Return	COND.W.R.	Low	Green	White
Chilled Water Supply	CH.W.S.	Low	Green	White
Chilled Water Return	CH.W.R.	Low	Green	White
Chilled Water	CH.W.	Low	Green	White
Domestic Cold Water Supply	D.W.S.	Low	Green	White
Domestic Hot Water Supply	D.H.W.S.	Low	Green	White
Domestic Hot Water Recirc.	D.H.W.R.	Low	Green	White
Hot Water Heating Supply (up to 120° C)	H.W.H.S.	Hazardous	Yellow	Black
Hot Water Heating Return (up to 120°C)	H.W.H.R.	Hazardous	Yellow	Black
High Temp. Hot Water Heating Supply (above 120°C)	H.T.W.S.	Hazardous	Yellow	Black
High Temp. Hot Water Heating Return (above 120°C)	H.T.W.R.	Hazardous	Yellow	Black
Make-up Water	M.U.W.	Low	Green	White
Boiler Feed Water	B.F.W.	Hazardous	Yellow	Black
Condensate Return - Gravity	C.R.G	Hazardous	Yellow	Black
Condensate Return - Pumped	C.R.P.	Hazardous	Yellow	Black
Blow Off	B.O.	Hazardous	Yellow	Black

Pipe Marker Legend	Valve Tag Legend	CGSB Hazard Classification	Background Colour	Text Colour
Treated Water	T.W.	Low	Green	None
Brine	B.	Low	Green	None
Wastewater	W.W.	Low	Green	None
Storm Sewer	S.S.	Low	Green	None
Sanitary Sewer	SAN.S.	Low	Green	None
Combination Sanitary Storm Sewer	C.S.S.S.	Low	Green	None
Acid Drain	A.D.	Hazardous	Yellow	Black
Isotope Drain	I.D.	Hazardous	Yellow	Purple
Refrigerant Suction (include refrigerant No.)	REF.S. (No.)	Hazardous	Yellow	Black
Engine Exhaust	E.E.	Hazardous	Yellow	Black
Fuel Oil (show type No.)	F.P. (No.)	Hazardous	Yellow	Black
Steam (indicate pressure)	S. kPa(psig)	Hazardous	Yellow	Black
Lube Oil	L.O.	Hazardous	Yellow	Black
Hydraulic Oil	H.O.	Hazardous	Yellow	Black
Instrument Air	I.A.	Hazardous	Green	White
Gasoline	G.	Hazardous	Yellow	Black
L.P. Gas	L.P.G.	Hazardous	Yellow	Black
Natural Gas	N.G.	Hazardous	Yellow	Black
Chlorine	CHLOR.	Hazardous	Yellow	Black
Nitrogen Pressure 700 kPa and lower	NIT.	Low	Green	White
Oxygen (not med gas)	OXY.	Hazardous	Yellow	Black
Vacuum (not med gas)	VAC.	Low	Green	White
Compressed Air – indicate pressure (700 kPag and lower)	C.A. kPa	Low	Green	White

Pipe Marker Legend	Valve Tag Legend	CGSB Hazard Classification	Background Colour	Text Colour
Compressed Air –indicate pressure (over 700 kPag)	C.A. kPa	Hazardous	Yellow	Black
Fire Protection Water	F.P.W.	Fire Protection	Red	White
Sprinkler Water	S.W.	Fire Protection	Red	White
Carbon Dioxide (fire protection)	CO	Fire Protection	Red	White
Vent (plumbing)	V.P.	Low	Green	White
Vent	V.	Hazardous	Yellow	Black

5.2 Functional Requirements

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5.3 Performance Requirements

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5.4 Prescriptive Requirements

- .1 Identification letters shall be 50 mm high black letters on white background, sized to suit label or provide laminated plastic plates with black face and white centre of minimum size 90 mm x 38mm x 2.5 mm engraved with 6.0 mm high lettering.
- .2 Provide valve identification tags and secure them using non-ferrous chain, braided band or plastic band (suitable for temperature). Tags may be of brass, aluminium, limacoid, or fibreglass, stamped or engraved, of 25 mm minimum diameter.
- .3 Colour markings shall be applied on piping by using paint, plastic bands or full circumference tape made to conform to the standards. Legends shall be applied on the piping with paint or plastic bands. Arrows shall be used to indicate the direction of flow. Decals shall not be used.

6.0 Testing, Adjusting, and Balancing

6.1 General Requirements

- .1 Testing, adjusting and balancing work shall be performed by a specialist company, who is a member of good standing of the AABC (Associated Air Balance Council) or the NEBB (National Environmental Balancing Bureau) or approved by City of Toronto.
- .2 Measurement, testing, adjusting, and balancing of HVAC systems and reporting shall be in compliance to ANSI/ASHRAE Standard 111-2008. For system balancing

and testing, the technician/balancer/tester shall be NEBB or AABC certified and hold a currently valid certification.

- .3 Testing, adjusting and balancing work shall be performed by an independent testing and balancing agency having successfully completed testing, adjusting and balancing work for a minimum of five (5) projects of similar size and scope during the last five (5) years.
- .4 All mechanical systems to be tested, adjusted, and balanced must be maintained in full, normal operation during each day of testing, adjusting, and balancing that the building is occupied so that the building tenant is not inconvenienced.
- .5 Balance all systems with due regard to potential objectionable noise issues which may be a factor when adjusting fan speeds and performing terminal work such as adjusting grille and diffuser air quantities.
- .6 Wherever possible, lock all balancing devices in place at the proper setting and permanently mark settings on all devices.
- .7 The locations of Pitot tube test ports in ducts should be specified by the designer and not left to the contractor.
- .8 All ducting shall be inspected to confirm that they are sufficiently clean for operation.

6.2 Functional Requirements

- .1 Testing, Adjusting and Balancing Reports:
 - a. Prepare the report using standard AABC, NEBB or equal forms to indicate all measurements required by the referenced balancing standard. Include static pressure readings wherever a change in pressure reading may affect the results, if a verification measurement check is done at a later date.
 - b. Include for each system to be tested, adjusted and balanced, a neatly drawn, identified (system designation, plant equipment location and area served) schematic "as-built" diagram indicating all equipment and accessories.

6.3 Performance Requirements

- .1 Check all air handling system mixing plenums for stratification, and report to the Consultant where the variation of mixed air temperature across coils is found to be in excess of plus or minus 5% of design requirements.
- .2 Perform testing, adjusting, and balancing to within plus or minus 5% of design values, and make and record measurements using instruments with minimum accuracy of within plus or minus 2% of required values.
- .3 Liquid handling systems shall be balanced to design volumes $\pm 15\%$.

6.4 Prescriptive Requirements

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7.0 Mechanical Insulation

7.1 General Requirements

- .1 Provide electric heat tracing and insulation of sanitary piping where it is at risk of freezing (e.g., unheated parking garages, loading docks, canopies, etc.).

- .2 Provide electric heat tracing and insulation of storm piping where it is at risk of freezing (e.g., unheated parking garages, loading docks, canopies, etc.).
- .3 Insulate rainwater leaders and cast iron fittings for the full length from the roof drain body to connection to below grade storm sewer.
- .4 Insulate domestic cold water systems including meter body, including traps on handicap lavatories.
- .5 Insulate domestic hot water and recirculating piping.
- .6 Insulate domestic tempered water supply and return piping.
- .7 Insulate all domestic water valves, flanges, PRVs, strainers and check valves.
- .8 Insulate interior irrigation and hose bibb supply piping.
- .9 Insulate all gravity and pumped condensate piping.
- .10 Insulate all domestic water heater heaters and storage tanks.
- .11 Thermal and acoustic insulation media shall not contain asbestos.
- .12 Thermal and acoustic insulation adhesives shall not contain starch.

7.2 **Functional Requirements**

- .1 Equipment data/name plates shall not be covered with insulation.
- .2 Pipes penetrating through walls and floors shall be insulated through penetration and sealed as required to protect penetration.
- .3 Make good all existing insulation disturbed or removed to facilitate alterations and additions to existing piping systems.
- .4 Insulation jackets for exposed piping within building shall PVC.
- .5 Insulation jackets for exposed outdoor piping, including parking garages, shall be aluminium.

7.3 **Performance Requirements**

- .1 Insulation thickness and performance rating shall be not less than that required by ASHRAE 90.1 – Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .2 Insulation shall be plenum rated with a maximum flame spread and smoke spread rating of 25/50 respectively.

7.4 **Prescriptive Requirements**

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8.0 **Commissioning of HVAC Systems**

8.1 **General Requirements**

- .1 Refer to Division 1 General Requirement for all commissioning requirements.
- .2 The mechanical consultant shall incorporate all commissioning requirements into the specifications, including listing all required pre-functional and functional testing specific to the project, and clearly identifying the responsibilities of the contractor and commissioning agent.
- .3 The mechanical contractor will be responsible for preparation of operating and maintenance manuals of all applicable systems, including preventative maintenance.

- .4 The Operator shall be trained in using and operating all system types as a part of the commissioning process and during the extended service and maintenance contract provided.
- .5 The mechanical contractor will be responsible for the pre-functional tests and equipment startups and for retaining the Testing, Adjusting & Balancing (TAB) Agency. Preparation of operating and maintenance manuals and testing of fire and smoke dampers must be included in the scope of work by the TAB Agency hired by the mechanical contractor. The mechanical contractor is responsible to support full commissioning by a third-party commissioning agent including functional testing.
- .6 The general contractor shall be responsible, with the cooperation of sub-trades, for coordinating integrated systems testing of the Fire Protection and Life Safety Systems as per CAN/ULC-S1001. Additional commissioning requirements for the electrical systems and building envelope shall be covered by the electrical consultant and architect.

8.2 **Functional Requirements**

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8.3 **Performance Requirements**

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8.4 **Prescriptive Requirement**

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9.0 **Hydronic Piping, Valves and Fittings**

9.1 **General Requirements**

- .1 Valves shall meet the requirements of the Manufacturers Standardization Society (MSS): iron gate valves to MSS-SP-70, iron globe and angle valves to MSS-SP-85, iron swing check valves to MSS-SP-71, and bronze gate, globe, angle and check valves to MSS-SP-80.
- .2 Piping should be located and/or designed so as not to require heat tracing; hence, avoid running hydronic piping outside, through unheated parking structures, within unheated soffits, etc.
- .3 Piping systems shall be designed in revers-return configuration whenever possible. Direct supply and return system is acceptable when limited by building physical constraints.
- .4 Pipe and fittings shall normally be Schedule 40 black steel designed with temperature and pressure rating required for system.
- .5 Circuit setting flow balancing valves shall be installed at each terminal unit, major pipe branch and otherwise where required to facilitate system balancing.
- .6 Dielectric or brass couplings shall be used when pipes of dissimilar metals are joined.

- .7 The attachment for flexible hoses shall be made with the hose manufacturer's recommended jointing system.
- .8 Where possible, pipe expansion should be accommodated with "U" bends rather than mechanical expansion compensators.
- .9 Drain valves shall be provided with a hose bib or piped to drain.
- .10 Air vents shall be provided at the top of all building risers, system and equipment high spots, coils convectors, heaters, expansion lines, pumps and storage tanks.
- .11 Strainers shall be installed ahead of PRV's, pumps, and control valves.
- .12 In general, hot and chilled water piping shall be threaded, flanged or welded. Grooved pipe joining methods shall only be used on: Condenser water; Chilled water within mechanical rooms; Hot water within mechanical rooms.
- .13 Grooved pipe joining methods should be used at water chiller evaporator and condenser ends to facilitate disassembly.
- .14 Press fit pipe joining systems shall not be used without express written consent by City of Toronto.
- .15 Refrigerant Piping:
 - a. All installations require best refrigeration practices.
 - b. All piping system must be pressure tested to 1 ½ times operating pressure.
 - c. All piping system must be evaluated to 500 microns.
 - d. All piping system over 3 ton must have TSSA Certification.
 - e. All systems under 3 tons must undergo pressure test and evacuation tests. Tests must be witnessed by Facilities Engineer or Refrigeration Mechanic.
 - f. All systems must be designed and installed to allow for serviceability.
 - g. All brazing must be performed by TSSA certified trades person.
 - h. All systems are to be installed by license trades persons.
 - i. Licenses and certificates must be provided prior to start of installation. Licensed HVAC technician must be on site while installation is performed.
 - j. TSSA inspection is required for all installs including completed refrigerant charge.
 - k. To assist in tube cleaning, centrifugal chillers shall have marine water boxes on the condensers.
 - l. Refrigerant vapor detection systems shall be provided with auxiliary alarm contacts for monitoring by the building automation system (BAS).
 - m. Vessels shall be provided for the storage of the full refrigerant charge of the largest chiller.

9.2 Functional Requirements

- .1 Drain valves shall be provided at the bottom of all building risers, main ventilation system coils, convectors, pumps, cooling towers, expansion tanks, storage tanks, water chillers and system low spots.
- .2 Drain valves shall be located for maximum effectiveness and convenience.
- .3 Isolation valves shall be provided to facilitate service and replacement. At a minimum, locations shall include:
 - a. Each piece of central or terminal equipment. All valves shall be installed such that valve remains in service without shutting down system when downstream piping or equipment is removed for service, alterations or repairs. Provide arrangement of unions or flanges and removable sections of pipe at final equipment connections to allow easy dismantling and pulling of associated equipment past remaining pipe assemblies without cutting pipe or breaking sweat or press-joint fitting connections.
 - b. Secondary / tertiary loops off of primary/secondary piping systems.

- c. Pipe mains at points exiting mechanical rooms, located accessibly within the mechanical room.
 - d. Any pipes at points exiting the building or running under slab or underground, located accessibly within the building interior.
 - e. Base of each riser.
 - f. Each horizontal branch takeoff of each riser.
 - g. Each branch takeoff serving groups of multiple terminals arranged to create hydronic modules to achieve strategically divided sections that can be isolated for service, modifications, and troubleshooting while the rest of system can remain in service.
 - h. Main or branch strainers or filters (on entering and leaving sides to allow for pulling screen).
 - i. Any thermal control zone, (e.g., perimeter finned tube zones controlled by exterior orientation).
 - j. Any 3-valve bypass around devices as required maintaining continuous flow for critical applications while servicing device.
 - k. Tees for future connections.
 - l. Pipe expansion compensating devices that would otherwise require extraordinary effort for system shutdown and drainage to be able to service or replace.
- .4 Cooling coils shall have fittings to allow compressed air to be blown through coils for winterization of coils.

9.3 Performance Requirements

- .1 Design hydronic systems for low flow, high temperature differences and variable flow distribution systems to minimize pump energy.
- .2 Minimum full load design flow at any terminal device shall not be less than 0.031 l/s (0.5 gpm) for effective flow measurement and heat transfer.

9.4 Prescriptive Requirement

- .1 Hydronic systems subject to freezing conditions shall be protected with separate piping loops with antifreeze solution, heat exchangers, pumps, expansion tanks, as required to prevent freezing in the event of extended electrical power outage and to minimize and isolate portions of systems requiring antifreeze from the main hot and chilled water loops.

10.0 Hydronic Specialties

10.1 General Requirements

- .1 Heating and cooling system expansion tanks shall be equipped with water level gauges that are conveniently located and easy to read, and a bladder to separate the air from the water.
- .2 Pipe system filters shall be installed across pumps in closed loop heating, cooling and condenser systems.

10.2 Functional Requirements

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10.3 Performance Requirements

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10.4 Prescriptive Requirement

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11.0 Hydronic Pumps**11.1 General Requirements**

- .1 Pumps and their associated systems should be designed to maximize energy efficiency, minimize moving parts and failure and optimize flexibility of use under varying conditions. Construction shall factor local condition for corrosion resistance.
- .2 Circulating pumps shall have gauges to indicate both low and high side pressures. Pressure gauges should be provided with pressure snubbers to protect gauges from pulsations in pressure.
- .3 Heating and cooling pumps shall be minimum duplex type and equipped with automatic pump change over controls.
- .4 Vertical in-line pumps 1 HP (0.75 KW) and larger should have a split type spacer coupling and have seal flushing connections complete with filter, sight flow indicator, and quarter- turn shut-off valves.
- .5 When size & pressure permit, in-line pumps with mechanical seals are preferred.
- .6 Mechanical seals should be of the outside type.
- .7 Circulating pumps should have flexible connections to limit the transfer of vibrations to the piping system.
- .8 All pumps should run at 1800 RPM or less, unless a higher RPM results in a higher efficient pump.
- .9 All circulating pumps shall have air vents.
- .10 Provide suction guides and check/balancing/shut-off combined valves on circulating pump inlets and outlets, respectively.
- .11 Pressure gauges shall be properly sized and installed such that all pump inlet and outlet pressures can be measured quickly and accurately.
- .12 With multiple pumps, provide mounts (either anchors or a monorail system) to service the pump.

11.2 Functional Requirements

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11.3 Performance Requirements

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11.4 Prescriptive Requirement

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12.0 Steam and Condensate Piping

12.1 General Requirements

- .1 Steam and condensate systems are limited to renovations that involve modifications to existing steam and condensate systems. The use of new steam and condensate systems shall not be incorporated into new designs without the approval of the City of Toronto.
- .2 If central heating plant steam is required to heat the building and/or support domestic hot water production, it shall be brought into the main mechanical room and immediately converted via steam-to-hot water heat exchangers to domestic hot water and heating water for distribution throughout the building. Steam shall only be used in main mechanical room.
- .3 All steam piping shall be graded in the direction of flow, 25mm per 12m (1" per 40 ft). At all low points in the steam piping system a drip station shall be installed.
- .4 All steam condensate shall drain completely by gravity or be pumped. Steam pressure shall not be used to lift condensate after a trap.
- .5 All gravity return condensate lines shall be pitched 25mm per 9m (1" in 30') in the direction of flow.
- .6 Provide offsets and bends wherever possible to allow for expansion and to control pipe movement. Provide anchors and expansion joints as required.
- .7 Steam piping and fittings shall normally be seamless and schedule forty (SCH.40) black steel to ASTM A106 Grade B
- .8 Condensate piping and fittings shall normally be seamless and schedule eighty (SCH.80) black steel to ASTM A106 Grade B.
- .9 Joints 50mm (2") and smaller, screwed; 65 mm (2-1/2") and larger, welded or flanged. All high pressure piping welded.
- .10 Strainers shall be installed ahead of PRV's, traps, and control valves.
- .11 Drain valves shall be provided at condensate tanks and shall be located for maximum effectiveness and convenience.
- .12 Drip legs shall be a minimum 1/2 the size of the steam main 450mm (18") in length with blow down valve at the bottom. Trap line connection shall be located in the center of the drip leg.
- .13 Isolation valves shall be provided for pressure reducing valves, major system components and building mains. The main line isolation valve, as it enters the building, shall be double block and bleed. On high pressure lines, a warming line should be installed in parallel with the downstream "double block and bleed" valve to slowly build pressure and prevent water hammer.

12.2 Functional Requirements

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12.3 Performance Requirements

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12.4 Prescriptive Requirement

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13.0 Steam Specialties

13.1 General Requirements

- .1 All steam fed tube bundles, coils and heat exchangers shall be equipped with vacuum breakers.
- .2 Steam condensate from steam modulated equipment shall not be lifted by steam pressure
- .3 Condensate pumps shall not be greater than 1800 RPM.
- .4 Pressure reducing valves shall be sized for 100%, and not 33% and 66%.
- .5 Safety relief valves and condensate tank vents shall be separately piped outside to a safe location. If they terminate on a roof, terminate 2.2m above roofline with a 45 degree angle out on top of the pipe. Vents for condensate tanks shall not be combined with vents for safety relief valves.
- .6 Condensate pumps shall be duplex and equipped with alternating switch and equipped with auxiliary contacts for monitoring at building automation system (BAS).
- .7 All steam traps shall have a 12 mm (1/2") or 19 mm (3/4") test valve, located downstream of the trap, to allow maintenance personnel to observe trap operation
- .8 Condensate tanks shall be cast iron or stainless steel and shall not use plastic multi-level float switches.
- .9 Flanged steam pressure reducing valves shall be supported close to each flange to reduce gasket failures.
- .10 All steam traps on steam modulated equipment shall be located 300 mm (12") minimum below the condensate outlet of the equipment.
- .11 Steam control valves serving steam converters to be normally closed and fail closed in a power outage to avoid boiling the water side of the system.

13.2 Functional Requirements

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13.3 Performance Requirements

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13.4 Prescriptive Requirement

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14.0 HVAC Water Treatment

14.1 General Requirements

- .1 Closed hydronic systems requiring chemical treatment include hot-water heating, chilled water, dual-temperature water, and glycol systems to maintain water quality.
- .2 Open hydronic systems requiring chemical treatment include condenser water and fluid cooler spray water systems to maintain water quality.
- .3 Steam boiler and condensate systems shall require chemical treatment to maintain quality.

- .4 Provide chemicals and service program to maintain water conditions for a period of one year from date of Substantial Completion, and shall include the following:
 - a. Initial makeup and (and subsequent analysis of water quality changes) system water analysis with HVAC water-treatment recommendations.
 - b. Startup assistance for Contractor to flush the systems, clean with disinfectant detergents, and initially fill systems with required chemical treatment prior to operation.
 - c. Minimum 4 hours of on-site training of building operators to use water treatment equipment, to handle and administer treatment chemicals.
 - d. Monthly and or more frequent field service and consultation.
 - e. Customer report charts and log sheets.
 - f. Laboratory technical analysis.
 - g. Analyses and reports of all chemical items concerning safety and compliance with government regulations to be delivered.
 - h. Summary review reports with graphs every six months in terms of treatment system performance or storage accompanied with recommended solutions to comply.
 - i. Limit the amount of make-up water: locate and repair system leaks immediately; do not drain and fill these systems seasonally; minimize the amount of water lost from the system during sampling, blow down, safety valve testing and filter cartridge replacement.

14.2 **Functional Requirements**

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14.3 **Performance Requirements**

- 1.0 Water quality for HVAC systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of HVAC equipment without creating a hazard to operating personnel or the environment.
- 2.0 Base HVAC water treatment on quality of water available at Project site, HVAC system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.

14.4 **Prescriptive Requirement**

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15.0 **HVAC Ducts and Casings**

15.1 **General Requirements**

- .1 Duct design and construction, including selection of acceptable materials, sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's HVAC Duct Construction Standards - Metal and Flexible".
- .2 Design ductwork to minimize 90 degree elbows and sharp transitions.
- .3 Select all air distribution fittings and components that offer the lowest pressure drop. Use fittings with low pressure drop characteristics such as long radius elbows (radius of 1.5 times duct width), smooth radius elbow with minimum radius of 0.75

- times duct width with splitter vane, 45° laterals or Wyes in direction of flow for branches, tapered transitions, and bell-mouth inlets.
- .4 Ensure there are adequate lengths of straight runs of properly sized ductwork before and after airflow measuring devices per manufacturer's installation instructions in order to get accurate readings.
 - .5 Every runout duct shall be provided with a low-loss rectangular 45° tap or round bell-mouth tap from the main duct. A manual balancing damper shall be installed at the take-off and used for balancing rather than relying on damper at air distribution devices in the space.
 - .6 Use round ducts wherever feasible.
 - .7 Give particular consideration to locate and design intake and discharge openings to minimize the penetration of wind driven rain and snow at all times.
 - .8 Include construction details inside such openings to contain and drain away any precipitation at points of entry so that rainwater or melted snow does not accumulate and leak into and damage surrounding building construction.
 - .9 Flex connections shall be provided at connections to **all** moving equipment.
 - .10 Flexible ductwork shall not exceed 1.5m (5)' in extended length.

15.2 **Functional Requirements**

- .1 Manual volume dampers shall be installed in all branch ducts for balancing and shall be indicated on the drawings. All balancing shall be done with branch duct dampers and **not** with diffuser dampers.
- .2 Dampers shall be opposed blade with adjustable quadrant and locking device with position indicator.
- .3 Hinged access door shall be installed at all automatic dampers, fire dampers, reheat coils and other apparatus requiring inspection and servicing:
 - a. Doors shall be suitable for the pressure classification.
 - b. Doors shall open against static pressure in duct.
 - c. Doors shall be fully gasketed and insulated when installed in insulated ductwork.

15.3 **Performance Requirements**

- .1 All duct systems shall be designed and constructed to minimize air leakage in order to achieve required air flows and pressure relationships with minimal heating, cooling and fan energy waste. All ducts and plenums shall be sealed to Seal Level A to comply with requirements in High Performance Building Standard ASHRAE 189.1.

15.4 **Prescriptive Requirement**

- .1 The use of fibrous/ fiberglass duct liner is prohibited.
- .2 Duct liner (non-fibrous) may be used, but limited to only where needed for acoustical purposes that cannot be achieved by other means and methods. Any insulation surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1, Airstream Surfaces for resistance to microbial growth and erosion.

16.0 HVAC Fans

16.1 General Requirements

- .1 All fans shall be designed for optimal operating efficiency and flexibility with the lowest life cycle cost.
- .2 Part Load Capacity Controls shall be effectively applied to fullest extent practical for optimal energy efficiency over entire system operating range.
- .3 Provide each fan with the AMCA seal.
- .4 Fans to have non-overloading horsepower characteristics.
- .5 Provide all fan wheels statically and dynamically balanced in accordance with AMCA Standard 204, Balance Quality and Vibration Levels for Fans. Fans to operate quietly and without pulsations.
- .6 Centrifugal fans should be rated in accordance with AMCS. Where possible, centrifugal fans should be of the airfoil type.
- .7 Forward curved fans greater than 18" (450mm) in diameter, should be equipped with greaseable pillow block bearings, supported on rigid steel frames.
- .8 All exhaust fans shall have backdraft dampers.

16.2 Functional Requirements

- .1 One set of spare drive belts should be provided.

16.3 Performance Requirements

- .1 The total allowable fan power limitation for each system shall be 10% less than the limits set by ASHRAE 90.1 or the current International Energy Conservation Code (whichever is more stringent), or as otherwise modified by most current edition of ASHRAE Standard 189.1.

16.4 Prescriptive Requirement

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17.0 HVAC Air Filtration

17.1 General Requirements

- .1 All filter frames, air cleaner racks, access doors, and air cleaner cartridges shall be sealed to prevent bypass pathways.

17.2 Functional Requirements

- .1 Filters shall have separate holding frame with side access and slide out frames properly sized in accordance with filter manufacturers' guidelines. Frames shall be located to permit removal of entire frame for filter replacement.
- .2 Provide sufficient access space, depending on its type, to make filters accessible for inspection and service. A distance of 500-1000mm (20 to 40 in.) is required, depending on the filter chosen.

- .3 Provide permanent indicators on air handling units to give notice when the filter reaches its final pressure drop.

17.3 Performance Requirements

- .1 Filters for comfort systems serving offices and other non-critical areas shall be minimum MERV 8 rated throwaway filters.
- .2 Filters for central air handling systems shall be minimum MERV 13 rated filters or as required by the project specific requirements.

17.4 Prescriptive Requirement

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18.0 Heat Exchangers

18.1 General Requirements

- .1 Provide plate and frame type heat exchangers whenever possible. Shell and tube type heat exchangers will be acceptable for steam-to-hot water applications.
- .2 Size and select the most appropriate number, combination, and arrangement of heat exchangers for optimal system efficiency and stable operation over entire operating range.
- .3 In variable flow pumping systems, minimum velocities to avoid laminar conditions to maintain adequate heat exchange capacity shall be maintained with minimum anticipated hydronic system flows.
- .4 Maximum velocities shall not be exceeded to avoid erosion of tube surfaces.
- .5 Maintain minimum recommended service clearances of 900mm (36") around service ends of heat exchangers and 600mm (24") in general.
- .6 Dimensions, sizes, weights and locations of heat exchangers must take into account how they can be easily moved in and out of building both during and after initial construction for installation and/or replacement.
- .7 For hot water applications, install pumps on the cooler return water side of the heat exchanger.

18.2 Functional Requirements

- .1 Locate heat exchangers in safe and convenient area and provide convenient means for frequently inspecting and cleaning.
- .2 Provide valves and bypasses in the piping so unit may be bypassed when required to permit isolation for inspection and repairs with interrupting main systems

18.3 Performance Requirements

- .1 Plate and Frame type heat exchangers:
 - a. Minimize water pressure drop while maintaining effective heat transfer: select to minimize pumping energy, typically 24 kPa (8 feet (3.5 psi)) max.
- .2 Shell and Tube type heat exchangers:
 - a. Converters shall typically be selected at 2 psig (13.8 kPa) steam pressure operating in the shell for most efficient operation heating fluids up to 200

- °F. Otherwise select a steam pressure that has a saturation temperature approximately 30 °F higher than the required outlet temperature of the fluid being heated in the tubes.
- b. Maximum velocity limits:
 - Tubeside Nozzle Velocity: 8 fps
 - Shellside Nozzle Velocity: 4 fps
 - Shellside Condensate Velocity: 2.5 fps
 - Maximum tube velocity shall not exceed the following but may be less to keep water pressure drop low.
 - Stainless Steel: 10 ft/sec
 - 90-10 Cupronickel: 10 ft/sec
 - Copper: 6 ft/sec
 - c. Minimize water pressure drop while maintaining effective heat transfer: select to minimize pumping energy, typically 24 kPa (8 feet (3.5 psi)) max.
 - d. Steam Traps: Provide properly sized and installed steam traps for complete condensate drainage.

18.4 **Prescriptive Requirement**

- .1 Heat exchangers for HVAC applications shall be rated for minimum of 1034 kPa (150 psig) working pressure at 191°C (375°F), or higher if otherwise required to provide rated working pressure of at least 1.5 times maximum operating pressure.

19.0 **Heat Pumps**

19.1 **General Requirements**

- .1 Select water-source or air-source heat pumps with due regard to life cycle costing, high efficiency, with refrigerant type for least environmental impact and best long term economic benefit.
- .2 Water-source heat pumps shall be designed to reject heat to heating loops (for simultaneous heating and cooling), condenser loops connected to cooling towers or condenser loops connected to geothermal fields.

19.2 **Functional Requirements**

- .1 Air-source heat pumps shall be capable of meeting 100% of the heating load down to -4°C (25°F) before needing supplemental heat.
- .2 Heat pumps requiring routine access for inspection shall be located in mechanical spaces with sufficient working clearance as required by manufacturer.
- .3 Noise generated by air-to-water heat pumps located, in most cases, on the roof shall be taken into account when considering using this system. Obtain comments from the acoustical consultants and consider using acoustical screens, low-noise condenser fans and additional noise attenuation for compressors.
- .4 Air-to-water heat pumps shall be protected from freezing. Provide minimum 45% polypropylene glycol solution in the heat pump source loop. Separate the heat pump source loop from the building load loop with a heat exchanger to limit glycol solution for outdoor heat pumps only.

19.3 Performance Requirements

- .1 Heat pumps shall comply with the energy efficiency requirements of the latest edition of the ASHRAE 90.1
- .2 Water-source heat pumps shall be designed to maintain a minimum deadband of 13°C (20°F) in the condenser water temperature control between minimum (enabling heat addition) and maximum setpoint (enabling heat rejection).

19.4 Prescriptive Requirement

- .1 Heat pumps shall have interface connection to the building automation system (BAS) using BACnet – 135 communication and interoperability protocols through the BAS. All points controlling the cooling and heating system shall be visible and adjustable through the Building Automation System.

20.0 Fan Coil Units**20.1 General Requirements**

- .1 Select high efficiency fan motors (ECM type) with variable speeds that can be automatically controlled to match load requirements in order to minimize fan noise, maximize fan energy and maximize potential for dehumidification during part load cooling operation.

20.2 Functional Requirements

- .1 A secondary drain pan for each cooling coil shall be provided for fan coils located above finished ceilings.
- .2 Access doors shall be provided on upstream side of all coils.
- .3 Maintain manufacturers clearance recommendations for maintenance access around fan coil units.

20.3 Performance Requirements

- .1 Design for minimizing fan energy. The high-performance target is that the allowable fan power limitation for each system shall be 10% less than the limits set by ASHRAE 90.1 or the current International Energy Conservation Code, or per the prescriptive path criteria of the current edition of ASHRAE Standard 189.1 (whichever is most stringent).

20.4 Prescriptive Requirements

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21.0 In-Floor Radiant Systems**21.1 General Requirements**

- .1 Provide detailed design information on the drawings for all heating zones including, but not limited to, room identification, room-by-room heat loss calculations, floor

covering insulation value, supply water temperature, design temperature drop, flow rate required per each zone, location of headers and thermostats.

- .2 PEX tubing shall carry a 25-year and manifolds a 5-year non-prorated warranty against failure due to defect in material or workmanship. Warranty shall provide for repair or replacement of any tube or fittings which are proven to be defective and pay for consequential damages.

21.2 Functional Requirements

- .1 Each radiant zone shall be equipped with the following:
 - a. supply and return manifold, complete with a lockable metal access cover
 - b. manual air vent on the return manifold
 - c. balancing, or isolating valves on each loop, supply and return
 - d. zone control valve
 - e. labels, or tags indicating room, and area of service, and length of each loop
- .2 All tubing shall be in accordance with ASTM F876 “Standard Specification for Cross-Linked Polyethylene (PEX) Tubing” and shall be provided with an oxygen barrier.
- .3 No pipework tubing joints are permitted under the slab.
- .4 In-slab PEX piping shall be protected by high-density polyethylene (HDPE) corrugated sleeves. Solid PVC sleeves shall be provided where tubes enter or exit concrete floors
- .5 Tubing shall not be placed under any area where a fridge or freezer may be placed, or under any cabinets. The preference is to locate the heating manifolds in common corridor areas.
- .6 Exposed PEX piping shall be protected from UV exposure during construction.
- .7 Fittings shall be PEX-A cold expansion type fittings in accordance with ASTM F1960 “Standard Specification for Cold Expansion Fittings with PEX Reinforcing Rings for Use with Cross-Linked Polyethylene (PEX) Tubing”. Use of crimped fittings is not permitted.

21.3 Performance Requirements

- .1 Supply water temperature in the in-floor loop shall be controlled based on the outdoor temperature reset schedule and maximum allowable floor surface temperature to avoid overheating.
- .2 All installations shall be tested with minimum twice the working pressure, the test shall stay on during the construction period.
- .3 Carefully consider run-outs of in-slab piping to individual floor heating loops. Where there is many run-outs located in the interior areas (e.g., corridors), insulate run-out piping with 13mm Armaflex insulation to prevent overheating

21.4 Prescriptive Requirement

- .1 Topping should be gypsum concrete, or equivalent. Minimum 19 mm (3/4”) coverage shall be provided by the topping.
- .2 All tubes and recommended fasteners shall be placed as per the manufacturer’s specifications. Tube spacing should not exceed 305 mm (12”) centre to centre. Each loop must be fastened at each bend, and spacing between each fastener should not

exceed 914 mm (3'). The length per loop in a zone for 12.7 mm (1/2") tubing shall not exceed 76.2 m (250').

- .3 At exterior walls, tubing should be installed 150 mm (6") on centre up to 1200 mm (4') from the wall.
- .4 PEX tubing shall carry a 25-year and manifolds a 5-year non-prorated warranty against failure due to defect in material or workmanship. Warranty shall provide for repair or replacement of any tube or fittings which are proven to be defective and pay for consequential damages

25 00 00 Integrated Automation

To reference existing City of Toronto Building Automation Systems specification

Refer to City of Toronto Standard Building Automation System (BAS) Specification – December 2019 version 6.1.6

26 00 00 Electrical

Applicable Codes and Standards

The project shall be designed, installed, commissioned, and operated in accordance with the latest versions at the time of design, of the relevant local and international standards, codes, guidelines, and regulations. Refer to the following documents:

- CSA C22.1 – Canadian Electrical Code Part 1
- CSA C22.2 – Canadian Electrical Code Part 2
- CSA C22.3 – Canadian Electrical Code Part 3
- Ontario Electrical Safety Code (OESC)
- National Building Code of Canada (NBC)
- Ontario Building Code (OBC)
- CSA-B72-M87 – Installation Code for Lightning Protection Systems
- CSA-C282 – Emergency Electrical Power Supply for Buildings
- CAN/CSA-C802. 2-12 Minimum Efficiency Values for Dry Type Transformers.
- CAN/ULC-S524 – Standard for Installation of Fire Alarm Systems
- CAN/ULC-S525: Audible Signal Devices for Fire Alarm Systems, Including Accessories.
- CAN/ULC-S526: Visible Signal Devices for Fire Alarm System, Including Accessories.
- CAN/ULC-S527: Standard for Control Units for Fire Alarm Systems.
- CAN/ULC-S528: Manual Stations for Fire Alarm Systems, Including Accessories.
- CAN/ULC-S529: Smoke Detectors for Fire Alarm Systems.
- CAN/ULC-S530: Heat Actuated Fire Detectors for Fire Alarm Systems.
- CAN/ULC-S531: Standard for Smoke-Alarms.
- CAN/ULC-S536 Inspection and Testing of Fire Alarm Systems.
- CAN/ULC-S537 Verification of Fire Alarm Systems.
- CAN/ULC -S1001 Integrated Systems Testing of Fire Protection and Life Safety Systems.
- CSA B44 - Safety Code for Elevators and Escalators
- Occupational Health and Safety Act and Regulations. (OHSA)
- Underwriters' Laboratories of Canada, ULC Standards. (ULC)
- National Electrical Manufacturers Association Standards. (NEMA)
- Institute of Electrical and Electronic Engineers (IEEE)
- Illuminating Engineering Society of North America (IESNA)

1.0 Site Electrical Services

1.1 General Requirements

- .1 All materials and equipment shall be new, CSA certified, and manufactured to the Standards specified. Where there is no alternative to supplying equipment which is not CSA certified, obtain special approval from the local Inspection Department. All electrical equipment, material, wiring and devices to conform to the Ontario Electrical Safety Code for the purpose for which they are to be used. All equipment to be designed and manufactured in accordance with applicable EEMAC and ANSI specifications.
- .2 Ensure circuit protective devices such as overcurrent trips, relays and fuses are installed to required values and settings.
- .3 Do not design or install single source or use proprietary equipment or systems.
- .4 Design consultant shall contact the utility provider to determine service availability, any known constraints and date that service can be made available.
- .5 For new construction, select service voltage to accommodate the majority of the load requirements.

1.2 Functional Requirements

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1.3 Performance Requirements

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1.4 Prescriptive Requirements

- .1 Location of Outlets
 - a. Do not install outlets back-to-back in wall; allow minimum 150mm horizontal clearance between boxes.
 - b. Locate light switches on latch side of doors.
 - c. Locate disconnect devices in mechanical and elevator machine rooms on latch side of floor.
- .2 Mounting Heights
 - a. Mounting height of equipment shall be measured from finished floor to centre line of equipment unless specified or indicated otherwise.
 - b. If mounting height of equipment is not specified or indicated, verify before proceeding with installation.
 - c. Install electrical equipment at following heights unless otherwise required as part of specific project design requirements:
 - Local switches: 1150 mm.
 - General Wall receptacles: 300 mm.
 - Receptacles above top of continuous baseboard heater: 200 mm.
 - Receptacles above top of counters or counter splash backs: 175 mm.
 - In mechanical rooms: 1150 mm.
 - Panelboards: as required by Code or as indicated.
 - Telephone and data outlets: 300 mm.
 - Wall mounted telephone and data outlets: 1150 mm.
 - Fire alarm stations: 1150 mm.
 - Fire alarm bells: 2100 mm.

- Television outlets: 1500 mm.
- Wall mounted speakers: 2100 mm.

