



**DIVISION 20 – GENERAL MECHANICAL
SPECIFICATIONS
FOR THE
THE CITY OF TORONTO SHELTER FACILITIES
101 PLACER COURT
TORONTO, ONTARIO**

Prepared by:

**The HIDI Group
155 Gordon Baker Road
Suite 200
Toronto, ON M2H 3N5**

Telephone: 416-364-2100

Our Project No. 2019-0495

Issued for: Tender/Permit

April 09, 2020

DISCIPLINES MECHANICAL
ELECTRICAL
PLUMBING
LIGHTING DESIGN
COMMUNICATIONS
SECURITY & RISK
COMMISSIONING
ENERGY SERVICES

SEAL:



Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: **Table of Contents**
Section No.: **Division 20 - General Mechanical**
Date: April 9, 2020

Section 20 00 00	General Requirements
Section 20 00 50	Basic Materials and Methods
Section 20 00 55	Work in Existing Buildings
Section 20 05 13	Electric Motors
Section 20 05 14	Electrical Wiring
Section 20 05 15	Electrical Ancillaries
Section 20 05 16	Expansion Compensation
Section 20 05 19	Meters and Gauges
Section 20 05 29	Bases, Hangers and Supports
Section 20 05 48	Vibration Isolation
Section 20 05 53	Identification
Section 20 05 93	Testing, Balancing and Adjusting
Section 20 07 00	Mechanical Insulation
Section 20 08 00	Commissioning
Section 20 09 49	Variable Frequency Drives

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: General Requirements
Section No.: 20 00 00
Date: April 9, 2020

INDEX

1	GENERAL
1.1	General
1.2	Definitions
1.3	Intent
1.4	Examination of Site and Contract Documents
1.5	Scope
1.6	Permits, Fees and Inspections
1.7	Contract Drawings
1.8	Construction Drawings
1.9	Shop Drawings
1.10	Scheduling
1.11	Record Drawings
1.12	Products
1.13	Alternates and Substitutions During Progress of Work
1.14	Valuation of Changes
1.15	Application for Payment
1.16	Superintendence
1.17	Installation Requirements
1.18	Temporary Service
1.19	Cooperation
1.20	Protection
1.21	Field Review
1.22	Services to Equipment Supplied by Others
1.23	Provision for Future Equipment and Construction
1.24	Cutting and Patching
1.25	Metals
1.26	Concrete
1.27	Excavation and Backfilling
1.28	Painting
1.29	Abbreviations
1.30	Manufacturer's Certification
1.31	Trial Usage
1.32	Instruction to Owner
1.33	Early Occupancy
1.34	Operation and Maintenance Manuals
1.35	Warranty

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: General Requirements
Section No.: 20 00 00
Date: April 9, 2020

1 **GENERAL**

1.1 GENERAL

1.1.1 Conform to the conditions stated in the Contract Form Document CCDC 2 – 2008, Supplementary Conditions and Division 01 - General Requirements of these Specifications.

1.1.2 The General Mechanical Requirements apply to all Sections of this Division and of Divisions 21, 22, 23 and 25.

1.1.3 The Specifications are arranged generally in accordance with the MasterFormat 2004 Edition. Sections of this Division are not intended to delegate functions or to delegate work to any specific Subcontractor(s).

1.2 DEFINITIONS

1.2.1 “Provide” means to supply and install the Products and services specified in the Contract Documents.

1.2.2 “The Work” means the total construction and related services required by the Contract, and it includes all labour, products, and services.

1.2.3 “Products” means all material, machinery, equipment, and fixtures forming part of the Work but does not include machinery and equipment used for preparation, fabrication, conveying and erection of the Work which is normally referred to as construction machinery and equipment.

1.2.4 “This Division” means all Subcontractors performing work under the Mechanical Contract, including Divisions 21, 22, 23 and 25.

1.2.5 “Other Divisions” means other Subcontractors not included in this Division.

1.2.6 “Balancing Subcontractor” means the Subcontractor responsible for the balancing work.

1.3 INTENT

1.3.1 Provide all work, including items, articles, materials, operations, and methods listed, mentioned, and scheduled in the Contract Documents. Include all labour, equipment, tools, scaffolds, and

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: General Requirements
Section No.: 20 00 00
Date: April 9, 2020

other incidentals necessary and required for the complete installation.

1.3.2 Consider the Specifications as an integral part of the Drawings, which accompany them. Do not use the Drawings or the Specifications alone. Consider any item or subject omitted from one, but mentioned or reasonably implied in the other, as properly and sufficiently specified and provided under the work of this Division.

1.3.3 This installation shall be made in strict accordance with the Drawings, Specifications, and all applicable codes, regulations, standards, bylaws, including the Ontario Building Code, requirements of local authorities having jurisdiction, Owner's Insurers', and NFPA regulations. Codes, standards, and regulations referenced by these Specifications shall be the latest edition as applicable at the time of building permit application unless noted otherwise or specifically defined under the OBC.

1.3.4 All equipment and devices used shall be UL/cUL listed and/or CSA certified where applicable.

1.3.5 Each Subcontractor is considered an expert in their field.

1.4 EXAMINATION OF SITE AND CONTRACT DOCUMENTS

1.4.1 Before tendering, visit the Site of the proposed Work and obtain all information as to existing conditions and limitations.

1.4.2 Examine the Specifications and all Drawings including the Specifications and Drawings of all other Divisions before commencing any portion of the work to this Division.

1.4.3 No allowance will be made for any consideration that may have been overlooked.

1.4.4 Unless exceptions are specifically noted in the Contract Documents at the time of Tender, the submission of a bid confirms that the Contract Documents and the Site conditions are accepted without qualification.

1.5 SCOPE

1.5.1 Major aspects of the work of this Division shall include, but not necessarily be limited to, the following items. Refer to Contract Drawings for the full scope of the Work included in the Contract.

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: General Requirements
Section No.: 20 00 00
Date: April 9, 2020

- 1.5.1.1 Heating, Ventilation, and Air Conditioning (HVAC) systems, consisting of rooftop units with VAV boxes and electric reheat on the perimeter, general exhaust and sanitary exhaust systems, associated ductwork, grilles, diffusers, humidifiers and controls. Air handling units, associated ductwork, grilles, diffusers, humidifiers and controls.
- 1.5.1.2 Supplementary heating systems, consisting of hydronic fan-forced heaters, cabinet heaters, unit heaters, wallfin radiation, associated controls, as required.
- 1.5.1.3 Kitchen make-up air supply and exhaust systems, including make-up air handling units, ecology units (as needed), associated welded and galvanized ductwork, grilles/diffusers and controls.
- 1.5.1.4 Laundry make-up air and exhaust systems, including make-up air handling unit, exhaust fan, lint trap, associated ductwork, grilles/diffusers and controls.
- 1.5.1.5 Plumbing systems, including incoming water services with water meters and inline filters, domestic water booster pumps, domestic cold water, sanitary drain and vent risers.
- 1.5.1.6 Central domestic hot water plant consisting of natural gas fired condensing boilers, 2 hot water storage tanks, domestic water booster pumps, distribution piping and recirculation system. Plumbing distribution piping to plumbing fixtures, public washrooms, kitchen and laundry equipment. Central grease collection system with storage tank, ejector pumps and heated grease lines. Plumbing rough-ins for retail stores.
- 1.5.1.7 Plumbing fixtures for public washrooms, kitchens, housekeeping rooms.
- 1.5.1.8 Fire protection systems including wet sprinkler system throughout the building, fire standpipe system with fire pump, siamese connections, fire hose stations and fire extinguishers throughout the building. An alternative approach of deleting fire hose stations may be considered.
- 1.5.1.9 Natural gas piping from outside meter to the rooftop units and hot water system.
- 1.5.1.10 Water collection system from perimeter and U/F weeper systems (installed by others), including sump pumps, piping and controls.

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: General Requirements
Section No.: 20 00 00
Date: April 9, 2020

1.5.1.11 Storm water drainage system, including drain piping and roof drains.

1.5.1.12 Noise control and vibration isolation systems.

1.5.1.13 DDC building automation system.

1.5.1.14 Testing, adjusting and balancing.

1.5.1.15 Commissioning of mechanical systems and equipment.

1.6 PERMITS, FEES AND INSPECTIONS

1.6.1 Apply for, obtain, and pay for all permits, licenses, inspections, examinations, and fees required.

1.6.2 Arrange for inspection of all work by the authorities having jurisdiction over the Work. On completion of the Work, present to the Owner the final unconditional certificate of approval of the Inspection Authorities.

1.6.3 Comply with requirements of the edition as applicable at the time of building permit application, of the relevant CSA standards, the requirements of the authorities, Federal, Provincial and Municipal codes, the applicable standards of the Underwriters' Association and all other authorities having jurisdiction. These codes and regulations constitute an integral part of these Specifications. In case of conflict between the Codes and the Contract Documents, the more stringent requirement shall apply.