2.0 Medium Voltage Dry Type Transformers

2.1 General Requirements

- .1 Applicable Codes and Regulations
 - a. All components shall be designed, manufactured and tested in accordance with the latest applicable/adopted standards of ANSI, NEMA, EEMAC and CSA, including but not limited to:
 - CSA C917 – Dry Type Transformers.
 - CSA C22.2 NO. 47-13 - Air-cooled transformers (dry type).
 - CAN/CSA-C802.2-18, Minimum Efficiency Values for Dry Type Transformers.
 - IEEE C57.12.01-2020 – General Requirements for Dry-Type Distribution and Power Transformers Including Those with Solid-Cast and/or Resin Encapsulated Windings.
 - IEEE C57.12.50.-1989 – Requirements for Ventilated Dry-Type Distribution Transformers, 1 to 500 kVA, Single-Phase, and 15 to 500 kVA, Three-Phase, with High-Voltage 601 to 34,500 Volts, Low-Voltage 120 to 600 Volts.
 - IEEE C57.12.51-2019 – Ventilated Dry-Type Power Transformers, 501 kVA and Larger, Three-Phase, with High-Voltage 601 V to 34,500 V; Low-Voltage 208Y/120V to 4160 V, General Requirements.
 - IEEE C57.12.91-2020, Test Code for Dry-Type Distribution and Power Transformers.
 - Canadian Energy Efficiency Regulations (SOR/2016-311)
 - NEMA TR 1, 2013 - Transformers, Step Voltage Regulators and Reactors
 - .2 Transformers shall be design with vibration isolation pads for transformer mounting.
 - .3 Transformers to be located in dedicated electrical rooms, positioned away from regularly occupied areas (offices, dwellings, etc) and will be provided with suitable acoustic measures.
 - .4 Location of transformers in new developments to be generally accessible from ground level directly from perimeter of the development.
 - .5 Electrical rooms shall be adequately ventilated in coordination with the Mechanical Consultant to account for all heat producing equipment within the room.
 - .6 Location and size of the transformer rooms shall meet all local utility company requirements, including but not limited to overhead clearances, and external guard posts to be provided, as required, to external entrance into any transformer rooms.
 - .7 Transformers can be installed at high level, only for sizes equal to or less than 75kVA in fully accessible locations without the need to remove ceiling panels.

2.2 Functional Requirements

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2.3 Performance Requirements

- .1 No load and full load losses not to exceed those indicated in CAN/CSA-C802.2.

2.4 Prescriptive Requirements

- .1 All transformers to be specified to supply circuits with a harmonic profile equal to a K-factor of 13.

3.0 Main and Sub-Main Distribution Panels

3.1 General Requirements

- .1 Applicable Codes and Regulations
 - a. All components shall be designed, manufactured and tested in accordance with the latest applicable/adopted standards including but not limited to:
 - CSA C22.2 No.31-[10], Switchgear Assemblies.
 - Electrical and Electronic Manufacturers' Association of Canada (EEMAC), EEMAC G8-3.3-[89], Metal Enclosed Interrupter Switchgear Assemblies.
 - CSA Z462 Workplace electrical safety
 - IEEE 1584 Guide for Performing Arc-Flash Hazard Calculations
- .2 For new construction projects, a dedicated electrical rooms shall be provided for the main and sub-main distribution panel(s) and metering equipment. The room shall be sized to accommodate all current equipment and allow spare space and/or wall space for future equipment/panelboards.
- .3 The location of these electrical rooms shall be appropriately close to the main load centres to avoid oversizing outgoing infrastructure.
- .4 No mechanical equipment or plumbing pipework shall transition through any electrical rooms at any point.
- .5 Main or sub-main distribution panels shall not be located in mechanical rooms, except for MCCs (Motor Control Centres).
- .6 Electrical rooms shall be adequately ventilated in coordination with the Mechanical Consultant to account for all heat producing equipment within the room.
- .7 Circuit breakers shall be used for all main and branch circuit protective devices, no fuses are allowed.
- .8 Preliminary short circuit calculations to be carried out by the Electrical Consultant prior to completion of the 100% design stage. These calculations shall ensure adequate fault duty ratings of all switchgear, panels, MCCs and overcurrent devices.
- .9 The contractor/manufacturer shall complete a coordination study that provides the final selected breakers, and to be reviewed by the Electrical Consultant and Owner. Upon acceptance of the study, settings shall be programmed for all applicable breakers and a copy of the Study shall be included in the operational and maintenance manual.
- .10 The Electrical Consultant shall confirm all breaker settings are coordinated with final Coordination Study Report at substantial completion stage.
- .11 An arc flash study shall be carried out by the Contractor for all new construction, additions, or renovations to existing projects. The Electrical consultant shall include the following scope of the arc flash requirements into their specifications:
 - a. New Construction: Entire distribution system.

- b. Renovations: New distribution systems.

3.2 Functional Requirements

- .1 Main distribution panel and all sub distribution panelboards shall be sized 25% above the combined current design capacity.
- .2 Provide 20% spare breakers and 10% spaces in all main and sub distribution panelboards.
- .3 Provision of future extension of the main distribution panel shall be accommodated on both sides.

3.3 Performance Requirements

- .1 The maximum arc rating of switchboard on the line side of the main breaker is not to exceed 40 cal/cm². In case non-compliant, proposed measures shall be submitted for review and approval.

3.4 Prescriptive Requirements

- .1 All arc flash labels shall follow requirement CSA Z462-15 Annex Q - Q.4 Detailed electrical hazard information label.
- .2 The operational and maintenance manual shall include the following details:
 - a. How to correctly interpret the hazard labels.
 - b. Selection and utilization of personal protective equipment.
 - c. Safety work practices and procedures.
- .3 A sample of the arc flash labels shall be provided for review and approval by the Electrical Consultant, the Commissioning Agent and the Owner prior to printing all labels.

4.0 Power Factor Correction Equipment

4.1 General Requirements

- .1 Applicable Codes and Regulations
 - a. All components shall be designed, manufactured and tested in accordance with the latest applicable/adopted standards including but not limited to:
 - CSA C22.2 No.190-[M1985(R2004)], Capacitors for Power Factor Correction.
- .2 Overall power factor across distribution system to be maintained to at least 95%.
- .3 If the project contains many large individual motors (>50HP), then the Electrical Consultant to provide preliminary calculations indicating power factor capacitor size/requirements. If power factor is reduced significantly due to large motor loads, the power factor must be corrected to minimum indicated requirements.

4.2 Functional Requirements

- .1 If power factor correction equipment is deemed necessary, then a controller shall be provided with the following features:
 - a. Standard metering capability including:

- Voltage
- Current
- Frequency
- Active Power (kW)
- Reactive power (kvar)
- Apparent power (kVA)
- Total voltage harmonic distortion (THDV)
- Total current harmonic distortion (THDI)
- b. Automatic sensing of kvar values per step.
- c. Visual indication of insufficient kvar to reach target power factor

4.3 Performance Requirements

Intentionally left blank.

4.4 Prescriptive Requirements

Intentionally left blank.

5.0 Panelboards

5.1 General Requirements

- .1 Applicable Codes and Regulations
 - a. Panelboards shall be designed, manufactured and tested in accordance with the latest applicable/adopted standards including but not limited to:
 - CEMA Standard G8-2, ANSI C37.20
 - CSA Specification C22.2 No. 31
- .2 Panelboards shall be located in dedicated electrical rooms/cupboards.
- .3 Panelboards can be located in storage or mechanical rooms upon Owner's approval.
- .4 Panelboards shall not be located behind doors in direction that they open.
- .5 Panelboards shall be designed to provide minimum 10% additional spare breakers in each panelboard. Provide spaces for future circuit breakers to be a minimum 25% of used spaces.
- .6 Panelboards shall be provided as flush mounted type. Surface mounted panelboards shall be accepted in service rooms/cupboards only.
- .7 In renovation projects, where panelboards cannot be relocated, these are permitted to be located in corridors but will require necessary access restrictions limiting any possible tampering.

5.2 Functional Requirements

Intentionally left blank.

5.3 Performance Requirements

- .1 The Minimum Integrated Short Circuit Rating for branch circuit panelboards shall be indicated on the drawings.
- .2 All panelboards shall come with complete circuit directory with legend showing location and load of each circuit.

5.4 **Prescriptive Requirements**

- .1 All sections of the panelboards shall be bolted together to form a rigid assembly.
- .2 The busses and connections shall consist of high conductivity copper bus bar mounted on heavy duty glass polyester supports. Bus joints and tap connections shall be bolted with high strength bolts and Belleville washers.

6.0 **Grounding and Bonding of Electrical Systems**

6.1 **General Requirements**

- .1 Applicable Codes and Regulations
 - a. All components shall be designed, manufactured and tested in accordance with the latest applicable/adopted standards of ANSI, NEMA, EEMAC and CSA, including but not limited to:
 - CSA C22.2 No.0.4, Bonding and Grounding of Electrical Equipment (Protective Grounding)
 - CSA C22.2 No.41, Grounding and Bonding Equipment
 - ANSI/IEEE 8372014, IEEE Standard for Qualifying Permanent Connections Used in Substation Grounding.
 - ANSI/IEEE 80-2013, IEEE Guide for Safety in AC Substation Grounding
 - .2 The design of the grounding and bonding system shall include electrodes, conductors, connectors, accessories to conform to the requirements of the local Electrical Supply Authority and connect to the building system at the nearest location.
 - .3 Ground each piece of fixed equipment back to the switchboard or panel feeding that equipment by one of the following methods:

6.2 **Functional Requirements**

Intentionally left blank.

6.3 **Performance Requirements**

- .1 Bonding conductor shall be designed as per Table 16 of the OESC with one bonding conductor for every three hot conductors.

6.4 **Prescriptive Requirements**

Intentionally left blank.

7.0 **Surge Protection**

7.1 **General Requirements**

- .1 Applicable Codes and Regulations
 - a. All components shall be designed, manufactured and tested in accordance with the latest applicable/adopted standards including but not limited to:
 - CSA C22.2 No. 269, Surge Protection Devices

- IEEE C62.41.2-2002, Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.
 - IEEE C62.45-2002, Guide on Surge Testing for Electrical Equipment Connected to Low-Voltage AC Power Circuits.
 - IEEE C62.62-2000, Standard Test Specifications for Surge Protective devices
- .2 Surge suppression shall be installed on the utility incoming mains. The Electrical Consultant shall ensure coordination with the Utility company.
 - .3 Surge protection devices (SPD) to be located internal to all panels.
 - .4 For areas containing a large group of electronically sensitive loads, provide surge protection on distribution equipment serving the area.
 - .5 Specify type 1, type 2 or type 3 for each Surge Protection Devices (SPD) based on loads the SPD protects.

7.2 Functional Requirements

Intentionally left blank.

7.3 Performance Requirements

Intentionally left blank.

7.4 Prescriptive Requirements

Intentionally left blank.

8.0 Conduits

8.1 General Requirements

- .1 Applicable Codes and Regulations
 - a. All materials and components shall be designed, manufactured and tested in accordance with the latest applicable/adopted standards including but not limited to:
 - CSA C22.2 No.40-M1989(R2009), Cutout, Junction and Pull Boxes.
 - CSA C22.2 No.45-M1981(R2003), Rigid Metal Conduit.
 - CSA C22.2 No.56-2017, Flexible metal conduit and liquid-tight flexible metal conduit.
 - CSA C22.2 No.83-M1985(R2017), Electrical Metallic Tubing.
 - CSA C22.2 No. 227.3-M91(R1996), Flexible Nonmetallic Tubing.
- .2 Specify all AC and DC wiring to be installed in conduit or wireway (except where AC90 cables are used).
- .3 All conduits must be concealed except in service areas or where there is no suspended ceiling and conduits cannot be cast into the concrete. These locations are to be approved by the Owner.
- .4 All conduits to be labelled with the purpose of conduit, at the junction box where conduit terminates.
- .5 The Electrical Consultant shall include in their specifications that the Contractor shall record the exact routing of underground or in slab conduit runs on record drawings. Provide sufficient details (such as dimensions from centrelines of the conduits to edge of column, or slab) so that the exact route can be determined

- during renovations and additions. Mark route of in slab conduit runs by using "electrical danger" tape or stained concrete.
- .6 Conduits shall mainly be rigid galvanized steel, to CSA C22.2 No. 45, with exterior zinc and interior enamel coatings, galvanized threads where factory cut, red lead coated threads where site cut, factory made bends where site bending is not possible, factory made and threaded fittings, and concrete tight where required.
 - .7 Where conduit is used in ceiling plenums, use steel EMT, do not use PVC conduit.
 - a. EMT (Thinwall), to CSA C22.2 No. 83, complete with factory made bends where site bending is not possible and joints and terminations made with set screw type connectors, concrete tight where required, maximum allowable size shall be 50mm diameter.
 - .8 Provide conduit for final drops in finished walls from cable tray in ceiling space.

8.2 Functional Requirements

Intentionally left blank.

8.3 Performance Requirements

- .1 Distribution of power services shall be designed to allow the following minimum distances from communication conduits to avoid EMI:

a. Exposed power cables <2KV:	125mm
b. Exposed power cables 2-5KV:	300mm
c. Exposed power cables >5KV:	600mm
d. Cables in conduit <2KV:	62mm
e. Cables in conduit 2-5KV:	150mm
f. Cables in conduit >5KV:	300mm
g. Luminaires :	300mm
h. Transformers and motors:	1000mm

8.4 Prescriptive Requirements

- .1 Provide flexible conduits for final connection to transformers.
- .2 Minimum size of conduit: 21mm (3/4")
- .3 A maximum of 30m of conduit run, or (two), 90 deg. bends, or equivalent up to 180 deg., will be permitted without installation of a pull box. Radius of bends must be no less than 10 (ten) times the conduit diameter.

9.0 Wires

9.1 General Requirements

- .1 Applicable Codes and Regulations
 - a. All materials and components shall be designed, manufactured and tested in accordance with the latest applicable/adopted standards including but not limited to:
 - CSA C22.2 No .0.3 96 and No. 174, Test Methods for Electrical Wires and Cables.
 - CAN/CSA C22.2 No. 131 M89 (R1994), Type TECK 90 Cable.
 - CSA C22.2 No. 38-05 – Thermoset-Insulated Wires and Cables.
 - CSA C22.2 No. 51-09: Armoured Cables.

- CSA C22.2 No. 75-08 – Thermoplastic-Insulated Wires and Cables.
 - CSA C22.2 No. 124-16 - Mineral-insulated cable.
 - CSA C22.2 No. 210-05 – Appliance Wiring Material Products.
 - CAN/ULC S139 – Standard Method of Fire Test for Evaluation of Integrity of Electrical Cables.
 - CAN/ULC-S139-12 – Standard Method of Fire Test for Evaluation of Integrity of Electrical Power, Data and Optical Fibre Cables.
- .2 Size feeders for a maximum 2% voltage drop from main distribution to branch circuit panelboards under rated full loads.
 - .3 Use copper conductors with RW90 X-Link or THNN insulation. Minimum size of branch circuit wire to be #12 AWG and #14AWG for control wiring.
 - .4 Minimum size of parallel conductors shall be #1/0. Conductor length for parallel conductors to be identical.
 - .5 Loading for lighting circuits shall be limited to:
 - a. 1200VA for 15A breaker at 120V
 - b. 1700VA for 20A breaker at 120V
 - c. 2800VA for 15A breaker at 277V
 - d. 3700VA for 20A breaker at 277V
 - e. 3900VA for 15A breaker at 347V
 - f. 5300VA for 20A breaker at 347V
 - .6 Designs should limit the number of general receptacles to six per circuit.
 - .7 Designs should limit the number of receptacles for computers to four per circuit.

9.2 Functional Requirements

Intentionally left blank.

9.3 Performance Requirements

Intentionally left blank.

9.4 Prescriptive Requirements

Intentionally left blank.

10.0 Wiring Devices

10.1 General Requirements

- .1 Applicable Codes and Regulations
 - a. All materials and components shall be designed, manufactured and tested in accordance with the latest applicable/adopted standards including but not limited to:
 - CSA C22.2 No.42-2010, General Use Receptacles, Attachment Plugs and Similar Devices.
 - CAN/CSA C22.2 No.42.1-2000(R2009), Cover Plates for Flush-Mounted Wiring Devices (Bi-national standard, with UL 514D).
 - CSA C22.2 No.55-M1986(R2008), Special Use Switches.
 - CSA C22.2 No.111-2010, General-Use Snap Switches (Bi-national standard, with UL 20).

- .2 Provide a minimum of one, general service outlets in corridors at approximately 15m intervals.
- .3 Identify all receptacles as to panel and circuit number on label affixed to top of device cover plate.

10.2 Functional Requirements

Intentionally left blank.

10.3 Performance Requirements

Intentionally left blank.

10.4 Prescriptive Requirements

Switches

- .1 Rocker style switches shall be used in all finished areas. Finished colour to be confirmed by architect of the project.
- .2 All switches in corrosive areas shall be complete with weatherproof PVC switch covers.

Receptacles

- .3 Receptacles shall be of the rectilinear style; white for normal power, red for emergency power, black for all floor box locations. Final finishes and colour to be confirmed by architect of the project.
- .4 Duplex receptacles shall be CSA type 5-20 R, 125 V, 20 A, U ground with following features:
 - a. Suitable for No. 10 AWG for back and side wiring.
 - b. Break-off links for use as split receptacles.
 - c. Eight back wired entrances, four side wiring screws.
 - d. Triple wipe contacts and rivetted grounding contacts.
- .5 Single receptacles shall be CSA type 5-20 R, 125 V, 20 A, U ground with following features:
 - a. Suitable for No. 10 AWG for back and side wiring.
 - b. Four back wired entrances, 2 side wiring screws.

11.0 Uninterruptible Power Supplies

11.1 General Requirements

- .1 Applicable Codes and Regulations
 - a. All materials and components shall be designed, manufactured and tested in accordance with the latest applicable/adopted standards including but not limited to:
 - CSA C22.2 No. 141-15 - Emergency Lighting Equipment.
 - CSA C22.2 No 107.1 – Commercial and Industrial Power Supplies.
 - IEEE 587 (ANSI C62.41) Category A & B – Recommended practices on surge voltages in low voltage power circuits.
 - IEEE 1184-2006 - IEEE Guide for Batteries for Uninterruptible Power Supply Systems
 - UL 1778, Standard for Uninterruptible Power Supply Equipment.

- IEC 62040-1 (International Electrotechnical Commission) – Uninterruptible power systems (UPS) – Part 1-1: General and safety requirements for UPS.
 - IEC 62040-2 (International Electrotechnical Commission) – Uninterruptible power systems (UPS) – Part 2: Electromagnetic Compatibility (EMC) requirements
 - IEC 62040-3 (International Electrotechnical Commission) – Uninterruptible power systems (UPS) – Part 3: Method of specifying the performance and test requirements.
 - NEMA PE-1 – Uninterruptible Power Systems standard.
- .2 Where a generator is part of the project, then critical loads (to be defined within the project, but include servers, life safety equipment, etc), an Uninterruptible Power Supply (UPS) system will be provided with a minimum of 5 minutes autonomy at the full rated load. Additional battery autonomy may be required and will be confirmed on a project by project basis.
 - .3 Central UPS systems are preferred to distributed UPS systems for projects that require large UPS backed loads.
 - .4 UPS battery systems shall be lithium-ion type with a minimum 10-year expected lifetime and battery management system. Lead-acid batteries are not permitted.
 - .5 All outputs from the UPS system will be monitored by the BAC system.

11.2 Functional Requirements

Intentionally left blank.

11.3 Performance Requirements

Intentionally left blank.

11.4 Prescriptive Requirements

- .1 The UPS system shall include a local, front mounted, sealed, touch screen, LCD display monitor to verify system electrical and temperature measurements, inform/alarm for abnormal system status, allow programming of user specified set points and inform of periodic system and battery test results.
- .2 The monitor shall display the following electrical parameters:
 - a. Input Voltage
 - b. Output Voltage (L1-N)
 - c. Output Voltage (L2-N).
 - d. Output Voltage (L1-L2)
 - e. Output Current (L1-N)
 - f. Output Current (L2-N)
 - g. Output Volt-Amperes (L1-N)
 - h. Output Volt-Amperes (L2-N)
 - i. Output Volt-Amperes (Total)
 - j. Output Watts (L1-N)
 - k. Output Watts (L2-N)
 - l. Output Watts (Total)
 - m. Output Power Factor (L1-N)
 - n. Output Power Factor (L2-N)
 - o. Output Power Factor (Total)
 - p. Output Percent Load (L1-N)

- q. Output Percent Load (L2-N)
 - r. Output Percent Load (Total)
 - s. Output Frequency
 - t. Battery Charger Current
 - u. Battery Voltage
- .3 The monitor shall display the following status and alarm conditions:
- a. Input Voltage (High/Low)
 - b. Output Voltage (L-N High/Low)
 - c. Output Voltage (L2-N High/Low)
 - d. Output Volt-Amperes (High – Overload)
 - e. Output Volt-Amperes (Low)
 - f. Output Frequency (High/Low)
 - g. Battery Voltage (High/Low)
 - h. Battery Charger Current (High)
 - i. Battery Temperature (High)
 - j. General Alarm
 - k. System On Battery
 - l. Low Battery Warning
 - m. Low Battery Shutdown
 - n. Inverter Over Temperature Shutdown
 - o. DC Charger Failure/ DC Open
 - p. Output Circuit Breaker Open
 - q. REPO Shutdown
 - r. System in Manual Bypass
 - s. Off Bus Remote Activation
- .4 The monitor shall display the following operational conditions:
- a. Battery Temperature
 - b. Percent Battery Time Remaining

12.0 Fire Alarm

12.1 General Requirements

- .1 Applicable Codes and Regulations
- a. The fire alarm system shall be provided in accordance with the Ontario Building Code and all relevant ULC codes, including but not limited to:
 - CAN/ULC-S524 – Standard for Installation of Fire Alarm Systems
 - CAN/ULC-S525: Audible Signal Devices for Fire Alarm Systems, Including Accessories.
 - CAN/ULC-S526: Visible Signal Devices for Fire Alarm System, Including Accessories.
 - CAN/ULC-S527: Standard for Control Units for Fire Alarm Systems.
 - CAN/ULC-S528: Manual Stations for Fire Alarm Systems, Including Accessories.
 - CAN/ULC-S529: Smoke Detectors for Fire Alarm Systems.
 - CAN/ULC-S530: Heat Actuated Fire Detectors for Fire Alarm Systems.
 - CAN/ULC-S531: Standard for Smoke-Alarms.
 - CAN/ULC-S536 Inspection and Testing of Fire Alarm Systems.
 - CAN/ULC-S537 Verification of Fire Alarm Systems.
 - CAN/ULC-S1001 Integrated Systems Testing of Fire Protection and Life Safety Systems.

- .2 Provide fire alarm system as a stand-alone system, independent of building control or security systems.
- .3 The system shall be programmable, microprocessor based with integrated fire alarm system and emergency voice communication system.

12.2 Functional Requirements

Intentionally left blank.

12.3 Performance Requirements

- .1 For new construction projects the system shall be configured with a main control panel located in the main electrical room with a remote annunciator located at the main entrance.

For renovation projects

- .2 The remote fire alarm annunciator shall be coordinated with the local fire department.
 - a. Annunciator shall include display of all required fire alarm and supervisory zones, controls required by the code and integral microphone for emergency paging.
 - b. Annunciator shall include both dedicated LED lamps for each alarm and supervisory zone and LCD display to display additional information.
 - c. Framed passive graphic drawing with building outlines, stairwells, etc. shall be provided adjacent to the main annunciator.
 - d. All necessary loop isolation modules required at fire separations, stairwells, floor assemblies, etc. shall be provided.
- .3 Smoke detectors shall be provided as per the OBC and at the top of all exit stairs. Heat detectors shall be provided at the top of the elevator shafts and in the elevator pits.
- .4 Pull stations shall be provided at all exits and located on the latch side of the doors only.
- .5 Connections shall be provided to all supervised valves, flow switches and pressure switches on the sprinkler system.
- .6 Speakers shall be used as audible signal appliances. Speakers in mechanical and electrical rooms shall be re-entrant horn type.
- .7 Strobe lights shall be provided in corridors, public spaces, noisy areas including mechanical equipment rooms and other areas required by code.
- .8 Where required, recirculating air handling systems shall be provided with duct smoke detectors and shut down where required by the code.
- .9 The system shall be provided with integral batteries for backup power for the minimum duration required by the code.

12.4 Prescriptive Requirements

- .1 Provide additional 20% spare capacity on the fire alarm system (i.e. control panel, annunciator, amplifiers, batteries, etc).
- .2 The fire alarm system shall interface with the building control and security systems where applicable.
- .3 Pull stations shall be on latch side of doors only.

Section 1 – Contractor Information

Contractor Company:	Date:
Location of Job:	Duration of Job:
Contractor On-Site Supervisor:	Phone Number:
Description of Job:	

Section 2 – Contractor Safety Record

Certificate of Insurance Provided?	<input type="checkbox"/> Yes <input type="checkbox"/> No
WSIB Clearance Certificate Submitted?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Have you reported any fatalities or critical injuries in the last 3 years? (If yes, provide report)	<input type="checkbox"/> Yes <input type="checkbox"/> No
Have you received any MLTSD safety-related orders, prosecutions, charges or fines in the last 3 years? (If yes, provide copy)	<input type="checkbox"/> Yes <input type="checkbox"/> No
Have you had fines or suspensions from TSSA in the last 3 years? (If yes, provide copy)	<input type="checkbox"/> Yes <input type="checkbox"/> No
Have you had fines or suspensions from a utility company in the last 3 years? (If yes, provide copy)	<input type="checkbox"/> Yes <input type="checkbox"/> No
Have you worked for the City of Toronto before? (If yes, provide Evaluation, if available)	<input type="checkbox"/> Yes <input type="checkbox"/> No

Section 3 – Safe Work Plan

Safe Work Procedure

The contractor is responsible for controlling health and safety hazards present on site and those that arise from the contractor’s work activities which may pose a risk to their workers, other contractors, City staff and members of the public.

In the section below, check off all the hazards associated with the contracted work, a complete written procedures on how to control identified hazards, including emergency response plans (if needed). contractors may provide additional documentation to supplement this form.

Hazards Associated with Job (Check all that apply)

Hazard	Description	Hazard	Description
<input type="checkbox"/> Biological Hazards		<input type="checkbox"/> Noise	
<input type="checkbox"/> Chemical Use		<input type="checkbox"/> Respiratory Hazards	
<input type="checkbox"/> Ergonomic		<input type="checkbox"/> Use of flammable or combustible liquids	
<input type="checkbox"/> Energized Electrical Work		<input type="checkbox"/> Working Alone or Remotely	
<input type="checkbox"/> Fall Hazard - Material		<input type="checkbox"/> Slips, trips, falls	
<input type="checkbox"/> Fall Hazard - Person		<input type="checkbox"/> Other	
<input type="checkbox"/> Heavy Lifting			

Job Steps/Task	Potential Hazard/Risk	Control Measures

Emergency Response Plan

Contractors must have an emergency response plan for any hazardous operations they conduct. All accidents must be reported to the City immediately, and an internal investigation report within 3 days of an incident.

- Contractors are required to have their own first aid kit and personnel who are trained in first aid for all jobs
- If there is use of chemicals for the job, SDSs must be present.
- Contractors must provide an entry and rescue plan for all confined space entry.
- Contractors must have a rescue plan for all work at heights.

Section 4 – Occupational Health and Safety Sign-Off

1. _____ (hereinafter referred to as 'Contractor') will employ for the
(Insert Company Name)

Work under this Contract a supervisor or supervisors who are competent persons as defined by section 1(1) of the Act, and specifically a person or persons who:

- (a) are qualified because of knowledge, training and experience to organize the Work and its performance;
- (b) are familiar with the Act and the regulations made thereunder that apply to the Work; and
- (c) have knowledge of any potential or actual danger to health and safety associated with the Work, and;

2. The Contractor acknowledges and represents that:

- a. The Contractor 's supervisory employees will carry out their duties in a diligent and responsible manner with due consideration for the health and safety of workers;
- b. The workers employed to carry out the Work have been provided with training in the hazards of the work to be performed and possess the knowledge and skills to allow them to work safely;
- c. The Contractor has provided, and will provide during the course of the agreement, all necessary personal protective equipment for the protection of workers;
- d. The Contractor will ensure that all subcontractors engaged by it are qualified to perform the work and that the employees of subcontractors are trained in the health and safety hazards expected to be encountered in the work.

3. The Contractor represents and warrants that it shall be in good standing with the WSIB throughout the Term of this Contract.

Contractor Representative completing this Safe Work Plan:

Name	Company and Title	Signature	Date
------	-------------------	-----------	------

Appendix 1 – Contractor Pre-Qualification Safe Work Plan

Appendix 2 – Pre-Work Meeting Agenda

MEETING DETAILS			
Date:		Time:	Location:
Site Representative:		Contractor Representative:	
PERSONS ATTENDING			
1.		2.	
3.		4.	
5.		6.	
7.		8.	

Potential Site-Specific Hazards (To be Completed By Site Representative)			
Hazard	Description	Hazard	Description
<input type="checkbox"/> Biological Hazards		<input type="checkbox"/> Public Safety	
<input type="checkbox"/> Chemical Use		<input type="checkbox"/> Respiratory Hazards	
<input type="checkbox"/> Confined Spaces		<input type="checkbox"/> Slips, trips, and falls	
<input type="checkbox"/> Exposure to Designated Substance		<input type="checkbox"/> Use of flammable or combustible liquids	
<input type="checkbox"/> Fire / Explosion Hazards		<input type="checkbox"/> Working around heavy machinery	
<input type="checkbox"/> Hazardous Waste Generation		<input type="checkbox"/> Work over/near water	
<input type="checkbox"/> Inadequate lighting		<input type="checkbox"/> Other	
<input type="checkbox"/> Noise		<input type="checkbox"/> Noise	

Contractor Questionnaire	
Has the contractor completed and submitted the Pre-Qualification Safe Work Plan?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A
Has the contractor provided a list of all subcontractors and associated safety compliance documents (i.e. WSIB clearance, certificate of insurance, permits, safe work plan, SDS, etc.)?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A
Has the Contractor (and all their employees) received site orientation (i.e. site contact, hazards present on site, emergency evacuation procedures, designated meeting area, etc.)?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A
Has the Contractor submitted Safety Data Sheets (SDS) for chemicals to be used on-site?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A
Has the Contractor submitted relevant safety permits? (ie. Hot Work, Confined Space, Lock Out Tag Out etc.)	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A
Has the Contractor submitted a traffic control plan, if required?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A
Will Contractor activity obstruct access to or part of the building?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A
Are there any environmental regulations or site-specific requirements that must be followed (e.g., waste disposal, spill control)?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A
Is there a plan in place for handling and disposing of hazardous materials?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A
Has applicable equipment been inspected and certified safe for use (Fall protection, rescue and retrieval equipment, scaffolding, heavy machinery, etc.)	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A

Comments:

Sign-Off:
I acknowledge that I have reviewed all the items outlined above and understand the expectations to comply with the relevant City of Toronto practices, policies, and procedures discussed with all involved parties. While the hazards identified above pertain to the current scope of work, they should not be considered the only potential risks. It is the Supervisor's responsibility to identify and report any additional hazards that may arise during the course of the work and to implement appropriate measures to control them in accordance with the Occupational Health and Safety Act and all other applicable regulations.

Contractor Representative:		Signature:	
Site Representative:		Signature:	

APPENDIX B

Structured Cabling Standard Guide of
City of Toronto
for Commercial Facilities



City of Toronto - Commercial Facilities

Structured Cabling Systems

Design Guide For

Consulting Engineers, Architects, Designers

& Contractors

Revision: 1.0

January 2023

Corporate Services | Network Services

Information Technology

Standards & Procedures

REVISION HISTORY

Version	Version Date	Issued by	Changes in Document	Next Review Date
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SECTION-1: INTRODUCTION

This design guide is to provide consulting engineers, architects and designers working for the City of Toronto (CoT) with a document for the design of commercial facilities (owned, controlled, or leased buildings) communications distribution and structured cabling systems that accurately reflects the City of Toronto (CoT) and industry standards in effect as of this publication. This document shall be referenced to develop project specification and tender documents, specifically extra costs, and Bell standard pricing.

Therefore, it is obligatory for consulting engineers, architects, and designers of telecommunications systems of City of Toronto (CoT) to follow and practice the most updated revision to reflect the methods, materials and standards that have been used for providing telecommunications services to the existing facilities. The updated document also reflects changes in industry practice as of this publication.

In general, it is the responsibility of the building communications distribution designer to coordinate with the other designers on a project (architect, structural, electrical, mechanical, etc.) to ensure that other systems are both compatible with and complementary to the communications cabling system. The City of Toronto (CoT) design philosophy is that it is critical to coordinate between disciplines during the design phase of a project, rather than attempting to make adjustments in the field during construction.

Communications distribution systems designed for the City of Toronto (CoT) commercial facilities are expected to support and integrate voice, data and video communications with common media (fiber optic and unshielded twisted pair copper cable).

DOCUMENT INTENT AND LIFE CYCLE

The purpose of this standard is to define the general guidelines and standards for the design, specification, installation, testing, troubleshooting, documentation and handing over of the commercial facilities (owned, controlled, or leased) communications distribution and structured cabling systems. This standard follows published industry standards and best practices applicable to the commercial buildings of City of Toronto (CoT). The life cycle of this document version is from January to December every year from 2023. Always consult City of Toronto (CoT) Network Services (IT) Division for the latest version of this standard guide.

This document addresses commercial buildings communications distribution and structured cabling system design as it relates to:

- Design guide, topology and methodology
- Communications Media – fibreoptics and copper unshielded twisted pair (UTP)
- Pathway System – cable trays, conduits, etc.
- Products

- Execution (installation)
- Testing and Commissioning
- Handing over (final acceptance)

This document should serve as a guide for making standards compliant project specification which, in due course, will be reflected in a master tender specification document. In addition to specifications for a telecommunications project, plan drawings and schematic diagrams will also need to be produced by the designer. The drawings should conform to the guidelines contained in this document. This document is to be used in conjunction with the latest edition of BICSI TDMM.

Though every attempt is made to cover unforeseen issues, every building and project has its own issues, therefore IT - Network Services and Telecommunication Services should be included right at beginning of the project and the communications specifications must be reviewed and approved by these groups within the City of Toronto (CoT).

TYPES OF CONSTRUCTION

Throughout this document, reference will be made to three types of construction as defined below: new, overbuild and basic construction. These definitions are applicable to the purposes of this document only. A new commercial building communications distribution and structured cabling system as well as the addition to and/or modification of existing cabling system is included in these construction projects. Tradeoffs between design standards and practicality will many times be dependent upon the type of construction. Different design approaches may be warranted for differing types of construction.

A- NEW CONSTRUCTION

New construction is defined as construction that results in a new (or new portion of an existing) commercial buildings communications distribution and structured cabling systems. For the most part, new pathway will be constructed, and new cabling will be installed in the pathway.

B- OVERBUILD CONSTRUCTION

Overbuild construction is defined as construction which may include demolition and/or abandonment of existing pathway and cabling, reuse of existing pathway for installation of new cabling and/or the addition of new pathway and/or cabling to existing pathway and/or cabling. Common terms referring to this type of construction include expansion, renovation, remodel, addition and retrofit, among others.

C- BASIC CONSTRUCTION

Basic construction is defined as construction that includes reuse of existing distribution pathway for the installation of new cabling. Demolition of existing cabling may be involved as well. Basic construction is focused on the installation of new cabling with no (minor) modifications to the existing pathway system.

CITY OF TORONTO AGREEMENT WITH BELL CANADA FOR COMMERCIAL FACILITIES

Effective January 10, 2010, the City of Toronto (CoT) has entered into a multiyear Voice and Data cabling agreement with Bell Canada. Bell Canada is to be used for all Data and Voice cabling for all owned and leased buildings of the City of Toronto.

A pricing table of services regarding this agreement having unit cost is available to share from CoT-IT with the permission to only authorized recipients.

Based on the agreement, current cabling vendor of record (VOR) shall be used. The cabling VOR shall be verified by CoT-IT Network Services at the time of proposed work or RFP.

Analog devices such as fax, POS (dialup), modems and other specialized monitoring lines are using Centrex. The voice cabling system for Centrex will be supplied and installed by Bell as part of an agreement between Bell and the City of Toronto. Bell will have ownership of the voice cabling system.

Please contact CoT-IT-Telecommunications Services, voice infrastructure group for more details.

CITY OF TORONTO TENDER DRAWINGS

This standard guide should be read in conjunction with the City of Toronto (CoT) standard drawings. The drawings shall typically be produced by the consulting engineers / designers and shall consist of (if applicable to the project) the followings but not be limited to:

1. Title Page and Drawing Index
2. Symbols (legends) and Notes General
3. Campus / Building Layout – Fibreoptics Backbone Network Layout (if applicable)
4. Fibreoptics Patch Panel Port Assignment (if applicable)
5. Campus / Building Layout – Voice (copper) Backbone Network Layout (if applicable)
6. Copper Patch Panel / BIX Blocks Port Assignment
7. Building Floor Plan
8. Serving Zone Floor Plan
9. Wireless Heatmap Plan
10. Entrance Facility Layout
11. Equipment Room Layout

12. Telecom Room Layout
13. Building Riser Layout – Horizontal / Backbone
14. Ceiling / Wall / Furniture / Floor Mounted Work Area Outlet Details and Bill of Materials
15. Telecom Enclosure Elevation and Bill of Materials
16. Telecom Enclosure Power Distribution Diagram
17. Telecom Enclosure UPS Panel Layout
18. Entrance Facility Backboard Elevation and Bill of Materials
19. Telecom Pathways (Cable Trays / Conduits) Layout
20. Typical Details of Cable Tray, Conduit / Sleeve, Fire-stopping, Horizontal/Backbone Labeling
21. Telecom Grounding and Bonding Layout (Riser and Floor Plan)
22. HVAC – Mechanical System Layout for Equipment Room / Telecom Room
23. Electrical / Power Layout for Equipment Room / Telecom Room / Work Areas
24. Demolition Drawings (all applicable drawings / layouts – if applicable)

SERVICES NOT PROVIDED BY THE CITY OF TORONTO

- The voice system technology (Bell Centrex etc.) shall be supplied and installed by Bell Canada.
- Entrance Facility and demarcation point shall be outlined in the specific design drawings. Service providers shall terminate the incoming copper cables on BIX and BIX cross-connect between the ISP and the OSP cabling at the Entrance Facility.
- Service providers shall terminate the incoming fibre cables in either wall mount or rack mount fibre enclosures between the ISP and the OSP cabling at the Entrance Facility.
- Witnessing field cable testing at site is NOT CoT's responsibility. The Contractor shall submit the test results to Consultant for their review, validation, witnessing and comment. Consultant shall forward the test results to CoT-IT/Network Services for further review (only if approved by the Consultant after their review). If there is no Consultant on the project, the contractor/cabling installer shall submit the test results to CoT's IT/Network Services for their review.
- BOQs/BOMs, layouts, elevations, drawings and schematics shall be prepared/reviewed by the Consultant.

MANDATORY DESIGNERS' QUALIFICATION REQUIREMENTS

- The standard is to be observed by the City of Toronto - IT Network Services Staff and Consultants involved with the design and implementation of structured cabling systems for data networks which include data networks, security networks, VoIP networks and any other networks that require a structured cabling system that is unified and connected to the City of Toronto network.
- The preparation and review of any network cabling system design, drawings and specification documents shall be conducted by a **Registered Communications Distribution Designer (RCDD)**. The credential holder shall be in good standing who have demonstrated knowledge in the design, integration and implementation of telecommunications and data communications transport systems and related infrastructure.
- All consultant design drawings and specification document shall be sealed / stamped by RCDD.
- All cabling is to be provided from the manufacturers noted with the following sections. Cabling provided by alternate manufacturers is not acceptable.