1.6.4 In no instance reduce the standard established by the Drawings and Specifications by applying any of the codes referred to herein.

1.6.5 Before starting any work, submit the required number of copies of the Drawings and Specifications to the authorities for their approval and comments. Comply with any changes requested as part of the Contract, but notify the Owner immediately in writing of such changes for proper processing of these requirements. Prepare and furnish any additional drawings, details or information as may be required.

1.7 CONTRACT DRAWINGS

1.7.1 The Drawings for the mechanical work are diagrammatic performance drawings, intended to convey the scope of the Work, and indicate general arrangement and approximate location of apparatus, fixtures, and pipe runs. The Drawings do not intend to

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: General Requirements
Section No.: 20 00 00
Date: April 9, 2020

show architectural and structural details.

- 1.7.2 Do not scale drawings, but obtain information involving accurate dimensions to structure from dimensions shown on architectural and structural drawings, or by site measurements. Consult general construction Drawings as well as detail Drawings to become familiar with all conditions affecting the Work and verify spaces in which the Work will be installed.
- 1.7.3 Make, at no additional cost to the Owner, any changes or additions to materials and/or equipment necessary to accommodate structural conditions (runs around beams, columns, etc.).
- 1.7.4 Alter at no additional cost to the Owner, the location of materials and/or equipment as directed, provided that the changes are made before installation and do not necessitate additional material.
- 1.7.5 Install all ceiling mounted components (diffusers, grilles, sprinklers) in accordance with reflected ceiling drawings reviewed by the Consultant.
- 1.7.6 Leave space clear and install all work to accommodate future materials and/or equipment as indicated and to accommodate equipment and/or material supplied by another Division of Work or Contract. Verify spaces in which Work is to be installed. Install all pipe runs, etc., to maintain headroom and clearances and to conserve space in shafts and ceiling spaces.
- 1.7.7 Confirm on the Site the exact location of outlets and fixtures. Confirm location of outlets for equipment supplied under other Divisions of Work or Contracts.
- 1.8 CONSTRUCTION DRAWINGS
- 1.8.1 Prepare dimensioned co-ordination drawings in conjunction with all Subcontractors concerned, showing sleeves, access door locations, and openings through structure and all insert sizes and locations. Show all weights on load points. Show all electrical systems, mechanical systems, conduit, and ductwork.
- 1.8.2 Prepare drawings of pump pits, equipment bases, anchors, inertia slabs, floor and roof curbs pertaining to the Mechanical Work. Base drawings upon reviewed Shop Drawings. Indicate all loads transferred to the structure.
- 1.8.3 Submit drawings approved by all trades, to the Consultant and

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: General Requirements
Section No.: 20 00 00
Date: April 9, 2020

include one complete set in each operating and maintenance instruction manual.

1.9 SHOP DRAWINGS

- 1.9.1 Submit Shop Drawings and samples for material and equipment as listed in the Specifications. Provide one (1) electronic pdf file. Each Shop Drawing shall have a clear margin equal to the half of a 216 mm x 280 mm (8-1/2" x 11") size sheet for the application of all necessary approval stamps.
- 1.9.2 Contractor shall provide a shop drawing submission schedule at the start of the project. Schedule shall indicate the description of each shop drawing and the date of submission to the Consultant.
- 1.9.3 The Consultant will only consider Shop Drawings bearing the stamp of approval of the Contractor and all Sub-Contractors involved when applicable. Check for all pertinent information such as physical dimensions, make, performance, electrical characteristics, and indicate the intended use and location before stamping these drawings approved.
- 1.9.4 Assume responsibility for accuracy of equipment dimensions related to available space and accessibility for maintenance and service, and compliance with Codes and Inspection Authorities.
- 1.9.5 Submit Shop Drawings showing the following:
- 1.9.5.1 Project name.
 - 1.9.5.2 Project tag number.
 - 1.9.5.3 Manufacturer's name and model number.
 - 1.9.5.4 Supplier's name.
 - 1.9.5.5 Approval agencies.
 - 1.9.5.6 Shipping and working weight.
 - 1.9.5.7 Performance characteristics.
 - 1.9.5.8 Dimensions including required clearances.
 - 1.9.5.9 Electrical characteristics.
 - 1.9.5.10 Materials used in manufacture and type of finish.

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
 Project No.: 2019-0495
 Section Name: General Requirements
 Section No.: 20 00 00
 Date: April 9, 2020

- 1.9.5.11 Time required to fabricate and to deliver.
- 1.9.5.12 All variations from Tender Documents.
- 1.9.5.13 Construction and field connection details.
- 1.9.5.14 Motor locations.
- 1.9.6 Shop Drawings for packaged equipment shall be submitted as complete packages, including all equipment components and details (wiring diagrams, control diagrams, etc.).
- 1.9.7 The Consultant's review shall not relieve the Contractor from responsibility for deviations from the Consultant's Drawings and Specifications, unless he has in writing, called the Consultant's attention to such deviations at the time of submission of drawings. The Consultant's review shall be construed to apply to and only to general arrangement and shall not relieve the Contractor from the entire responsibility for correctness of details and dimensions. Any fabrication, erection, setting out or other work done in advance of the receipt of stamped drawings shall be done entirely at the Contractor's risk.
- 1.9.8 Shop Drawings will be marked by the Consultant for action by the Contractor as follows:
- | Consultant's
<u>Markings</u> | Action by
<u>Contractor</u> |
|---------------------------------|--|
| No comment | Proceed with work |
| Make correction noted | Proceed in accordance with mark-up. Resubmit revised drawings for record |
| Revise and Resubmit | Submit revised drawings for review before proceeding |
| Rejected | Product not suitable. Do not proceed. Review specifications and drawings, and resubmit shop drawing that |

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
 Project No.: 2019-0495
 Section Name: General Requirements
 Section No.: 20 00 00
 Date: April 9, 2020

complies with the Contract.

Not reviewed

Product does not fall under this Division's scope and it does not affect this Division's Work in any way

1.10 SCHEDULING

1.10.1 Comply with the Contractor's construction schedule.

1.10.2 Provide in the tender price any costs for premium time outside of normal working hours to complete the work on schedule.

1.11 RECORD DRAWINGS

1.11.1 Obtain one (1) compact disc (CD) with AutoCAD drawing files and with electronic copy of the Contract Documents in pdf format from the Consultant after returning Consultant's waiver signed. As the job progresses, produce white prints of the relevant drawings and mark the prints to accurately indicate installed work. Have the white prints available for inspection at the site at all times, and present for scrutiny at job meeting. Transfer all information onto the AutoCAD drawing files. Drawing files shall retain all original layering standards. Submit one (1) set of AutoCAD drawing files and one (1) set of pdf files on CD of final "Record" documents (drawings and specifications) to the Consultant for review. Note that the consultant's AutoCAD drawing files are copyrighted and may not be used for any other purpose other than that described above.

1.11.2 The drawing files shall be provided solely to assist the Subcontractor in the preparation of "Record" drawings. The Consultant assumes no liability for any errors, omissions, incomplete information, incorporation of latest changes, or other instructions.

1.11.3 While the Consultant takes precautions to ensure that no computer virus is transmitted, scanning for viruses upon receipt is recommended.

1.11.4 Prepare Record Drawings showing the following:

1.11.4.1 Inverts of all services entering and leaving the building and at

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: General Requirements
Section No.: 20 00 00
Date: April 9, 2020

property lines.

- 1.11.4.2 Dimensions of underground services in relation to building lines at key points of every run.
- 1.11.4.3 Elevations of underground services in relation to Ground floor level of the building.
- 1.11.4.4 Dimensioned location of all services embedded in the structure.
- 1.11.4.5 Dimensioned location of all services left for future Work.
- 1.11.4.6 All Addendum changes.
- 1.11.4.7 All changes to the work due to Change Orders.
- 1.11.4.8 All changes to the Work during construction.
- 1.11.4.9 Location and designation of all electrically supervised valves and smoke dampers.
- 1.11.4.10 Location and designation of all items requiring access or service in a hidden location.
- 1.11.4.11 All changes to Specifications, details and equipment schedules.
- 1.11.4.12 All duct traverse points and associated airflow rates as reported in final Air Balancing reports.
- 1.11.5 Identify each "Record" drawing as follows, "Record Drawing: This drawing has been revised to show all systems as installed. Remove references to the Consultant.
- 1.11.6 Prior to Testing, Adjusting and Balancing, provide print copies of all current record drawings to the Balancing Subcontractor and the Commissioning Agent.
- 1.12 PRODUCTS
- 1.12.1 Provide only new Products. Where manufacturer is not specified provide Products of high commercial standard and quality consistent with the standards of these Specifications.
- 1.12.2 All Products must bear the approval of the CSA or have special approval of the inspection authority having jurisdiction for their respective functions and environments.

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: General Requirements
Section No.: 20 00 00
Date: April 9, 2020

1.12.3 Provide products of same manufacture for similar applications unless noted otherwise in the Contract Documents.

1.12.4 Refer to equipment performance schedules in the respective Specification Section and on the Drawings.

1.13 ALTERNATES AND SUBSTITUTIONS DURING PROGRESS OF WORK

1.13.1 Substitute Products will only be considered when Products specified in the Contract Documents become unobtainable.

1.13.2 Provide detailed Specifications and Shop Drawings with complete performance characteristics of the proposed alternate with the submission to the Consultant.

1.13.3 Assume responsibility and pay for any additional installation costs incurred by the work of all Divisions resulting from the substitution.

1.14 VALUATION OF CHANGES

1.14.1 For each change submit a complete itemized breakdown of labour and material.

1.14.2 Only the net difference between an extra and a credit will be subject to overhead and profit mark-up. Overhead and profit shall be as shown on the Tender Form.

1.15 APPLICATION FOR PAYMENT

1.15.1 Conform to the Consultant's method of submission of application for payment, which will be issued after the award of Contract.

1.16 SUPERINTENDENCE

1.16.1 The supervisory staff assigned to the project shall be fully competent to implement efficiently all requirements for scheduling, coordination, field engineering reviews, inspections and submittals defined in the Specifications.

1.17 INSTALLATION REQUIREMENTS

1.17.1 The Consultant's Drawings and instructions govern the general location of all items.

1.17.2 Install all equipment and apparatus to allow free access for maintenance, adjustment and replacement.

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: General Requirements
Section No.: 20 00 00
Date: April 9, 2020

- 1.17.3 Install all Products and services in accordance with the manufacturer's requirements and/or recommendations.
- 1.17.4 Do not use explosive activated tools.
- 1.17.5 Install all services capped for future to allow easy access for future tie-in.
- 1.17.6 All equipment installed in parking structure floor slabs, ramps and driving areas shall meet all requirements of CAN/CSA-S413-07 with regard to corrosion protection:
 - 1.17.6.1 The use of dissimilar materials shall be avoided, or if unavoidable, electric contact shall be prevented.
 - 1.17.6.2 Embedded materials used for floor drains, pipes and other hardware shall be:
 - 1.17.6.2.1 Non metallic, or;
 - 1.17.6.2.2 A low copper aluminum alloy or an equally corrosion resistant metal, coated on surfaces in contact with concrete to prevent galvanic corrosion with steel reinforcing, or;
 - 1.17.6.2.3 Protected against the corrosive effects of de-icing chemicals by an effective and durable coating.
- 1.17.7 Install equipment neatly to the satisfaction of the Consultant. Unless noted otherwise in the Contract Documents, install all Products and services to follow building planes. Installation shall permit free use of space and maximum headroom.
- 1.17.8 Cap off and seal all open ends of installed ductwork, piping and conduits to prevent entrance of foreign matter.
- 1.17.9 Do not install piping in a location or manner, which might result in freezing.
- 1.18 TEMPORARY SERVICE
 - 1.18.1 Refer to Section 01 50 00 regarding temporary services, Contractor's shop, storage and other facilities.
 - 1.18.2 Do not use any of the permanent mechanical systems during construction, unless specific written permission is obtained from the Consultant or unless allowed elsewhere in the Contract Documents.

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: General Requirements
Section No.: 20 00 00
Date: April 9, 2020

1.18.3 The use of permanent facilities for temporary construction service shall not affect in any way the commencement of the warranty period. The warranty period shall commence as specified in the Contract Documents.

1.19 COOPERATION

1.19.1 Confer with all Subcontractors installing equipment that may affect the work of this Division, and arrange equipment in proper relation with equipment installed under other Divisions of the Contract.

1.19.2 Furnish all items to be built in, in time, complete with all pertinent information, commensurate with the progress of the work.

1.19.3 Store materials neatly and out of the way and clean up daily all refuse caused by the work.

1.19.4 Coordinate work with the work of all other Divisions. Relocate equipment and/or material installed, but not coordinated with the work of other Divisions, as directed by the Consultant, at no extra cost. Inform other Divisions of the locations of openings, chases, sleeves, supports, services, connections, etc. to be incorporated into the work.

1.20 PROTECTION

1.20.1 Protect building and structure from damage due to carrying out this work.

1.20.2 Protect all mechanical work from damage. Keep all equipment dry and clean at all times.

1.20.3 Cover all openings in equipment and materials.

1.20.4 Be responsible for and make good any damage caused directly or indirectly to any walls, floors, ceilings, woodwork, brickwork, finishes, etc.

1.21 FIELD REVIEW

1.21.1 The Consultants will make periodic visits to the Site during construction to ascertain reasonable conformity to plans and specifications. The Consultant is not responsible for quality control. Contractor shall maintain his own quality control and will be responsible for the execution of his work in conformity with the Contract Documents and with the requirements of authorities.

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: General Requirements
Section No.: 20 00 00
Date: April 9, 2020

- 1.21.2 The Owner and Consultant shall have access to the Site at all times for periodic inspections. Maintain a complete set of contract documents on Site for field reference by the Consultant.
- 1.21.3 Provide all gauges, instruments, and other equipment necessary for field review by the Consultant.
- 1.21.4 Application for final review will be considered when the Work has been completed and written declarations submitted that all commissioning, adjustment, set up and documentation is complete. Final review shall be done when:
 - 1.21.4.1 All reported deficiencies have been corrected.
 - 1.21.4.2 All systems have been balanced, tested, commissioned and are operational.
 - 1.21.4.3 The Owner has been instructed in the operation and maintenance of all equipment.
 - 1.21.4.4 All reports have been submitted and reviewed.
 - 1.21.4.5 All instruction manuals have been submitted and reviewed.
 - 1.21.4.6 All tags and nameplates are in place and all data submitted and reviewed.
 - 1.21.4.7 Cleaning up is finished in all respects.
 - 1.21.4.8 All spare parts and replacement parts specified have been provided.
 - 1.21.4.9 All record drawings have been submitted and reviewed.
- 1.22 SERVICES TO EQUIPMENT SUPPLIED BY OTHERS
 - 1.22.1 Provide all necessary connections required for equipment supplied by the Owner and the work of other Divisions. Examine all the Drawings and Specifications and identify all requirements.
 - 1.22.2 Provide valves, unions, caps, and vibration isolation for all services.
 - 1.22.3 The Contractor shall be responsible to verify, adjust and coordinate the type, size and location of mechanical services required for all equipment supplied by the Owner and the work of other Divisions.

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: General Requirements
Section No.: 20 00 00
Date: April 9, 2020

1.23 PROVISION FOR FUTURE EQUIPMENT AND CONSTRUCTION

- 1.23.1 Spaces designated for future equipment or building expansion shall be left clear.
- 1.23.2 Provide services for future extensions complete with Products necessary for present termination and to permit future extension.
- 1.23.3 Identify each service by a permanent marker at its termination point.

1.24 CUTTING AND PATCHING

- 1.24.1 Inform all other Divisions in time, concerning required openings. Where this requirement is not met, bear the cost of all cutting and patching, including layout, x-rays, ferros scanning at premium time. Obtain the permission of the Consultant before doing any cutting.
- 1.24.2 Do all necessary cutting and patching of existing work. X-ray all proposed floor-opening locations prior to core drilling. Refer to Section 20 00 55 – Work in Existing Buildings.
- 1.24.3 Obtain the Consultant's approval before doing any cutting and patching. Any structural modifications must not affect structural, fire barrier or vapor barrier integrity.

1.25 METALS

- 1.25.1 Metal construction required for the mechanical work and shown on the Structural Drawings will be carried out by Division 05 – Metals.
- 1.25.2 Provide all other metal work necessary for the mechanical work, such as, but not limited to, equipment bases, platforms, catwalks, supports, lintels, ladders, pit and trench covers. Have such work carried out in accordance with Division 05 – Metals.
- 1.25.3 Provide platforms and catwalks complete with safety rails, 6mm (¼") checkered plate or grating cover, suitable for minimum 750mm (30") wide. Provide removable sections where required for equipment removal.
- 1.25.4 Provide ladders using 13mm by 50mm (½" by 2") steel bar stringers and 19mm (¾") diameter steel bar rungs fastened through and welded to stringers at 300mm (12") on centers. Fabricate ladders 450mm (18") wide and locate 150mm (6") clear of wall face. Secure stringers at top and bottom and at minimum every 1.8m (6 ft) using welded steel brackets.