In addition, the RCDD shall have the following qualifications:

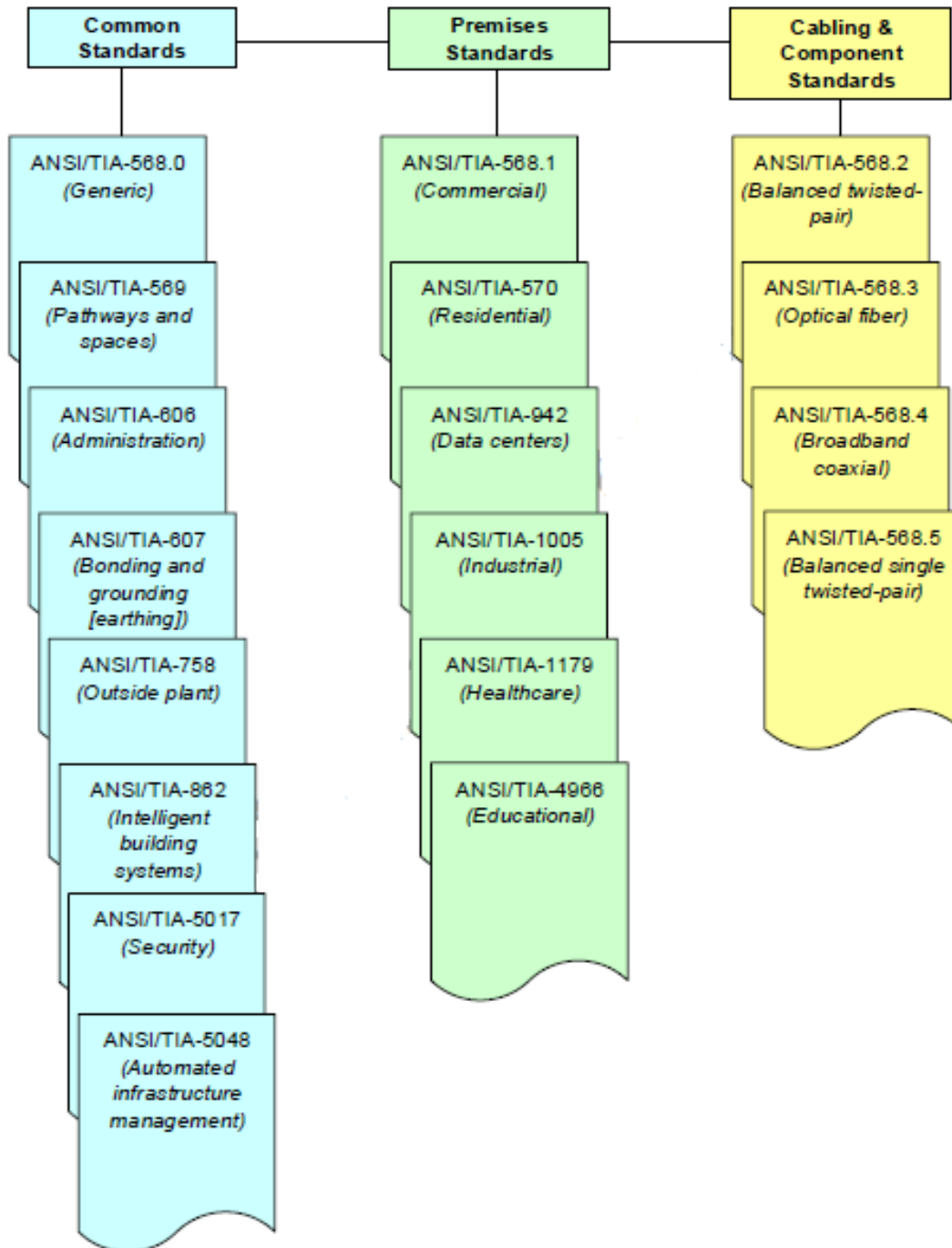
- The RCDD shall demonstrate a minimum of 5 years of experience in the design of commercial buildings communications distribution systems. Experience not directly related to the design and installation of commercial buildings communications distribution systems, such as sales and/or marketing, is not acceptable.
- The RCDD shall demonstrate that he/she has designed or has had personal design oversight of a minimum of five projects similar in size and construction cost to the current CoT project.
- The RCDD consultant must have verifiable design experience with products and solutions from **Belden**.

Before commencing any work for or on behalf of the City of Toronto, the RCDD shall provide a copy of their RCDD certificate showing up to date registration in accordance with the **Building Industry Consultant Services International (BICSI)** policies and guidelines.

MANUFACTURERS

In addition to the standards listed below, the City of Toronto has selected **Belden** as a manufacturer of communications cabling infrastructure products for commercial buildings. The manufacturer is identified in the Product Section. The commercial building communications distribution designer is required to incorporate only this manufacturer into the design and to design a communications distribution structured cabling system that will be suitable for the use of products from the manufacturer.

ANSI/TIA RELATIONSHIP DIAGRAM



Relationships between ANSI/TIA Standard Documents

DESIGN AND REFERENCE STANDARDS

It is required that the designer be thoroughly familiar with the content and intent of these references, standards, and codes and that the designer be capable of applying the content and intent of these references, standards, and codes to all commercial communications system designs executed on behalf of the City of Toronto.

Listed in the table below are references, standards, and codes applicable to commercial communications systems design. If questions arise as to which reference, standard, or code should apply in a given situation, the more stringent shall prevail. As each of these documents is modified over time, the latest edition and addenda to each of these documents is considered to be definitive.

Standard	Title	Date
TIA-568.0-E	Generic telecommunications cabling for customer premises	2020
TIA-568.1-E	Commercial Building Telecommunications Cabling Standard	2020
TIA-568.2-D	Commercial Building Telecommunications Cabling Standard Part 2: Balanced Twisted- Pair Cabling Components	2018
TIA-568.3-E	Optical Fibre Cabling Components Standard	2022
TIA-568.4-E	Broadband Coaxial Cabling and Components Standard	2022
TIA-568.5	Balanced Single Twisted-pair Telecommunications Cabling and Components Standard	2022
TIA 606-D	Administration standard for telecommunications infrastructure	2021
TIA- 607-D	Generic telecommunications bonding and grounding (earthing) for customer premises	2019
TIA-569-E	Telecommunications Pathways and Spaces	2019
TIA-758-B	Customer-Owned Outside Plant Telecommunications Infrastructure Standard	2012
TIA-942-B	Telecommunications Infrastructure Standard for Data Centers	2017
TIA-598-D	Optical Fibre Cabling Coding	2014

Standard	Title	Date
TIA-862-C	Structured Cabling Infrastructure Standard for Intelligent Building Systems	2022
TIA-1152-A	Requirements for field test instruments and measurements for balanced twisted-pair cabling	2016
TIA-1005-A	Telecommunications infrastructure standard for industrial premises	2012
TIA-526-14-C	Optical Power Loss Measurement of Installed Multimode Fiber Cable Plant; Modification of IEC 61280-4-1 edition 2, Fiber-Optic Communications Subsystem Test Procedures- Part 4-1: Installed Cable Plant-Multimode Attenuation Measurement	2015
TIA-526-7-A	Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant, Adoption of IEC 61280-4-2 edition 2: Fibre-Optic Communications Subsystem Test Procedures – Part 4-2: Installed Cable Plant – Single-Mode Attenuation and Optical Return Loss Measurement	2015
TIA-TSB-162-B	Telecommunications Cabling Guidelines for Wireless Access Points	2021
TIA-TSB-184-A	Guidelines for Supporting Power Delivery Over Balanced Twisted-Pair Cabling	2017
TIA-604-10-C	FOCIS 10 Fiber Optic Connector Intermateability Standard- Type LC	2021
BICSI TDMM	Telecommunications Distribution Methods Manual, 14th Edition	2020
ANSI/BICSI 002-2019	Data Center Design and Implementation Best Practices	2019
ANSI/BICSI 007-2020	Information Communication Technology Design and Implementation Practices for Intelligent Buildings and Premises	2020
ANSI/BICSI 008-2018	Wireless Local Area Network (WLAN) Systems Design and Implementation Best Practices	2018

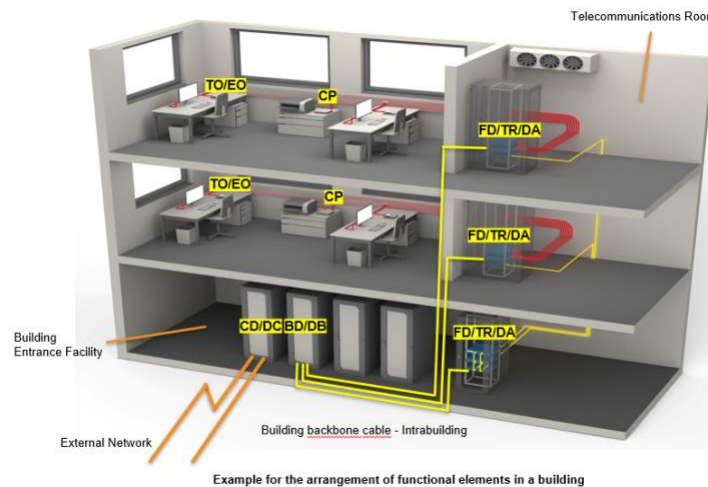
DEVIATION FROM STANDARDS

It is the intent of City of Toronto (CoT) to rigidly impose standards on every aspect of a commercial building communications system design. However, each design is unique and may be subject to situations in which deviations from the standards are warranted.

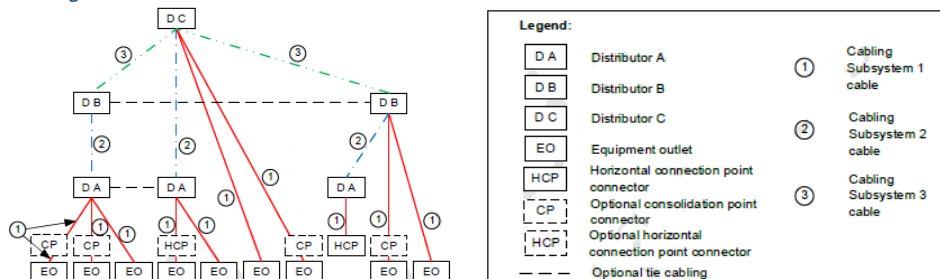
If the designer feels that deviation from a given standard is warranted, the designer shall submit a written deviation request to City of Toronto (CoT-IT). The request will, at a minimum, indicate the standard from which there is a proposed deviation, the substitution being proposed in place of the standard, the reason of the request being made, and an explanation of the justifications (economic, technical or otherwise) for the deviation. The designer may, upon written approval from CoT-IT, incorporate the design deviation into the overall design. The City of Toronto (CoT) approval is required on a project-by-project basis. The designer should not assume that a deviation approval for one project means that the deviation will necessarily be approved for a subsequent project.

GENERIC TOPOLOGY

The figure below is an illustration of a generic cabling topology for Cabling Subsystem 1, Cabling Subsystem 2, Cabling Subsystem 3, Distributor A, Distributor B, Distributor C, an optional consolidation point and the equipment outlet. Elements of Generic Cabling Topology in both Standards are as below:



ANSI/TIA-568.0 Terminologies

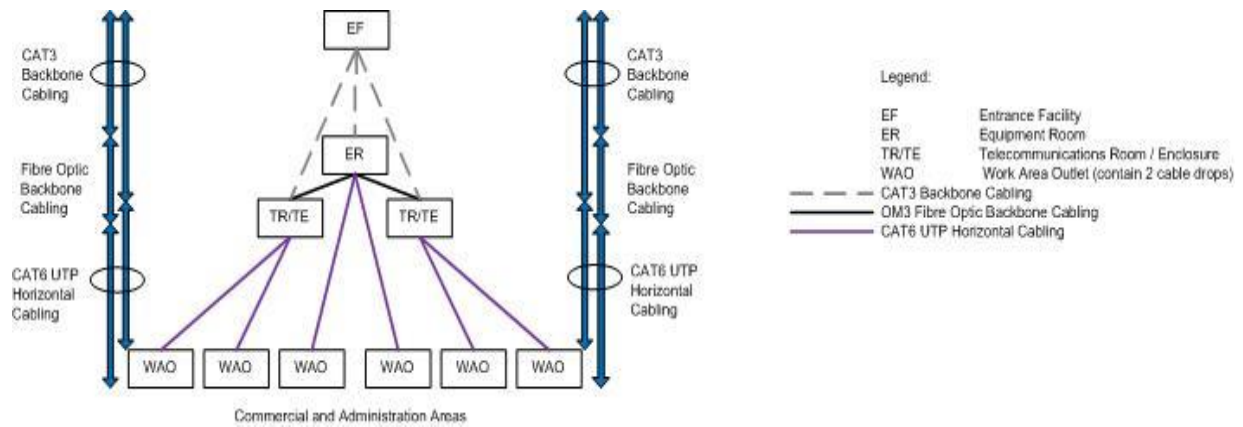


CITY OF TORONTO - STRUCTURED CABLING SYSTEM - DESIGN CONSIDERATIONS

This section highlights design considerations of particular importance to City of Toronto (CoT). It also discusses different CoT construction arrangements (new, overbuild, or basic) for a particular project.

CITY OF TORONTO - COMMERCIAL BUILDING CABLING TOPOLOGY

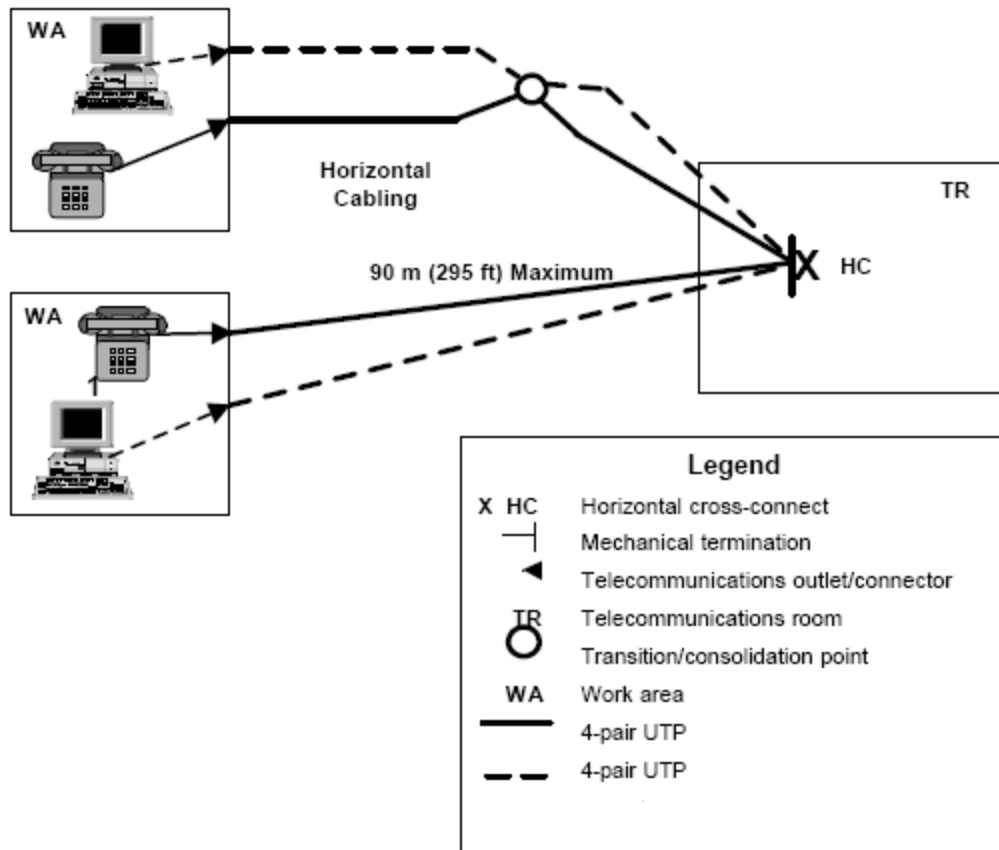
The figure below is an illustration of the City of Toronto commercial building cabling topology. Some of the cabling system such as CAT3/5e backbone, may or may not be applicable to the project.



Elements of the City of Toronto Standard Topology for Commercial Facilities

DESIGN SUMMARY

- The network shall be a distributed star topology network.
- All horizontal copper cables shall connect to the TE/TR from the WAO and fibre backbone cable shall connect to the ER (Server Room) from the TR/TE. The CAT3/5e backbone cabling from the TR/TE to the ER, may or may not be applicable to all the CoT projects.
- The specified copper network cables for all commercial buildings shall be Belden.
- The horizontal copper cable shall be U/UTP Category 6/6A and shall be in accordance to this specification.
- Length of the patch cables from WAO to the end device shall be in compliance to the Ethernet and structured cabling applicable standards.



- The backbone copper multi-pair (minimum 25 pairs) cable shall be U/UTP Category 3/5e and shall be in accordance to this specification. The multipair backbone, may or may not be applicable to all the CoT projects.
- The containment system for the voice and data network shall be as per the specified material mentioned in this document, unless specified otherwise on the design drawings/project scope. The approved conduit system is EMT type, appropriately sized as per TIA-569 standard. The cable tray shall be basket wire mesh type, corrosion resistant, standard sized as per TIA-569.
- The horizontal copper cables shall be permanently terminated at the patch panel in the Telecommunications Enclosure (TE) on one end, to a work-area outlet on the other end located on the walls of a commercial building.
- Horizontal cables in the commercial buildings shall always be collated of two (2) cables per work area outlet (WAO) located on the wall/furniture of the closed office or a cubicle.
- Office cubicles shall contain 1 WAO with 4 ports (1 Voice/VoIP, 1 Data and 2 Blank ports).

- Closed offices shall contain 1 WAO with 4 ports (1 Voice/VoIP, 1 Data and 2 Blank ports), shall be provided to every 10m² (100ft²) of office space (i.e. if the office is 10m² then it shall have 1 WAO). If the office is larger than 10m² (100ft²), then 2 WAOs shall be provided (with 2 Data and 2 Blank ports for the 2nd WAO).
- Each group of horizontal cables shall be associated with a single 4-port, work-area outlet on the wall/furniture and a 4-port, snap-in faceplate in the Telecommunication Enclosure patch panel.
- Approval for additional ports per cubicle or office must be granted by CoT IT/Network Services Technical Representative before proceeding with this work.
- Containment pathways shall be designed and sized for a minimum of four (4) horizontal cables, unless otherwise mentioned differently in the design drawings.
- The Fibre Optic Backbone is defined as the fibre optic segments radiating out from the Network Core Closet to the Telecommunications Enclosure/Room.
- The fibre allocation within the fibre optic backbone cable is as follows:
 - 12 Core fibre backbone: Multimode (OM4) and/or Singlemode (OS2)
 - City of Toronto LAN — 4 fibre strands active (2 primary, 2 redundant and 8 reserved)
 - All fibre cables shall be terminated and tested bi-directionally to the appropriate wavelengths (850/1300nm | 1310/1550nm) using calibrated certified testing equipment
- All passive network components shall be from a single manufacturer (Belden).
- The term "free-issue" refers to equipment supplied by the City. All the Network Switching and Routing Equipment will be freely issued by the City. The network equipment will be configured, tested and installed by City of Toronto IT/Network Services group.

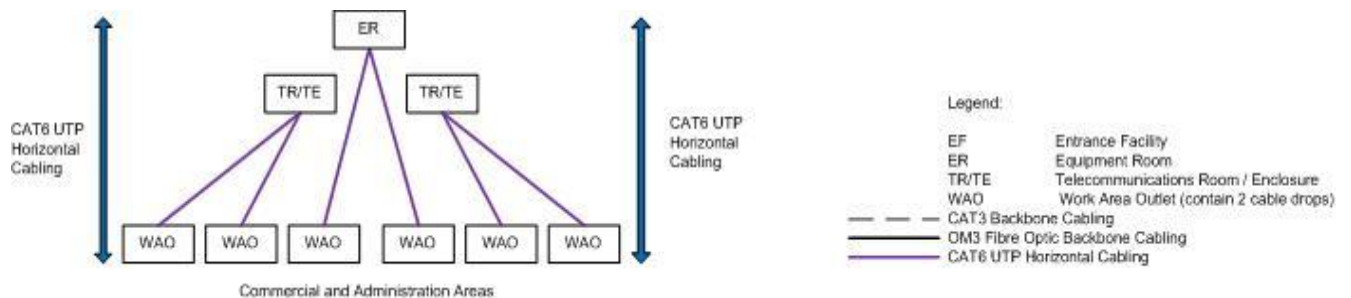
DESIGN DETAILS OF HORIZONTAL CABLING SYSTEM (CABLING SUBSYSTEM – 1)

Horizontal cabling includes installation cable, telecommunications connector/jack/module at the work area outlet (WAO), and mechanical terminations at both ends. Patch cords are required at WAO and TR/TE. Horizontal cabling length limitation requirements as specified in the ANSI/TIA-568.0-E and ANSI/TIA-568.1-E standards apply unless otherwise specified in this Standard.

TOPOLOGY

The horizontal cabling shall meet the star topology requirements of ANSI/TIA-568.0 and ANSI/TIA-568.1. Each telecommunication work area outlet (WAO)/connector/module shall be connected to the

horizontal cross-connect (HC) located at the TE/TR as shown in figure below. The horizontal installation cable shall be terminated on a jack/module (balanced twisted pair) at one or both ends.



Horizontal Cabling Topology

LENGTH

The horizontal cable length extends from the termination of the media on a patch panel at the TE/TR to the telecommunications connector/jack/module at the work area outlet (WAO). For balanced twisted-pair cabling the max permanent link length in the office/administration areas shall be 90m (295ft).

The length of the cross-connect/inter-connect jumper or patch cord at the cross-connect facility, including TE/TR, shall not exceed 5m (16ft) in the office/admin work area and 5m (16ft) in the TE/TR.

RECOGNIZED MEDIA

The recognized media, which shall be used individually or in combination, are:

- Minimum 4-pair 100 ohm balanced twisted-pair cabling, category 6 or higher
- 4-pair 100 ohm balanced twisted-pair cabling, category 6A (as per ANSI/TIA-568.2-D, preferred)

The Recognized media and associated connecting hardware, jumper, patch cord, equipment cord, and work area cord shall meet the requirements specified in this document.

CHOOSING MEDIA

Cabling specified by this Standard is applicable to different requirements within the commercial premises. Depending upon the characteristics of the individual application, choices with respect to transmission media should be made. In making this choice, factors to be considered include:

- Environmental classifications;
- Mitigation such as separation, protection or isolation;

- Cabling performance enhancements in accordance with performance test requirements;
- Applications to be supported by the cabling system;
- Equipment vendor recommendations or specifications;
- Configuration of cabling components;

The recognized cable has individual characteristics that make it suitable for a myriad of applications such as voice, data, video, automation and building controls, security, fire alarm, HVAC and audio visual (AV).

DESIGN DETAILS OF BACKBONE CABLING SYSTEM (CABLING SUBSYSTEM – 2 AND 3)

Backbone cabling is the portion of the commercial building telecommunications cabling system that provides interconnections between Entrance Facility (EF), Equipment Room/Server Room (ER) and Telecommunications Room/Enclosure (TR/TE). Primary and redundant, 12 strands in each cable shall run between the equipment room and the telecom room. Total of 2 x 12 strands shall run with diverse pathways between the equipment and telecom rooms. As such, the backbone cabling shall meet the requirements of ANSI/TIA-568.0, ANSI/TIA-568.2 and ANSI/TIA-568.3 for Cabling Subsystem 2 and Cabling Subsystem 3.

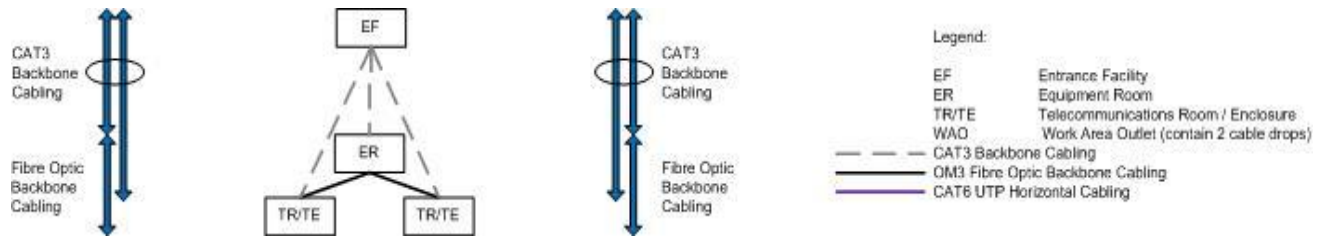
Backbone cabling consists of the multipair copper/fibre cable(s), intermediate and main cross-connect mechanical terminations and patch cords or jumpers used for backbone-to-backbone inter-connection. The cabling should be planned to accommodate future equipment needs, diverse user applications, ongoing maintenance, service changes and relocation.

TOPOLOGY

The backbone cabling shall meet the hierarchical star topology requirements of ANSI/TIA-568.0, unless otherwise specified by this Standard.

There shall be no more than two hierarchical levels of cross-connect in the backbone cabling. From the Horizontal Cross-Connect (HC) or Telecommunications Enclosure/Room (TE/TR), no more than one cross-connect shall be passed through to reach the Main Cross-Connect (MC) or Equipment Room (ER) depending on configuration. Therefore, connections between any two HCs shall pass through three or fewer cross-connect facilities.

NOTE – The topology required by this specification has been selected because of its acceptance and flexibility in meeting a variety of application requirements. The limitation to two levels of cross-connects is imposed to limit signal degradation for passive systems and to simplify moves, adds and changes. This limitation may not be suitable for facilities that have a large number of buildings or those that cover a large geographical area.



Backbone Cabling Topology

COMMERCIAL FACILITIES

The incoming fibre cable from the service provider enters the building Entrance Facility (EF) and spliced to ISP fibre at EF if the distance from the EF to the ER exceeds 15m (50ft). The ISP service provider cable runs from EF and terminates at Equipment Room (ER).

The multipair copper cable (if applicable to the project) for centrex voice runs from the ER/TR/TE to EF.

SMALL COMMERCIAL SITES

In small commercial buildings of City of Toronto, there is no ER. The TE/TR acts as an ER. The incoming fibre cable from the service providers enters the facility and spliced to ISP fibre if the distance from the facility entrance to the TE/TR exceeds 15m (50ft). The ISP service provider cable runs from entrance point and terminates at Telecom Enclosure (TE)/Telecom Room (TR)/Equipment Room (ER).

LENGTH

The backbone cable length extends from the termination of the media at the EF (Entrance Facility) to an IC (Equipment Room) or HC (Telecommunications Enclosure/Room). To minimize cabling distances, it is often advantageous to locate the EF near the center of the premises. Cabling installations may be divided into areas, which can be supported by backbone cabling within the scope of this Standard.

Cabling length is dependent upon the application and upon the specific media chosen (see ANSI/TIA-568.0 and the specific application standard). The backbone length includes the backbone cable, patch cords and cross-connect/inter-connect jumpers.

The length of the cross-connect/interconnect jumpers and patch cords in the EF or IC should not exceed 20m (66ft). The length of the cord used to connect telecommunications equipment directly to the EF or IC should not exceed 30m (98ft). For backbone link length less than 150m (492ft), OM4 multimode fibreoptics cable shall be used. More than 150m (492ft), OS2 singlemode fibreoptics cable shall be used.

BACKBONE RECOGNIZED MEDIA

Recognized cables with associated connecting hardware, jumpers, patch cords, and equipment cords shall meet the requirements specified in this document. The recognized media of backbone shall be:

- For Data, the fibre allocation within the fibre optic backbone cable is as follows:
 - 12 Core fibre backbone: Multimode (OM4) and/or Singlemode (OS2) as per backbone cable link length requirements mentioned above
- For Centrex Voice:
 - CAT3/5e multipair U/UTP cabling (if applicable), 25 pair (or higher pair count)

CHOOSING MEDIA

Backbone cabling specified by this Standard is applicable to a wide range of different user requirements. Depending upon the characteristics of the individual application, choices with respect to transmission media have to be made. In making this choice, factors to be considered include:

- Link length [$\leq 150\text{m}$ (492ft) is OM4 multimode, $> 150\text{m}$ (492ft) is OS2 singlemode]
- Useful life of backbone cabling
- Site size, user population and environmental conditions

Each recognized cable has individual characteristics that make it useful in a variety of situations. A single cable type may not satisfy all user requirements. It is then necessary to use more than one media in the backbone cabling. In those instances, the different media shall support the same facility architecture.

CABLING DIRECTLY BETWEEN TELECOMMUNICATIONS ROOMS / TELECOMMUNICATIONS ENCLOSURES

Cabling directly between HCs (Telecommunication Enclosures/Rooms) is not permitted. All backbone cabling must follow the star topology specified in ANSI/TIA-568.0 by connecting back to the IC (Equipment Room/Server Room).

DESIGN CONSIDERATIONS FOR SPACES, ENCLOSURES AND ROOMS

SPACES

- Spaces in commercial premises shall meet the requirements of ANSI/TIA-569-E.
- Spaces shall comply with local codes and regulations.

- Spaces should be designed to be compatible with the worst-case environment to which they will be exposed (see ANSI/TIA-568.0 and TIA/TSB-185 for information on environmental classifications).
- Temperature and humidity shall meet the requirements for Class 4 as per ANSI/TIA-569-E, unless stated otherwise.
- Perform additions and modifications to the existing Local Area Network as shown on the Contract Drawings.

DESIGN GUIDE OF EQUIPMENT ROOM / NETWORK / SERVER ROOM (ER)

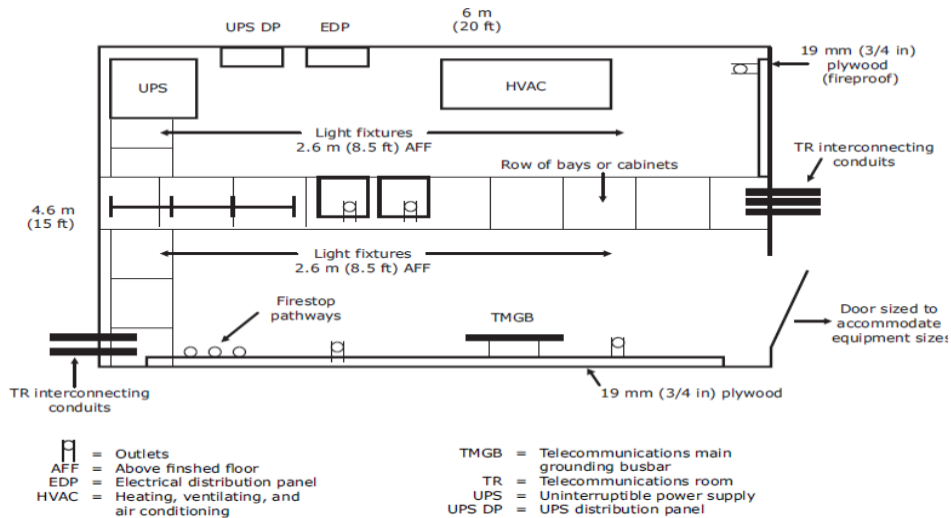
- If designing ER, consult this standard as a reference guide for Equipment Room (ER). Follow architectural/engineering drawings and project specifications as a design guide.
- The ER shall be strategically located to minimize the size and length of the backbone, especially in multiple-backbone situations.
- The ER shall accommodate the delivery of large equipment.
- The doors and hallways shall be sized appropriately for the movement of large equipment.
- Elevator or hoist and loading docks shall be available for large equipment movement.
- The weight capacity of the floors must be rated for large equipment.
- Any potential difficulties in scheduling and use of access routes and facilities for moving large equipment during installation and future changes shall be considered.
- Present and future needs shall be considered in properly locating and designing the ER.
- The ER telecommunications infrastructure shall be sized as required and capable of supporting a broad range of telecommunications applications required by the building or campus.
- Infrastructure shall be present for a large volume of cable between main distribution equipment and server racks.
- The ER telecommunications infrastructure shall be capable of supporting existing telecommunications equipment and/or cabling.
- The length of electrical power feeds from the electrical service entrance to the ER shall be minimized to aid in an optimal bonding and grounding arrangement.
- Access Card Reader should be added to access ER. Refer to CoT CORP SEC Standard for ACR/Sys.

- The distance (no closer than 3m [10ft]) to potential EMI and RFI sources shall be considered. These include transformers, motors, generators, radio transmitters, induction heating devices, photocopier, arc welding equipment, etc.
- The ER shall not be located in any place that may be subject to:
 - Water infiltration
 - Steam infiltration
 - Humidity from nearby water or steam
 - Heat (e.g. direct sunlight)
 - Corrosive atmospheric or adverse environmental conditions
 - Locations below water level unless infiltration preventive measures are employed.
- The ER shall not be located in any space in or adjacent to:
 - Mechanical rooms
 - Washrooms
 - Custodial closets
 - Storage rooms
 - Loading docks
 - Any area that contains sources of excessive EMI, hydraulic equipment, heavy vibration, steam pipes, plumbing, and cleanouts
- The ER must provide space for all planned equipment and access to all equipment for maintenance, administration and growth.
- The ER must meet the space requirements specified by equipment providers. Space and layout requirements for different telecommunications applications (e.g. voice, data) must be taken into account.
- For voice and data, provide 0.07m² (0.75ft²) of ER space for every 10m² (100ft²) of usable work area space.
- The minimum ER size shall be based on the known number of work areas as shown on the table below and not on usable floor area:

Equipment outlets served	Minimum floor space m ² (ft ²)	Typical dimensions m (ft)
Up to 100	9 (100)	3 X 3 (10 X 10)
101 to 200	13.5 (150)	3 X 4.5 (10 X 15)
201 to 800	36 (400)	6 X 6 (20 X 20)
801 to 1600	72 (800)	6 X 12 (20 X 40)
1601 to 2400	108 (1200)	9 X 12 (30 X 40)

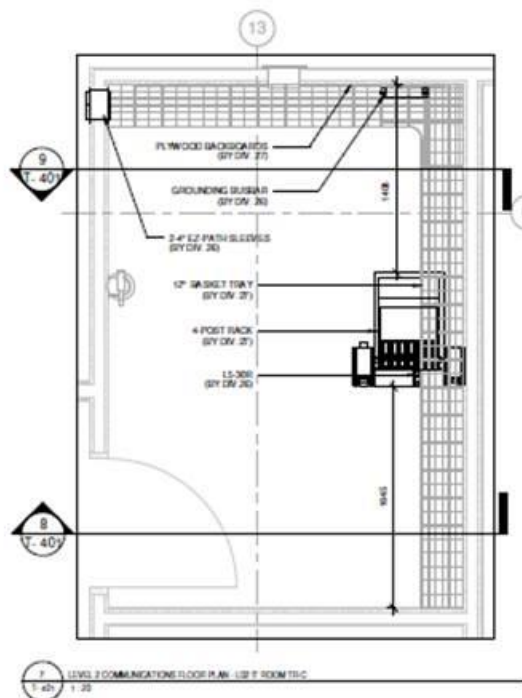
- The guidelines for other support equipment, such as power distribution, conditioner systems, and UPS up to 100kVA shall be permitted in the ER. UPS larger than 100kVA should be located in a separate room.
- The ER layout and floor plan shall comply with TIA-568, TIA-569 and BICSI TDMM latest edition.
- A minimum ER space of 3m (10ft) by 4.5m (15ft) shall be allocated.
- The ER shall include adequate space to support equipment changes with minimal disruption. Sizing shall include projected future as well as present requirements.
- Equipment not related to the support of the ER (e.g. piping, ductwork, pneumatic tubing, etc.) shall not be installed within, pass through, or enter the ER.

Typical equipment room layout



- The ER shall include space for environmental control equipment, power distribution/conditioners, and uninterruptible power supply (UPS) systems that may be installed.
- The ER shall be designed and comply with the City of Toronto (CoT) Security requirements.

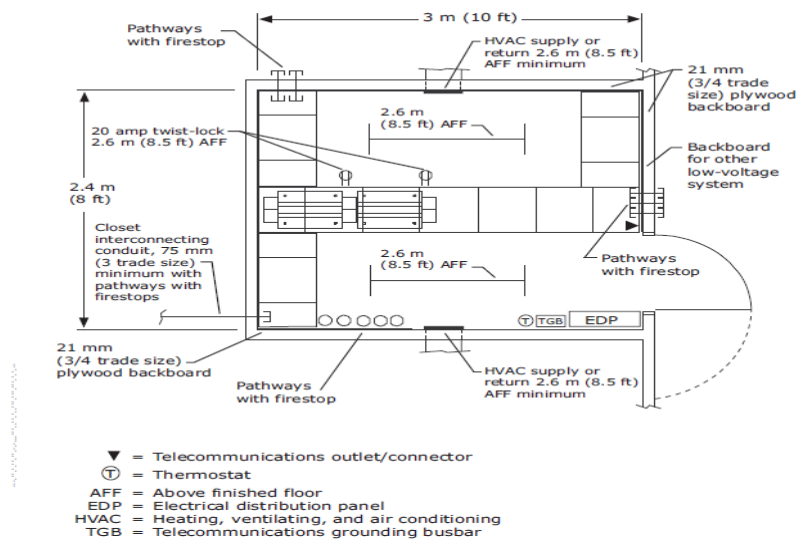
- The ER shall include barriers to protect sensitive network equipment from dust including door seals and air filtration.
- The ER shall include equipment and systems (grounding straps) to protect sensitive network equipment from static electricity.
- The ER shall be designed to comply with local zoning requirements for earthquakes and other natural disasters.
- The ER shall be designed to comply with NFPA-75 and include a pre-action fire protection system and hand-held fire extinguishers.
- The ER shall be designed for flood prevention and include a minimum of one floor drain for every 100m² (1075.84ft²).
- The ER shall attenuate ambient room noise to acceptable Acoustic Noise level limits in accordance with applicable standards.
- There shall be no attachment of pull boxes or any type of panel/enclosure onto the surface of the Telecom Enclosure/Cabinet/Rack. It is strictly prohibited and shall not be allowed in any circumstances to have a box or enclosure attached/fixed on the surface of a Telecom Enclosure/Cabinet/Rack.

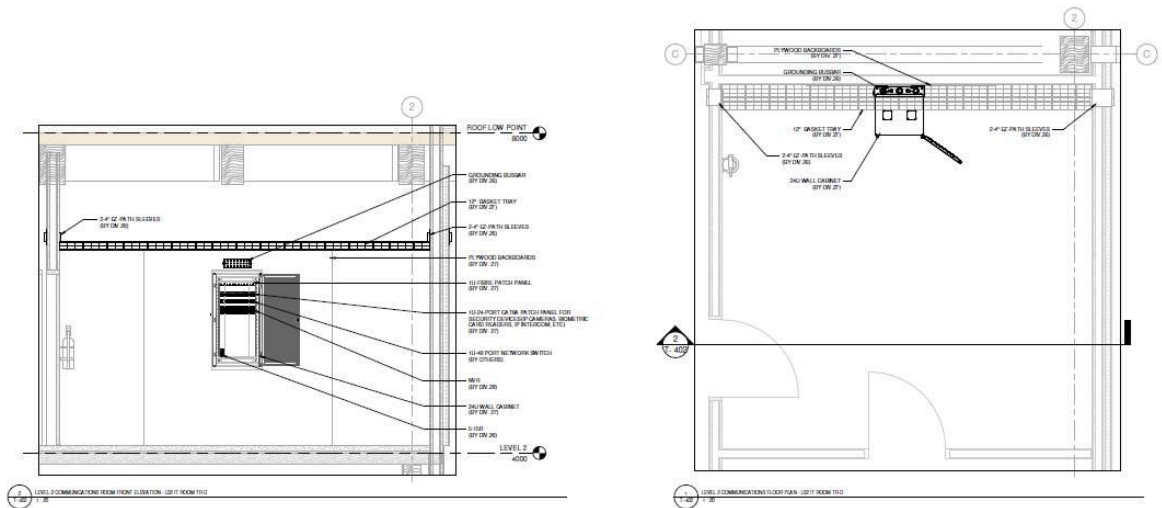


DESIGN GUIDE OF TELECOMMUNICATIONS ROOM (TR)

- If designing TR, consult this standard as a reference guide for Telecommunications Room (TR). Follow architectural/engineering drawings and project specifications as a design guide.
- A properly designed TR includes an HC (FD) that provides a floor-serving distribution facility for horizontal cabling. This cross-connect is capable of providing horizontal cabling connections to floor-serving telecommunications equipment and backbone cables from other TRs|TEs|ERs|EFs.
- Access Card Reader should be added to access ER. Refer to CoT CORP SEC Standard for ACR/Sys.
- The TR should be provisioned to house telecommunications equipment. In some cases, it may be necessary to combine the building and floor-serving functions of the ER and TR in one room. Instances where the two may be combined include smaller buildings (i.e., less than 500 m² [5400 ft²]) and those with limited space for distribution facilities.
- There must be at least one TR per floor. Multiple rooms are required if the cable length between the HC (FD) and the telecommunications outlet location, including slack, exceeds 90m (295ft) or if the usable floor space to be served exceeds 929m² (10,000ft²). For TRs that serve areas with an office density of less than one work area per 9.3m² (100ft²) of usable floor space, a TR may serve larger areas, provided the horizontal cable length requirements are met.
- Figure below shows a typical layout of a full-size TR, suitable for a maximum of 480, 4 twisted-pair cable terminations. The drawing illustrates architectural, mechanical, electrical, and telecommunications requirements on a single plan view perspective for purposes of showing coordination issues. Actual design documents will typically separate requirements by discipline.