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: General Requirements
Section No.: 20 00 00
Date: April 9, 2020

1.26 CONCRETE

- 1.26.1 Concrete work required for mechanical work and shown on the structural Drawings will be carried out by Division 03 – Concrete.
- 1.26.2 Provide all other concrete work specified but not shown on structural Drawings, necessary for the mechanical work including but not limited to inertia slabs, housekeeping pads, and pipe cradles. Have such work carried out in accordance with Division 03 – Concrete.
- 1.26.3 Ensure that the ultimate compressible strength after 28 Days shall not be less than:
- 1.26.4 13,790 kPa (2,000 psi) for pipe encasing and backfill or excessive excavations.
- 1.26.5 20,665 kPa (3,000 psi) for all other work.

1.27 EXCAVATION AND BACKFILLING

- 1.27.1 All excavation and backfilling required for the mechanical work will be done under Division 31 – Earthwork of the Specifications, except as noted below. Refer to soil report regarding the type of soil.
- 1.27.2 Ensure that bottom of pipe trench is graded as required.
- 1.27.3 In firm, undisturbed soil, excavation will be carried out under Division 31 – Earthwork, to within 150mm (6") of the bottom of pipes. Excavate under this Division to desired grade, lay pipes directly on the soil and shape soil to fit the lower $\frac{1}{3}$ segment of all pipes and pipe bells. Ensure even bearing along the barrels.
- 1.27.4 In rock and shale and where noted, excavation will be carried out under Division 31 – Earthwork, to 150mm (6") below and minimum 200mm (8") to either side of the pipe. Fill back under this Division, a bedding of 9mm ($\frac{3}{8}$ ") crushed stone or granular 'A' gravel.
- 1.27.5 In unstable soil, in fill and in all cases where pipe bedding has been removed in earlier excavation, particularly near perimeter walls of building and at catch basins, excavation will be carried out to 200mm (8") below the pipe under Division 31 – Earthwork. Compact to maximum possible density under this Division of Work and support the pipe by a 200mm (8") thick concrete cradle spanning full length, between firm supports. Install reinforcing

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: General Requirements
Section No.: 20 00 00
Date: April 9, 2020

steel in cradle or construct piers at maximum 2400mm (8 ft) spacing. Provide a minimum of one pier per length of pipe, down to solid load bearing strata. Use same method where pipes cross. Do all excavation for such piers.

- 1.27.6 Provide support over at least the bottom $\frac{1}{3}$ segment of the pipe in all bedding methods.
- 1.27.7 Before backfilling, obtain approval from Consultant.
- 1.27.8 Backfill trenches within the building to a compacted level of 300mm (12") above the top of pipes with clean, sharp sand in individual layers, maximum 150mm (6") thick, hand compacted to a density of 95% Modified Proctor.
- 1.27.9 Backfill trenches outside the building to a compacted level of 300mm (12") above the top of the pipes with individual layers of material up to 150mm (6") thick, hand compacted to a density of 95% Modified Proctor, using Granular 'A' gravel.
- 1.27.10 Obtain written approval of all backfilling done under this Division from Consultant before work commences on additional backfilling under Division 31 – Earthwork.
- 1.28 PAINTING
- 1.28.1 Provide all exposed ferrous metal work and Products, except ductwork and piping, with at least one (1) factory prime coat or paint one prime coat on site. Clean up or wire brush all equipment before painting. Unless otherwise noted finish painting will be done under Division 09 – Finishes of these Specifications.
- 1.28.2 If not factory coated or galvanized, clean, wire brush and paint all ferrous supports and hangers concealed in ceiling spaces of kitchens or other similar high humidity areas.
- 1.28.3 Repaint or refinish all damaged factory applied finishes.
- 1.28.4 Provide oil-base red oxide primer applied as per manufacturer's recommendations.
- 1.29 ABBREVIATIONS
- 1.29.1 Abbreviations with respect to government agencies, testing agencies, technical societies, approval agencies and technical terminologies are as listed below:

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: General Requirements
Section No.: 20 00 00
Date: April 9, 2020

AGA	American Gas Association
AHRI	Air-Conditioning, Heating, and Refrigeration Institute
AMCA	Air Moving and Conditioning Association
ANSI	American National Standards Institute
API	American Petroleum Institute
ARI	Air Conditioning and Refrigeration Institute
ASHRAE	American Society of Heating, Refrigerating, and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASSE	American Society of Safety Engineers
ASTM	American Society for Testing and Materials
AWS	American Welding Society
AWWA	American Water Works Association
BAS	Building Automation System
BC	National or State (US) Building Codes
CGA	Canadian Gas Association
CRN	Canadian Registration Number
CSA	Canadian Standards Association
DDC	Direct Digital Control
ECM	Electronically Commutated Motor
EEMAC	Electrical Equipment Manufacturers Association of Canada
FM	Factory Mutual
IAO	Insurers' Advisory Organization (CGI Information Systems and Management Consultants Inc.)
IEEE	Institute of Electrical and Electronics Engineers
ISTA	International Safe Transit Association
MERV	Minimum Efficiency Reporting Value

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
 Project No.: 2019-0495
 Section Name: General Requirements
 Section No.: 20 00 00
 Date: April 9, 2020

MICA	Midwest Insulation Contractors Association
MSS	Manufacturers Standardization Society of the Valve and Fittings Industry
NBC	National Building Code
NBFU	National Board of Fire Underwriters (currently American Insurance Association)
NC	Noise Criterion
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NPT	National Pipe Thread
OBC	Ontario Building Code
OESC	Ontario Electrical Safety Code
OSHA	Occupational Safety and Health Administration
PID	Proportional–Integral–Derivative
PSC	Permanent-Split Capacitor
PWM	Pulse-Width Modulation
SCR	Silicon Controlled Rectifier
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
TEMA	Tubular Exchanger Manufacturers Association
ULC/cUL	Underwriters' Laboratories of Canada
VAV	Variable Air Volume
VFD	Variable Frequency Drive

1.30 MANUFACTURER'S CERTIFICATION

1.30.1 Submit letters from the manufacturers of all equipment certifying that their technical representatives have inspected and tested their equipment, have approved the methods of installation and operation. Where existing systems are extended, provide letters covering both new and existing equipment and connections.

1.30.2 These letters shall state the names of persons present at the

inspection and testing, methods used and a list of functions performed with location and room numbers where applicable.

1.30.3 Refer to the respective equipment sections for requirements for letters.

1.31 TRIAL USAGE

1.31.1 The Owner has the privilege of the trial usage of mechanical systems or parts thereof for the purpose of testing and learning the operational procedures.

1.31.2 Carry out the trial usage over a length of time as deemed reasonable by the Consultant, at no extra cost.

1.31.3 Carry out the operations only with the express knowledge and under supervision of the Contractor and/or appropriate Subcontractors who shall not waive any responsibility because of trial usage.

1.31.4 Trial usage shall not be construed as acceptance by the Owner.

1.32 INSTRUCTION TO OWNER

1.32.1 Instruct the Owner's representatives in all aspects of the operation of systems and equipment. Refer to requirements for demonstration in respective equipment sections.

1.32.2 Arrange for, and pay for services of service engineers and other manufacturer's representatives required for instruction on specialized portions of the installation.

1.32.3 Submit to the Consultant at the time of final inspection a complete list of systems stating for each system:

1.32.3.1 Date instructions were given to the Owner's staff.

1.32.3.2 Duration of instruction.

1.32.3.3 Names of persons instructed.

1.32.3.4 Other parties present (manufacturer's representative, consultants, etc.).

1.32.3.5 Signatures of the Owner's staff stating that they properly understood the system installation, operation and maintenance requirements.

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: General Requirements
Section No.: 20 00 00
Date: April 9, 2020

1.33 EARLY OCCUPANCY

- 1.33.1 The Owner will negotiate with the Contractor to occupy portions of the building before the Work is complete. Sufficient advance notice will be given to allow scheduling of the mechanical work to meet the Owner's requirements.
- 1.33.2 Notify the Contractor of any scheduling problems.
- 1.33.3 Schedule the Work and set construction priorities to satisfy the Owner's requirements.
- 1.33.4 Schedule the Work of this Division as follows:
- 1.33.4.1 Relevant equipment is ready for start-up as defined in these Specification Sections.
- 1.33.4.2 Systems are balanced.
- 1.33.4.3 Safety controls are in place.
- 1.33.4.4 Automatic temperature controls are operational.
- 1.33.4.5 Primary equipment is tested and started-up.
- 1.33.4.6 All filters are in place.
- 1.33.5 The Owner will take over individual items of equipment used for Early Occupancy and the warranty period will start when:
- 1.33.5.1 Conditions of start-up (Item 1.33.4) have been complied with.
- 1.33.5.2 Air and fluid systems have been balanced.
- 1.33.6 The Consultant will issue a list of deficiencies covering the individual items of equipment used for Early Occupancy at the time of takeover by the Owner.
- 1.33.7 Early Occupancy and the Owner's takeover of individual items of equipment does not relieve the Contractor of his responsibility to test, adjust, balance, commission and demonstrate the systems in accordance with the Contract Documents.