Typical telecommunications room layout

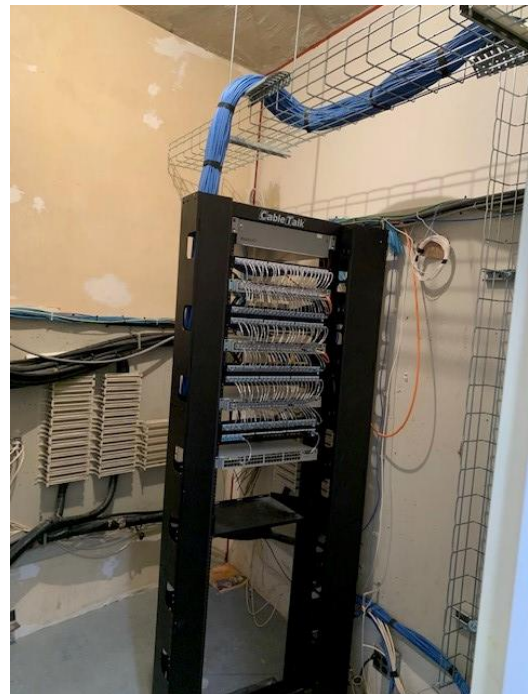
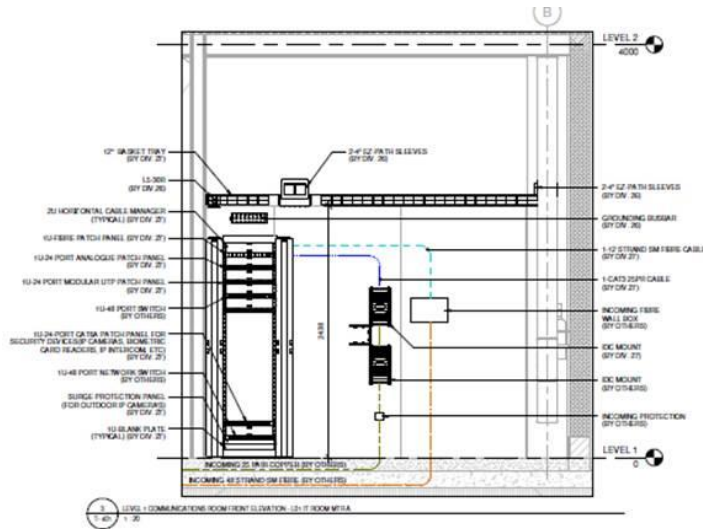




ENTRANCE FACILITY REQUIREMENTS (EF) | SHARED LAN/NETWORK ROOMS

- If designing EF, follow architectural/engineering drawings and project specifications as a design guide.
- Where functions of an entrance facility (EF) are combined with functions of the ER in the same space, the ER may house equipment dedicated to the Access Provider (AP). Requirements specified by the AP must be considered.

- As per ANSI/TIA-569-E, in shared LAN/Network Rooms between CoT-IT and other Agency/Third Party, individual spaces should be segregated by means of partitions using full size lockable cabinets or collocate cabinets. In extreme conditions, partitions may be comprised of cages, architectural assemblies or wire mesh walls.
- Where access providers and service providers share space (shared LAN/Network Rooms), individual spaces should be segregated by means of partitions. Partitions may be comprised of wire mesh walls or architectural assemblies.
- If separate AP space is required, it shall be adjacent to the EF. The design may require a mesh partition or locked cabinet. Space size at least 1.2m x 1.83m (4ft x 6ft) should be allocated for each AP.

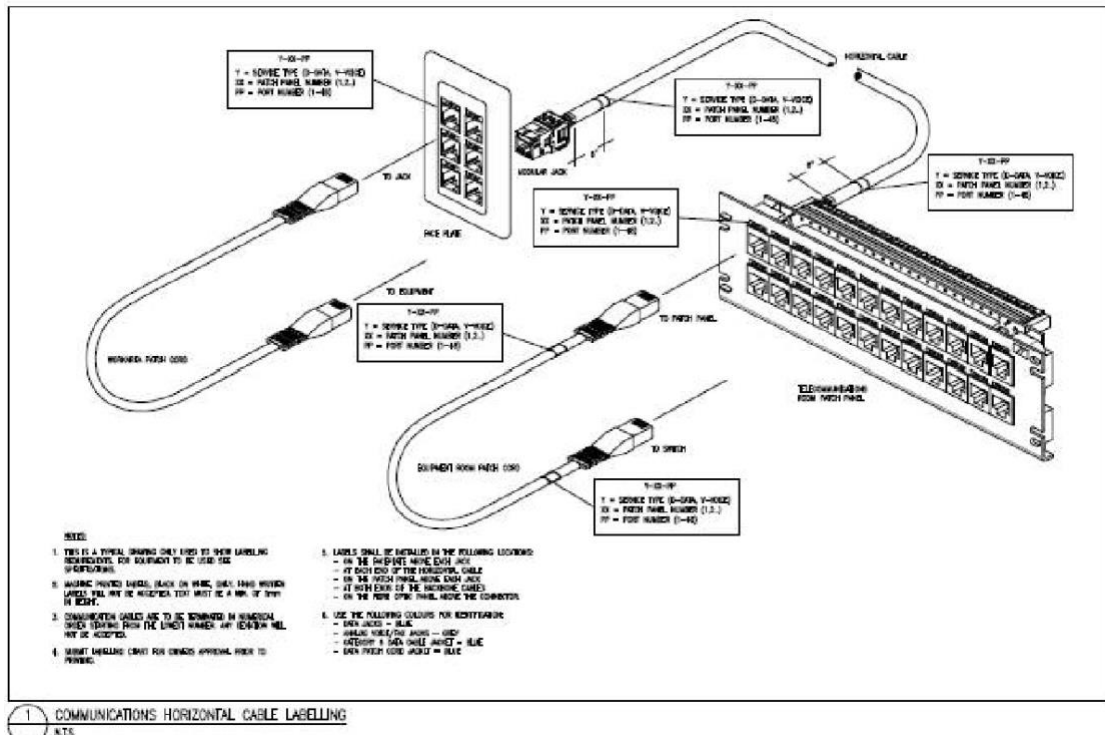


WORK AREA OUTLET (WAO)

- The work area outlet (WAO) components extend from the telecommunications outlet/connector end of the horizontal cabling system to the work area equipment. The telecommunications outlet/connector shall meet the requirements of this Standard. To simplify relocations, consider a single style of outlet/connector for all work area outlets of the same media type.

WORK AREA OUTLET (WAO) FOR OFFICE AREAS

- Provide one 4-ports, single-gang, work area outlet in each work area for termination of the horizontal CAT6/6A cables. Faceplate or decora module frame shall be from Belden.
- One 4-port, work-area outlet shall be associated with as many ports necessary (in groups of 2 or 4) on the snap-in faceplate installed in the patch panel of the Telecommunication Enclosure.
- In the majority of cases the 4-port, work-area outlet shall be installed within the cubical partitions. In some situations, the work-area outlet shall be installed directly on the wall in office areas.
- All UTP connectors in the office area shall be unshielded modular jacks and wired for a T586A wire-map.



U/UTP PATCH CORD FOR WAO IN OFFICE AREAS

- Patch cords used in the WAO shall meet the requirements of ANSI/TIA-568.2. WAO cabling may vary in form depending on the application. When application-specific adaptations are needed at the WAO, it shall be external to the telecommunications outlet/connector.
- Supply two (2) 5-metres or less, CAT6/6A U/UTP patch cords for each work area outlet.
- The contractor is responsible for certifying that the supplied patch cords shall meet or exceed the requirements for U/UTP patch cords as described in the ANSI/TIA-568.0 standard.

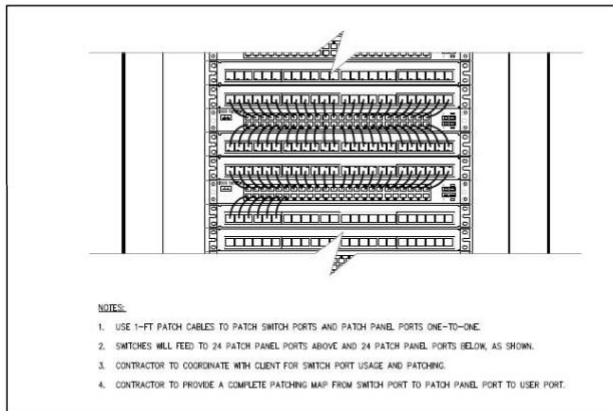
WORK AREA OUTLET (WAO) FOR WIRELESS ACCESS POINT (WAP)

- Provide one (1) 4-port, single-gang, work-area outlet, connectors and accessories for termination of the horizontal UTP cables (2 for each WAP) dedicated for Wireless Access Point (WAP). Where ever, it is possible to connect to the closest TR, additional and separate WAO may not be required.
- CAT6/6A modular jacks shall populate two (2) modules/jacks in a 4-port WAO for each WAP.
- Each 4-port, work-area cable outlet shall be associated with a 4-port, snap-in faceplate installed in the Telecommunication Enclosure patch panel.

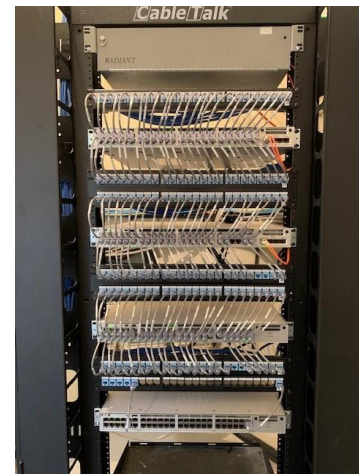
- WAP Heatmaps are required for accurate location of WAOs. Sample heatmaps are in Appx-C.

UTP PATCH CORD FOR TE/TR/ER

- Supply minimum of 0.5 metre (2ft) CAT6/6A U/UTP patch cord for each data/VoIP drop (jack/module) to patch at TE/TR/ER.



03 PATCHING DETAIL
T-04 N.T.S.



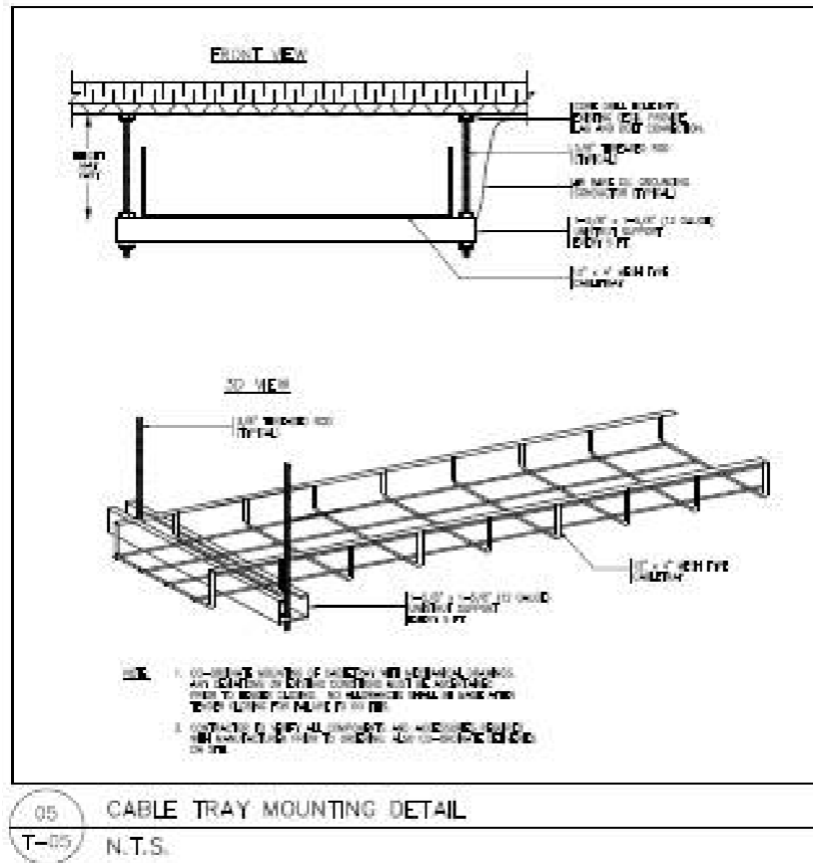
DESIGN CONSIDERATION OF PATHWAYS AND CONTAINMENT SYSTEM

- Pathways in commercial premises shall meet the requirements of latest ANSI/TIA-569 standard.
- Pathways should be designed to be compatible with the worst-case environment to which they will be exposed (see ANSI/TIA-568.0 for information on environmental classifications).
- Pathways in commercial premises shall comply with local codes and regulations.

DESIGN GUIDE OF CABLE TRAY SYSTEM

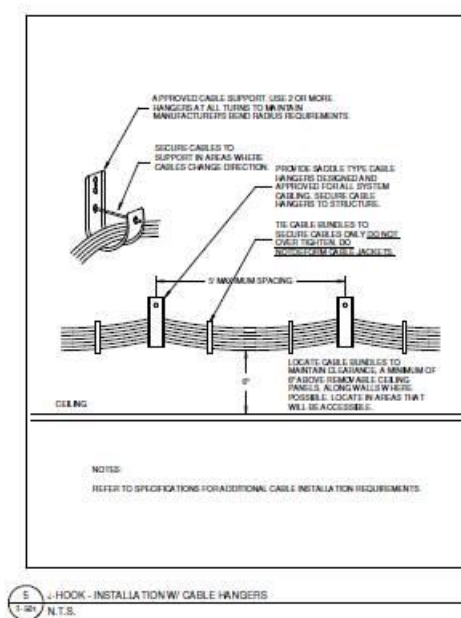
- All cable trays shall be either a ventilated trough, wire-mesh or ladder-rack type, pre-fabricated structure 300mm (12 inches) in width or greater.
- Ventilating trays shall be equipped with two side rails with a maximum height of 150mm (6 inches) and consisting of a light, rugged and tubular steel or aluminum construction.
- Should aluminum trays be specified (CoT approval is mandatory), the engineer is to ensure that, during the grounding or bonding aspects of the installation, the contractor uses tin plated or zinc coated ground connectors.

- Install the ventilated cable tray in the horizontal cable distribution system such as hallways and under floor.
- A cable ladder rack system is to be installed within the Equipment/Server Room (ER) and Telecom Rooms (TR). Refer to the project specifications/drawings or reference in this document for the type of ladder rack to be used in the horizontal cable distribution system and within the applicable ER/TR's. Spine type and improperly centre hung cable trays will not be accepted.
- All metal cable trays shall be bonded together to the TMGB/PBB or a TGB/SBB.
- All metal cable trays shall be coated to prevent rust or galvanic action.
- Accessories and fittings such as elbows and reducers shall be manufactured by the cable tray manufacturer.
- Install cable trays at least 300mm (12in) away from fluorescent luminaries and cross power cables at right angles.
- The minimum clearances for cable trays shall be in accordance with Canadian Electrical Code C22.1-09.
- Allow 300mm (12in) vertical clearance excluding the depth of cable trays, between cable trays installed in tiers.
- 300mm (12in) vertical clearance from the top of cable trays to all ceilings, heating ducts and heating equipment.
- 600mm (24in) horizontal clearance on one side of cable tray mounted adjacent to one another or to walls or other obstructions.
- All cable trays/ladders shall be labeled at regular intervals. The distance separating labels shall not exceed 15 metres (50ft).
- The design fill ratio of a cable tray is 25% to a maximum fill ratio of 50% as per ANSI/TIA-569 standard.



DESIGN GUIDE OF CONDUIT SYSTEM

- All telecommunications cables shall be installed in home run EMT conduits originating from the outlet to the cable tray system, Telecommunications Enclosure, or Telecommunications Room. The use of J-hooks, brackets and other attachments are not preferred but acceptable. Only Velcro ties are allowed. Plastic cable ties are not allowed in any condition.



- The inside radius of a bend in a conduit shall be not less than six times the internal diameter when the conduit is less than 50mm (2in) in diameter and ten times the internal diameter when conduit is 50mm (2in) in diameter or larger.
- All zone conduits shall be identified and labeled at both ends and at regular intervals not to exceed 10 metres (32.8ft). Tags shall identify start and finish of conduit runs. Pull boxes shall be labeled on the exposed exterior.
- All conduits shall originate and be physically connected to the telecom backboards in the Equipment Room, Telecommunications Room, cable tray and pull box.
- All metallic parts of the cable distribution supporting system shall be bonded together mechanically inclusive of all transition points (i.e. cable tray and distribution conduit not mechanically connected) using a 6 AWG green jacketed stranded copper ground wire. The metallic components of the cable distribution system shall be bonded together at the ER and TRs and then bonded to their respective telecom ground busbars.
- All fittings, connectors and couplings shall be of the same material as the conduit used on site.
- All conduits/sleeves that enter the ER or any TR shall be fitted with an approved ground bushing with ground lug and bonded together mechanically (one continuous piece preferred). This shall be connected to the approved building ground by means of a No. 6 AWG to the grounding busbar.

- Cable fill capacities of conduit shall not be greater than 40%.
- All conduits entering or existing through the ceiling or walls of the ER or TR shall protrude into the room 25-50mm (1-2in).
- Riser sleeves in the Equipment Room/Server Room and Telecommunication Rooms shall protrude through the floor 50-75mm (2-3in) above finished floor (AFF).
- All conduit runs shall follow building grid lines and shall be concealed where possible.
- All conduits shall be EMT, reamed and bushed at both ends and bonded to the distribution system unless installed in areas deemed chemically hazardous in which cases PVC coated or Aluminum conduit shall be used. Approval from the City of Toronto is required in such instances.
- All conduit runs shall be a maximum of 30 meters (100ft) in length with a maximum of two 90 degree bends between pull points, unless otherwise specified.
- Conduits ending in the vicinity of a cable tray shall be terminated at a height of no less than 100mm (4in) and no more than 150mm (6in) from the top of the cable tray. Conduit runs shall not be punched through the side of the tray. Conduit ends shall be bonded to the cable tray.
- The use of LB, LL, LR, C and T type fittings are not permitted. Only LBs designed and manufactured for communications systems are allowed where applicable.
- Conduit fittings shall not be used in place of pull boxes or bends.

DESIGN GUIDE OF PULL BOX

- 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 (100ft), or if there is a reverse bend in the run.
- Pull boxes shall be constructed and sized in accordance with Canadian Electrical Code, TIA and BICSI standards of code gauge steel and shall have a rust resistant finish.
- In all instances pull boxes shall be placed in straight sections of 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 shall not be used in place of pull boxes or bends.
- Conduit must enter the outlet boxes from the top or bottom.
- Pull boxes shall be installed at a reasonable height, in an exposed location and such that access for installation of cables is not prohibited. Pull boxes shall not be placed in a fixed false ceiling

space, unless immediately above a suitably marked and hinged access panel. Provide indicator decals on ceiling T-bar rail or ceiling tiles showing location of pull box or splice box.

- All conduits shall be installed in accordance with Canadian Electrical Code, Part 1 Section 12, applicable building codes and ANSI/TIA 569.
- The minimum size (inside diameter) for conduit running between the Equipment Room or a Telecommunications Room and the Telecommunications outlet at an outlet location is 25mm (1in).
- The maximum horizontal cable run distance shall not exceed 90 metres (295ft).
- The cable length from the mechanical termination in the TR and ER to the telecommunications outlet, where the horizontal distance exceeds 90m (295') provided additional rooms as required.
- Future requirements for additional cables to each outlet shall be considered.
- A pull cord shall be installed in all conduits.
- The telecommunications outlet conduit system shall be labeled green.
- Place pull boxes in readily accessible locations only.
- The use of LB, LL, LR, C and T type fittings are not permitted. Only LBs designed and manufactured for communications systems are allowed where applicable.
- There shall be no attachment of pull boxes or any type of panel/enclosure onto the surface of the Telecom Enclosure/Cabinet/Rack. It is strictly prohibited and shall not be allowed in any circumstances to have a box or enclosure attached/fixed on the surface of a Telecom Enclosure/Cabinet/Rack.

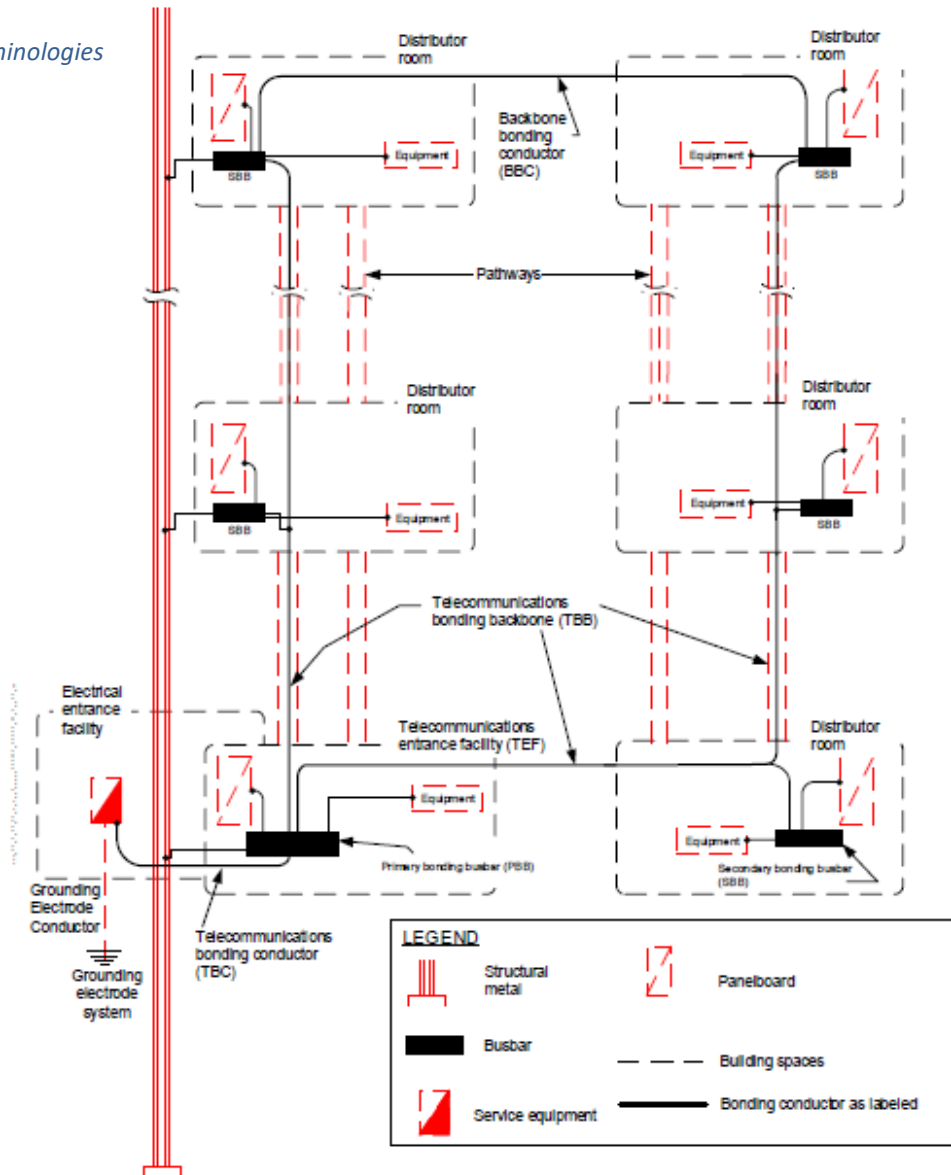
DESIGN GUIDE OF TELECOMMUNICATIONS BONDING AND GROUNDING SYSTEM

In general, a telecommunications grounding system contains the following components:

- Primary Bonding Busbar (PBB) or Telecommunications Main Grounding Busbar (TMGB)
- Telecommunications Bonding Backbone (TBB)
- Secondary Bonding Busbar (SBB) or Telecommunications Grounding Busbar (TGB)
- Telecommunications Bonding Conductor (TBC)

- The Telecommunications Bonding Backbone (TBB) consists of green jacketed stranded copper conductors and insulated copper busbars. The system extends from the Building Grounding Electrode Conductor through the ER to the TR’s, within the building. The construction of the TBB is a requirement of the latest version of the ANSI/TIA-607. This standard shall be used in the design, installation, management and administration of the TBB systems in CoT facilities.

TIA--607-Terminologies



- All metallic parts shall be bonded together mechanically and attached to the approved building ground in accordance with applicable CEC, TIA and CSA standards. In all cases, the CEC shall be met or exceeded.

- Bonding conductors shall be continuous and routed in the shortest possible straight-line path. Any bends placed in the conductor shall be sweeping bends.
- Aluminium wires, clamps or terminal connectors are not acceptable for grounding and bonding.
- The following general requirements shall apply when constructing the TBB system:
 - An insulated pre-drilled, electro tin plated copper busbar, minimum dimensions of 6mm thick x 100mm wide and variable in length, shall be installed on the wall of the ER/EF adjacent to the cable entrance conduits, 150mm from the corner of the ER/EF and 150mm AFF. This busbar is known as the Primary Bonding Busbar (PBB) or Telecommunications Main Grounding Busbar (TMGB) and shall be insulated from its support by a minimum of 50mm.
 - An insulated pre-drilled, electro tin plated copper busbar, minimum dimensions of 6mm thick x 50mm wide and variable in length shall be installed on the wall of each TR (formally known as a Telecom Closet - TC), adjacent to the cable entrance sleeves, 150mm from the corner of the TR and 300mm AFF. These busbars are known as the Secondary Bonding Busbar (SBB) or Telecommunications Grounding Busbars (TGBs) and shall be insulated from its support by a minimum of 50mm.
 - A green jacketed stranded copper ground wire sized to maintain a voltage drop of less than 40 Volts under maximum short time rating. This wire shall be sized no smaller than No. 6 AWG nor larger than a 3/0 and shall be installed from the service equipment ground (main building ground) to the PBB/TMGB in the ER/EF. This ground wire is known as the Telecommunications Bonding Conductor (TBC). The Telecommunications Bonding Conductor (TBC) may be secured to the surface of the building if not subject to physical and mechanical damage, or installed in non-ferrous conduit. If ferrous conduit, such as EMT is used, the conductors shall be bonded to each end of the conduit with a conductor minimum sized as a No. 6 AWG green jacketed stranded copper ground wire.
 - The TBC shall be connected to the Primary Bonding Busbar (PBB)/Telecommunications Main Grounding Busbar (TMGB). The connection to the PBB/TMGB shall be done using a 2-hole electro tin plated compression lug. All joints to the TBC shall be done using irreversible compression-type connectors, exothermic welding, or equivalent.
 - The Telecommunications Bonding Conductor (TBC) shall be connected to the service equipment ground (main building ground) by qualified personnel and in accordance with the CEC and ANSI/TIA-607.
 - A green jacketed stranded copper ground wire sized the same as the Bonding Conductor for Telecommunications, shall be installed from the farthest TR, through each TR to the

Bonding Conductor for Telecommunications located in the ER/EF. This ground wire is known as the Telecommunications Bonding Backbone (TBB). The TBB may be fastened to the underside of open cable tray or installed in non-ferrous conduit. If ferrous conduit, such as EMT is used, the conductors shall be bonded to each end of the conduit with a conductor sized as a No. 6 AWG minimum.

- The TBB in each TR shall be connected to the SBB/TGB. All joints to the grounding wires shall be done using irreversible compression-type connectors, exothermic welding, or equivalent. The connection to the SBB/TGB shall be done using 2-hole compression connectors.
- The PBB/TMGB in the ER/EF and the SBB/TGB in the TR/TE(s) shall be bonded to the closest electrical panel using a No. 6 AWG green jacketed stranded copper ground wire.
- The metallic components of the horizontal distribution supporting infrastructure (conduits, cable trays and ducts) shall be bonded to the to the telecommunications busbars of the ER/EF or TR/TE in which they originate using a No. 6 AWG green jacketed stranded copper ground wire.
- A No. 6 AWG green-jacketed stranded copper ground wire shall be installed from each telecommunications busbar to the metal frame (structural steel) of buildings that are effectively grounded and whose structural steel is accessible.

SEPARATIONS FROM EMI

- Copper cables shall not be installed at a distance less than 300mm from lighting ballasts, less than 1 meter from electric motors or at a separation distance from source of 480V or less.
- Where electric power cable is not installed in EMT conduit, telecommunications cable shall not be run in parallel with it for more than 10 meters if the separation is less than 300mm.
- Electrical protection must be provided for copper cables entering the building. Protection shall be in accordance with the Canadian Electrical Code CSA C22.1-2006 and BICSI practices.

DESIGN GUIDE OF TAGGING CONVENTION (IDENTIFICATION AND LABELING)

- The requirements of this section shall take precedence over other sections.
- The labeling of the City of Toronto network components, structured cabling and cable routing/containment shall comply with the ANSI/TIA-606 standard

- The codification of network components, cables and cable routing shall follow the identification standards detailed in this standard.
- For example:
 - Building Location: YDE – 30 Dee Ave
 - Floor and Room Location: ER – Equipment Room / Server Room / Main Communications Room
 - TRA – Telecom Room - A
 - TRB – Telecom Room – B
 - EF - Entrance Facility
 - Service Provider / Network Cabinet Label in ER: COT-IT-YDE-0100
Network Closet
 - Network Cabinet Label in ER: COT-IT-YDE-0200
Network Closet
 - Server Cabinet Label in ER: COT-IT-YDE-0300
Server Closet
 - Patch Panel:
 - A – Data Patch Panel A (A,B,C, etc ...)
 - FP01 – Fibre Optic Patch Panel
 - TP01 – Telephone/Voice Patch Panel
 - Patch Panel Port: 01 – Patch Panel Port (01, 02, 03, ..., 24)
 - Work Area Number: 125 – Work Area number associated in the admin/office areas of the facility
 - Work Area Outlet:
 - WA01 – Work area outlet (01, 02, 03, etc...)
 - 1 – Port number (1, 2, 3, 4)

EQUIPMENT / NETWORK / SERVER ROOM CABINETS IDENTIFICATION AND LABELING

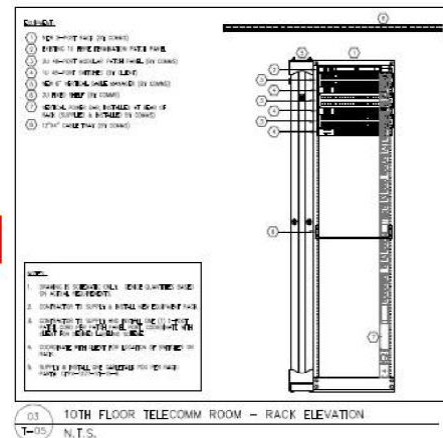
- Equipment Room/Server Room network enclosure contains active network components, including: Network Core Closet, Server Closet and Telecommunications Enclosure.
- All Network Closets/Cabinets related to the Equipment Room (ER) shall be tagged as follows.

- COT-IT-XYZ-XX00, where:
 - XYZ = Site three-character code name
 - XX00 = First two numbers (XX) identify the closet
- For all closets/enclosures/cabinets in the Equipment Room, the last two numbers are always zero (00).
- For Closets/Cabinets in the Equipment Room, they are numbered from (0100) to (1000).
- Network Core Closet and Server Closet nameplate shall conform as follows:
 - Provide nameplate for each enclosure on the bottom-center of the door, front and back.
 - Use engraved gravoply laminate nameplates using black letters on a white background.
 - The laminate nameplates shall have a dimension of 210mm W x 50mm H.
 - Minimum character height shall be 12mm. Character lettering shall be centered on each line.
 - Mount nameplates with two stainless steel machine screws.
 - Include device identification (tag) number as well as a descriptive name.
 - For example: the tag name: COT-IT-XYZ-0100 followed by the description: Sample nameplate diagram is as below:



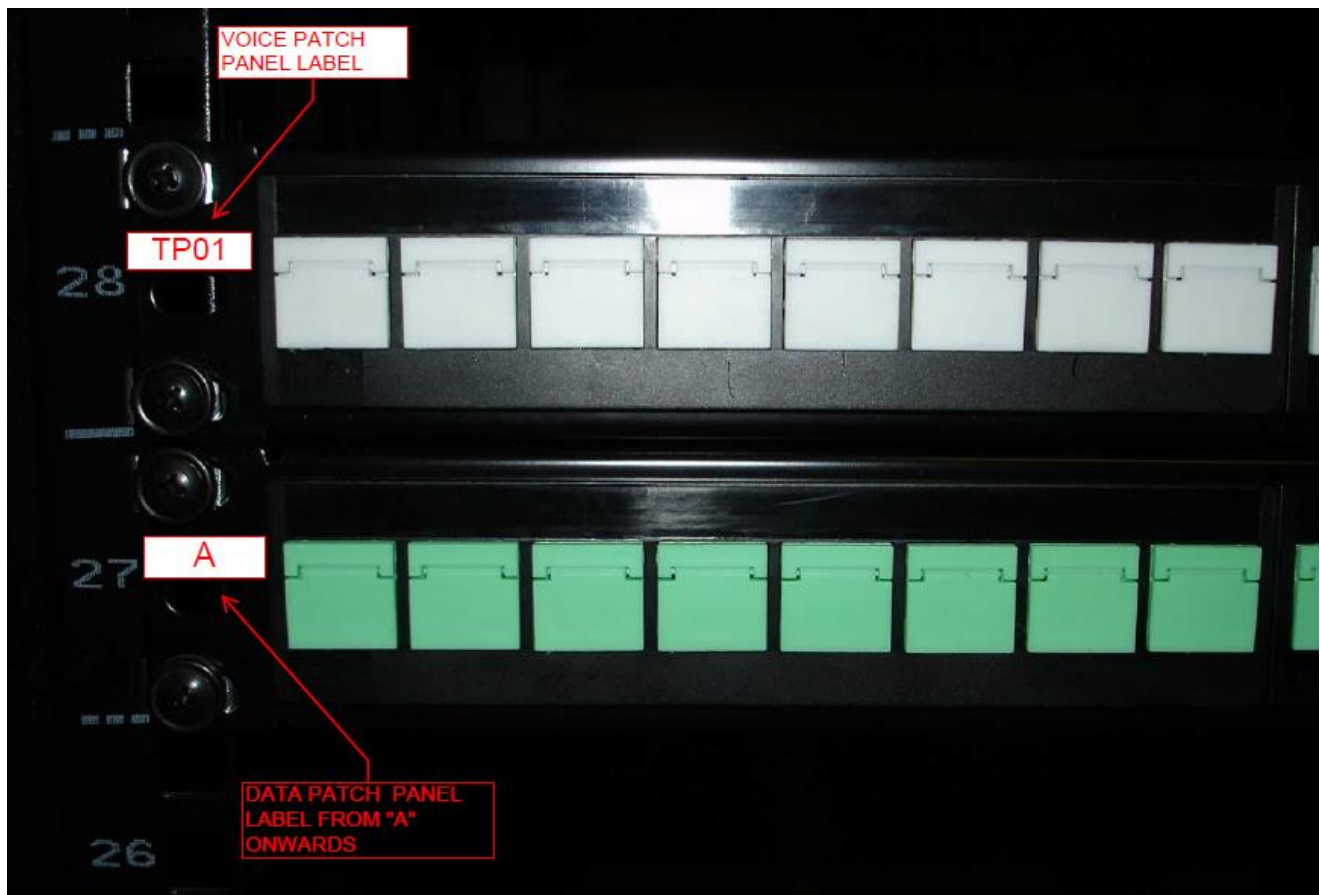
COT-IT-YDE-0100
NETWORK CLOSET

(Lamacoid label on the cabinet shall be at the bottom. IT will provide lamacoid spec standard)

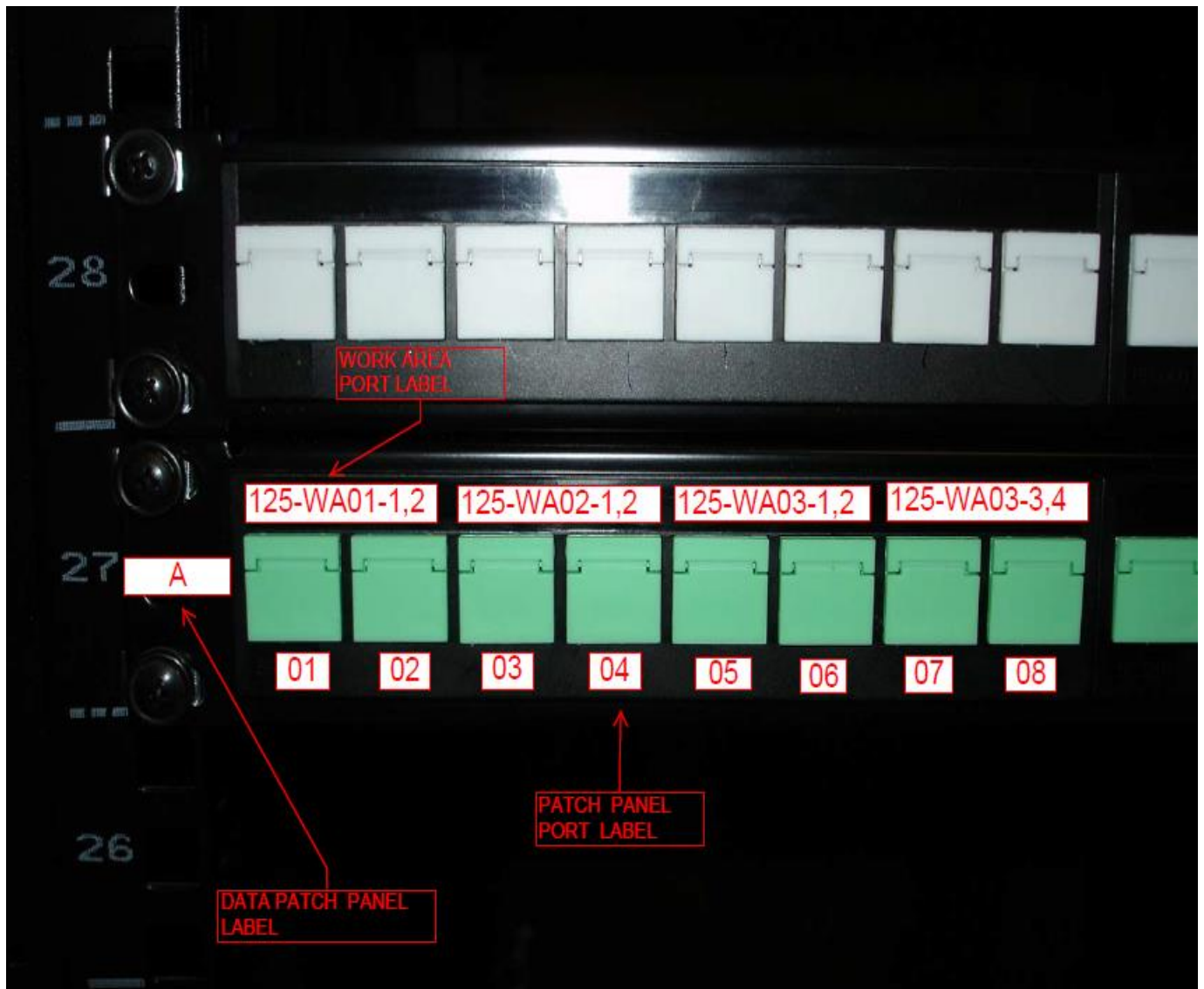


COPPER PATCH PANEL (CP) & WORK AREA OUTLET (WA) IDENTIFICATION AND LABELING

- The copper data patch panels in a Telecommunications Enclosure/Closet shall employ one character A, B, C, ..., Z. The rack shall be populated with patch panel(s) as necessary and labeled in sequential order from top to bottom.
- For example, the first copper data patch panel from the top of the rack shall be labeled A, the second shall be B, and so on.
- Each 24-port patch panel shall have six (6) snap-in faceplates that group four terminations. For office areas, the minimum number of ports associated with a work area outlet shall be a group of two (2) ports.
- Labels shall be applied to patch panels in such a manner as to be readily visible and not obscured by structured cabling or patch cords.



- Labels for each 4-port or 2-port, snap-in faceplate shall be laser printed, self-laminating, adhesive, polyester or polyolefin. Hand-written labels shall not be accepted.
- Lettering shall be black on a white background. Characters are a minimum of 4mm high.
- Apply a label on the top of each group of 4-ports or 2-ports on the snap-in faceplate to indicate the destination of the cables terminated on the data ports (RJ).
- For office areas, the label 125-WA01 would be applied on the patch panel for a group of 2 ports with destination cables to work area outlet 125-WA01. Whereas, 125 represents the room number of the facility and WA01 represents the work area 01.



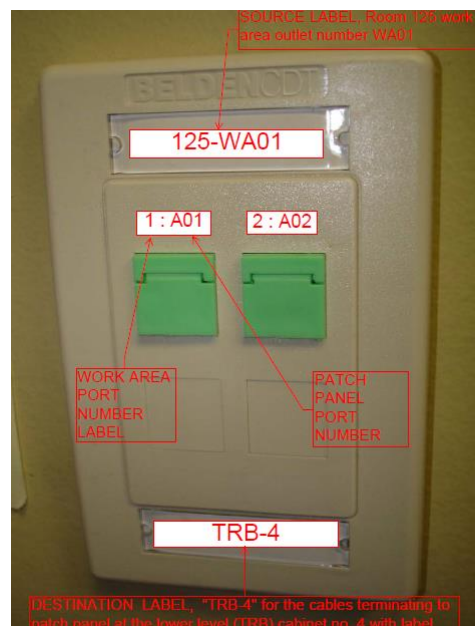
- Apply a two-digit label immediately above each data port (RJ) indicating its destination port number on the work area outlet. For example, a group of four consecutive ports on a 24-port patch panel whose destination is port numbers 1 to 4 on a WAO would have the ports labeled 1, 2, 3, 4. Provide color-coded, snap-in icons for each data port (RJ).

FIBREOPTICS PATCH PANEL (FPP) IDENTIFICATION AND LABELING

- Lettering shall be black on a white background. Characters are a minimum of 4mm high.
- Terminate all 12 fibres of each fibre optic cable in Fibre Enclosures (Telecommunications Enclosure or Network Core Closet).
- The fibre cable for all even-numbered Telecommunications Enclosures shall terminate at Network Core Closet 02 (XYZ-0200) while odd-numbered shall terminate at Network Core Closet 01 (XYZ-0100).
 - For cases where Network Core Closet 01 and Network Core Closet 02 are located in different Equipment Rooms, Telecommunications Rooms / Telecommunications Enclosures shall have fibre terminating in both Network Core Closets.
- The ordering and color of individual fibres shall be the same for each fibre cable and compliant with the latest ANSI/TIA-568.3 and ANSI/TIA-598 standards.
- Labels for patch panels shall be laser printed, self-laminating, adhesive, polyester or polyolefin. Hand-written labels shall not be accepted.
- Labels shall be applied to patch panels in such a manner as to be readily visible and not obscured by structured cabling or patch cords.
- A label shall be applied to the top of the LC duplex adapter modules associated with a single fibre cable indicating the destination of the cable.
- For example, the adapter modules that terminate the fibre cable whose destination is Telecommunications Enclosure 1400 would be labeled as XYZ-1400.
- The fibre patch panel label shall be labeled as follows FPXX where XX is the fibre patch panel sequence i.e. 01, 02, 03...etc. The rack shall be populated with patch panels as necessary and labeled in sequential order from top to bottom.
- For example, the first patch panel from the top of the rack would be labeled as FP01, the second is FP02 and so on.

WORK AREA OUTLET (WAO) IDENTIFICATION AND LABELING

- Labels for each 4-port, work area outlet shall be laser printed, self-laminating, adhesive, polyester or polyolefin. Hand-written labels shall not be accepted.
- Lettering shall be black on a white background. Characters shall be a minimum of 4mm high.
- A label shall be applied to the top of each 4-port, work-area outlet indicating the source of the Horizontal cables.
- For example, WAO port 1 connected to patch panel A port 1 would be labelled as A01. WAO port 2 to patch panel A port 2 is labelled A02 and so on.



CABLE IDENTIFICATION AND LABELING

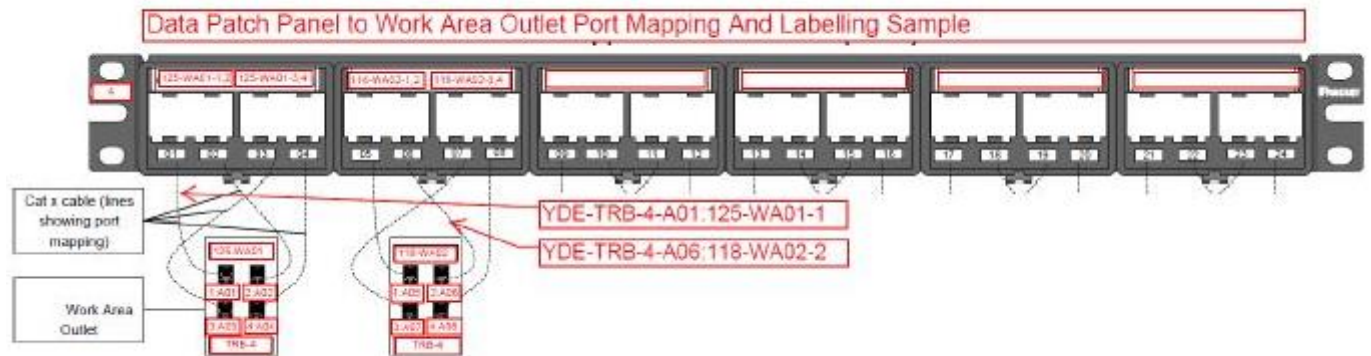
- Use durable non-fading sleeve type wire markers to identify all network cables.
- Labels for cabling shall be laser printed, self-laminating, adhesive, polyester (indoor/outdoor). Hand-written labels will not be accepted.
- Lettering shall be black on a white background. Characters shall be a minimum of 4mm in height.

FIBREOPTICS BACKBONE CABLE IDENTIFICATION AND LABELING

- As a minimum, all fibre optic backbone cables shall be labeled at both ends of the cable, within every pull box and every 15 metres.
- In addition, the fibre backbone cables shall be labeled at each transition. A transition is defined as: a change in ducting (e.g. cable tray to conduit), a change in direction of more than 45 degrees, or an entrance and exit of ducting through a wall or floor.
- If the fibre cable is run in conduit then the transition labels shall be applied to the conduit.
- The tagging convention for identification of fibre optic backbone cables shall indicate the source and destination of the cable separated by a colon.
- For example, a fibre optic backbone cable whose source is Network Core Closet 2 (XYZ-0200), Fibre Patch Panel 01, adapter panel A and terminates in Telecommunications Enclosure 1400 (XYZ-1400) on the fibre patch panel 01 adapter panel A would have the following tag: 0200-FP01-A.01: 1400-FP01-A.01. The last "01" digits represent fibre strands.
- The Telecommunications Enclosure fibre optic patch panel must be labeled. For example: Telecommunication Enclosure 1400 with two fibre optic patch panels would be labeled "FP01" and "FP02", where "FP01" is the first patch panel from the top.

HORIZONTAL COPPER CABLE IDENTIFICATION AND LABELING

- As a minimum, all horizontal CAT6/CAT6A cables shall be labeled at both ends of the cable, within every pull box and every 15 metres.
- In addition, the cables shall be labeled at each transition. A transition is defined as: a change in ducting (e.g. cable tray to conduit), a change in direction of more than 45 degrees, or an entrance and exit of ducting through a wall or floor.
- If the cable is run in conduit then the transition labels shall be applied to the conduit.
- The tagging convention for identification of Horizontal cables shall indicate the source and destination of the cable separated by a colon.
- Example 1: a horizontal cable whose source is Telecommunications Enclosure TRB-4, Patch Panel A, port 01 and whose destination is port 1, Work-Area Outlet 01, in room number 125 would have the following tag: YDE-TRB-4-A01:125-WA01-1.



VOICE BACKBONE COPPER CABLE IDENTIFICATION AND LABELING

- As a minimum, all voice backbone cables shall be labeled at both ends of the cable, within every pull box and every 15 metres.
- In addition, the voice backbone cables shall be labeled at each transition. A transition is defined as - a change in ducting (e.g. cable tray to conduit), a change in direction of more than 45 degrees, or an entrance and exit of ducting through a wall or floor.
- If the voice cable is run in conduit then the transition labels shall be applied to the conduit.
- The tagging convention for identification of voice cables between the voice block and the Telecom Closet/Enclosure patch panel in the building shall be VFFA-CC : XYZ-A-TP01 (indicate the source and destination of the cable separated by a colon), where V indicates voice, FF indicates the floor number, EF indicates telecommunications entrance facility ID, CC indicates 2-digit voice cable number, and XYZ-A is telecommunications closet/enclosure ID.
 - For example, voice cable 01 whose source is entrance room EF and terminates in Telecommunications Room B (YDE-TRB) on patch panel TP01 would have the following tag: V01EF-01 : YDE-TRB-TP01.

PATCH CORD IDENTIFICATION AND LABELING

- As a minimum, all Contractor installed CAT6/CAT6A or fibre optic patch cords shall be labeled at both ends of the cable.
- The tagging convention for identification of patch cords shall indicate the source and destination of the cable separated by a colon. The source is the switch port and the destination is the patch panel, termination point.

CABLE PATHWAYS IDENTIFICATION AND LABELING

- All ducting (cable tray or conduit) carrying fibre optic and multi-pair voice backbone cables shall be tagged as "LAN BACKBONE".
- All ducting (cable tray or conduit) carrying Horizontal cables shall be tagged as "LAN HORIZONTAL" with the source and destination network panels.
- All ducting shall be labeled at each transition. A transition is defined as - a change in ducting (e.g. cable tray to conduit), a change in direction of more than 45 degrees, or an entrance and exit of ducting through a wall or floor.
- Use engraved gravoply laminate nameplates using black letters on white background.
- The laminate nameplates shall have a dimension of 210mm W x 50mm H.
- Minimum character height shall be 12mm. Character lettering shall be centered on each line.

FIRE STOPPING

- Fire stop systems in commercial premises shall meet the requirements of latest ANSI/TIA-569.
- Fire stop systems should be designed to be compatible with the worst-case environment to which they will be exposed (refer to ANSI/TIA-568.0 for information on environmental classifications).
- Provide EZ PATH solution where conduit penetrates fire rated walls, floors, partitions and ceilings to ensure that the fire rating is maintained. Abandoned penetrations shall be properly fire stopped. Provide EZ PATH system.
- The required fire rating is minimum 2 hours.

SUBMITTALS

- Comply with the requirements of Section 01300 - Submittals.
- Shop Drawings shall be submitted to the City of Toronto IT staff for final review before proceeding with any works.

- The shop drawings and all submissions shall be reviewed and sealed by the RCDD Contractor's PM and re-reviewed and sealed by the Consultant's RCDD before reaching the City for final review.
- Final design drawings/construction drawings shall be submitted to the City of Toronto IT staff for final review and before proceeding with any works. These drawings shall be reviewed by PM RCDD Contractor and re-reviewed and approved by RCDD Consultant before reaching to the City for final review.
- The CADD drawings shall meet the City's CADD standards. Any non-compliance shall be at the Consultants own expense.
- Submit proposed cable and enclosure tag labels to the Contract Administrator and the City of Toronto IT Technical Representative for approval before proceeding with this work.
- Submit red-lined Site Drawings identifying the proposed location of all enclosures including Telecommunication Enclosures, Termination Panels and Work Area Outlets prior to installation and as part of shop drawing submittals.
- Submit site drawings identify the fibre optic backbone cable routes and horizontal cabling routes to be used prior to installation and as part of the shop drawing submittals.
- Prior to x-raying and coring access holes submit red-lined Site Drawings showing the proposed location of the holes.
- Submit red-lined annotated working Drawings to the Contract Administrator, to clearly document the as-built network including details related to: location (closets, work area outlets), cabling (size, length, type, routing), tagging (cable ducting, cabling, closets and work area outlets).
- Submit all submissions in both a hardcopy and electronic native format. Handwritten submissions are not acceptable. Also, submit electronic files in a PDF digital format that is indexed and searchable.
- Submit the following documentation prior to starting the site acceptance test:
 - City of Toronto IT/Network Services — Cable Test Results
 - Operations and Maintenance Manual of any and all electronic equipment to or is installed.
 - Revise and annotate Contract Drawings, to clearly document the as-built network including details related to: location (closets, terminations panels) cabling (size, length,

type, routing), tagging (cable ducting, cabling, closets and termination panels) final as built drawings, cabling schematics, pathways and conduits drawings (containment system), any other documents, reports and drawings needed by the City of Toronto during or after work is completed.

- Consultants shall review and approve all submissions prior to final review by the City.
- Consultant is responsible to submit the final as-built drawings of the project / facility to the City.

END OF SECTION

SECTION -2: PRODUCTS

Products and part numbers often change without notice. The Consultant shall verify all parts specified and used are current and available.

Consultant shall practice the procedure of shop drawings / products approval as stated in this section. Shop drawings shall be submitted by the Contractor to the Consultant. The Consultant / Designer shall review and approve the shop drawings submittal before sending it to the City of Toronto IT for final review. After receiving the submittal from the City IT, the Consultant / Designer shall send the final approval or approval with comments / notes to the Contractor.

APPROVED MANUFACTURERS

- All backbone fibreoptic cables, connectors, patch cords, patch panels, cassettes and adaptors shall be from Belden.
- All CAT6/CAT6A modular jacks, faceplates, U/UTP patch cords and Category 6/6A cables shall be from Belden.
- Where cross connect punch down is required at Entrance Facility for termination of all voice backbone cables, it shall be from Belden.
 - www.belden.com
- All wall mount Telecommunication Enclosures shall be from Hammond Manufacturing.
 - www.hammondmfg.com
- All free standing Paramount Telecommunication Enclosures in the Equipment Room / Telecom Room shall be from Chatsworth Products.
 - www.chatsworth.com
- All fire-stopping EZ-PATH components shall be from Specified Technologies Inc.
 - www.stifirestop.com
- For UPS and Power Distribution Unit, Liebert - Emerson and APC shall be the manufacturers.
 - www.emersonnetworkpower.com ; www.apc.com
- Manufacturer Substitution of any part other than those specified in this standard is strictly prohibited without the written consent of the City of Toronto Information Technology (IT) Network Services Division.

ENTRANCE FACILITY PROTECTION

- Indoor voltage protector to protect entrance terminal to provide voltage and current protection and a disconnect facility at building entry points.
- Integral, 28 AWG (0.32 mm), non-replaceable fuse link wire between the incoming pairs and the protector modules.
- 25-pair connector for single-pair terminations (one pair "IN", one pair "OUT"), compatible with 22 to 26 AWG.
- The protected entrance terminal shall comply with CSA specification C22.2, No. 226-92, "Protectors in Telecommunication Networks," including the high-voltage fault test.
- Protectors to be included with supplied assembly.
- Consultant to use Belden data sheet to specify correct part number for the application.

FIRE RATED BACKBOARD PLYWOOD

- In the Entrance Facility, Equipment Room and Telecom Room Fire Rated plywood shall be provided on the walls or struts such that there is proper cable penetration from behind.
- Plywood shall be void-free and either fire-rated or treated on all sides with at least two coats of fire-retardant light-colored paint.
- Have at least two walls lined with A/C grade or better, 2.4 m (8 ft) high with a minimum thickness of 19 mm (3/4 in). To reduce warping, plywood should be kiln-dried to maximum moisture content of 15 percent. Mount plywood 200 mm (8 in) AFF to avoid damaging the plywood. Have the plywood with the grade A surface exposed. The plywood should be securely fastened to wall-framing members to ensure that it can support attached equipment.
- All joints screw and nail holes are to be caulked and / or covered.
- The plywood is to be provided for cross-connect fields, security panels, power supplies etc. as may be required and is not intended for cabinet installation.

NETWORK CABINETS (CORE AND SERVER CLOSETS)

- 44U Floor Standing Cabinets
 - Cabinets shall be supplied and installed complete with all accessories to provide a complete cabinet as indicated below.

- Cabinets shall be floor mounted, freestanding and have the ability to be ganged together.
- Cabinets shall have a capacity of 44U with mounting holes as per EIA-310-E.
- Each server cabinet shall be black with square hole rails.
- Each network / service provider cabinet shall be black with round hole rails.
- Specified Product:
 - W762mm X D1067mm X H2133mm Cabinet
 - Front Door
 - Rear Split Door
 - Solid Side Panels
 - Rackmount rails (square for server and round for network cabinets)
 - Top Panel
 - 483 mm (19") Mounts with cage nuts
 - 10-32 Cage nuts and screws (square for server and round for network cabinets)
- Electrical
 - Contractor is to provide the electrical distribution for each IT Network and Server cabinet as per the related Electrical Distribution drawings and relevant City standards.
 - Bond each 19" cabinet to ground.
 - Provide each Core and Server cabinet with two (2) 20A, 120 VAC, receptacles for UPS circuits. Terminate each UPS circuit at a 3-wire, duplex receptacle mounted to the rail of the 19" cabinet.
 - The duplex receptacles shall be mounted in such a manner as not to interfere with access to or removal of other equipment within the enclosures.
 - Power distribution within the enclosure shall be via vertically mounted metered power bars.
 - Redundant power supplies, within the same device, shall not be connected to the same UPS circuit.

- Power Distribution Unit (PDU – Power Bar)
 - The Liebert MPH rack PDU shall be managed three-phase power distribution unit that shall be monitoring along with receptacle control.
 - Liebert MPH units shall be available for mounting in either vertical, zero-U configuration and rack-mounting in standard, network enclosures.
 - The output receptacles support equipment requiring connection with NEMA 5-20R and IEC60320-C13 plugs.
 - Remote monitoring shall be enabled by the included communication card, the Liebert RPC™, which permits managing the Liebert MPH over a secure Web page and SNMP-based network management system.
 - The Liebert RPC shall permit interconnecting multiple Liebert MPH and / or Liebert MPX units for monitoring and management.
 - A Liebert MPH shall be monitored locally with an RPC BDM™, an optional display module that connects directly to the communication card. The display module can be handheld, mounted in or on the rack or mounted on a nearby wall.
 - Multiple Liebert MPHs can be centrally managed with Liebert Nform™, which adds group-based receptacle management.

TELECOMMUNICATIONS ENCLOSURE (TE)

- Unless otherwise specified all indoor enclosures containing network components are to be NEMA 12.
- A lockable double hinged door allows front and rear access to rack-mounted components.
- All screws, bolts, fasteners etc. shall be corrosion resistant stainless steel.
- All wall-mounted panels shall be separated from the wall by stainless steel spacers or galvanized steel struts.
- Doors shall have continuous hinges with removable pin and oil resistance cellular neoprene gasket secured by gasket retainers. Front door handles shall be recessed type (freestanding enclosures) or 3-point external latch (wall mount), complete with key locks.
- Provide locking mechanism for rear door. All key locks shall be identically keyed.
- Key number shall be provided.

- Cable bundles shall be neatly laced, run in ducting or approved cable managers and secured to 19" cabinet or mounting back-panel.
- All enclosure doors shall open through 180 degrees without restriction from front and the back.
- Enclosure layout and equipment spacing shall be constructed to allow for device removal, calibration and maintenance without disassembly of adjacent devices.
- All enclosures shall have sufficient structural reinforcements to ensure a limited plane surface vibration and to provide rigidity during shipment, installation and operation without distortion or damage to the enclosure, mounting panel or mounted instruments.
- All enclosure seams shall be continuously welded and ground smooth to be undetectable after painting.
- Devices shall be installed on the enclosure back-panel or 19" cabinet only.
- There shall be no devices installed on the side plates of the enclosure.
- Conduit accessibility shall be per manufacturer's guidelines with conduit egress through the bottom and sides but not the top of the enclosure.
- There are three sizes of TE, 12U, 19U and 26U. All provided by Hammond Manufacturing.
- Minimum items in the TE shall include but are not limited to one fibre termination panel (1U), three 24 port (1U) patch panels (1 x Telephone and 2 x Data), two (2) 24 ports or one (1) 48 ports Cisco switch, two (2) 2U Horizontal Cable Manager, one (1) 1U monitored PDU and other optional equipment as may be requested by CoT-IT such as UPS or other equipment.
- All TEs shall be bonded to the Telecommunications Bonding System as per the standard.
- The bonding cable shall be sized according to distance and terminated at the nearest Telecommunications Grounding Busbar and run within conduit.
- The TE shall be CSA approved and sealed.
- Provide the enclosure electrical distribution as per the Telecommunication Enclosure (Typical) - Electrical Distribution drawing.
 - The Telecommunication Enclosure shall be powered by two separate 15 A, 120 VAC supplies (Utility and Network). The Utility Supply is to power non-critical components (enclosure lighting and power bar). The Network Supply (UPS) is to power the critical network components (Ethernet Switch) and environmental controls (ventilating fans).

Contractor shall provide the Utility Supply from the nearest lighting panel as per the TE Installation drawings. The Network Supply is to be provided by others. Where applicable, the Contractor shall provide a 15A Supplementary DIN rail mounted breaker for termination of the Network Supply. In addition, the Contractor shall provide a knockout for the Network Supply conduit as per the Access Closet Installation drawings. All power distribution installation shall be mounted to the top rear side of the TE.

- Provide 120 VAC, 3-wire, duplex receptacles, circuit breakers, surge suppressor, wire duct and grounding bar per the Telecommunication Enclosure Layout drawing and associated Component Schedule. The Contractor shall provide rigid-steel conduit and wiring to provide the 15 A, 120 VAC Utility Supply as per the Access Closet Installation drawings. The Utility Supply shall be terminated at a 15 A, DIN rail mounted, circuit breaker and surge suppressor. Distribution of the Utility Supply is as documented in the Telecommunications Enclosure – Electrical Distribution drawing.
- All power distribution installation shall be mounted to the top rear side of the TE.
- A rack mount UPS shall be supplied that will power the Telecommunication Enclosure Network Supply. The Contractor shall be responsible for the distribution of the Network Supply within the TE and for providing a 15 A supplemental breaker for termination of the supply by others.
- Power Distribution Unit (PDU - APC)
 - The APC rack mount PDU/transfer switch shall be managed three-phase power distribution unit that monitoring along with receptacle control.
 - The APC units shall be available for rack-mounting in standard, network enclosures.
 - The output receptacles support equipment requiring connections (10) with NEMA 5-15R.
 - Remote monitoring shall be enabled with a secure Web page and SNMP-based network management system.
 - The APC PDU shall permit interconnecting multiple units for monitoring and management.

WORK AREA OUTLETS FOR OFFICE AREA

- All modular jacks, faceplates and furniture inserts shall be Belden and performance rated to Category 6/6A.

- Provide one 4-port, single-gang, work area outlet in each work area for termination of the horizontal CAT6/6A cables with faceplates or decora module frames.
- For new construction, it is recommended that the outlet boxes be 100mm X 100mm X 54mm deep, complete with a mud ring cover specifically designed for single gang faceplates intended for flush mounting to the wall. This single gang outlet box aids in the maintaining of Category 6/6A and higher bend radius requirements.
- Where walls are not suitable or have insufficient depth, stand electrical size outlet boxes shall be used.
- Each manager’s office shall have two (2) work area outlets on separate walls.
- One (1) 4-port, work-area outlet shall be associated with as many ports necessary (in groups of 4 or 2) on the snap-in faceplate installed in the patch panel of the TE or TR as is provided.
- Within each office outlet, only two of the ports shall be terminated at the work area faceplate and patch panel unless otherwise specified.
- Space shall be left in each conduit and faceplate for a third and fourth cable to be added at a later time.
- In the majority of cases one (1) 4-port, work-area outlet shall be installed within each systems furniture cubical work area partition.
- In some special situations where the systems furniture is configured fully the work-area outlet shall be installed directly on the wall in the office areas.
- Within systems furniture, only two of the four positions shall be terminated with work area jacks and on the patch panels unless otherwise specified.
- Space shall be left in conduits and faceplates for the inclusion of a third and fourth cable at a later time.
- In boardrooms and large general office areas, one single gang work area outlet shall be provided every 3.0 metres and within 1.0 metres of an electrical outlet if provided.
- Only two of the four positions shall be terminated with work area jacks and on the patch panels unless otherwise specified.

FACEPLATES

- Faceplates shall be modular Belden white format opening to allow the possibility of changing connector types in the future without replacing the entire unit.
- Faceplates shall be equipped with small form factor terminating connectors to fit the individual outlet's requirements
- Faceplates shall be equipped with a minimum of four (4) openings for modules. Contractors are to equip the faceplate with the required number of blank inserts as required.

WORKSTATION FACEPLATES AND ADAPTERS - CUBICLES

- Workstation outlets shall be supplied and installed for all terminations at the workstation end and as further specified below to suit the application.
- Each workstation shall be equipped with minimum two (2) RJ45 Cat6/6A green color jacks.
- The Communications Consultant shall confirm the color of outlets prior to placing order.
- Modular Furniture Faceplates
 - Modular furniture faceplates shall be installed in all furniture outlets that have a modular furniture knockout shall consist of 4 ports.
 - Each outlet shall be installed with the specified termination modules or a blank insert. No openings shall remain exposed.
 - Communications Consultant shall verify furniture modular faceplate requirement.
 - Belden MDVO modular furniture adapter, 4 port, white
 - Belden MDVO modular furniture adapter, 4 port, black
- Surface Mount Boxes
 - Surface mount boxes shall be installed for all furniture outlets that do not have a modular furniture knockout, exposed ceiling outlets or any location not provided with an electrical back box.
 - The surface mounted box shall consist of a minimum of two (2) ports.
 - Each outlet shall be installed with the specified termination modules or a blank insert. No openings are to remain exposed.

- Belden MDVO side entry box, white
- Belden MDVO side entry box, black

RJ45 CAT6/6A JACKS

- Belden Eight-position modular jack (RJ45), type Category 6/6A to TIA-568 shall be green color and shall have the following minimum performance characteristics:
 - Modular jack current rating: 1.5 Amperes maximum
 - Modular jack durability 1,000 mating cycles
 - Modular jack contact Pressure: 100 grams minimum per contact
 - Dielectric voltage strength: 1,000 V RMS at 60Hz for 1 minute
 - Insulation resistance: 200 milli-ohms minimum
 - Contact resistance 1 milli-ohms per contact
- The contact material of the jack in a modular jack connector shall be phosphor bronze with 50 micro-inches of gold over nickel.
- UTP termination modules shall be of the same category as the UTP cabling to ensure that manufacturer end to end warranties can be attained.
- UTP cables used for IP voice shall be terminated with the same specified jacks.
- All UTP termination modules shall be Belden MDVO type.
- Belden CAT6/6A modular jack, MDVO style, green color.
- Belden ID data tab, MDVO style, green color.

COPPER PATCH PANEL (CPP)

- All horizontal CAT6/6A U/UTP cabling shall be terminated on 1U, 24 ports, Belden CAT6/6A modular patch panel.
- All copper patch panels shall be black.
- All modular patch panels shall be populated with CAT6/6A UTP modules/jacks as required.
- The modular copper patch panel shall mount to standard TIA 482.6 mm (19") rack.

- Contractor to refer to installation instructions provided with the patch panel for proper installation.

COPPER CAT6/6A HORIZONTAL CABLE (U/UTP)

- Belden, four-pair, 100 ohm balanced unshielded-twisted-pair (U/UTP) cable, appropriate flame test classification, Category 6/6A (CAT 6/6A) shall be in compliance to TIA-568 standard.
- All cables fully contained within conduit or areas that are not plenum rated shall use CMR/FT4 rated cable.
- Any cable, regardless of length passing through a return air plenum ceiling and not in conduit shall be rated CMP/FT6.
- All UTP cables shall meet requirements identified below:
 - Color: Blue
 - Rating: CMR/FT4 (riser rated or in conduit) or CMP/FT6 (plenum areas or in J-hooks)
 - Category: 6/6A
 - 23 AWG, spool-in-a-box
- All CAT6/6A horizontal cables shall be eligible for the Belden 25 years Certification Warranty.
- Cabling shall be installed and terminated as per the BICSI Installation Methods Manual, Belden Certification training and the manufacturers' installation instructions.

COPPER CAT6/6A PATCH CORD (U/UTP)

- Patch cord shall be manufactured of stranded conductor cable with 8-position, 4-pair terminations at both ends.
- All patch cords shall be manufactured by Belden and performance rated to CAT 6/6A.
- All patch cords shall be of the same or higher performance category and manufacturer of the U/UTP horizontal cabling system that shall be warranted as part of the end-to-end solution.
- All patch cords shall be standard compliant and minimum of FT4 or LSZH rated.
- All patch cords shall be manufactured and certified, 4-pair stranded conductors copper cables, field assembled patch cords are not allowed.

- All patch cords shall be gray in color.
- The Contractor shall supply patch cords in the following length:
 - At patch panel location, provide 0.5 metres long patch cords for all terminated horizontal cables unless otherwise advised by Consultant or CoT-IT.
 - At workstation or work area outlet location, provide patch cords of suitable length and not longer than 5 metres (typically 2.1 metres but Project Consultant to finalize) for every terminated horizontal cable unless otherwise advised by Consultant or CoT-IT.
- Patch cords shall be installed and terminated into the final device by the Contractor as per the BICSI Installation Methods Manual, Belden Certification training and the manufacturer's installation instructions.

BACKBONE CABLE FOR VOICE CENTREX ONLY - ISP (CAT3/5E)

- Category 3/5e rated wire and cable placed in the inside environment shall be solid, 24 AWG, twisted pair and multi-conductor.
- All cables fully contained within conduit or areas that are not plenum rated shall use CMR rated cable.
- Any cable, regardless of length passing through a return air plenum ceiling and not in conduit shall be rated CMP.
 - Belden: CMR: min 25 pairs | CMP: min 25 pairs

TELEPHONE PATCH PANEL FOR VOICE (TPP)

- Minimum 1U 24 RJ45 UTP ports.
- Accommodates 180, 110, or 90 degree patch cord connectors on back of patch panel.
- Does or doesn't require the use of a punch-down tool and mounts to standard EIA 19" rack.
- Belden for voice unloaded patch panel - black
- Belden jacks for voice unloaded patch panel, white – CAT3/5e
- Belden ID voice tab for unloaded patch panel, white

VOICE CROSS CONNECT AT ENTRANCE FACILITY (EF)

- Voice cross-connect is a system that consists of various sizes of BIX blocks, cable distribution accessories (such as moulded rings and strips) and a BIX tool to terminate wires at the BIX block. The voice cross-connect system is primarily composed of two parts: the mount and the connectors.
- Cross-connect mount is a wall-mounted frame, generally built from 16-gauge steel. The frame features a rectangular plastic backplate and two plastic brackets that extend from either side of the backplate to fit between two and ten connectors. The connectors shall be oriented horizontally on the mount.
- The connectors are rectangular punch-down blocks used to terminate up to 25 pairs. The connectors shall have a slip-in fitting which automatically strips the wire as it is punched down, eliminating the need for pre-stripping. The connectors shall also have a pair-splitter to facilitate fast arranging of wires on the punch-down block.
- Backbone cables shall be terminated on the backboard (as shown on drawings) unless otherwise specified in this document.
- All cables shall be terminated on IDC connectors complete with associated hardware such as mounts, cable / cross-connect wire managers, etc.
- The IDC connectors shall accept 24 to 26 AWG solid copper conductors.
- The IDC mounts shall accept cables from behind the connector.
- Cross-connect shall be a 5-pair block and include appropriate mounting and number of designation strips and labels.
- Cable management in the form of distribution rings or approved similar shall be provided between columns and rows of IDC mounts to support cross connect management in a manner recommended by the manufacturer.
- Instruction sheets for products are available from Belden.
- Belden 50 pair BIX mount
- Belden BIX distribution connector – 5 pair marking
- Belden accessories such as jumper wires, labels etc. to complete the system.

FIBREOPTIC CABLES

INDOOR BACKBONE MULTIMODE OM4 FIBREOPTIC CABLE

- The cable is performance rated to OM4 and shall be used only if the backbone link length is less than or equal to 150 meters.
- Primary and redundant, 12 strands in each cable shall run between the equipment room and the telecom room. Total of 2 x 12 strands shall run with diverse pathways between the equipment and telecom rooms.
- All cables shall be fully contained within conduit or areas that are not plenum rated shall use OFNR/FT4 rated cable.
- Any cable, regardless of length passing through a return air plenum ceiling and not in conduit or using cable tray / J-hook shall be rated OFNP/FT6.
- Fiber cables shall be protected when entering the patch panel with a black color flexible conduit.
- Core-locked, tight-buffered, black, indoor/outdoor fiber-express distribution cables.
- 50/125-micron core/cladding, laser optimized.
- 4700 MHz-km bandwidth at 850nm wavelength (EMB).
- 3500 MHz-km bandwidth at 1300nm wavelength.
- Only cables from Belden shall be accepted.
- All fibreoptics cables shall be installed and terminated into fibre optic adapters contained in fibre optic patch panels by the Contractor as per the BICSI Installation Methods Manual, Belden certification training and installation instructions.
- Belden:
 - OFNR/FT4
 - OFNP/FT6

FIBREOPTICS PATCH PANEL (FPP)

- Fibreoptics cabling shall be terminated in patch panels intended for fibre optic cable management.

- Belden Fibreoptics Rack Mount Enclosure for Telecommunication Enclosures shall be:
 - 3U - 19" Rack Mount Enclosure
 - Durable black powder coat finish
 - Be equipped with cable strain relief and slack storage
- Belden Blank Fibre Adapter Panel shall be:
 - Blank Fibre Adapter Panel to fit Fibre Adapter Patch Panel
 - Durable black powder coat finish
- Belden Fibreoptics LC Fibre Adapter Strip shall be:
 - Loaded with TIA-604 FOCIS-10 compatible adapters, TIA-568.3 standard compliant
 - Split sleeve: Zirconia Ceramic
 - Adapter housing colors follow TIA-568.3 suggested color identification scheme.
 - Belden part number for 6 LC duplex adapter strip
- Belden 1U fibre cover, smoked plexiglas
- Belden Splice Case / Modules / Trays for OM4 Cable Terminations shall be:
 - Belden splice tray for 3U rack mount fibre enclosure

FIBREOPTICS LC CONNECTOR FOR FIELD TERMINATION OF OM4 CABLE

- Optical fibre terminations for OM4 cable shall be made for field termination with a pre-polished connector and shall be of the same manufacturer and LC style to suit the cabling installed.
- Fibre connectors shall match the performance of the fibreoptics cable (OM4).
- Fibre terminations shall be made with a ceramic ferrule and cable boot.
- Optical fibre cables shall be terminated with pre-polished connectors having the characteristics as below:
 - Return loss: >20dB (multimode)
 - Termination Style: Pre-Polished

- Connector Type: LC
- Ferrule Type Zirconia Ceramic
- The connector shall include connector body / ferrule assemblies, crimp sleeves, dust caps, clip, and appropriate boot.
- All Fiberoptics connector terminations and adapters shall be contained in fibre optic patch panels from Belden by the Contractor as per the BICSI Installation Methods Manual, Belden certification training and installation instructions

FIBEROPTICS LC PIGTAIL FOR FIELD TERMINATION OF OM4 CABLE

- Optical fibre OM4 cable shall be fusion spliced to pig-tails for field termination and shall be of the same manufacturer and LC style to suit the cabling installed.
- Pigtail shall be OFNR (FT4) or LSZH rated and stamped/printed accordingly.
- The pigtail shall be 100% factory terminated and inspected end face geometry in compliance with Telcordia GR-326-CORE, issue 3.
- Typical insertion loss per pigtail connection: 0.25dB.
- Field assembled pigtails are not allowed.
- The Contractor shall supply and fusion splices every strand of the fibre backbone cable with a pigtail. The pigtail length shall be 1m.
- Belden OM4 pigtail
- Belden fusion splice heat shrink protector sleeves

FIBEROPTICS MULTIMODE LC-LC DUPLEX PATCH CORDS – OM4

- All patch cords shall be CSA/TIA/UL approved, CMR (FT4) or LSZH rated and printed accordingly.
- All optical fibre patch cords shall be OM4.
- All optical fibre patch cords shall be manufactured and certified, 1-pair (duplex, 2 strands). Field assembled patch cord is not allowed.
- The Contractor shall supply a minimum two (2) patch cords for every OM4 backbone cable:

- At patch panel in the telecom room (TE), provide one (1) 2-meter-long patch cord unless otherwise specified by CoT IT.
- At patch panel location in the equipment room (ER), entrance facility (EF), or any other space provide one (1) 2-meter-long patch cord unless otherwise specified by CoT IT.
- All optical fibre patch cords shall be LC to LC duplex.

PATHWAY SYSTEM – CONDUIT AND CABLE TRAY

- Cable tray shall be used above ceilings in commercial facilities and below raised floor systems as may be found in equipment rooms or data centers.
- All pathway (conduit and cable tray) systems shall be designed in accordance with the latest version of the ANSI/TIA-569-E Standard which exceeds the minimum requirements of Canadian Electrical Code. Pathway systems that are designed only to the Canadian Electrical Code and do not include all requirements of the ANSI/TIA-569-E standard will be considered substandard and removed until such time as they are in compliance.
- Consultant to confirm with both the facility and CoT-IT regarding the areas that are suitable for Electrical Metallic Tubing (EMT).

ELECTRICAL METALLIC TUBING CONDUIT - EMT

- To be used within the office areas only (if applicable).
- Electrical Metallic Tubing shall be electro-galvanized steel.

FITTINGS

- Fittings for electrical metallic tubing shall be single screw indenter fittings for conduits up to 2" and double screw indenter fittings for conduits 2" and larger.
- Die-cast or pressure cast fittings are not permitted.
- Connectors shall have insulated throat up to and including 1" size. For sizes 1-1/4" and larger, provide plastic insulating bushing.
- Provide conduit body types, shapes and sizes as required to suit application and NEC requirements. Provide matching gasket covers secured with corrosion-resistant screws.