1.34 OPERATION AND MAINTENANCE MANUALS

- 1.34.1 Assemble three (3) manuals, each containing data sheets, brochures, operating, maintenance, recommended spare parts,

and lubricating instructions and a complete set of reviewed shop drawings and bind in hard cover. Identify cover "Operation and Maintenance Manual for _____". Manuals shall be separated with dividers in logical sections and volumes.

- 1.34.2 Present one (1) copy for review by Consultant. Make all corrections requested by the Consultant and forward the corrected review copy plus a duplicate to the Owner with a copy of transmittal to Consultant for his records. Include the following information in each manual:
 - 1.34.2.1 Refrigeration Equipment
 - 1.34.2.1.1 Operating instructions detailing the procedures to be followed for:
 - Charging
 - Start-up
 - Changeover from one season to another
 - Shutdown
 - Night operation
 - Maintenance instructions
 - 1.34.2.1.2 Lubrication instruction for moving parts detailing type of lubricant to be used and the lubrication intervals in operation hours.
 - 1.34.2.1.3 List of safety devices and instructions for their testing and adjusting.
 - 1.34.2.1.4 Complete set of shop drawings showing:
 - Control sequence with description of the sequences of operation.
 - Detailed layout and sections indicating all maintenance, cleaning and lubrication points.
 - 1.34.2.1.5 List of parts (bill of material) indicating the catalogue number and manufacturer, complete with drawings indicating the location of each part in the complete assembly.
 - 1.34.2.1.6 Recommended chemical analysis of chilled water.
 - 1.34.2.2 Heat Exchangers and Coils
 - 1.34.2.2.1 Equipment layout (plans and section) giving all information on type of flanges, bolts, nuts, studs, tubes, etc.

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
 Project No.: 2019-0495
 Section Name: General Requirements
 Section No.: 20 00 00
 Date: April 9, 2020

- 1.34.2.2.2 Tube replacement instructions.
- 1.34.2.2.3 Cleaning instructions.
- 1.34.2.3 Pumps and Fans. Include for each different type and size:
 - 1.34.2.3.1 Shop drawings indicating maintenance and lubrication points.
 - 1.34.2.3.2 List of parts indicating the catalogue number and manufacturer, complete with drawings indicating the location of each part in the complete assembly.
 - 1.34.2.3.3 Performance curves.
- 1.34.2.4 Valves and Fittings
 - 1.34.2.4.1 Three (3) copies of framed valve charts for the project.
 - 1.34.2.4.2 A list of valves as per the valve chart indicating size, type, catalogue number, make of each valve, strainer and steam trap.
- 1.34.2.5 Instrumentation and Control
 - 1.34.2.5.1 Complete instrument list for all gauges, thermometers, gauge glasses and other instruments.
 - 1.34.2.5.2 Sequence and description of operation for each control system.
 - 1.34.2.5.3 Control diagram for each system complete with equipment summary giving system designation and catalogue number for each component.
 - 1.34.2.5.4 Catalogue leaflet of each component used.
 - 1.34.2.5.5 Applications programming information and programmer's manual.
 - 1.34.2.5.6 Description of operating procedures, including required actions at each operator position, operation of computer peripherals, input and output formats and procedures, and emergency alarm and failure recovery procedures. Descriptions of system start-up, back-up equipment operation, and execution of all system functions and operating modes shall be provided.
 - 1.34.2.5.7 Provide description of data communication, including data types and formats, data link components and interfaces, and operator test.

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
 Project No.: 2019-0495
 Section Name: General Requirements
 Section No.: 20 00 00
 Date: April 9, 2020

- 1.34.2.5.8 Instructions and schedules for inspections, cleaning, lubricating and calibration.
- 1.34.2.6 Other Equipment
- 1.34.2.6.1 Description of start-up and activating procedures, and commissioning procedures, as well as follow-up instructions to the Owner's operating staff to slowly break-in unit.
- 1.34.2.6.2 Maintenance instructions for all other equipment containing moving parts or requiring lubrication or chemical charging.
- 1.34.2.6.3 Include instruction list of parts indicating catalogue number and manufacturer, complete with drawings indicating the location of each part in the complete assembly; performance curves.
- 1.34.2.7 A list of all motors serving mechanical equipment. Include in the list:
 - 1.34.2.7.1 Location of motor.
 - 1.34.2.7.2 Name of unit served by motor.
 - 1.34.2.7.3 Motor serial number, manufacturer.
 - 1.34.2.7.4 Power rating, voltage, full load current, service factor and rpm of motor (nameplate data), rating and catalogue number of motor starter thermal overload relays.
 - 1.34.2.7.5 Serial number, rpm, airflow, manufacturer, static pressure (or head) of fan or pump.
 - 1.34.2.7.6 Quantity, sizes and V-belt number of belts.
 - 1.34.2.7.7 Sizes and types of drives used.
 - 1.34.2.7.8 Type of oil or grease lubrication of gearbox, lubrication interval in hours of operation.
 - 1.34.2.7.9 Type of grease lubrication for driven equipment, lubrication interval in hours of operation.
- 1.34.2.8 A copy of the following:
 - 1.34.2.8.1 All reviewed sprinkler layouts and hydraulic calculations.
 - 1.34.2.8.2 Final NFPA certification letter. Certification letter shall contain

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: General Requirements
Section No.: 20 00 00
Date: April 9, 2020

contractor's contact information, the building permit number, certification statement in regard to NFPA compliance and be stamped by a licensed professional engineer.

- 1.34.2.8.3 Certificates from all equipment manufacturers, duct-cleaning agents, pipe-cleaning agents, chemical treatment agents and local authorities having jurisdiction.
- 1.34.2.8.4 All pipe and duct pressure test reports.
- 1.34.2.8.5 Warranties and letters of guarantee from contractors and equipment manufacturers.
- 1.34.2.8.6 Copies of permits, licenses and certificates.
- 1.34.2.8.7 Start-up and activation and commissioning procedures and check sheets.
- 1.35 WARRANTY
- 1.35.1 Refer to General Conditions of the Contract and Specimen Warranty Form.
- 1.35.2 Furnish all extended warranty for equipment as required in the Specifications.

END OF SECTION

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Basic Materials and Methods
Section No.: 20 00 50
Date: April 9, 2020

INDEX

1 GENERAL

- 1.1 General
- 1.2 Shop Drawings
- 1.3 Materials and Equipment

2 PRODUCTS

- 2.1 Access Doors and Panels
- 2.2 Bearings and Gear Boxes

3 EXECUTION

- 3.1 Flashing
- 3.2 Bearings and Gear Boxes
- 3.3 Belt Drives, Sheaves and Guards
- 3.4 Inserts, Sleeves, Escutcheons and Curbs
- 3.5 Access Doors and Panels
- 3.6 Drip Pans
- 3.7 Workmanship

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Basic Materials and Methods
Section No.: 20 00 50
Date: April 9, 2020

1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 – General Requirements shall apply to and govern this Section.

1.2 SHOP DRAWINGS

1.2.1 Provide Shop Drawings for:

1.2.1.1 Access doors and panels.

1.3 MATERIALS AND EQUIPMENT

1.3.1 Use only new materials and equipment of Manufacturer as specified or shown on the Drawings. Ensure that equipment and materials for similar applications are of the same Manufacturer.

1.3.2 If the Subcontractor wishes to substitute materials of Manufacturers other than those named, he shall state in his Tender the name and a complete description of the materials to be substituted, along with the amount of change in the Contract Price.

1.3.3 Ensure that materials not specified to a specific Manufacturer are of high commercial standard and quality.

2 **PRODUCTS**

2.1 ACCESS DOORS AND PANELS

2.1.1 In plaster, gypsum board, tiled or masonry walls for exposed flush installation, provide 203mm by 203mm (8" x 8") prime coated 16 ga. access door with 18 ga. mounting frame, continuous concealed hinge, and screwdriver operated stainless steel cam latch, similar to Acudor UF-5000.

2.1.2 In plaster or tiled walls for recessed installation, provide 305mm by 305mm (12" x 12") 16 ga. access door recessed by 25mm (1"). Door to be complete with 14 ga. mounting frame, concealed pivoting rod type hinge, and flush-to-surface screwdriver operated stainless steel cam latch, similar to Acudor AT-5020.

2.1.3 In gypsum board surfaces or in acoustic tiles for recessed installation in public areas, provide 305mm by 305mm (12" x 12") bauco-plus architectural access door with concealed hardware and gypsum board inlay. Standard features include cam latch flush

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Basic Materials and Methods
Section No.: 20 00 50
Date: April 9, 2020

with surface, aluminum frame and glass fibre-reinforced nylon hardware, fully hinged removable door panel and integrated safety catches, perimeter gasket installed onsite.

2.1.3.1 In areas not accessible by public, provide 305mm by 305mm (12" x 12") 16 ga. access door recessed by 25mm (1"). Door to be complete with 14 ga. mounting frame with drywall taping bead on all sides, concealed pivoting rod type hinge, and flush-to-surface screwdriver operated stainless steel cam latch, similar to Acudor DW-5015.