EXPANSION FITTINGS

- Provide expansion fittings with external grounding straps at building expansion joints.
- Minimum 4" movement in either direction.
- At expansion joints in concrete pours, provide deflection/expansion fittings capable of movement of $\frac{3}{4}$ " in all directions from the normal.

WATER PROOFING SEALS

- Provide watertight expanding link-type seals for installation between the conduit and the sleeve or core drilled hole.

WIRE BASKET TRAY

- The wire basket tray shall be 12 – 13 gauge, straight sections shall be powder coated black with an average paint thickness of 1.2 mils (30 microns) to 3.0 mils (75 microns).
- Tray shall be designed in such a way as to be secured to the following, but not limited to: wall, ceiling every 1.2 metres.
- Splicing trays shall be accomplished by using a single manufacturer supplied UL classified connector bolt or splice plate.
- Depth: Tray depth shall be (unless otherwise shown on the drawings) 100mm (4 inches).
- Width: Tray width shall be (unless otherwise shown on the drawings) 300mm (12 inches).
- Turning Fences shall maintain approved bend radius and be constructed from sheet steel and plated in accordance with applicable standards.
- Intersections shall be made from high strength steel, welded and plated in accordance with applicable standards.
- Proper manufactured accessories and fittings such as elbows, reduces, crossovers, tees and riser shall be used for any change in direction, height or size of the cable basket tray.
- Support cable tray to suit loading and recommended support requirements in the Canadian Electrical Code Part II.
- Materials bolted or riveted to the cable tray shall be free of burrs and or sharp edges.

VENTILATED CABLE TRAYS

- All cable tray systems shall be designed in accordance with the latest version of the ANSI/TIA-569-E Standard and BICSI TDMM which exceed the minimum requirements of Canadian Electrical Code. Cable tray systems that are designed only to the Canadian Electrical Code and do not include all requirements of the ANSI/TIA-569-E Standard and BICSI TDMM shall be considered substandard and removed until such time as they are in compliance.
- Consultant to confirm with both the facility and CoT-IT regarding the areas that are suitable for cable tray, if suitable, what material type given the impact of certain airborne chemicals (aka Chlorine) that corrode metals.
- The ventilated cable tray is preferred to be used for horizontal cable distribution.
- The ventilated cable tray shall include but not be limited to the following characteristics:
 - A prefabricated structure consisting of a ventilated bottom with integral longitudinal side rails with no openings exceeding 50mm or 2" in a longitudinal direction.
 - Shall be prefabricated from a pre-punched sheet to produce a one-piece ventilated tray.
 - Shall be available in Aluminum, pre-galvanized Steel, hot dip Galvanized Steel and Stainless Steel 316.
 - Shall be a minimum of 103mm or 4" in depth or as appropriately designed and approved by Project Consultant and CoT-IT.
 - Proper manufactured accessories and fittings such as elbows, reduces, crossovers, tees and riser shall be used for any change in direction, height or size of the cable tray.
 - Spine type cable tray is not acceptable.
 - Support cable tray to suit loading and recommended support requirements in the Canadian Electrical Code Part II.
 - The support shall be placed within a maximum of 610mm on either side of any connection to a fitting.
 - Materials bolted or riveted to the cable tray shall be free of burrs and or sharp edges.

JUNCTION BOX

- All junction box applications shall be designed in accordance with the latest version of the ANSI/TIA-569-E Standard and BICSI TDMM which exceed the minimum requirements of Canadian Electrical Code. Application of junction boxes that are only designed to the Canadian Electrical Code and do not include all requirements of the ANSI/TIA-569-E Standard and BICSI TDMM shall be considered substandard and removed until such time as they are in compliance.
- Consultant to confirm with both the facility and CoT-IT regarding the areas that are suitable for junction box construction type given the impact of certain airborne chemicals (aka Chlorine) that corrode metals.
- For standard non chemically hazardous environments junction boxes shall be constructed of not less than 14-gauge galvanized steel with trim for flush or surface mounting in accordance with the location to be installed.
- Provide screw-on type cover boxes installed in damp or wet locations shall be of rain-tight construction with gasketed cover and threaded conduit hubs.
- Boxes shall be NEMA approved for the environmental condition of the location where they will be installed.

POKE THROUGH FLOOR BOX

- Where office facilities exist but access for cable distribution from above is not possible it may be practical to serve the floor from the ceiling space below with a Poke Through.
- Aluminum modular fire rated poke-through floor boxes coverings.
- Installs in 4" (101.6mm) diameter core drilled hole through concrete.
- UL listed for use in 1-4 hour rated floors.
- Poke-through fitting and universal cover combination exceed UL514A scrub water exclusion requirements.
- Stationary fire barrier expands during fire conditions to provide upper fire seal with adjustable fire barrier that would accommodate concrete floor thickness from 2-1/4" to 7".
- Dual 1" E.M.T. conduit tubes feed from communications feed and one for the electrical (when needed).
- Furniture feed for both power and communication services to modular furniture systems.

- Poke-through to have dual panels, one to hold four (4) RJ45 CAT6/6A Data/Voice ports. The other panel will have a blank plate.
- One-piece dual style line Poke-Through aluminum finish.
- Aluminum modular fire rated poke-through floor boxes coverings.
- Installs in 4" (101.6mm) diameter core drilled hole through concrete.
- UL listed for use in 1-4 hour rated floors.
- Poke-through fitting and universal cover combination exceed UL514A scrub water exclusion requirements.
- Stationary fire barrier expands during fire conditions to provide upper fire seal with adjustable fire barrier that would accommodate concrete floor thickness from 2-1/4" to 7".

GROUNDING AND BONDING

- All bonding to ground systems shall be designed and installed in accordance with the latest version of the ANSI/TIA-607-D Standard and BICSI TDMM which exceed the minimum requirements of the Canadian Electrical Code. Grounding and Bonding for Communications that are designed only to the Canadian Electrical Code and do not include all requirements of the ANSI/TIA-607-D Standard and BICSI TDMM shall be considered substandard and removed until such time as they are in compliance.
- Consultant to confirm with both the facility and CoT-IT regarding the areas that are suitable bonding and grounding points given the impact of certain airborne chemicals (aka Chlorine) that corrode metals.

PRIMARY BONDING BUSBAR (PBB) / TELECOMMUNICATIONS MAIN GROUNDING BUSBAR (TMGB)

- An insulated predrilled copper busbar listed by NRTL, electro-tin plated with holes 8mm diameter for use with standard-sized lugs.
- Dimensions 6mm thick, 100mm wide, variable length as applicable.
- Shall be insulated from its support by a minimum of 50mm.

SECONDARY BONDING BUSBAR (SBB) / TELECOMMUNICATIONS GROUNDING BUSBAR (TGB)

- Predrilled copper busbar listed by NRTL, electro tin plated with holes 8mm diameter for use with standard-sized lugs.
- Dimensions 6mm thick, 50mm wide, variable length as applicable.
- Shall be insulated from its support by a minimum of 50mm.

TELECOMMUNICATIONS BONDING BACKBONE (TBB)

- Cable assemblies shall be UL Listed and CSA Certified and be a minimum of 6 AWG copper conductor, green insulated.
- Telecommunications Grounding and Bonding Conductor Label Kits shall be supplied and installed by the Electrical Contractor at every rack and cabinet as well as one for every Telecommunications Grounding Busbar.
- The bonding conductor size shall be as follows:

TBB Length in Linear metres Metres (feet)	TBB Size (AWG)
Less than 4 (13)	6
4-6 (14 – 20)	4
6-8 (21 – 26)	3
8 – 10 (34 – 41)	2
13 – 16 (42 – 52)	1/0
16 – 20 (53 – 66)	2/0
Greater than 20 (66)	3/0

TELECOMMUNICATIONS BONDING CONDUCTOR (TBC)

- Cable assemblies shall be UL Listed and CSA Certified and be a minimum, the same size as the largest TBB copper conductor.
- Shall be green insulated and marked in accordance with ANSI/TIA-607-D.

WARNING LABELS

- Non-metallic warning labels in English: TIA-607-D.
- Identify labels with wording "If this connector is loose, please call the building telecommunications manager or site / area supervisor".

FIRE-STOPPING

- A fire-stop system is comprised of the item or items penetrating the fire rated structure, the opening in the structure and the materials and assembly of the materials used to seal the penetrated structure. Firestop systems comprise an effective block for fire, smoke, heat, vapor and pressurized water stream.
- All penetrations through fire-rated building structures (walls and floors) shall be sealed with an appropriate fire-stop system (EZ-PATH). This requirement applies to through penetrations (complete penetration) and membrane penetrations (through one side of a hollow fire rated structure). Any penetrating item i.e., riser slots and sleeves, cables, conduit, cable tray, and raceways, etc. shall be properly fire-stopped with EZ-PATH.
- Firestop systems shall be UL Classified to ASTM E814 (UL 1479) and shall be approved by a qualified Professional Engineer (PE), licensed (actual or reciprocal) in the state where the work is to be performed. A drawing showing the proposed fire-stop system, stamped/embossed by the Professional Engineer of Ontario (P.Eng.), shall be provided to the Owner's Technical Representative prior to installing the fire-stop system(s).
- EZ-PATH Part Numbers:
 - EZ-PATH Series 22, 33 and 44 (size based on cable quantities).

END OF SECTION

SECTION – 3: EXECUTION

It is Consultant / Designer responsibility to check the latest version of this document from CoT-IT.

GENERAL

- RCDD certified engineer shall perform the design and consulting work.
- Contractors / Technicians shall be certified with Belden and Fluke Networks to perform installations and testing / commissioning.
- Contractors must have an RCDD installation Team Lead / Project Manager.
- Technicians who have not completed the appropriate certification or training shall not pull, terminate or otherwise be involved in the installation of the telecommunications physical infrastructure with the exception of bonding to ground.
- Installers performing the testing (SAT, Acceptance, Commissioning, etc.) shall be Certified Cabling Test Technician on Fluke DSX / Versiv and Optifibre OTDR equipment.
- Following are the procedures to follow for successful project handing over:
 - Cable Acceptance Testing (CAT) – See Appendix for correct Sample Test Results and Compliance Sheet
 - Site Acceptance Testing (SAT) - See Appendix for Sample SAT Documents
 - As-built Drawings and Documents (ADD)
 - Consultant Review and Comments (CRC)
 - CoT-IT Approval of Satisfaction (AoS) – Signing off

HORIZONTAL CABLE INSTALLATION

- All cables and components shall be installed as per the Belden’s instruction sheets, ANSI/TIA standards and the BICSI Installation Methods Manual to complete the project.
- All testing of the Category 6/6A cabling system shall be with Fluke DSX-5000 / 8000 Versiv Cable Analyzers.

FIBREOPTIC CABLE INSTALLATION

- All cables and components shall be installed as per Belden’s instruction sheets, ANSI/TIA standards and the BICSI Installation Methods Manual to complete the project.
- All testing of the fibre optic installation shall be with test equipment from Fluke DSX-5000 / 8000 Versiv and if required (upon CoT-IT request) Optifibre OTDR.

CABLE ACCEPTANCE TESTING

- This section specifies the acceptance testing requirements for backbone fibre optic as well as horizontal UTP cabling.
- Supply all of the test equipment required to conduct acceptance tests.
- Submit acceptance documentation as defined in this section.
- All of the installed cabling must be tested and successfully pass all test criteria.
- Standards referenced in this section include:
 - ANSI/TIA-568: Telecommunications Cabling Standard. All standards referenced within the TIA-568, where applicable, constitute standard provisions of this specification.
 - ANSI/TIA-526-14: Optical Power Loss Measurement, Multimode
 - ANSI/TIA-526-7: Optical Power Loss Measurement, Single-mode
 - ANSI/TIA-1152: Requirements for field test instruments and measurements for balanced twisted-pair cabling
- Visually inspect all cables, cable reels and shipping cartons to detect possible cable damage incurred during shipping and transport. Visibly damaged goods shall be returned to the supplier and replaced at no additional cost to the City.
- All cables and termination hardware shall be 100% tested for defects in installation and to verify cabling system performance under installed conditions according to the requirements of ANSI/TIA-568 standard. All pairs of each installed cable shall be verified prior to system acceptance. Any defect in the cabling system installation including but not limited to cable, connectors, feed through couplers, patch panels and connector blocks shall be repaired or replaced in order to ensure 100% useable conductors in all cables installed without cost to the City.

COPPER PERMANENT LINK TESTING – HORIZONTAL CABLING

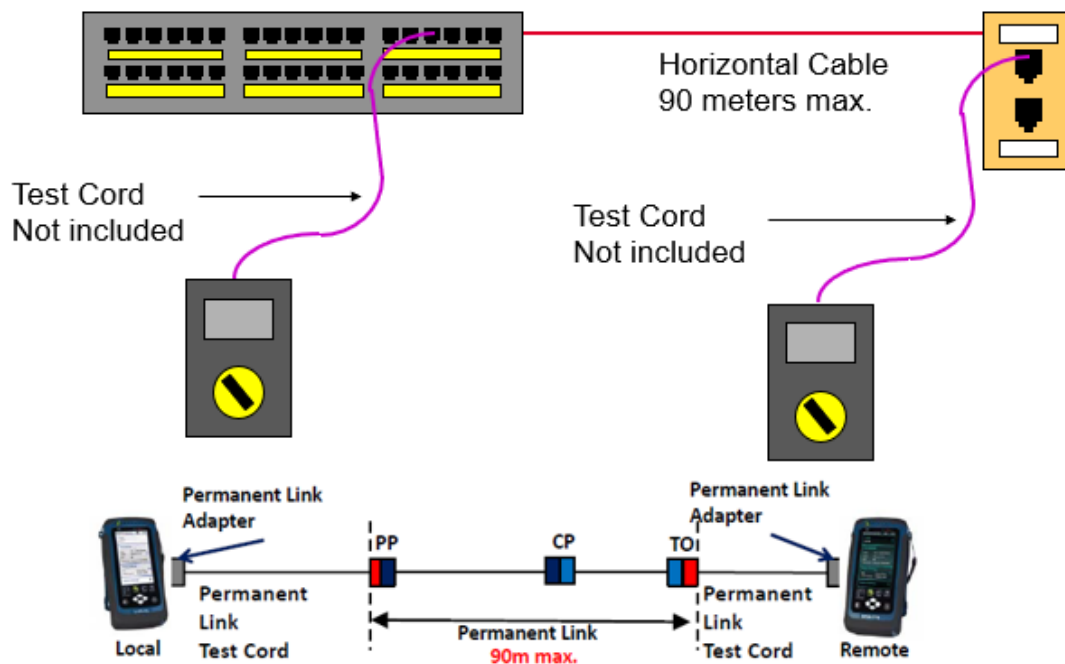
- All unshielded twisted-pair copper cable links shall be tested for continuity, pair reversals, shorts, opens and performance to Category 6/6A. Horizontal cabling shall be tested using a minimum level IIIe test unit for Category 6/6A performance compliance.
- Continuity - Each pair of installed cable shall be tested using a test unit that shows opens, shorts, polarity and pair-reversals, crossed pairs and split pairs. The test shall be recorded as pass/fail as indicated by the test unit and referenced to the appropriate cable identification number and circuit or pair number. Any faults in the wiring shall be corrected and the cable re-tested prior to final acceptance.
- Length - Each installed cable link shall be tested for installed length using a TDR type device. The cables shall be tested from patch panel to patch panel, block to block, patch panel to outlet or block to outlet as appropriate. The cable length shall conform to the maximum distances set forth in the ANSI/TIA-568.2 standard. Cable length shall be recorded, referencing the cable identification number and circuit or pair number. For multi-pair cable, the shortest pair length shall be recorded as the length for the cable.
- Horizontal twisted pair cable shall meet or exceed the permanent link, performance requirements specified in ANSI/TIA-568.2 for Category 6/6A, Unshielded Twisted Pair (U/UTP).
- All tests shall be conducted using permanent link configuration on the testing equipment.

COPPER TEST EQUIPMENT

- Category 6/6A Test Equipment - Category 6/6A test equipment shall meet the following minimum criteria:
 - All test equipment of a given type shall be from the same manufacturer and have compatible electronic results output. Acceptable test equipment manufacturer is Fluke Networks. Unless the manufacturer specifies a more frequent calibration cycle, calibration date shall be not more than a year from cable test date. Recommended test equipment is a Fluke Networks DSX 5000 / 8000 Versiv Cable Analyzer.
 - Test adapters must be approved by the manufacturer of the test equipment. Adapters from other sources are not acceptable. For horizontal cabling, permanent link adapters shall be used.
 - Baseline accuracy of the test equipment must meet or exceed TIA Level IIIe, as indicated by independent laboratory testing.

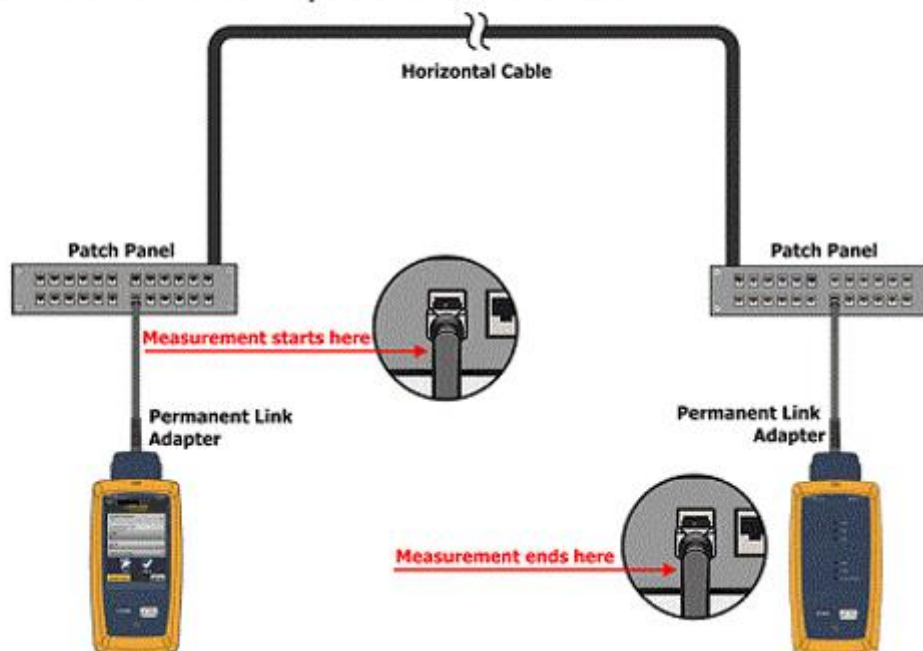
- Test equipment must be capable of certifying Category 6/6A to TIA-568.2 standard.
- Test equipment must have a dynamic range of at least 100 dB to minimize measurement uncertainty.
- Test equipment must be capable of storing full frequency sweep data for all tests.
- Test equipment must include S-Band time domain diagnostics for NEXT and return loss (TDNXT and TDRL) for accurate and efficient troubleshooting.
- Test equipment must be capable of running individual NEXT, return loss, etc., measurements in addition to auto tests. Individual tests increase productivity when diagnosing faults.
- Test equipment must make swept frequency measurements in compliance with ANSI/TIA-568.2 standard.
- The measurement reference plane of the test equipment shall start immediately at the output of the test equipment interface connector. There shall not be a time domain dead zone of any distance that excludes any part of the link from the measurement.
- The calibration of equipment shall be valid within one (1) year of the test date.

■ Permanent Link in LAN



■ Permanent Link Test in DC

Data center two connector permanent link definition:



HORIZONTAL CABLE TESTING DOCUMENTATION - COPPER

- Category 6/6A (UTP) Documentation - As a minimum, test reports shall include the following information for each U/UTP CAT6/6A cabling element tested:
 - Wiremap results that indicate the cabling has no shorts, opens, split, reversed, or crossed pairs and end-to-end connectivity is achieved.
 - Attenuation, NEXT, PSNEXT, Return Loss, ELFEXT and PSELFEXT data that indicate the worst-case result, the frequency at which it occurs, the limit at that point and the margin. These tests shall be performed in a swept frequency manner from 1 MHz to highest relevant frequency, using a swept frequency interval that is consistent with TIA and ISO requirements. Information shall be provided for all pairs or pair combinations and in both directions when required by the appropriate standards.
 - Length (in meters), propagation delay and delay skew relative to the limit.
 - Any individual test that fails the relevant performance specification shall be marked as a FAIL.

- Cable manufacturer, cable model number/type and NVP.
- Tester, manufacturer, model, serial number, hardware version and software version.
- Circuit ID number (Cable Tag Id) and Facility name.
- Test criteria used.
- Overall pass/fail indication.
- Date and time of test.

BACKBONE FIBREOPTIC TESTING

- Backbone fibre optic cable shall meet or exceed the permanent link, performance requirements specified in ANSI/TIA-568.3 for multimode and singlemode fibre.
- Test link attenuation with an OLTS:
 - For multimode fibre, make reference measurements in accordance with TIA-526-14, Annex A – One cord reference method. Measure optical loss on each fibre at 850nm and 1300nm. It is required to measure loss on each fibre from each direction (bi-directional).
 - For singlemode fibre, make reference measurements in accordance with TIA-526-7, one cord reference method. Measure optical loss on each fibre at 1310nm and 1550nm. It is required to measure loss on each fibre from each direction (bi-directional).
- Measure link length optically or calculate using cable sheath length markings.
- Multimode backbone fibre optic cabling shall meet the following loss and length criteria:
 - Attenuation @ 850nm shall be less than or equal to: fibre length (km) x 3.0 dB/km + number connector pairs x 0.5 dB + number of splices x 0.3 dB.
 - Attenuation @ 1300nm shall be less than or equal to: fibre length (km) x 1.5 dB/km + number connector pairs x 0.5 dB + number of splices x 0.3 dB.
 - Length shall be less than or equal to 150 meters.
- VCSEL driver is preferred to be used for testing as the SFP active modules on the switch runs with VCSEL drivers up to 10Gbps.
- Singlemode backbone fibre optic cabling shall meet the following loss and length criteria:

- Attenuation @ 1310nm shall be less than or equal to: fibre length (km) x 0.4 dB/km + number connector pairs x 0.75 dB + number of splices x 0.3 dB.
- Attenuation @ 1550nm shall be less than or equal to: fibre length (km) x 0.4 dB/km + number connector pairs x 0.75 dB + number of splices x 0.3 dB.
- Length more than 150 metres and shall be less than or equal to 10000 meters.

BACKBONE FIBREOPTICS TESTING DOCUMENTATION

- Fibreoptics Documentation: As a minimum, test reports shall include the following information for each fibreoptics cabling element (fibre) tested:
 - Actual measured attenuation, maximum allowable attenuation (loss) and the attenuation margin at the specified wavelengths. An individual test that fails the link criteria shall be marked as FAIL.
 - Reference method.
 - Number of mated connectors.
 - Actual length and maximum allowable length. Any individual test that fails the link length criteria shall be marked as FAIL.
 - Group refractive index (GRI) for the type of fibre tested, if length was optically measured.
 - Tester manufacturer, model, serial number and software version.
 - Circuit ID number (Cable Tag ID) and facility name.
 - Link criteria used.
 - Overall pass/fail indication.
 - Date and time of test.

FIBREOPTIC TEST EQUIPMENT

- All test equipment of a given type shall be from the same manufacturer and have compatible electronic results output. Acceptable test equipment manufacturer is Fluke Networks. Unless the manufacturer specifies a more frequent calibration cycle, calibration date shall not be more than a year from cable test date. Recommended test equipment is a Fluke Networks DSX-5000 /

8000 Versiv Cable Analyzers using VCSEL fibre modules (preferred) for multimode testing and/or OptiFiber OTDR (if advised by CoT-IT).

- The calibration of equipment shall be valid within one (1) year of the test date.
- Fiberoptics test equipment shall meet the following minimum criteria:
 - Test equipment shall be capable of measuring relative or absolute optical power in accordance with TIA-526-14, "Optical Power Loss Measurement of Installed Multimode Fiber Cable Plant."
 - Test equipment shall be capable of measuring relative or absolute optical power in accordance with TIA-526-7, "Optical Power Loss Measurement of Installed Single-mode Fibre Cable Plant."
 - Test equipment shall not include the loss or length of the test jumpers in the cable plant measurements.
 - Multimode test equipment shall incorporate both 850nm and 1300nm VCSEL/LED sources.
 - Single-mode test equipment shall incorporate both 1310nm and 1550nm laser sources.
 - Sources and meters shall automatically synchronize wavelengths to prevent calibration-related errors.
 - Test equipment shall employ a communications port to facilitate uploading of saved information from tester to PC.
 - Test equipment capable of measuring a Tx/Rx fibre pair simultaneously is recommended to enhance productivity. It is recommended that test equipment utilizing dual function main and remote units be used for bi-directional testing, eliminating the need to swap optical source and power meter.

CABLE TEST RESULTS MANUAL

- Consulting Engineer shall first review and comment on the test report. CoT-IT shall only receive the report after the review and approved comments of the Consulting Engineer. CoT-IT will finally provide their final review comment.
- Submit test reports in both a hardcopy and electronic format (native file). Hand-written test reports are not acceptable. If test results cannot be converted to a PDF format then provide any necessary proprietary/native software to view the results at no cost to the City.

- Fibre optic backbone cable test results shall be incorporated in the City of Toronto, Network - Cable Test Results manual. Submit two (2) copies of the Cable Test Results manual for each facility. The manual consists of hardcopy test result reports placed into lockable ‘D’ ring binders with a cover and spine that clearly indicates the title of the manual. Put a CD with the electronic copies of test reports in a pocket in the Cable Test Results manual.
- The Contractor (RCDD) PM must sign hardcopy reports before submitting it to the Consultant.

TEST COMPLIANCE SHEET

- A compliance sheet shall be prepared for every project of City of Toronto - IT. The criteria is summarized as below:

1	Test equipment with latest software version	8	Test results limits - TIA
2	Test equipment with latest test limit version	9	Test results based on VCSEL/LED Encircled Flux for OM4
3	Calibration of test equipment	10	Test results based on Laser for OS2
4	Test results submitted in native format and PDF format	11	MM testing at 850nm and 1300nm wavelength
5	Test result cable ID in compliance	12	SM testing at 1310nm and 1550nm wavelength
6	Permanent Link testing performed on copper (CAT6/6A)	13	Bi-directional testing
7	Test result cable type (copper and fibre) in compliance	14	Accurate quantity of adapters and splices

SITE ACCEPTANCE TEST (SAT)

- A Site Acceptance Test (SAT) will NOT test functionality of the system or its components. Site Acceptance Tests will evaluate the workmanship and verify installation against the *Installation* and *Layout* drawings.
- The SAT plan shall be submitted to CoT-IT, two (2) weeks in advance of commencement.

- The SAT plan shall have a checklist and identify tests with a schedule for CoT-IT to review and coordinate staff. Submit to the Contract Administrator/Project Manager and Consultant, three weeks prior to the commencement of the test, for review. The Contractor shall conduct the test when directed by the Contract Administrator. As a minimum, the Contract Administrator/Project Manager, Consultant and CoT-IT shall witness the test.
- The plan shall be sealed by the Installation Project Manager RCDD, followed by the RCDD Consultant.
- Prior to SAT, the Consultant shall review and approve all copper and fibre cabling testing, bonding and grounding inspections and any other criteria as may be described in the project tender.
- The SAT shall evaluate workmanship and verify construction and components against the Layout Drawings and associated Component Schedules submitted to and reviewed by the Consultant.
- The SAT shall be completed only when all items in the checklist have been witnessed and installed by the Contract Administrator/Project Manager, Consultant and CoT-IT as being in conformance with the design as specified.
- SAT of Equipment Room / Telecom Room
 - Each facility shall have one or more equipment room / telecom room, which house the server and network core closets. Each equipment / telecom room shall undergo a witnessed SAT.
 - The Consultant is responsible for the equipment / telecom room UPS, lighting panel and any ER/TR modifications noted in the tender drawings and specifications. The extent of ER/TR modifications varies for each facility.
 - In addition to the above, the ER/TR SAT shall include the evaluation of the server and core closet installation, power supplies to each closet and external cable management (e.g. cable tray). For the purpose of the ER/TR SAT the server and core closets shall be empty except for the installation of duplex receptacles to receive the UPS.
- SAT of Telecom Enclosure
 - As a minimum, the complete Telecom Enclosure for the SAT shall include the installation of copper patch panels, fibre patch panel, power supplies, horizontal cable terminations, cable management and patch cords.
 - At each facility, the Contractor shall provide one complete telecom enclosure, associated accessories and horizontal cable for the SAT. Following acceptance, the Contractor will be directed to proceed with the installation of the remaining TEs and horizontal cabling. The Contractor is to note that the fibre optic backbone cable installation will be included in the core closet SAT.

- The City reserves the right to do a random inspection of the telecom enclosure and those that do not comply with the above shall be made compliant at no expense to the City.

FIELD SUPPORT

- Provide 160 hours of on-site support for each facility beginning immediately after successful site acceptance test at that facility for a period of 24 months following Substantial Performance.
- Respond within 24 hours to a request for on-site support.
- The minimum site time per support call will be four (4) hours.
- The cost for the on-site field support shall be paid based on the rates quoted in the Schedule of Prices.

MAINTENANCE

- For a period of twelve (12) months following Final Acceptance, the Contractor shall provide a qualified technician/electrician to assist in the resolution of network related problems. The Contractor shall be given twenty-four (24) hours notice as to their requirement on-site.
- The Contractor will be compensated at the per diem rate quoted by the Contractor in the Form of Tender. However, if the source of the problem is discovered to be a result of work or components supplied by the Contractor, the Contractor shall not be compensated.

WARRANTY

- Testing and certification of the Building Network Distribution Cabling System shall be by the installer and shall include the provision of a Belden Warranty covering performance, products and installation.
- The Warranty shall cover the full repair and/or replacement of any component failing or failure to meet the design requirements within one (1) year.
- Warranty shall be delivered by the Contractor in coordination with Belden to the Client's Project Manager with the Testing and Certification documents. The project site shall receive manufacturer's plaque. All coordination regarding warranty and handing over of the manufacturer's plaque is the responsibility of the Contractor.

- The manufacturer shall warrant the project for twenty-five (25) years against application assurance and extended product manufacturing defects.
- The Contractor shall warrant installation against all product installation defects and that all approved cabling components meet or exceed the specified requirements for a period of twenty-five (25) years following acceptance.
- The Contractor shall warrant that all permanent fibre optic links meet or exceed the performance requirements of TIA-568.3 for multimode and singlemode fibre.
- The Contractor shall warrant that all permanent twisted pair links meet or exceed the performance requirement of TIA-568.2 for category 6/6A, unshielded twisted pair.
- Contractor must provide complete end to end mapping of all connectivity at the end in both hard and softcopy formats. This includes but not limited to horizontal data / voice cable number, copper and fibre backbone cable and active equipment ports.
- Within ten (10) days after testing, the cable installer shall provide the Project Manager with documentation, which shall include cable test results, a marked-up copy of the as-built cable network drawing and an electronic copy of the completed installation in Bentley Microstation Ver. 8 and AutoCAD or as per City's CAD guidelines.
- Contractor shall provide a manufacturer written certificate, plaque and warranty that the structured cabling platform is installed and fully operating in accordance with this standard and manufacturers specification.
- The warranty must guarantee that the design or installation negligence on the part of the Cabling Contractor shall not negate or void any portion of the certified system. The manufacturer must guarantee that all material, components and labour are covered in this circumstance for the full certification period of twenty-five (25) years. It must also guarantee that in the event a Cabling Contractor is no longer able to service the warranty, the full certification remains valid and is responsibility of the manufacturer.
- If a warranty issue arises for the cabling, the Warrantor must make arrangements to undertake the repair or replacement of warranty issues within 24 hours of notification. This may require the repair/replace of cabling components outside regular working hours at no additional cost.
- The warranty for the cabling must be such that the cable meets or exceeds the requirements of TIA-568 'Transmission Performance Specifications for 100 Ohm 4-pair Category 6/6A Cabling' including all Standards stated in this Contract.
- The Cabling Contractor shall forward the Structured Cabling Platform certification request form(s) to the proper authority and ensure that a Plaque and Certificate is issued to the Customer / Project Site along with the Structured Cabling Platform user manual. The successful bidder shall provide a certification number within two weeks of award of this project. Please

note that the Plaque/Certificate must have the Customer name/Project name on the Plaque/Certificate.

- The Cabling Contractor shall provide letter(s) of Certification within two weeks of substantial completion of the project to the Customer. This document will include the following: verification of the performance of the installed system, identification of the installation by location and project number and a copy of the warranty.
- Upon request and at no additional cost to the Customer the Cabling Contractor must provide a manufacturer's technical representative to conduct an on-site visit to ensure complete technical compliance.
- The Cabling Contractor must supply a copy of an unexecuted warranty statement (at the time of bidding) including all related terms and conditions. This copy shall be the Standard to which the warranty will be held. No changes shall be accepted unless it is deemed to benefit the Customer. Any proposed changes to the warranty must be submitted in writing to the Customer/their representative for review. The changes will then be accepted or declined by the Customer at their discretion. This is to remain valid for the entire warranty period.
- All cable Cabling Contractor technicians on site must be trained by the manufacturer of the Structured Cabling Platform being installed.
- Any defective or improperly installed products shall be replaced, or correctly reinstalled at no cost to the Customer.

QUALIFICATIONS AND TRAINING

- An on-site training may be required for the Client to understand the system and installation.
- Contractors shall be certified with Belden and Fluke Networks to perform installations and testing.
- Contractors must have an RCDD installation Project Manager.
- Technicians who have not completed any certification program shall not pull, terminate or otherwise be involved in the installation of the telecommunications physical infrastructure with the exception of bonding to ground.
- Installers performing the testing (SAT, Acceptance, Commissioning, etc.) shall be certified CCTT on Fluke DSX and/or Optifibre OTDR.
- All Fluke credentials shall be submitted to the City during project award process for validation.
- The testing equipment shall be valid and calibrated within one (1) year as per manufacturer specifications.

- The cable installer shall have full working knowledge of cabling low voltage applications such as, but not limited to, Non-Secure Data/Voice communications cabling systems.
- Provide references of the type of installation provided for in this specification.
- Have knowledge of all applicable Telecommunication Standards such as but not limited to: CSA, TIA, IEEE and ANSI.
- Have experience in the installation of pathways and support for horizontal and backbone cabling.
- Be experienced in the installation and testing of telecommunication network cabling system, including the use of a light meter and OTDR.
- Provide proof of being a manufacturer certified installer for all cable network components being installed such as but not limited to cables, connectors and end termination equipment. The use of a non-manufacturer certified installer is not permitted.

AS-BUILT DRAWINGS

- The drawings shall include cable routes and outlet locations.
- Outlet locations shall be identified by their sequential number as defined elsewhere in this document.
- Numbering, icons and drawing conventions used shall be consistent throughout all documentation provided.
- For new infrastructure project, the Consultant shall provide the design drawings / tender drawings / floor plans in paper and electronic (Microstation) formats on which as-built construction information can be added.
- For an existing infrastructure upgrade, the Owner may provide floor plans in paper and electronic (Microstation) formats on which as-built construction information can be added.
- These documents shall be modified accordingly by the Telecommunications Contractor to denote as-built information as defined above and returned to the Owner.
- The Contractors shall annotate the base drawings and return a hard copy (same plot size as originals) and electronic (Microstation) form.