2.1.4 In fire rated walls, provide 305mm by 305mm (12" x 12") 16 ga. rated access door, ULC listed "B" label for 1-1/2 or 2 hours. Door to be complete with 16 ga. mounting frame, concealed hinge, spring closer, and knurled knob operated universal self-latching bolt, similar to Acudor FB-5060.

2.2 BEARINGS AND GEAR BOXES

2.2.1 Provide bearings suitable for application and environment, i.e., dust, corrosive atmospheres, high temperatures, etc. Bearings shall have a lifetime guarantee of not less than five (5) years.

3 **EXECUTION**

3.1 FLASHING

3.1.1 Provide galvanized or aluminum sleeves for piping through roof.

3.1.2 Ensure that the flashing suits roof and extends minimum 450mm (18") on all sides. Leave flashing as directed by the Contractor, to be built into roofing, rendering a watertight connection.

3.1.3 Provide counter flashing on diesel and boiler exhaust stacks, ducts, and pipes passing through roofs to fit over flashing or curb. Coordinate with the Subcontractor responsible for the roofing work of the Contractor.

3.1.4 Sleeve pipes through waterproof floors.

3.1.5 Pay special attention to the waterproofing conditions of basement walls and floors. Co-operate at all times with the water proofing trade and do not cut or destroy any waterproofing seal without the consent of the waterproofing trade. Provide piping sleeves passing through waterproof walls with asphalt roofing felt wrapped around to leave 25mm by 50mm (1" x 2") recess on both sides of the wall.

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Basic Materials and Methods
Section No.: 20 00 50
Date: April 9, 2020

These recesses and the space between pipe and sleeve shall be caulked by this Division in accordance with the requirements of Division 07 – Thermal and Moisture Protection.

3.2 BEARINGS AND GEAR BOXES

3.2.1 Run-in all bearings, gearboxes and fluid couplings for a period recommended by the manufacturer. Flush out, and refill with new charge of recommended lubricant.

3.2.2 Provide all necessary lubricating materials and labour for all operating equipment until acceptable for operation and care by the Owner.

3.2.3 Provide oil-lubricated bearings and sumps with level gauge, in easily accessible location. Provide grease-lubricated bearings, if not readily accessible, with extended nipples.

3.3 BELT DRIVES, SHEAVES AND GUARDS

3.3.1 Provide all belt-driven equipment with V-belt drive, designed for at least 130 percent of motor nameplate power rating, and in accordance with manufacturer's recommendations for type of service intended. Belt drives to be at least 95 percent efficient. Balance and properly align drives. Provide matched sets of belts for multiple belt assemblies. Select belts to suit starting torque for driver. Use single belt drives only for motors 1.5kW (2.0 HP) and smaller.

3.4 INSERTS, SLEEVES, ESCUTCHEONS AND CURBS

3.4.1 Use only factory made, threaded, or toggle type inserts as required for supports and anchors, properly sized for the load to be carried. Place inserts only in portions of the main structure and not in any finishing material.

3.4.2 Use factory made expansion shields where inserts cannot be placed, but only where permission is given by the Consultant.

3.4.3 Do not use powder-activated tools except with written permission from the Consultant.

3.4.4 Supply and locate inserts, holes, anchor bolts, and sleeves in time when walls, floors and roof are erected.

3.4.5 Sleeves shall be concentric with pipe and be a minimum of 50mm (2") larger than pipe size.

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Basic Materials and Methods
Section No.: 20 00 50
Date: April 9, 2020

- 3.4.6 Pass insulation unbroken where pipe or duct is insulated, except through fire rated walls and floors. Size sleeves to provide 13mm (½") clearance all around.
- 3.4.7 Use the following sleeving material for pipe sleeves:
 - 3.4.7.1 Through interior walls use Schedule 10 steel pipes, machine cut, flush with finished structure. Check room-finish schedules.
 - 3.4.7.2 Through exterior walls above grade use Schedule 10 steel pipes, machine cut, flush with finished structure inside and to suit flashing on outside.
 - 3.4.7.3 Through exterior walls below grade and other waterproof walls use extra heavy weight cast iron or PVC sleeves, machine cut. Check flashing details for further information.
 - 3.4.7.4 Through waterproof floors, through janitor's closets, mechanical rooms, compartment mechanical rooms, showers, kitchens, washrooms, and through roofs, use Schedule 40 sleeves, machine cut. As an alternative, copper DWV sleeves up to and including 150mm (6") sleeve size and rolled 32 ounce copper sleeves for larger than 150mm (6") sleeve size may be used. Extend sleeves 100mm (4") above finished floor upwards and cut flush with underside of floor. Refer to flashing details through waterproof floors.
 - 3.4.7.5 Through other interior floors use Schedule 10 steel pipes, machine cut, flush with finished structure on both sides. Check room-finish schedules for further information.
 - 3.4.7.6 Ensure that watertight concrete curbs, 100mm (4") high by 100mm (4") wide with 19mm (¾") chamfered edges, are furnished around pipes passing through waterproof floors except where furred in. Read Division 03 – Concrete for further information.
- 3.4.8 Pack spaces between the insulated pipe and the sleeve or where uninsulated, between the pipe and the sleeve, with ULC listed fire rated foam. Maintain vapour barrier on cold lines. Seal the annular space both sides as follows:
 - 3.4.8.1 For horizontal sleeves in exposed areas, use a seal equal to or better fire rated than the wall to be sealed. Use "Fire barrier" as distributed by Double A/D Distributors Ltd. (UL No. 4 U 18.7 approved).

- 3.4.8.2 For horizontal concealed sleeves through firewalls and through walls separating areas of different air pressure, use a permanently resilient (silicone base or equal) sealing compound.
- 3.4.8.3 For vertical sleeves through roofs, janitor's closets, equipment rooms, and where required to provide fire rated separation, use permanently resilient (silicone base or equal) sealing compound, non-flammable and waterproof. Ensure that the seal is compatible with floor and ceiling finishes. Check the room-finish schedules for further information.
- 3.4.8.4 All fire stop materials and methods must be approved in accordance with CAN/ULC-S115-11, and be ULC listed.
- 3.4.8.5 Seal is not required for other sleeves.
- 3.4.9 Cover exposed floor and wall pipe sleeves in finished areas with satin finish chrome or nickel plated solid brass or with satin finish stainless steel escutcheons with non-ferrous set screws. Split cast plates of the screw locking type may be used. Do not use stamped steel friction type split plates.
- 3.4.10 Use the following sleeving for ducts:
 - 3.4.10.1 Unless otherwise noted, use minimum 1.3mm (18 gauge) galvanized steel sleeves.
 - 3.4.10.2 For rectangular duct openings through walls and floors provide a removable wood box-out of the required size.
 - 3.4.10.3 Through firewalls, build fire dampers into wall.
 - 3.4.10.4 Through floors where ducts are not furred in or enclosed in a duct-shaft, ensure the 100mm (4") high by 100mm (4") wide watertight concrete curbs are provided, with 19mm ($\frac{3}{4}$ ") chamfered edges all around. Extend sleeves where used, flush to top of curb. Read Division 03 – Concrete, for further information.
 - 3.4.10.5 Through floors where ducts are enclosed in a duct shaft or furred in, provide the watertight concrete curbs at the extreme top and bottom ends of the shaft only.
 - 3.4.10.6 Through roofs, provide curbs and sleeves as shown on the detail drawings and to suit flashing requirements.
- 3.4.11 After ducts are installed, pack the opening and seal both sides as follows:

- 3.4.11.1 Use fiberglass insulation for packing, except through curbed concrete floors use "Fire barrier" as distributed by Double A/D Distributors Ltd. (UL No. 4 U 18.7 Approved).
- 3.4.11.2 Seal the packing in openings through floors with permanently resilient (Silicone base or equal) compound, non-flammable and waterproof. Press duct supports firmly into caulking before bolting down to curb.
- 3.4.11.3 Through all vertical walls seal the fibreglass packing using a permanently resilient (silicone base or equal) sealing compound.
- 3.4.11.4 All fire stop materials and methods must be approved in accordance with CAN/ULC-S115-11, and be ULC listed.
- 3.4.11.5 Seal is not required for other packings.
- 3.4.12 Brace duct sleeves and box-outs to retain their position and shape during the pouring of concrete and other work.
- 3.4.13 Provide bracing for each duct at every passing through structure to prevent sagging.
- 3.4.14 Cover exposed duct sleeves and openings in exposed areas only. Use 1.3mm (18 gauge) galvanized steel escutcheons in form of a duct collar. Over curbs extend the collar 25mm (1") down the side of the curb, similar to counter flashing. Fix collar in position with cadmium plated screws.
- 3.5 ACCESS DOORS AND PANELS
- 3.5.1 Install all concealed mechanical equipment requiring adjustment or maintenance in locations easily accessible through access panels or doors. Install systems and components to result in a minimum number of access panels. Indicate access panels on "As Built" drawings.
- 3.5.2 Provide the work of respective Division with panels, doors or the frames therefore; complete with all pertinent information for installation. Arrange with and deliver to the Subcontractor(s) in whose work they occur to install them. Ensure that access doors are installed in a manner to match the building material grids where applicable.
- 3.5.3 Prepare detailed and coordinated drawings showing location and type of all access doors. Submit these drawings to the Consultant

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Basic Materials and Methods
Section No.: 20 00 50
Date: April 9, 2020

to review.