FINAL ACCEPTANCE

- Once all work has been completed including all documentation submissions, the City will notify the satisfaction to the Consultant in writing of formal acceptance of the system.
- Consultant must warrant in writing that 100% of the installation meets the design requirements as specified.
- Contractor must warrant in writing that 100% of the installation meets the requirements specified in the tender documents.
- The CoT-IT reserves the right to conduct, using Contractor equipment and labour, a random re-test of up to five (5) percent of the cable plant to confirm documented results. Any failing cabling shall be re-tested and restored to a passing condition. In the event more than two (2) percent of the cable plant fails during re-test, the entire cable plant shall be re-tested and restored to a passing condition at no additional cost to the Owner.
- Acceptance shall be subject to completion of all work, successful post-installation testing which yields 100% PASS rating and receipt of full documentation as specified.
- The City may agree to allow certain cable runs to exceed acceptable standardized performance criteria. If required these cable runs will be exempt from meeting the specified standards. However, the Contractor will still be required to test these cable runs to validate component and installation performance.
- Documentation: The Contractor shall submit the following documentation for final acceptance:
 - City of Toronto - IT Network — Cable Test Results Manual.
 - Cable Acceptance Test (CAT) – Compliance Sheet
 - Site Acceptance Test (SAT)
 - As-built Drawings and Documents (ADD)
 - Consultant Review and Comments (CRC)
 - CoT-IT Approval of Satisfaction (AoS) – Signing off

APPENDIX-A: SAMPLE OF CABLE ACCEPTANCE TEST (CAT)



CITY OF TORONTO - CABLE TEST RESULTS COMPLIANCE SHEET

Project Name		Contract/Project Number	
Facility Name		Facility Address	
Location		Closet/Rack Number	
Consultant		Contractor	
Original Submission Date	Second Submission Date	Third Submission Date	Fourth Submission Date
City Reviewer	Date Issued	Status <input type="checkbox"/> Approved <input type="checkbox"/> Disapproved	

General

No.	GENERAL	Comply	Does Not Comply	Not Applicable
1	Cable test equipment DSX-5000 / 8000 with latest software version			
2	Cable test equipment DSX-5000 / 8000 with latest limit version			
3	Calibration certificate of the cable test equipment provided to the City			
4	Cable test results supplied to the City in PDF and Native format			
5	Test result specify the project name and / or contract number			
6	Test result specify site name or facility code			

Copper Test Results

No.	COPPER	Comply	Does Not Comply	Not Applicable
1	Permanent link testing performed			
2	Patch cord testing performed			
3	Test result cable identification in compliance with CoT-IT Standard			
4	Test result cable type in compliance with CoT-IT Standard – TIA-568 Horizontal			

Fiberoptics Test Results

No.	FIBRE	Comply	Does Not Comply	Not Applicable
1	Test results based on LED/VCSEL for OM4 50/125 um MM fibre cabling			
2	Test results based on FP Laser for OS2 9/125 um SM fibre cabling			
3	MM testing at 850nm and 1300nm modal bandwidth			
4	SM testing at 1310nm and 1550nm modal bandwidth			
5	Test result cable identification in compliance with City of Toronto-IT Standard			
6	Test result cable type in compliance with City of Toronto-IT Standard and TIA-568 Backbone MM/SM			
7	Test link attenuation in accordance with TIA-526-14 or TIA-526-7 makes reference measurements in accordance with METHOD-B (one jumper cable measurement for MM) or METHOD-A.1 (one jumper cable measurement for SM). Measure optical loss on each fibre at 850nm and 1300nm (for MM) or 1310nm and 1550nm (for SM).			
8	Measure loss on each fibre from each direction (bi-directionally) as per CoT-IT Standard			
9	Accurate quantity of adapter and splices			
10	Smart Remote mode used for testing dual-fibre strands			





Cable ID: CCTV-MZ/02/01/020

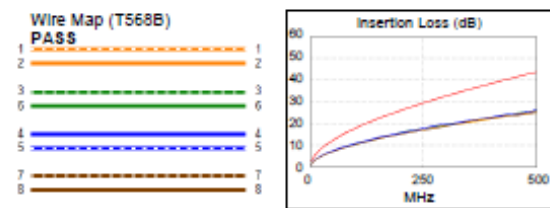
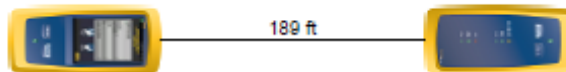
Test Summary: PASS

Test Limit: TIA Cat 6A Perm. Link
 Limits Version: V7.6
 Date / Time: 06/06/2022 04:38:25 PM
 Operator:
 Headroom 3.3 dB (NEXT 3,6-7,8)
 Cable Type: Cat 6A U/UTP
 NVP: 68.2%

Main: Versiv
 S/N: 2790064
 Software Version: V6.6 Build 2
 Calibration Date: 01/31/2022
 Adapter: DSX-5000 (DSX-PLA004)
 S/N: 4710039

Remote: Versiv
 S/N: 2797296
 Software Version: V6.6 Build 2
 Calibration Date: 01/31/2022
 Adapter: DSX-5000R (DSX-PLA004)
 S/N: 4710040

Length (ft), Limit 295	[Pair 7,8]	189
Prop. Delay (ns), Limit 498	[Pair 4,5]	295
Delay Skew (ns), Limit 44	[Pair 4,5]	13
Resistance (ohms)	[Pair 4,5]	9.09
Insertion Loss Margin (dB)	[Pair 3,6]	17.4
Frequency (MHz)	[Pair 3,6]	497.0
Limit (dB)	[Pair 3,6]	43.6



Worst Case Margin Worst Case Value

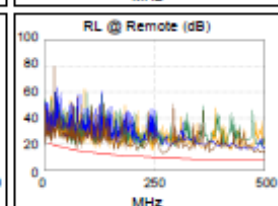
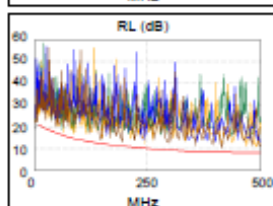
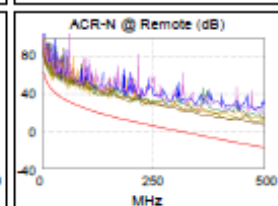
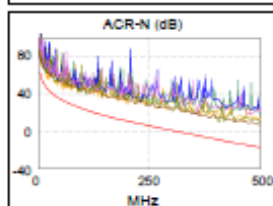
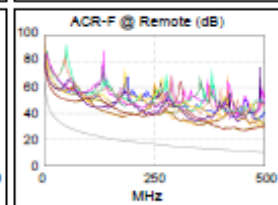
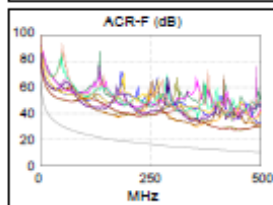
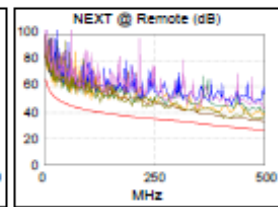
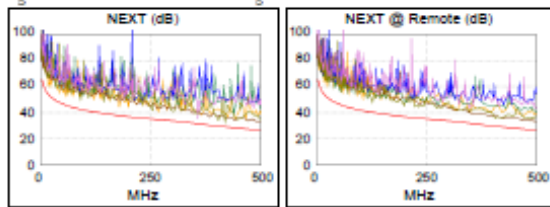
PASS	MAIN	SR	MAIN	SR
Worst Pair	3,6-7,8	3,6-7,8	3,6-7,8	3,6-4,5
NEXT (dB)	3.3	6.1	3.3	6.4
Freq. (MHz)	410.0	406.0	410.0	497.0
Limit (dB)	29.5	29.6	29.5	26.7
Worst Pair	3,6	3,6	3,6	3,6
PS NEXT (dB)	4.6	5.5	6.4	7.0
Freq. (MHz)	410.0	424.0	500.0	497.0
Limit (dB)	26.7	26.2	23.8	23.8

PASS	MAIN	SR	MAIN	SR
Worst Pair	4,5-3,6	3,6-4,5	4,5-3,6	3,6-4,5
ACR-F (dB)	15.7	15.9	15.7	15.9
Freq. (MHz)	441.0	450.0	441.0	450.0
Limit (dB)	11.3	11.1	11.3	11.1
Worst Pair	3,6	3,6	3,6	3,6
PS ACR-F (dB)	16.9	16.4	18.4	17.8
Freq. (MHz)	1.1	1.3	463.0	453.0
Limit (dB)	60.2	59.3	7.9	8.1

N/A	MAIN	SR	MAIN	SR
Worst Pair	1,2-3,6	1,2-3,6	3,6-4,5	3,6-4,5
ACR-N (dB)	10.6	12.2	24.0	23.8
Freq. (MHz)	17.4	17.4	500.0	497.0
Limit (dB)	46.8	46.8	-17.1	-16.9
Worst Pair	3,6	1,2	3,6	3,6
PS ACR-N (dB)	11.8	13.7	24.1	24.3
Freq. (MHz)	19.3	17.3	500.0	497.0
Limit (dB)	43.3	44.4	-20.0	-19.7

PASS	MAIN	SR	MAIN	SR
Worst Pair	7,8	7,8	7,8	7,8
RL (dB)	1.9	3.5	2.0	5.0
Freq. (MHz)	146.5	274.0	357.0	481.0
Limit (dB)	12.3	9.6	8.5	8.0

Compliant Network Standards:
 10BASE-T 100BASE-TX 100BASE-T4
 100BASE-T 2.5GBASE-T 5GBASE-T
 10GBASE-T ATM-25 ATM-51
 ATM-155 100VG-AnyLan TR-4
 TR-16 Active TR-16 Passive



LinkWare™ PC Version 10.5





Cable ID: 024 **Test Summary: PASS**
 Date / Time: 02/15/2022 09:45:58 AM n = 1.467000 (1310 nm) Backscatter Coefficient: -79.4dB (1310 nm)
 Cable Type: SMF G652D n = 1.468000 (1550 nm) Backscatter Coefficient: -81.7dB (1550 nm)

Loss (R->M)
PASS

Test Limit: ISO/IEC 14763-3
 Limits Version: 7.6
 Date / Time: 02/15/2022 09:45:58 AM
 Operator: JOHN
 Main: Versiv
 S/N: 21123084
 Software Version: V5.7 Build 1
 Module: CertiFiber Pro (CFP-QUAD)
 S/N: 21212667
 Calibration Start Date: 08/12/2021
 Remote: Versiv
 S/N: 21120065
 Software Version: V5.7 Build 1
 Module: CertiFiber Pro Remote (CFP-QUAD)
 S/N: 21212670
 Calibration Start Date: 08/12/2021

Propagation Delay (ns)	7887	
Length ft	5284	PASS
Limit 16404		
Result	1310 nm	1550 nm
Loss (dB)	PASS	PASS
Limit (dB)	0.78	0.52
Margin (dB)	3.21	3.21
Reference (dBm)	2.43	2.69
Reference (dBm)	-4.04	-4.00

Number of Adapters: 2
 Number of Splices: 2
 Connector Type: LC
 Patch Length1 (ft): 7
 Reference Date: 02/15/2022 08:55:51 AM
 1 Jumper

Loss (M->R)
PASS

Test Limit:
 Limits Version:
 Date / Time:

Result	1310 nm	1550 nm
Loss (dB)	PASS	PASS
Limit (dB)	0.46	0.32
Margin (dB)	3.21	3.21
Reference (dBm)	2.75	2.89
Reference (dBm)	-3.07	-3.05

Compliant Network Standards:

- | | | |
|----------------------------|----------------------------|---------------------------|
| 100GBASE-LX | 100GBASE-ER4 | 100GBASE-LR4 |
| 10GBASE-E | 10GBASE-L | 10GBASE-LX4 |
| 40GBASE-ER4 | 40GBASE-LR4 | Fibre Channel 100-SM-LC-L |
| Fibre Channel 1200-SM-LC-L | Fibre Channel 1600-SM-LC-L | Fibre Channel 200-SM-LC-L |
| Fibre Channel 400-SM-LC-L | Fibre Channel 400-SM-LC-M | Fibre Channel 800-SM-LC-L |

LinkWare™ PC Version 10.5



APPENDIX-B: SAMPLE OF SITE ACCEPTANCE TEST (SAT) DOCUMENTS

Checklist of Telecom Enclosure (TE) / Network / Core Closet Site Acceptance Test (SAT)

Facility:	Project Name:
Contract No.:	Telecom Enclosure / Network / Core Closet Tag:
Building:	Sub-Location:
Consultant:	Contractor:
Date:	CoT-IT Staff:

TELECOM ENCLOSURE (TE) / NETWORK / CORE CLOSET LAYOUT AND AS-BUILT DRAWINGS**Procedure:**

- Verify that the as-built drawings are present.
- Verify the Telecom Enclosure components match the bill of materials.
- Verify equipment layout is as shown in the as-built drawings.
- Verify all components are tagged and wiring is labeled as per the drawings. (Enclosure, Patch Panels, Copper Patch Panel(s) Work Area Outlets, Cables, Power Distribution Components, etc.)
- Verify the horizontal and backbone fibre cable terminations and labeling.

If any comments are necessary, enter a note number in the test form column and record the comment in the comments form at the end of this document.

Acceptance Criteria:

Telecom Enclosure construction and labeling shall match the as-built drawings.

As Built Drawings Verification			
Item No.	Description	Pass/Fail	Notes
1	As built drawings present		
2	Bill of materials in compliance		
3	Layout / arrangement of components in compliance		
4	All components tagged as per as-built drawings. (Enclosure, Patch Panels, Copper Patch Panel(s) Work Area Outlets, Power Distribution Components, etc.)		
5	All wiring labeled as per as-built drawings		

Power and Fusing Verification

Procedure:

Verify that the indicated circuit breakers or fuses are installed and labeled with the indicated rating and source and destination distribution panel, breaker position ID. Refer to as built Telecom Enclosure wiring diagrams for the required circuit protection and rating. Record the installed protection device rating.

If the indicated installed circuit protection device matches the required rating enter PASS in the test form column.

If any comments are necessary, enter a note number in the test form column and record the comment in the comments form at the end of this document.

Acceptance Criteria:

Installed fuses and circuit breakers shall match the required specifications and labeled accordingly. The correct equipment is powered by the fuse and/or circuit breaker as shown on the as-built electrical drawings.

TE AC Power, Fusing and Tagging/Labeling Verification						
Circuit Breaker / Fuse ID	Description	Required Rating	Installed Rating	Pass / Fail	Source / Destination ID	Notes
120V AC UPS Power Supplementary Protectors						
SP02	UPS Receptacle and UPS Pilot Light (if applicable)	15A				
120V AC Hydro Power Supplementary Protectors						
SP01	Surge Suppressor and Utility Pilot Light (if applicable)	15A				
SP03	Panel Light	5A				
SP04	Utility Receptacle	15A				

Grounding & Bonding Verification

Procedure:

Verify that the indicated component is properly connected to the ground.

- Switch off system power.
- Verify the installation of the ground connection between the grounding bus or common ground terminal and the indicated component.
- Measure the DC resistance between the grounding bus or common ground terminal and the indicated component.
- Record the measured DC resistance between the ground connection and the component.

If the indicated grounding connection is installed and meets the maximum DC resistance specification enter a PASS in the test form column. If any comments are necessary, enter a note number in the test form column and record the comment in the comments form at the end of this document.

Acceptance Criteria:

The grounding or bonding conductor is installed and the DC resistance measurement must be less than or equal to 0.2 Ω between termination points.

Telecom Enclosure (TE) Grounding & Bonding Verification				
Grounding / Termination Point	Ground Conductor Visual Inspection	Resistance Ω Measured	Pass / Fail	Notes
Surge Suppressor		Ω		
UPS Receptacle / Isolated Ground		Ω		
Utility Receptacle		Ω		
Enclosure Door		Ω		
APC Power Bar		Ω		
Rack Mount Ground Bus		Ω		

Spare Parts, Loose Shipped Components, TE - Bill of Material Verification

Procedure:

Verify all spare parts and loose shipped components as required in the as-built drawings and bill of material are present. Typical items may be Fiber Optic Patch Cables, Copper Patch Cables, etc.

Enter PASS in the test form column if parts are present. If any comments are necessary, enter a note number in the test form column and record the comment in the comments form at the end of this document.

Acceptance Criteria:

Spare parts and loose shipped components are present as required.

Spare Parts and Loose Shipped Items			
Item No.	Description	Pass / Fail	Notes
1	Drawings		
2	Fiber Optic Patch Cords		
3	Copper Patch Cords		
4			
5			
6			
7			
8			
9			
10			

Approvals / Sign Off

Site Acceptance Test

City

Name : _____ Company: _____

Signature: _____ Date: _____

Consultant

Name : _____ Company: _____

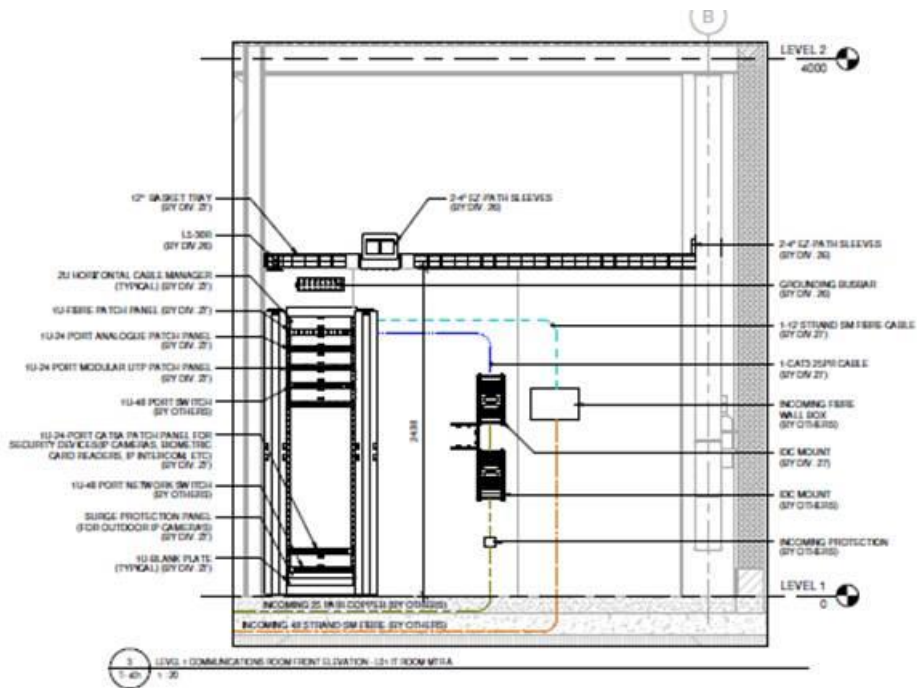
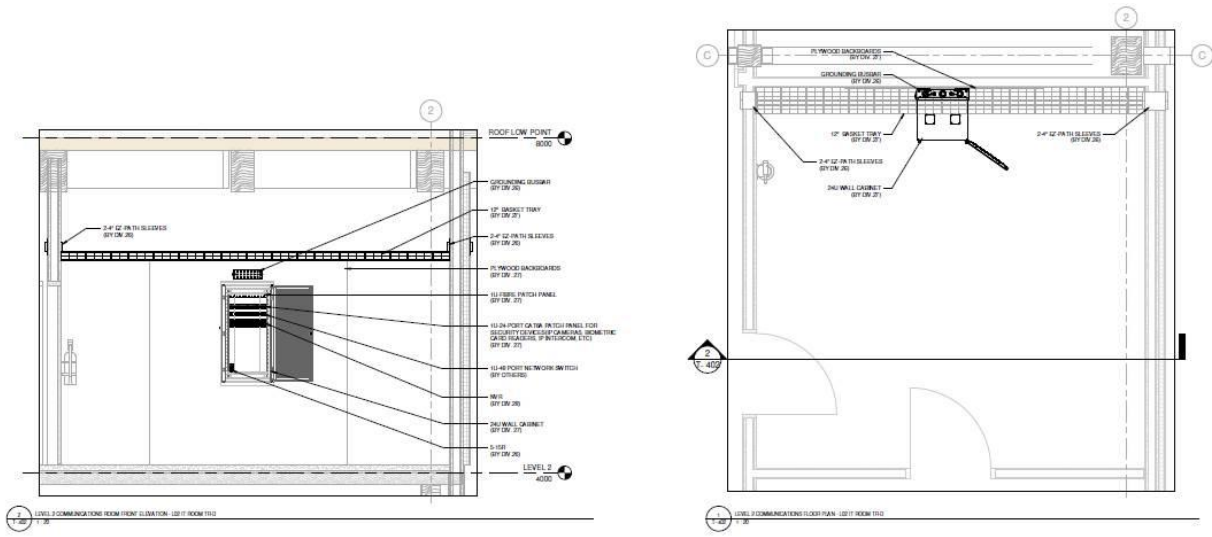
Signature: _____ Date: _____

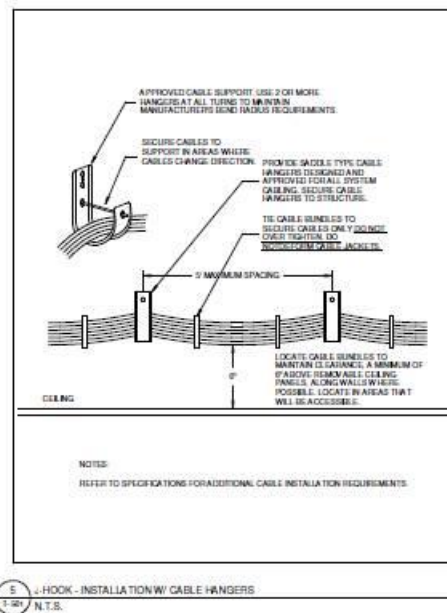
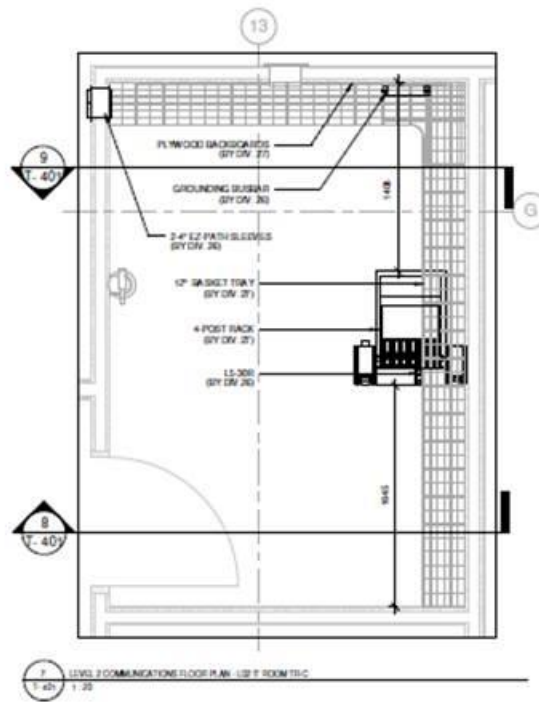
Contractor

Name : _____ Company: _____

Signature: _____ Date: _____

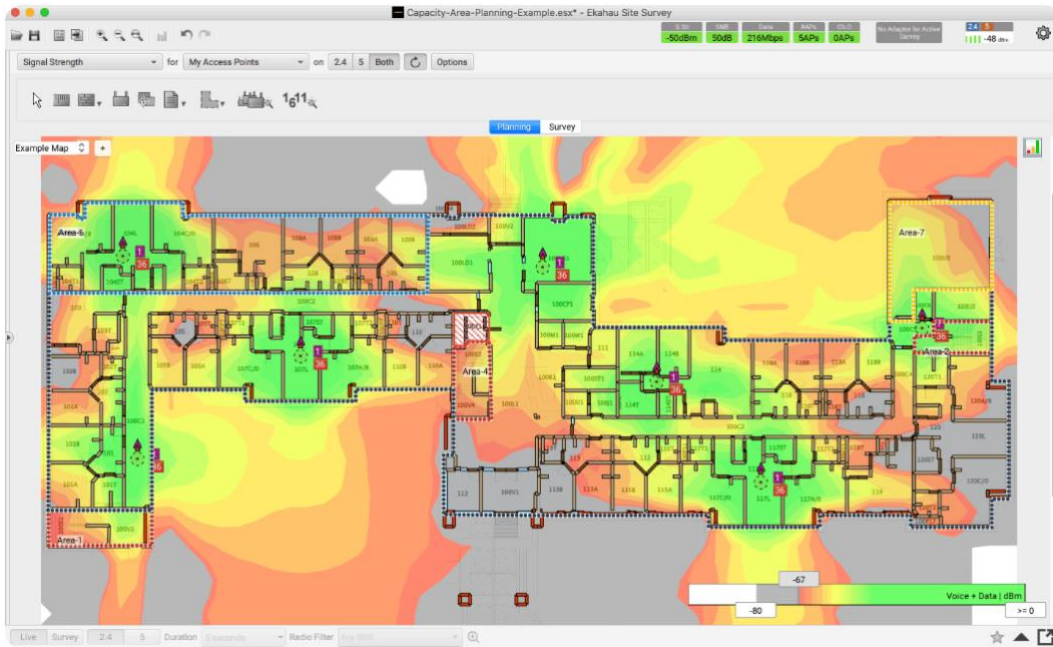
APPENDIX-C: SAMPLE OF TELECOM WIRING DIAGRAMS | DRAWINGS | PHOTOGRAPHS











WI-FI COVERAGE HEATMAP – EXAMPLE (EKAHAU)

END OF DOCUMENT

APPENDIX C

Pre-Renovation Designated Substances and Hazardous Materials Survey

Prepared by
Environmental Consulting Occupational Health
Dated: January 10, 2025



Environmental Consulting
Occupational Health

PRE-RENOVATION DESIGNATED SUBSTANCES AND HAZARDOUS MATERIALS SURVEY

**TORONTO WATER OFFICES
95 THE ESPLANADE
TORONTO, ON**

Prepared for:
City of Toronto
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ECOH Project No.: 29001
January 10, 2025



EXECUTIVE SUMMARY

ECOH Management Inc. (ECOH) was retained by the City of Toronto to conduct a Pre-Renovation Designated Substances and Hazardous Materials assessment at the Toronto Water Offices, located at 95 The Esplanade, in Toronto, ON. The objectives of the survey were to identify potential environmental considerations associated with areas of the building to be impacted by the planned renovations to the interior offices of the facility, hereafter referred to as the "Project Area", and provide recommendations, as necessary, to fulfil requirements set forth within the Ministry of Labour Codes as well as the Ontario Occupational Health and Safety Act. Joey Huynh of ECOH performed the survey and assessment on December 20, 2024.

This executive summary provides a brief overview of the key survey findings and associated recommendations. Detailed information regarding the findings and recommendations are discussed in the body of the report.

FINDINGS

Table 1 presents a brief outline of ECOH's findings within the Project Area. For analytical results for asbestos and lead, refer to Appendix II - Results of Bulk Sample Analysis for Asbestos & Lead. Refer to the main body of the report and Appendix I for specific details, quantities and locations of Designated Substances and Hazardous Materials in the Project Area.

Table 1: Summary of Findings	
Material	Findings
Asbestos	No asbestos-containing materials (ACM) were observed to be present within the Project Area. Additional asbestos-containing materials may be present within concealed conditions of the Project Area.
Lead	No major sources of lead or lead-containing products were identified during the survey; however, lead may be present in: <ul style="list-style-type: none">• Internal batteries associated with emergency lighting system,• Ceramic tile glazing,• Wiring connectors and electric cable sheathing, and• Solder joints on copper piping.
Mould	Mould-growth was not observed to be present at the time of the assessment.
Mercury	Minor quantities may be present as a possible constituent of paints and adhesives.
Polychlorinated Biphenyls (PCBs)	PCBs were not observed to be present within the Project Area.
Silica	Present in all concrete and masonry products.

EXECUTIVE SUMMARY

Table 1: Summary of Findings

Material	Findings
Other Designated Substances and Hazardous Materials	Acrylonitrile, Arsenic, Benzene, Coke Oven Emissions, Ethylene Oxide, Mould, Ozone Depleting Substances, Isocyanates, Urea Formaldehyde Foam Insulation (UFFI) and Vinyl Chloride Monomer were not noted in significant quantities or forms, if at all.

RECOMMENDATIONS

The following recommendations meet the requirements of the Occupational Health and Safety Act. Asbestos recommendations meet the requirements of the Designated Substance – Regulation respecting *Asbestos on Construction Projects and in Buildings and Repair Operations*, Ontario Regulation 278/05. Based upon review of historical reports, as well as analytical results and observations of this assessment, ECOH offers the following for your consideration.

Asbestos

Based on survey results, the following conclusions are made with regards to asbestos-containing materials (ACMs) within the Project Area:

- As the materials present in the Project Area anticipated for disturbance are non-asbestos containing, removal or disturbance of these materials does not require asbestos safety procedures. However, general health and safety precautions including, in part, the use of dust suppression techniques and appropriate respiratory protection.
- During project work, if any additional materials are found beyond those which are described in this report or described in the existing inventory of asbestos-containing materials (i.e., materials not previously identified, or materials that are not homogenous to those previously identified, or materials that become revealed during the work), additional testing for asbestos-content should be completed immediately and prior to disturbance of the material. Alternatively, these materials can be assumed to contain asbestos, and the appropriate level of asbestos safety precautions must be implemented.

Lead

The removal of assumed or confirmed lead-containing construction materials (i.e., lead concentrations >0.1% or 1000ppm) should be completed in accordance with the recommendations of the Environmental Abatement Council of Canada (EACC), *EACC Lead Guideline for Construction, Renovation, Maintenance or Repair*, October 2014, which incorporates the Ontario Ministry of Labour Document, *Guideline Lead on Construction Projects*, April 2011.

Materials containing even trace amounts of lead should be removed without grinding, cutting, torching, or chemical stripping. Additionally, workers should employ general safety precautions such as appropriate dust suppression methods and proper personal protective equipment.

EXECUTIVE SUMMARY

Mercury

Avoid direct skin contact with mercury and avoid inhalation of mercury vapour. Dispose of mercury following requirements of the Canada Environmental Protection Act, the Transportation of Dangerous Goods Act and provincial legislative requirements that may be applicable.

Silica

Cutting, grinding, or demolition of materials containing silica should be completed using general health and safety precautions including the use of dust suppression techniques and appropriate respiratory protection.

During major renovations, removal of materials containing silica should be removed following recommendations detailed within the Ministry of Labour document, *Guideline - Silica on Construction Projects*, dated, April 2011.

This executive summary provides a brief overview of the study findings. It is not intended to substitute for reading the complete report, nor does it discuss specific issues documented in the report.

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1. INTRODUCTIONS

ECOH Management Inc. (ECOH) was retained by the City of Toronto to conduct a Pre-Renovation Designated Substances and Hazardous Materials assessment at the Toronto Water Offices, located at 95 The Esplanade, in Toronto, ON. The objectives of the survey were to identify potential environmental considerations associated with areas of the building to be impacted by the planned renovations to the interior offices of the facility, hereafter referred to as the "Project Area", and provide recommendations, as necessary, to fulfil requirements set forth within the Ministry of Labour Codes as well as the Ontario Occupational Health and Safety Act. Joey Huynh of ECOH performed the survey and assessment on December 20, 2024.

The survey included an investigation for the presence of Designated Substances including:

- Acrylonitrile
- Arsenic
- Asbestos
- Benzene
- Coke Oven Emissions
- Ethylene Oxide
- Isocyanates
- Lead
- Mercury
- Silica
- Vinyl Chloride Monomer

And for Hazardous Materials including:

- Polychlorinated Biphenyls (PCB)s
- Mould
- Ozone Depleting Substances (ODS)
- Other Hazardous Materials

The following report details the project scope of work, regulatory requirements, survey and analytical methodologies, survey findings and recommendations, and survey statement of limitations.

1.1 Regulatory Requirements

A Designated Substances and Hazardous Materials Report is completed to fulfil the Owner's requirements under Section 30 of the Ontario Occupational Health and Safety Act. Prior to tendering project work in a building, the building owner must provide this report to contractors tendering on the work.

Ministry of Labour Regulation 278/05, *Regulation respecting Asbestos on Construction Projects and in Buildings and Repair Operations*, controls the disturbance of asbestos materials on construction projects. Ministry of Environment Regulation, R.R.O. 347, controls the disposal of asbestos waste. The Ministry of Labour has also issued guidelines for the control of Lead and Silica on construction projects, these entitled, *Guideline - Lead on Construction Projects* and *Guideline - Silica on Construction Projects*.

There are no specific Ministry of Labour regulations for control of the remaining Designated Substances on construction projects. However, the Ministry of Labour actively enforces the general duty clause of the Occupational Health and Safety Act which protects workers and

provides guidance on exposure monitoring, permissible exposure levels, medical monitoring, etc., for all Designated Substances in an occupational setting.

2. SURVEY SCOPE OF WORK AND METHODOLOGY

2.1 General Approach

Details of the survey methodology, as was applied to this facility, are as follows:

- Visual inspections of the Project Area (as denoted on the project drawings) were completed using the following protocol:
 - All Accessible areas (i.e., above false ceilings or within solid ceilings and walls where access hatches were available)
 - The survey did not include demolition of building systems or finishes to visually assess concealed conditions.
- Reporting the findings of visual inspections is completed using the following protocol:
 - Details of specific observations are reported for each room in which observations were collected during visual inspections.

2.2 Records Review

As part of this survey, ECOH reviewed the following reports:

- *95_Esplanade_MECH_50%_SUBMISSION*, prepared for the City of Toronto by Arcadis Professional Services (Canada) Inc., dated November 19, 2024.
- *95_The Esplanade_Electrical_50%_Submission*, prepared for the City of Toronto by Arcadis Professional Services (Canada) Inc., dated November 19, 2024.
- *2024.11.18_ISSUED FOR 50% DESIGN SUBMISSION*, prepared for the City of Toronto by Arcadis Professional Services (Canada) Inc., dated November 19, 2024.
- *Survey for Designated Substances and Hazardous Materials, City of Toronto Inspection Services*, 95 The Esplanade, Toronto, Ontario, prepared for the City of Toronto by ECOH Management Inc., dated November 14, 2014. ECOH Project No. 15170-B38.

2.3 Asbestos Survey Methodology

2.3.1 Asbestos Survey Omissions from Scope

When conducting an asbestos survey, it is standard practice to assume that certain building materials potentially contain asbestos. Depending on the material, this assumption is undertaken for one or more of the following reasons:

1. The material is inaccessible (i.e., underground piping).
2. There is an inherent danger in sampling the material (i.e., high voltage wires, mechanical control centre units).

3. Sampling will compromise the integrity of the building structure or envelope (i.e., roofing felts).

Therefore, for the purpose of this survey, ECOH assumed the following materials (if present) are asbestos-containing:

- Fire doors
- High voltage wiring
- Mechanical packing and gaskets
- Underground services or piping

In addition, no identification was made of asbestos products used in manufacturing processes or operations (i.e., manufacturing equipment, laboratories, etc.).

2.3.2 Asbestos Sampling Strategy and Analytical Methods

Bulk samples of potential asbestos-containing materials were collected for analysis during the survey. As per the requirements of Ontario Regulation 278/05, multiple samples (ranging from 1 to 7 depending on quantity and type of material) are required to confirm the absence of asbestos. Only one positive result (i.e., confirming the presence of asbestos) is required to classify a material as asbestos-containing. Therefore, ECOH's sampling strategy involves the collection of sufficient numbers of samples to meet regulatory requirements, followed by instructions to the laboratory to cease analysis when one sample within a series has already proven positive for asbestos. Sampling required a small volume of material to be removed either from a damaged section of suspect material or cut from intact material and then repaired by sealing with tape to prevent fibre release. The collected samples were placed in plastic bags and sealed during shipment to an independent laboratory. A formal chain of custody procedure was maintained between ECOH and the sub-contract laboratory during sample transport. Samples were then analyzed following the analytical procedure prescribed by the Regulation 278/05, U.S. Environmental Protection Agency Test Method EPA/600/R-93/116: Method for the Determination of Asbestos in Bulk Building Materials. June 1993. Although not required by provincial regulation, all laboratories used by ECOH are accredited under the U.S. National Voluntary Laboratory Accreditation Program (NVLAP) to ensure consistent, accurate and defensible results.

Where possible, ECOH has used existing analytical data, rather than collect and analyze additional bulk samples. Although historical sample information is used to confirm the presence of asbestos in suspect materials, historical samples are not used in defining materials as non-asbestos. Historical sample results were only used if the surveyor, based on his/her experience, could clearly associate the sample information with the material present at the Site.

The collection of samples was performed with sufficient frequency to obtain a general pattern of asbestos use within the building. Due to building renovations or modifications that may have occurred in the past, the consistency of the application of asbestos materials may not be uniform throughout the entire facility. It is important to note that without sampling every wall,

pipe section, ceiling tile, etc., it is not possible to identify the asbestos content in every material present in the building. For this reason, similar materials to those already sampled elsewhere in the building were visually identified as being the same as those samples without additional analysis.

The Chain of Custody and the Certificate of Analysis, which details analytical results referenced in the findings section, for all bulk sampling is presented within Appendix II - Results of Bulk Sample Analysis for Asbestos & Lead.

The recommendations in this report take into consideration the condition and accessibility of the asbestos material as well as other factors such as water damage, vibration, air movement and general activities in the area.

Where ACM is found to be in GOOD condition and not likely to deteriorate or fall, the general recommendation is to re-evaluate the condition of the material on an annual basis. This recommendation is subject to change if the material is located in a manner that persons untrained in asbestos awareness could physically damage it.

Where the ACM is found to be damaged, a recommendation to have the material repaired, removed, encased, or encapsulated is offered. The recommendation will also indicate which asbestos safety precautions (i.e., Type 1, Type 2 or Type 3) should be undertaken when performing the remedial work.

2.4 Mould Assessment

A visual mould assessment of the facility was carried out during this survey included a visual assessment and sampling, if required, but did not include intrusive investigation (i.e., test-cuts).

2.5 Survey of Other Hazardous Materials

Materials suspected of containing Designated Substances and Hazardous Materials, other than asbestos, were identified by appearance, age, and knowledge of historic applications in building construction and equipment design.

3. FINDINGS

3.1 Asbestos

The following is a brief discussion of the extent to which asbestos-containing materials (ACM) were identified in the Project Area. The discussion is organized under the headings of materials that are generally suspected of containing asbestos. Please refer to Table 2 for sample details and laboratory analysis results.

Table 2: Summary of Analysis of Asbestos Bulk Samples			
Sample Number	Sample Location	Sample Description	Results
29001-ASB-01A	Lower Floor (Loc. 1-01)	Drywall Joint Compound Wall	None Detected

Table 2: Summary of Analysis of Asbestos Bulk Samples			
Sample Number	Sample Location	Sample Description	Results
29001-ASB-01B	Lower Floor (Loc. 1-01)	Drywall Joint Compound Wall	None Detected
29001-ASB-01C	Lower Floor (Loc. 1-01)	Drywall Joint Compound Wall	None Detected
29001-ASB-01D	Upper Floor (Loc. 1-02)	Drywall Joint Compound Wall	None Detected
29001-ASB-01E	Upper Floor (Loc. 1-02)	Drywall Joint Compound Wall	None Detected
29001-ASB-01F	Pump Room (Loc. 1-09)	Drywall Joint Compound Wall	None Detected
29001-ASB-01G	Electrical Room (Loc. 1-09)	Drywall Joint Compound Wall	None Detected
29001-ASB-02A	Kitchen (Loc. 1-04)	Vinyl Sheet Flooring 3 – Light Grey with Dark Grey Streaks	None Detected
29001-ASB-02B	Kitchen (Loc. 1-04)	Vinyl Sheet Flooring 3 – Light Grey with Dark Grey Streaks	None Detected
29001-ASB-02C	Kitchen (Loc. 1-04)	Vinyl Sheet Flooring 3 – Light Grey with Dark Grey Streaks	None Detected
29001-ASB-03A	Lower Floor (Loc. 1-01)	Baseboard Mastic	None Detected
29001-ASB-03B	Lower Floor (Loc. 1-01)	Baseboard Mastic	None Detected
29001-ASB-03C	Lower Floor (Loc. 1-01)	Baseboard Mastic	None Detected
29001-ASB-04A	Lower Floor (Loc. 1-01)	Carpet Mastic	None Detected
29001-ASB-04B	Upper Floor (Loc. 1-02)	Carpet Mastic	None Detected
29001-ASB-04C	Upper Floor (Loc. 1-02)	Carpet Mastic	None Detected
29001-ASB-05A	Entrance (Loc. 1-03)	Ceramic Tile Grout	None Detected
29001-ASB-05B	Entrance (Loc. 1-03)	Ceramic Tile Grout	None Detected
29001-ASB-05C	Entrance (Loc. 1-03)	Ceramic Tile Grout	None Detected
29001-ASB-06A	Exterior (Loc. 0-00)	Grey Door Caulking	None Detected
29001-ASB-06B	Exterior (Loc. 0-00)	Grey Door Caulking	None Detected
29001-ASB-06C	Exterior (Loc. 0-00)	Grey Door Caulking	None Detected
29001-ASB-07A	Kitchen (Loc. 1-04)	White Sink Caulking	None Detected
29001-ASB-07B	Kitchen (Loc. 1-04)	White Sink Caulking	None Detected

Table 2: Summary of Analysis of Asbestos Bulk Samples			
Sample Number	Sample Location	Sample Description	Results
29001-ASB-07C	Kitchen (Loc. 1-04)	White Sink Caulking	None Detected
29001-ASB-08A	Kitchen (Loc. 1-04)	Sink Mastic	None Detected
29001-ASB-08B	Kitchen (Loc. 1-04)	Sink Mastic	None Detected
29001-ASB-08C	Kitchen (Loc. 1-04)	Sink Mastic	None Detected
	- shading indicates sample result positive for asbestos (if applicable)		

3.1.1 Spray Applied Fireproofing or Thermal Insulation (Friable)

Spray applied fireproofing was not observed within the Project Area at the time of the assessment.

3.1.2 Thermal Mechanical Insulation (Friable)

Various non-asbestos mechanical insulations are present within the Project Area. The following presents a brief description of the mechanical insulations and the systems to which they are applied. Thermal mechanical insulation may be present within concealed conditions of the Project Area (i.e., above fixed ceilings, within wall cavities, pipe chases, etc.) and may not be denoted on Survey Drawings included as Appendix III.

3.1.2.1 Piping Systems

Pipe fittings (which may include elbows, valves, tees, hangers, etc.) observed throughout the Project Area were observed to be not insulated or insulated with non-asbestos materials (e.g., fibreglass, foam, etc.).

Straight sections of pipe observed throughout the Project Area were observed to be not insulated or insulated with non-asbestos materials (e.g., fibreglass, foam, etc.).

3.1.2.2 Duct Systems

Ducts observed throughout the Project Area were observed to be not insulated or insulated with non-asbestos materials (e.g., fibreglass, foam, etc.).

3.1.2.3 Mechanical Equipment

Mechanical equipment observed throughout the Project Area were observed to be not insulated or insulated with non-asbestos materials (e.g., fibreglass, foam, etc.).

3.2 Asbestos Cement Products (Non-Friable)

Asbestos cement products were not observed within the Project Area at the time of the assessment.

3.3 Acoustic Ceiling Tiles (Friable)

Acoustic ceiling tiles – 2’x4’ short random fissures and pinpricks were observed within the Project Area. This material was composed of fiberglass and not expected to contain asbestos.

3.4 Vinyl Floor Tiles (Non-Friable)

Vinyl floor tiles were not observed within the Project Area at the time of the assessment.

3.5 Vinyl Sheet Flooring (Potentially-Friable)

Vinyl sheet flooring 3 – light grey with dark grey streaks was observed within the Project Area. Three (3) representative samples of this material were collected (29001-ASB-02A-C) and determined by laboratory analysis to be non-asbestos.

3.6 Drywall Joint Compound (DJC) (Non-Friable)

Drywall with joint compound was observed on walls and ceilings throughout the Project Area. Seven (7) representative samples of joint compound were collected (29001-ASB-01A-G) and determined by laboratory analysis to be non-asbestos.

This material was also previously sampled (15170-B38-01A-G & 15170-B38-02A-D) and determined by laboratory analysis to be non-asbestos.