3.5.4 Size all access doors to provide adequate access and commensurate with the type of structure and architectural finish, minimum size 150mm (6") by 150mm (6). Should it be necessary for persons to enter, provide a minimum 600mm (24") by 450mm (18") size doors.

3.5.5 Ensure proper fire rating of access doors in fire separations, fire-rated walls and ceilings.

3.5.6 Lay-in type tiles, properly marked, may serve as access panels.

3.6 DRIP PANS

3.6.1 Construct drip pans of min. 1.0mm (20 gauge) galvanized steel sheet with sealed connections. Provide drain lines from drip pans to nearest hub drain, funnel floor drain, janitor's sink or appropriate approved location.

3.6.2 Provide drip pans at the following locations:

3.6.2.1 Beneath all pipes passing through electrical, battery, UPS, elevator machine, diesel generator, and telephone rooms, over horizontal runs of bus ducts, and in locations as indicated on the Drawings.

3.7 WORKMANSHIP

3.7.1 Install ducts and pipes parallel and perpendicular to the building planes and concealed in chases, behind furring or above ceiling, except in unfinished areas. Install all exposed systems neatly and group together, to present a neat appearance.

3.7.2 Install all equipment and apparatus requiring maintenance, adjustment, or replacement with sufficient clearance for servicing.

END OF SECTION

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: **Work in Existing Buildings**
Section No.: 20 00 55
Date: April 9, 2020

INDEX

1	GENERAL
1.1	General
1.2	Co-Ordination Between New and Existing Installations
1.3	Penetrations in Existing Structure
1.4	Use of Existing Material and Equipment
1.5	Salvage Materials
1.6	Existing Services
1.7	Interruption of Services
1.8	Premium Time
1.9	Fire Protection

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Work in Existing Buildings
Section No.: 20 00 55
Date: April 9, 2020

1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 – General Requirements, shall apply to and govern this section.

1.2 CO-ORDINATION BETWEEN NEW AND EXISTING INSTALLATIONS

1.2.1 Check and co-ordinate all systems in the new building addition which are extended to or from existing systems to ensure their proper operation.

1.2.2 Provide interfacing components between new and existing systems as necessary for proper performance and operation.

1.3 PENETRATIONS IN EXISTING STRUCTURE

1.3.1 Do all cutting and core drilling for the Work of this Division. Obtain Consultant's approval before proceeding.

1.3.2 Provide sleeves and follow Consultant's instructions where necessary to completely penetrate existing floors, walls, ceiling, roof or structural members.

1.3.3 X-ray all proposed penetrations of concrete slabs to locate hidden services before penetrating existing structure. Advise Consultant of any interference.

1.3.4 Do all necessary patching and repairing. Maintain integrity of fire ratings.

1.3.5 Flash all parts passing through or built into a roof, outside wall or waterproof floor.

1.3.6 If any fire proofing material or insulation on building structure is damaged where mechanical equipment has been removed or added, Contractor to repair at this Division's expense.

1.4 USE OF EXISTING MATERIAL AND EQUIPMENT

1.4.1 Test existing equipment, which is to remain in areas being renovated for proper operation. Identify required repairs in written report to Consultant.

1.4.2 Clean, test for proper operation and repair existing equipment to be

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Work in Existing Buildings
Section No.: 20 00 55
Date: April 9, 2020

relocated before being put back into service. Identify required repairs in written report to Consultant.

1.4.3 Repair or replace, without adjustment to the Contract price, all existing equipment, which is damaged in process of relocation.

1.4.4 Unless noted otherwise provide additional equipment of the same type and manufacturer where required to supplement existing equipment.

1.4.5 Review existing equipment on site to determine operating conditions prior to Tender.

1.5 SALVAGE MATERIALS

1.5.1 Remove from the site all materials in renovated areas of the existing building which are not to remain or be reused, unless noted as remaining the property of the Owner.

1.6 EXISTING SERVICES

1.6.1 Disconnect and remove all existing products, which are abandoned.

1.6.2 Remove all piping, which is abandoned except inaccessible piping in furred-in space. Cut and cap piping below finished surfaces.

1.6.3 Plug and cap all abandoned drain and vent points in systems, which are being reused. Plug and cap to the approval of the local authorities.

1.6.4 Allow for all work necessary to complete the alterations, rerouting and/or repositioning of existing services and equipment, and all interconnections of new and existing systems.

1.6.5 Verify the location and size of all existing services before proceeding with the work.

1.6.6 Maintain heating and cooling in the building as required to protect the building and equipment or to provide comfort conditions for the occupants.

1.6.7 Keep all sprinkler, standpipe and other fire and life safety protection systems in operation at all time.

1.7 INTERRUPTION OF SERVICES

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: **Work in Existing Buildings**
Section No.: 20 00 55
Date: April 9, 2020

- 1.7.1 Co-ordinate all work with the use of the building by the Owner.
- 1.7.2 Maintain all mechanical services to all parts of the building which are in use. Provide temporary services as necessary.
- 1.7.3 Obtain Owner's written approval before interrupting any service.
- 1.7.4 Request permission to interrupt services in writing not less than two (2) weeks in advance and state time(s) and duration(s) of interruptions.
- 1.8 PREMIUM TIME
- 1.8.1 Include cost of premium time in Tender Price for work during nights, weekends or other time outside normal working hours necessary to maintain all mechanical services in operation.
- 1.9 FIRE PROTECTION
- 1.9.1 Maintain fire protection at all times in accordance with governing authorities' rules and regulations.

END OF SECTION

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: **2019-0495**
Section Name: **Electric Motors**
Section No.: **20 05 13**
Date: April 9, 2020

INDEX

1	GENERAL
1.1	General
2	PRODUCTS
2.1	Motors
3	EXECUTION

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Electric Motors
Section No.: 20 05 13
Date: April 9, 2020

1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 – General Requirements, shall apply to and govern this Section.

2 **PRODUCTS**

2.1 MOTORS

2.1.1 Supply and install all motors for Mechanical Equipment.

2.1.2 All motors shall be 60 cycle, 1750 rpm, except where noted otherwise.

0.37kW (1/2 HP) and smaller: 120V, 1 Ph, 60 Hz.

0.56kW (3/4 HP) and larger: 575V, 3 Ph, 60 Hz.

2.1.3 Motors shall be squirrel-cage induction motors, built to CEMA and NEMA motor and generator standards. 2-speed motors shall be single winding variable torque.

2.1.4 The minimum requirement for three phase motors shall be CEMA Design B; Class B insulated for maximum 40°C (104°F) ambient.

2.1.5 Single-phase motors shall be capacitor types, for minimum 10 starts per hour.

2.1.6 Motors 44.7kW (60 HP) and over shall be with inherent overheat protection, consisting of thermistors embedded in each phase of the stator winding and wired to the motor conduit box.

2.1.7 Select motors for quiet, continuous operation to suit loads, which may be imposed by equipment. Recognize that motor powers specified and scheduled are minimum sizes. If larger motors are required, ensure that extra costs of larger motors, starters, power wiring, and additional control wiring are included in the work.

2.1.8 All motor 0.75kW (1 HP) to 373kW (500 HP), unless otherwise specified, shall be T-frame AC three phase, and equal or exceed the motor efficiency levels as tested to CSA-C390-M or the nominal efficiency noted in Tables 10.4.1.A.(a) or 10.4.1.A.(b) of SB-10 of the OBC (premium efficiency/energy efficient), whichever is the highest. Motors to be approved under Canadian Electrical Safety Code.

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Electric Motors
Section No.: 20 05 13
Date: April 9, 2020

- 2.1.9 Motor enclosures shall be as follows:
 - 2.1.9.1 If protected from the weather and entraining moisture, use open drip-proof, service factor 1.15.
 - 2.1.9.2 Motors located in air streams shall be selected to operate satisfactorily at maximum temperature and moisture levels of surrounding air. Use drip-proof motors with encapsulated windings and weatherproof terminal box.
 - 2.1.9.3 For all other locations, use totally enclosed fan-cooled, service factor 1.0.
 - 2.1.9.4 Use explosion-proof motors where scheduled.
- 2.1.10 All motors shall be fitted with sealed for life bearing requiring no periodic lubrication.
- 2.1.11 Submit an accurate schedule of all motors. Include for each motor, the motor capacity, speed, nameplate current, equipment served, location, electrical characteristics, and identification number.
- 2.1.12 Provide each motor with a terminal box sized to accommodate the conductors connected thereto. Locate the terminal box to face the outside of the equipment assembly.
- 2.1.13 Provide EEMAC adjustable sliding bases for motors used with belt drives.
- 2.1.14 All motors driven by Variable Frequency Drives (VFD's) shall be NEMA31 design, have class F insulation, and be rated for inverter duty. Refer to Section 20 09 49 – Variable Frequency Drives.