3.7 Grout (Non-Friable)

Ceramic tiles with grout were observed within the Project Area. Three (3) representative samples of the grout were collected (29001-ASB-05A-C) and determined by laboratory analysis to be non-asbestos.

3.8 Plaster (Non-Friable)

Plaster was not observed within the Project Area at the time of the assessment.

3.9 Mortar (Non-Friable)

Mortar was not observed within the Project Area at the time of the assessment.

3.10 Mastic (Non-friable)

Three (3) distinct applications of mastic were observed within the Project Area:

- Baseboard mastic. Three (3) representative samples of this material were collected (29001-ASB-03A-C) and determined by laboratory analysis to be non-asbestos.
- Carpet mastic. Three (3) representative samples of this material were collected (29001-ASB-04A-C) and determined by laboratory analysis to be non-asbestos.
- Sink mastic. Three (3) representative samples of this material were collected (29001-ASB-08A-C) and determined by laboratory analysis to be non-asbestos.

3.11 Firestop/Caulking (Non-Friable)

Three (3) distinct applications of caulking were observed within the Project Area:

- Grey caulking on windows and doors. Three (3) representative samples of this material were collected (29001-ASB-06A-C) and determined by laboratory analysis to be non-asbestos.
- White caulking on sink. Three (3) representative samples of this material were collected (29001-ASB-07A-C) and determined by laboratory analysis to be non-asbestos.

3.12 Lead

Samples of any suspected lead-containing surface coatings were collected and submitted for laboratory analysis by Flame Atomic Absorption Spectroscopy (bulk samples) during this survey. A result from either sample exceeding 1000ppm lead content indicates the material is lead-containing. All laboratories used by ECOH are accredited under the U.S. EPA National Environmental Lead Laboratory Accreditation Program (NLLAP) and/or American Industrial Hygiene Association (AIHA) Environmental Lead Laboratory Accreditation Program (ELLAP) to ensure consistent, accurate and defensible results.

Please refer to Table 3 for sample details and laboratory analysis results for paints scheduled for potential disturbance. For the laboratory chain of custody and the certificate of analysis, refer to Appendix II - Results of Bulk Sample Analysis for Asbestos & Lead.

Table 3: Summary of Analysis for Lead Samples			
Sample Number	Location	Description	Analytical Results
29001-Pb-01	Lower Floor (Loc. 1-01)	Light Green Paint on Wall	<5 ppm
29001-Pb-02	Lower Floor (Loc. 1-01)	Teal Paint on Wall	8 ppm
29001-Pb-03	Upper Floor (Loc. 1-02)	Light Grey Paint on Wall	<5 ppm
29001-Pb-04	Upper Floor (Loc. 1-02)	Yellow Paint on Wall	<5 ppm
29001-Pb-05	Entrance (Loc. 1-03)	Ceramic Tile grout	<5 ppm
	- shading indicates sample result positive for lead (if applicable)		

No major sources of lead or lead-containing products were observed during this survey. However, lead may be present in:

- Internal batteries associated with emergency lighting system,
- Ceramic tile glazing,
- Wiring connectors and electric cable sheathing, and
- Solder joints on copper piping.

3.13 Mercury

Mercury may be present in minor quantities throughout the Project Area in the following forms:

- As a possible constituent of paints and adhesives.

3.14 Silica

Free crystalline silica, in the form of common construction sand, is present in all concrete and masonry products within the Project Area.

3.15 Mould

Mould-affected building materials were not identified within the Project Area at the time of assessment.

3.16 Ozone Depleting Substances (ODS)

Ozone depleting substances may be present in refrigeration and cooling units.

3.17 Polychlorinated Biphenyls (PCBs)

Fluorescent light ballasts were not observed within the Project Area.

3.18 Other Designated Substances and Hazardous Materials

The following Designated Substances and Hazardous Materials were not noted in significant quantities or forms, if at all, during this survey; Acrylonitrile, Arsenic, Benzene, Coke Oven Emissions, Ethylene Oxide, Isocyanates, Urea Formaldehyde Foam Insulation (UFFI), and Vinyl Chloride Monomer.

If present on site in insignificant quantities or forms, these Designated Substances and Hazardous Materials would not be expected to pose an immediate or potential risk to human health. Adequate worker protection should be achieved when implementing general health and safety precautions during general demolition or renovation activities.

4. CONCLUSIONS AND RECOMMENDATIONS

The following recommendations meet the requirements of the Occupational Health and Safety Act. Asbestos recommendations meet the requirements of the Designated Substance – Regulation respecting *Asbestos on Construction Projects and in Buildings and Repair Operations*, Ontario Regulation 278/05. Based upon review of historical reports, as well as analytical results and observations of this assessment, ECOH offers the following recommendations.

4.1 Asbestos

Based on survey results, the following conclusions are made with regards to asbestos-containing materials (ACMs) within the Project Area:

- As the materials present in the Project Area anticipated for disturbance are non-asbestos containing, removal or disturbance of these materials does not require asbestos safety procedures. However, general health and safety precautions including, in part, the use of dust suppression techniques and appropriate respiratory protection.

During project work, if any additional materials are found beyond those which are described in this report or described in the existing inventory of asbestos-containing materials (i.e., materials not previously identified, or materials that are not homogenous to those previously identified, or materials that become revealed during the work), additional testing for asbestos-content should be completed immediately and prior to disturbance of the material. Alternatively, these materials can be assumed to contain asbestos, and the appropriate level of asbestos safety precautions must be implemented.

4.2 Lead

Any work involving the disturbance of building materials confirmed to be lead-containing or containing trace amounts of lead should be conducted following recommendations detailed within the Ministry of Labour document *Guideline - Lead on Construction Projects*, dated April 2011, and the Environmental Abatement Council of Canada (EACC) *Lead Guideline*, dated October 2014.

Renovation, demolition or general construction work involving the removal of non-lead-based paints (i.e., trace concentrations of lead below 0.1%, or 1000 ppm, by dry weight) can be completed without lead specific safety precautions provided that:

- Work does not include 'fume generating activities' (heat producing) such as welding, torching, burning, high temperature cutting, etc.,
- Dust levels are maintained below 3 mg/m³, and
- General health and safety construction procedures are implemented, which would include dust suppression methods, proper respiratory protection (minimum of a 1/2-face respirator) and protective clothing, as is appropriate for the work being completed.

4.3 Mercury

Avoid direct skin contact with mercury and avoid inhalation of mercury vapour. Dispose of mercury following requirements of the Canada Environmental Protection Act, the Transportation of Dangerous Goods Act and provincial legislative requirements that may be applicable.

4.4 Silica

Cutting, grinding, or demolition of materials containing silica should be completed using general health and safety precautions including the use of dust suppression techniques and appropriate respiratory protection, as is appropriate for the work being completed.

Removal of building materials containing silica should be completed following recommendations detailed within the Ministry of Labour document, *Guideline - Silica on Construction Projects*, dated, April 2011.

5. STATEMENT OF LIMITATIONS

Due to the nature of building construction, and on-going building activities, some limitations exist to the thoroughness of a building assessment. The field observations, measurements and analysis are considered sufficient in detail and scope to form a reasonable basis for the findings and conclusions presented in this report. The observations, results and conclusions drawn by ECOH Management Inc. (ECOH) are limited to the specific scope of work for which ECOH was retained and are based solely on information generated as a result of the specific scope of work authorized by the City of Toronto. Only those items that are capable of being observed and are reasonably obvious to ECOH personnel or have been identified to ECOH by other parties, can be reported. ECOH has exercised a degree of thoroughness and competence that is consistent with the profession during the execution of this assessment. ECOH considers the opinions and information as they are presented in this report to be factual at the time of the assessment. The conclusions are limited to the specific locations of where testing and/or observations were completed during the course of the assessment.

It is important to note that work was completed with the utmost care and our extensive expertise in carrying out assessments. ECOH believes that the information collected during the assessment concerning the Work Area is reliable. No other warranties are implied or expressed. ECOH, to the best of its knowledge, believes this report to be accurate, however, ECOH cannot guarantee the completeness or accuracy of information supplied to ECOH by third parties. It should also be noted that any investigation regarding the presence of hazardous materials in the work area is based on interpretation of conditions determined at specific sampling locations, and conditions may vary between sampling locations.

ECOH is an Environmental Consulting Company and as such any results or conclusions presented in this report should not be construed as legal advice. The material in this report reflects ECOH's professional interpretation of information available at the time of report preparation. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. ECOH accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report. Should additional information become available that suggests other environmental issues of concern beyond that described in this report, ECOH retains the right to review this information and modify conclusions and recommendations presented in this report accordingly.

6. CLOSURE

We trust this report meets your requirements. If you have any question, please contact the undersigned at 905-795-2800.

ECOH

Environmental Consulting
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APPENDIX I

Hazardous Materials Room by Room Inventory Sheet

APPENDIX I - HAZARDOUS MATERIALS ROOM BY ROOM INVENTORY SHEET

Building Address	95 The Esplanade, Toronto	Date(s) of Current Assessment:	December 20, 2024
Building Name	Toronto Water Offices	Organization completing Asbestos Reassessment:	ECOH Inc.

Summary of Findings

Location Number	Location Name	Building System	Material Observed	Potential Hazardous Material	Sample ID	Asbestos Type/Content	Quantity	Condition	Notes/Required Action
0-00	Exterior	Windows	Door and Window Caulking	Asbestos	29001-ASB-06A-C	None Detected	N/A	N/A	Sampled during ECOH 2024 DSS
0-00	Exterior	Wall	N/A	N/A	N/A	N/A	N/A	N/A	
0-00	Exterior	Roof	N/A	N/A	N/A	N/A	N/A	N/A	Multi-storey facility, roof is not City of Toronto property.
1-01	Lower Open Office Area	Floor	Carpet Mastic	Asbestos	29001-ASB-04A	None Detected	N/A	N/A	Sampled during ECOH 2024 DSS
1-01	Lower Open Office Area	Wall	Drywall Joint Compound	Asbestos	Not Sampled	Visually consistent with 15170-B38-01,02 (None Detected)	N/A	N/A	
1-01	Lower Open Office Area	Wall	Drywall Joint Compound	Asbestos	29001-ASB-01A-C	None Detected	N/A	N/A	Sampled during ECOH 2024 DSS
1-01	Lower Open Office Area	Wall	Baseboard Mastic	Asbestos	29001-ASB-03A-C	None Detected	N/A	N/A	Sampled during ECOH 2024 DSS
1-01	Lower Open Office Area	Wall	Paint - Light Green	Lead	29001-Pb-01	<5 ppm	N/A	N/A	Sampled during ECOH 2024 DSS
1-01	Lower Open Office Area	Wall	Paint - Teal	Lead	29001-Pb-02	8 ppm	N/A	N/A	Sampled during ECOH 2024 DSS
1-01	Lower Open Office Area	Ceiling	Ceiling Tiles 1	Asbestos	Not Sampled	Visually Non-ACM	N/A	N/A	2 x 4 Short random fissure & pinpricks, fibreglass
1-02	Upper Open Office Area	Floor	Carpet Mastic	Asbestos	29001-ASB-04B,C	None Detected	N/A	N/A	Sampled during ECOH 2024 DSS
1-02	Upper Open Office Area	Wall	Drywall Joint Compound	Asbestos	15170-B38-01G 15170-B38-02D	None Detected	N/A	N/A	Sampled during ECOH 2014 Reassessment Survey
1-02	Upper Open Office Area	Wall	Drywall Joint Compound	Asbestos	29001-ASB-01D, E	None Detected	N/A	N/A	Sampled during ECOH 2024 DSS
1-02	Upper Open Office Area	Wall	Paint - Light Grey	Lead	29001-Pb-03	<5 ppm	N/A	N/A	Sampled during ECOH 2024 DSS
1-02	Upper Open Office Area	Wall	Paint - Yellow	Lead	29001-Pb-04	<5 ppm	N/A	N/A	Sampled during ECOH 2024 DSS
1-02	Upper Open Office Area	Ceiling	Ceiling Tiles 1	Asbestos	Not Sampled	Visually Non-ACM	N/A	N/A	2 x 4 Short random fissure & pinpricks, fibreglass
1-03	Entrance	Floor	Ceramic Tile	Asbestos	29001-ASB-05A-C	None Detected	N/A	N/A	Sampled during ECOH 2024 DSS
1-03	Entrance	Floor	Ceramic Tile	Lead	29001-Pb-05	<5 ppm	N/A	N/A	Sampled during ECOH 2024 DSS
1-03	Entrance	Wall	Drywall Joint Compound	Asbestos	Not Sampled	Visually consistent with 15170-B38-01,02 & 29001-ASB-01A-G (None Detected)	N/A	N/A	
1-03	Entrance	Ceiling	Drywall Joint Compound	Asbestos	Not Sampled	Visually consistent with 15170-B38-01,02 & 29001-ASB-01A-G (None Detected)	N/A	N/A	
1-04	Kitchen	Floor	Vinyl Sheet Flooring 2	Asbestos	Not Sampled	Visually Non-ACM	N/A	N/A	Grey with black streaks, jute backing Not Observed

APPENDIX I - HAZARDOUS MATERIALS ROOM BY ROOM INVENTORY SHEET

Location Number	Location Name	Building System	Material Observed	Potential Hazardous Material	Sample ID	Asbestos Type/Content	Quantity	Condition	Notes/Required Action
1-04	Kitchen	Floor	Vinyl Sheet Flooring 3	Asbestos	29001-ASB-02A-C	None Detected	N/A	N/A	Light grey with dark grey streaks Sampled during ECOH 2024 DSS
1-04	Kitchen	Wall	Drywall Joint Compound	Asbestos	15170-B38-02B	None Detected	N/A	N/A	Sampled during ECOH 2014 Reassessment Survey
1-04	Kitchen	Ceiling	Ceiling Tiles 1	Asbestos	Not Sampled	Visually Non-ACM	N/A	N/A	2 x 4 Short random fissure & pinpricks, fibreglass
1-04	Kitchen	Other	White Sink Caulking	Asbestos	29001-ASB-07A-C	None Detected	N/A	N/A	Sampled during ECOH 2024 DSS
1-04	Kitchen	Other	Sink Mastic	Asbestos	29001-ASB-08A-C	None Detected	N/A	N/A	Sampled during ECOH 2024 DSS
1-05	Office	Floor	Carpet Mastic	Asbestos	Not Sampled	Visually Consistent with 29001-ASB-04A-C (None Detected)	N/A	N/A	
1-05	Office	Wall	Drywall Joint Compound	Asbestos	Not Sampled	Visually consistent with 15170-B38-01.02 & 29001-ASB-01A-G (None Detected)	N/A	N/A	
1-05	Office	Ceiling	Ceiling Tiles 1	Asbestos	Not Sampled	Visually Non-ACM	N/A	N/A	2 x 4 Short random fissure & pinpricks, fibreglass
1-06	Hub Room	Floor	Vinyl Sheet Flooring 2	Asbestos	Not Sampled	Visually Non-ACM	N/A	N/A	Grey with black streaks, jute backing Not Observed
1-06	Hub Room	Floor	Vinyl Sheet Flooring 3	Asbestos	Not Sampled	Visually Consistent with 29001-ASB-02A-C (None Detected)	N/A	N/A	Light grey with dark grey streaks
1-06	Hub Room	Wall	Drywall Joint Compound	Asbestos	Not Sampled	Visually consistent with 15170-B38-01.02 & 29001-ASB-01A-G (None Detected)	N/A	N/A	
1-06	Hub Room	Ceiling	N/A	N/A	N/A	N/A	N/A	N/A	no false ceiling observed
1-08	Electrical Room	Floor	Vinyl Sheet Flooring 2	Asbestos	Not Sampled	Visually Non-ACM	N/A	N/A	Grey with black streaks, jute backing Not Observed
1-08	Electrical Room	Floor	Vinyl Sheet Flooring 3	Asbestos	Not Sampled	Visually Consistent with 29001-ASB-02A-C (None Detected)	N/A	N/A	Light grey with dark grey streaks
1-08	Electrical Room	Wall	Drywall Joint Compound	Asbestos	Not Sampled	Visually consistent with 15170-B38-01.02 & 29001-ASB-01A-G (None Detected)	N/A	N/A	
1-08	Electrical Room	Wall	Drywall Joint Compound	Asbestos	29001-ASB-01G	None Detected	N/A	N/A	Sampled during ECOH 2024 DSS
1-08	Electrical Room	Ceiling	N/A	N/A	N/A	N/A	N/A	N/A	no false ceiling observed
1-09	Pump Room	Floor	Vinyl Sheet Flooring 2	Asbestos	Not Sampled	Visually Non-ACM	N/A	N/A	Grey with black streaks, jute backing Not Observed
1-09	Pump Room	Floor	Vinyl Sheet Flooring 3	Asbestos	Not Sampled	Visually Consistent with 29001-ASB-02A-C (None Detected)	N/A	N/A	Light grey with dark grey streaks
1-09	Pump Room	Wall	Drywall Joint Compound	Asbestos	15170-B38-01D-G	None Detected	N/A	N/A	Sampled during ECOH 2014 Reassessment Survey
1-09	Pump Room	Wall	Drywall Joint Compound	Asbestos	29001-ASB-01F	None Detected	N/A	N/A	Sampled during ECOH 2024 DSS
1-09	Pump Room	Ceiling	N/A	N/A	N/A	N/A	N/A	N/A	no false ceiling observed

APPENDIX I - HAZARDOUS MATERIALS ROOM BY ROOM INVENTORY SHEET

Location Number	Location Name	Building System	Material Observed	Potential Hazardous Material	Sample ID	Asbestos Type/Content	Quantity	Condition	Notes/Required Action
1-11a-d	Offices	Floor	Carpet Mastic	Asbestos	Not Sampled	Visually Consistent with 29001-ASB-04A-C (None Detected)	N/A	N/A	
1-11a-d	Offices	Wall	Drywall Joint Compound	Asbestos	15170-B38-02C	None Detected	N/A	N/A	Sampled during ECOH 2014 Reassessment Survey
1-11a-d	Offices	Ceiling	Ceiling Tiles 1	Asbestos	Not Sampled	Visually Non-ACM	N/A	N/A	2 x 4 Short random fissure & pinpricks, fibreglass
1-12	Photocopy Area	Floor	Vinyl Sheet Flooring 1	Asbestos	Not Sampled	Visually Non-ACM	N/A	N/A	Grey-green, jute backing Not Observed
1-12	Photocopy Area	Floor	Vinyl Sheet Flooring 3	Asbestos	Not Sampled	Visually Consistent with 29001-ASB-02A-C (None Detected)	N/A	N/A	Light grey with dark grey streaks
1-12	Photocopy Area	Wall	Drywall Joint Compound	Asbestos	15170-B38-02A	None Detected	N/A	N/A	Sampled during ECOH 2014 Reassessment Survey
1-12	Photocopy Area	Ceiling	Ceiling Tiles 1	Asbestos	Not Sampled	Visually Non-ACM	N/A	N/A	2 x 4 Short random fissure & pinpricks, fibreglass
1-13	Closet	Floor	Carpet Mastic	Asbestos	Not Sampled	Visually Consistent with 29001-ASB-04A-C (None Detected)	N/A	N/A	
1-13	Closet	Wall	Drywall Joint Compound	Asbestos	Not Sampled	Visually consistent with 15170-B38-01.02 & 29001-ASB-01A-G (None Detected)	N/A	N/A	
1-13	Closet	Ceiling	Ceiling Tiles 1	Asbestos	Not Sampled	Visually Non-ACM	N/A	N/A	2 x 4 Short random fissure & pinpricks, fibreglass
<i>Surveyor's Field Notes</i>									

APPENDIX II

Results of Bulk Sample Analysis for Asbestos & Lead

Laboratory Analysis Report

To:

Joey Huynh
 ECOH Management Inc.
 75 Courtney Park Drive West
 Unit 1
 Mississauga, Ontario
 L5W 0E3

EMC LAB REPORT NUMBER: A113334
Job/Project Name: 95 The Esplanade – DSS
Analysis Method: Polarized Light Microscopy – EPA 600
Date Received: Dec 24/24 **Date Analyzed:** Jan 3/25
Analyst: Fabio Anunciacao
Reviewed By: Malgorzata Sybydlo

No. of Phases Analyzed: 28
Job No: 29001
Number of Samples: 28
Date Reported: Jan 3/25

Client's Sample ID	Lab Sample No.	Description/Location	Sample Appearance	SAMPLE COMPONENTS (%)		
				Asbestos Fibres	Non-asbestos Fibres	Non-fibrous Material
29001-ASB-01A	A113334-1	Drywall joint compound on wall – lower floor	White, joint compound	ND		100
29001-ASB-01B	A113334-2	Drywall joint compound on wall – lower floor	White, joint compound	ND		100
29001-ASB-01C	A113334-3	Drywall joint compound on wall – lower floor	White, joint compound	ND		100
29001-ASB-01D	A113334-4	Drywall joint compound on wall – upper floor	White, joint compound	ND		100
29001-ASB-01E	A113334-5	Drywall joint compound on wall – upper floor	White, joint compound	ND		100
29001-ASB-01F	A113334-6	Drywall joint compound on wall – pump room	White, joint compound	ND		100
29001-ASB-01G	A113334-7	Drywall joint compound on wall – electrical room	White, joint compound	ND		100
29001-ASB-02A	A113334-8	Vinyl sheet flooring 3 – light grey with dark grey streaks – kitchen	Grey, vinyl flooring	ND	10	90
29001-ASB-02B	A113334-9	Vinyl sheet flooring 3 – light grey with dark grey streaks – kitchen	Grey, vinyl flooring	ND	10	90
29001-ASB-02C	A113334-10	Vinyl sheet flooring 3 – light grey with dark grey streaks – kitchen	Grey, vinyl flooring	ND	10	90
29001-ASB-03A	A113334-11	Baseboard mastic – lower floor	Yellow, mastic	ND		100
29001-ASB-03B	A113334-12	Baseboard mastic – lower floor	Yellow, mastic	ND		100

EMC LAB REPORT NUMBER: A113334

Client's Job/Project Name/No.: 29001

Analyst: Fabio Anunciacao

Client's Sample ID	Lab Sample No.	Description/Location	Sample Appearance	SAMPLE COMPONENTS (%)		
				Asbestos Fibres	Non-asbestos Fibres	Non-fibrous Material
29001-ASB-03C	A113334-13	Baseboard mastic – lower floor	Yellow, mastic	ND		100
29001-ASB-04A	A113334-14	Carpet mastic – lower floor	Off white and colourless, mastic	ND		100
29001-ASB-04B	A113334-15	Carpet mastic – upper floor	Off white and colourless, mastic	ND		100
29001-ASB-04C	A113334-16	Carpet mastic – upper floor	Off white and colourless, mastic	ND		100
29001-ASB-05A	A113334-17	Ceramic tile grout – entrance vestibule	Grey, cementitious material	ND		100
29001-ASB-05B	A113334-18	Ceramic tile grout – entrance vestibule	Grey, cementitious material	ND		100
29001-ASB-05C	A113334-19	Ceramic tile grout – entrance vestibule	Grey, cementitious material	ND		100
29001-ASB-06A	A113334-20	Grey door caulking – entrance vestibule	Grey, caulking	ND		100
29001-ASB-06B	A113334-21	Grey door caulking – entrance vestibule	Beige, caulking	ND		100
29001-ASB-06C	A113334-22	Grey door caulking – entrance vestibule	Grey, caulking	ND		100
29001-ASB-07A	A113334-23	White sink caulking – kitchen	White, caulking	ND		100
29001-ASB-07B	A113334-24	White sink caulking – kitchen	White, caulking	ND		100
29001-ASB-07C	A113334-25	White sink caulking – kitchen	White, caulking	ND		100

EMC LAB REPORT NUMBER: A113334

Client's Job/Project Name/No.: 29001

Analyst: Fabio Anunciacao

Client's Sample ID	Lab Sample No.	Description/Location	Sample Appearance	SAMPLE COMPONENTS (%)		
				Asbestos Fibres	Non-asbestos Fibres	Non-fibrous Material
29001-ASB-08A	A113334-26	Sink mastic – kitchen	White, mastic	ND		100
29001-ASB-08B	A113334-27	Sink mastic – kitchen	White, mastic	ND		100
29001-ASB-08C	A113334-28	Sink mastic – kitchen	White, mastic	ND		100

Note:

1. Bulk samples are analyzed using Polarized Light Microscopy (PLM) and dispersion staining techniques. The analytical procedures are in accordance with EPA 600/R-93/116 method.
2. The results are only related to the samples analyzed. **ND** = None Detected (no asbestos fibres were observed), **NA** = Not Analyzed (analysis stopped due to a previous positive result).
3. This report may not be reproduced, except in full without the written approval of EMC Scientific Inc. This report may not be used by the client to claim product endorsement by NVLAP or any other agency of the U.S. Government.
4. The Ontario Regulatory Threshold for asbestos is 0.5%. The limit of quantification (LOQ) is 0.5%.

CHAIN OF CUSTODY AND ASBESTOS ANALYSIS REQUEST FORM

EMC Lab Report No: A113334

Contact Name: Joey Huynh	Phone: 416-371-6377	Job/Project Name: 95 The Esplanade - DSS
Company: ECOH Management Inc.	Fax No: 905-795-2800	Job/Project No: 29001
Address: 75 Courtney Park West	Email: juynh@ecoh.ca sbizi@ecoh.ca arachmadsyah@ecoh.ca	Special Instructions: Stop Positive Analyzed all Layers if applicable

City, Province Postal Code: Mississauga, Ontario Please select (✓): () Fax Results (✓) Email Results *All results will also be sent by mail.*

Sample ID	Description/Location	Date Sampled	Sample Type	Air Volume (L)	Turnaround Time (✓)				Analysis Requested *	SP **	For Lab Use
					4hr	24 hr	48 hr	STD			
29001-ASB-01A	Drywall Joint Compound on Wall – Lower Floor	December 20, 2024	Asbestos Bulk	N/A				✓	EPA-600/R-93/116	✓	
29001-ASB-01B	Drywall Joint Compound on Wall – Lower Floor	December 20, 2024	Asbestos Bulk	N/A				✓	EPA-600/R-93/116	✓	
29001-ASB-01C	Drywall Joint Compound on Wall – Lower Floor	December 20, 2024	Asbestos Bulk	N/A				✓	EPA-600/R-93/116	✓	
29001-ASB-01D	Drywall Joint Compound on Wall – Upper Floor	December 20, 2024	Asbestos Bulk	N/A				✓	EPA-600/R-93/116	✓	
29001-ASB-01E	Drywall Joint Compound on Wall – Upper Floor	December 20, 2024	Asbestos Bulk	N/A				✓	EPA-600/R-93/116	✓	
29001-ASB-01F	Drywall Joint Compound on Wall – Pump Room	December 20, 2024	Asbestos Bulk	N/A				✓	EPA-600/R-93/116	✓	
29001-ASB-01G	Drywall Joint Compound on Wall – Electrical Room	December 20, 2024	Asbestos Bulk	N/A				✓	EPA-600/R-93/116	✓	
29001-ASB-02A	Vinyl Sheet Flooring 3 – Light Grey with Dark Grey Streaks – Kitchen	December 20, 2024	Asbestos Bulk	N/A				✓	EPA-600/R-93/116	✓	
29001-ASB-02B	Vinyl Sheet Flooring 3 – Light Grey with Dark Grey Streaks – Kitchen	December 20, 2024	Asbestos Bulk	N/A				✓	EPA-600/R-93/116	✓	
29001-ASB-02C	Vinyl Sheet Flooring 3 – Light Grey with Dark Grey Streaks – Kitchen	December 20, 2024	Asbestos Bulk	N/A				✓	EPA-600/R-93/116	✓	
29001-ASB-03A	Baseboard Mastic – Lower Floor	December 20, 2024	Asbestos Bulk	N/A				✓	EPA-600/R-93/116	✓	
29001-ASB-03B	Baseboard Mastic – Lower Floor	December 20, 2024	Asbestos Bulk	N/A				✓	EPA-600/R-93/116	✓	
29001-ASB-03C	Baseboard Mastic – Lower Floor	December 20, 2024	Asbestos Bulk	N/A				✓	EPA-600/R-93/116	✓	

29001-ASB-04A	Carpet Mastic – Lower Floor	December 20, 2024	Asbestos Bulk	N/A				✓	EPA-600/R-93/116	✓	
29001-ASB-04B	Carpet Mastic – Upper Floor	December 20, 2024	Asbestos Bulk	N/A				✓	EPA-600/R-93/116	✓	
29001-ASB-04C	Carpet Mastic – Upper Floor	December 20, 2024	Asbestos Bulk	N/A				✓	EPA-600/R-93/116	✓	
29001-ASB-05A	Ceramic Tile Grout – Entrance Vestibule	December 20, 2024	Asbestos Bulk	N/A				✓	EPA-600/R-93/116	✓	
29001-ASB-05B	Ceramic Tile Grout – Entrance Vestibule	December 20, 2024	Asbestos Bulk	N/A				✓	EPA-600/R-93/116	✓	
29001-ASB-05C	Ceramic Tile Grout – Entrance Vestibule	December 20, 2024	Asbestos Bulk	N/A				✓	EPA-600/R-93/116	✓	
29001-ASB-06A	Grey Door Caulking – Entrance Vestibule	December 20, 2024	Asbestos Bulk	N/A				✓	EPA-600/R-93/116	✓	
29001-ASB-06B	Grey Door Caulking – Entrance Vestibule	December 20, 2024	Asbestos Bulk	N/A				✓	EPA-600/R-93/116	✓	
29001-ASB-06C	Grey Door Caulking – Entrance Vestibule	December 20, 2024	Asbestos Bulk	N/A				✓	EPA-600/R-93/116	✓	
29001-ASB-07A	White Sink Caulking – Kitchen	December 20, 2024	Asbestos Bulk	N/A				✓	EPA-600/R-93/116	✓	
29001-ASB-07B	White Sink Caulking – Kitchen	December 20, 2024	Asbestos Bulk	N/A				✓	EPA-600/R-93/116	✓	
29001-ASB-07C	White Sink Caulking – Kitchen	December 20, 2024	Asbestos Bulk	N/A				✓	EPA-600/R-93/116	✓	
29001-ASB-08A	Sink Mastic – Kitchen	December 20, 2024	Asbestos Bulk	N/A				✓	EPA-600/R-93/116	✓	
29001-ASB-08B	Sink Mastic – Kitchen	December 20, 2024	Asbestos Bulk	N/A				✓	EPA-600/R-93/116	✓	
29001-ASB-08C	Sink Mastic – Kitchen	December 20, 2024	Asbestos Bulk	N/A				✓	EPA-600/R-93/116	✓	

Sample Collected by: Joey Huynh, Abia Rachmadsyah		Total Number of Samples Submitted: 28	
Relinquished by: Abia Rachmadsyah Date/Time: October 23, 2024		Received by: _____ Date/Time: _____	
Relinquished by: _____ Date/Time: _____		Received at lab by: <i>AM</i> Date/Time: <i>DEC 23/24 4p</i>	
Authorized by Client (Signature): _____		Print Name: _____ Date: _____	
Sample Shipped by: _____ Date/Time: _____		Shipped via: () Courier by _____, (✓) Drop off, (✓) Other _____	
Sample Condition upon Receipt at Lab (✓): (✓) Acceptable, () Unacceptable (Explain): _____			

* Please indicate if sample to be analyzed by layer (PLM-L) or homogenized (PLM-H) when applicable.

** **SD** STOP POSITIVE status indicates if required

C.O.C.: -

REPORT No: 24-039383 - Rev. 0

Report To:

EMC Scientific Inc.
 5800 Ambler Dr. #100
 Mississauga, ON L4W 4J4

CADUCEON Environmental Laboratories

2378 Holly Lane
 Ottawa, ON K1V 7P1

Attention: Alister Haddad

DATE RECEIVED: 2024-Dec-24
 DATE REPORTED: 2024-Dec-31
 SAMPLE MATRIX: Paint Chips

CUSTOMER PROJECT: 95 The Esplanade - DSS
 P.O. NUMBER: 29001

Analyses	Qty	Site Analyzed	Authorized	Date Analyzed	Lab Method	Reference Method
ICP/OES (Solid)	5	OTTAWA	APRUDYVUS	2024-Dec-30	D-ICP-02	EPA 6010

R.L. = Reporting Limit
 NC = Not Calculated

Test methods may be modified from specified reference method unless indicated by an *

Client I.D.	Sample I.D.	Date Collected	Parameter	Units	R.L.
			Lead	ppm	5
					-
29001-Pb-01 Light green on wall - lower floor	24-039383-1	2024-Dec-20			<5
29001-Pb-02 Teal on wall - lower floor	24-039383-2	2024-Dec-20			8
29001-Pb-03 Light grey on wall - upper floor	24-039383-3	2024-Dec-20			<5
29001-Pb-04 Yellow on wall - upper floor	24-039383-4	2024-Dec-20			<5
29001-Pb-05 - Ceramic tile grout - entrance vestibule	24-039383-5	2024-Dec-20			<5



Michelle Dubien
Data Specialist

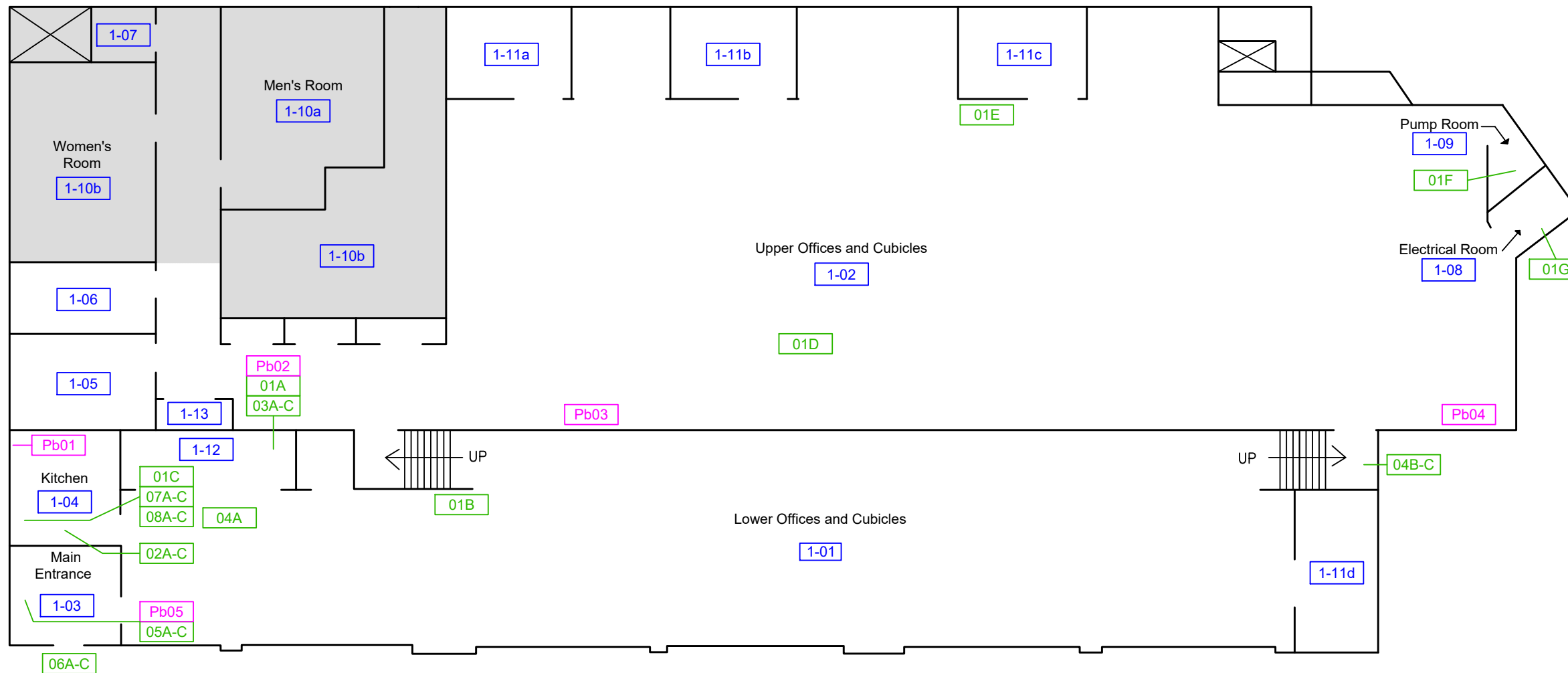
APPENDIX III

Drawings



Legend

- 1-01 Location Numbers
- 01A Asbestos Bulk Sample Location (29001-ASB-xx)
- Pb01 Lead Bulk Sample Location (29001-Pb-xx)
- Outside of Project Scope



The drawing does not illustrate locations of drywall joint compound, plaster, window caulking or roofing materials, for reasons discussed in Section 6 of the Standard Operating Procedure for Asbestos Reassessment Surveys. Please refer to the Asbestos Reassessment Survey Form in Appendix I for information regarding the locations and asbestos-content of these materials.

All information relating to room size and location is approximate and for visual aid only. ECOH does not guarantee the drawing to be complete, absolute, accurate or current. The drawing should not be used by any party in lieu of obtaining architectural drawings.

Figure 1

Ground Floor Plan

BUILDING NAME:
Senior Housing Co-op Building -
City of Toronto Inspection Services

LOCATION:
95 The Esplanade,
Toronto, Ontario

PROJECT:
Pre-Renovation Designated Substances Survey

CLIENT: City of Toronto

PROJECT NUMBER: 29001 **DATE:** Jan. 2025 **DRW BY:** EM

CAD FILE: FIG1 P29001 95 The Esplanade **SCALE:** Not to Scale **CHK BY:** JH

APPENDIX IV

Site Photographs



Client Name:

City of Toronto

Site Location:

Toronto Water Offices
95 The Esplanade, Toronto, Ontario

Project No.

29001

Photo No. 1.

Date:

December 20, 2024

Location:

Throughout Project Area

Description:

Non-asbestos
fiberglass ceiling
tiles (CT1).



Photo No. 2.

Date:

December 20, 2024

Location:

Electrical Room
(Loc. 1-08)

Description:

Non-asbestos vinyl
sheet flooring
(VSF3).





Client Name:

City of Toronto

Site Location:

Toronto Water Offices
95 The Esplanade, Toronto, Ontario

Project No.

29001

Photo No. 3.

Date:

December 20, 2024

Location:

Building Exterior
(Loc. 0-00)

Description:

Non-asbestos grey
window caulking.

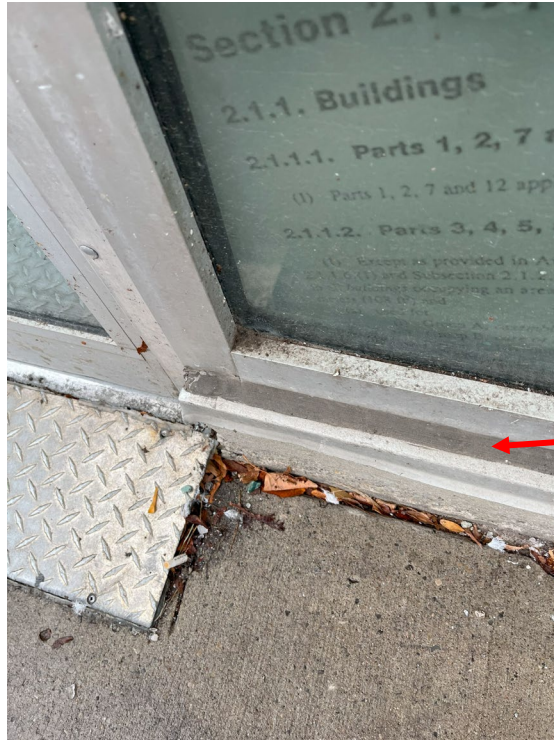


Photo No. 4.

Date:

December 20, 2024

Location:

Kitchen (Loc. 1-04)

Description:

Non-asbestos sink
mastic.