3 EXECUTION

Not Used.

END OF SECTION

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Electrical Wiring
Section No.: 20 05 14
Date: April 9, 2020

INDEX

1	GENERAL
1.1	General
1.2	Scope of Work
2	PRODUCTS
2.1	General
3	EXECUTION
3.1	General

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Electrical Wiring
Section No.: 20 05 14
Date: April 9, 2020

1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Division 26 - Electrical will do all power wiring for equipment provided by Divisions 21, 22, 23 and 25.

1.2.2 Division 26 - Electrical will do all line side power wiring for equipment provided by Division 21 – Fire Suppression, Division 22 – Plumbing, Division 23 – HVAC and Division 25 – Integrated Automation, up to the respective starter, motor control center, control panel, disconnect or VFD, also provided under Divisions 21, 22, 23 and 25. Load side power wiring shall be under Divisions 21, 22, 23 and 25.

1.2.3 Divisions 21, 22, 23 and 25 shall provide all disconnect switches for mechanical equipment as required by code. Provide weatherproof switches for all outdoor locations.

1.2.4 Field control wiring of local safeties and interlocks for packaged equipment shall be provided under the respective Sections unless otherwise specified.

1.2.5 Conduit and wiring materials and methods shall be in strict accordance with the requirements of Division 26 - Electrical.

1.2.6 Check all wiring diagrams and control diagrams submitted in shop drawing form. Before submitting these shop drawings to the Consultant, submit these drawings to Division 26 - Electrical Contractor for approval. Have these drawings stamped by Division 26 - Electrical Contractor as verification of their approval before forwarding to the Consultant. Co-operate in the commissioning of all electrically driven equipment with Division 26 - Electrical.

2 **PRODUCTS**

2.1 GENERAL

2.1.1 Conduit and wiring materials and methods shall be in strict accordance with the requirements of Division 26 - Electrical.

3 **EXECUTION**

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: **2019-0495**
Section Name: **Electrical Wiring**
Section No.: **20 05 14**
Date: April 9, 2020

3.1 GENERAL

3.1.1 Refer to Division 26 - Electrical.

END OF SECTION

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Electrical Ancillaries
Section No.: 20 05 15
Date: April 9, 2020

INDEX

1	GENERAL
1.1	General
1.2	Scope of Work
1.3	Submittals
1.4	Electrical Equipment and Work
2	PRODUCTS
3	EXECUTION
3.1	Contactors and Control Devices

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Electrical Ancillaries
Section No.: 20 05 15
Date: April 9, 2020

1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 – General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools equipment, training commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 Contactors and control devices.

1.3 SUBMITTALS

1.3.1 Submit Shop Drawings for:

1.3.1.1 Contactors and control devices.

1.4 ELECTRICAL EQUIPMENT AND WORK

1.4.1.1 Read together with Division 26 – Electrical and adhere to its requirements. Supply and install all electrical apparatus that is required and is not covered by Division 26 – Electrical.

2 **PRODUCTS**

Not Used.

3 **EXECUTION**

3.1 CONTACTORS AND CONTROL DEVICES

3.1.1 Install all automatic devices such as thermostats, controlling electrical equipment, supplied under this Division.

3.1.2 Disconnect switches, starters, push button stations, cable lugs, pilot lights, and control circuit transformers shall be supplied and installed by Division 26 – Electrical, except as noted below.

3.1.2.1 Division 21, 22 and 23 shall provide all starters, contactors, fuses, etc., for packaged equipment such as chillers, boilers, domestic hot water heaters, rooftop air conditioning and heating units, electric reheat coils, computer room air conditioning units, etc., as specified in the respective sections. Division 26 – Electrical shall

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: **2019-0495**
Section Name: **Electrical Ancillaries**
Section No.: **20 05 15**
Date: April 9, 2020

provide disconnect switches for these equipment as required by applicable code.

- 3.1.3 Provide Division 26 – Electrical Contractor with all details of the motors and electrical equipment supplied for selection of overload protection, etc.

END OF SECTION

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: **2019-0495**
Section Name: **Expansion Compensation**
Section No.: **20 05 16**
Date: April 9, 2020

INDEX

1	GENERAL
1.1	General
1.2	Scope of Work
1.3	Submittals
1.4	Quality Assurance
2	PRODUCTS
2.1	General
2.2	Expansion Compensators
3	EXECUTION
3.1	General
3.2	Expansion Compensation
3.3	Manufacturer's Review

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Expansion Compensation
Section No.: 20 05 16
Date: April 9, 2020

1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools equipment, training commissioning and certification required to complete the work as shown on the Drawings and specified herein, including:

1.2.1.1 All necessary expansion compensation elements for piping and equipment.

1.2.2 Manufacturer of expansion compensation equipment shall guarantee specified isolation system deflection.

1.2.3 Manufacturer to provide installation instructions, drawings, and field supervision to assure proper installation and performance.

1.2.4 In addition to the work of this Section, comply with description of individual systems and general requirements of all other Specification Sections of this Division.

1.3 SUBMITTALS

1.3.1 Provide shop drawings for expansion compensation equipment.

1.3.2 As a minimum provide the following information:

1.3.2.1 Catalogue cuts and data sheets on specific compensators to be utilized showing compliance with the Specifications.

1.3.2.2 Drawings showing methods of suspension, support guides for piping and ductwork. Submittals must include the initial load, initial deflection, change in deflection, final load and change in load at all spring and anchor support locations, as well as guide spacing. Calculations shall include pipe stress at end conditions and branch off locations and the manufacturer must include installation instructions.

1.3.3 Submittal must be stamped and signed by a licensed professional engineer, either in the employ of the expansion compensation vendor or specialized to the field of expansion compensation system design, for at least 5 years.

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Expansion Compensation
Section No.: 20 05 16
Date: April 9, 2020

1.3.4 Submit letter from manufacturer certifying that expansion compensation equipment have been installed in accordance with its recommendations and the Contract Documents, and that it operates to his satisfaction.

1.4 QUALITY ASSURANCE

1.4.1 All grooved joint couplings and specialties shall be the products of a single manufacturer.

2 **PRODUCTS**

2.1 GENERAL

2.1.1 All expansion compensation devices shall be the product of a single manufacturer.

2.2 EXPANSION COMPENSATORS

2.2.1 Provide manufactured expansion joints suitable for working and test conditions of the pipe in which they are installed, with adequate cyclic life to last through 25 years of normal operation. Select the joints for the expected movement in the temperature ranges from 4.4°C (40°F) to maximum operating temperature plus 25% for hot pipes and from 26.6°C (80°F) to minimum operating temperature plus 25% for cold pipes.

2.2.2 Rubber expansion joints shall be peroxide cured EPDM throughout with Kevlar tire cord reinforcement. Substitutions must have certifiable equal or superior characteristics. The raised face rubber flanges must encase solid steel rings to prevent pull out. Flexible cable wire is not acceptable. Sizes 40mm through 350mm (1-1/2" through 14") shall have a ductile iron external ring between the two spheres. Sizes 400mm to 600mm (16" through 24") may be single sphere. Sizes 20mm through 50mm (3/4" through 2") may have one sphere, bolted threaded flange assemblies and cable retention.

2.2.2.1 Minimum ratings through 350mm (14") shall be 1.72MPa at 77°C and 1.48MPa at 121°C (250psi at 170°F and 215psi at 250°F), 400mm (16") through 600mm (24") 1.24MPa at 77°C and 1.03 MPa at 121°C (180psi at 170°F and 150psi at 250°F). Higher published rated connectors may be used where required.

2.2.2.2 Control rods passing through 12mm (1/2") thick Neoprene washer bushings large enough to take the thrust at 0.7 kg/mm² (1000 psi)

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
 Project No.: 2019-0495
 Section Name: Expansion Compensation
 Section No.: 20 05 16
 Date: April 9, 2020

of surface area may be used on unanchored piping where the manufacturer determines the condition exceeds the expansion joint rating without them.

- 2.2.2.3 Expansion joint to achieve a minimum reduction of 20 dB in vibration accelerations and 10 dB in sound pressure levels at typical blade passage frequencies.
- 2.2.2.4 Safety factors shall be a minimum of 3/1. All expansion joints must be factory tested to 150% of maximum pressure for 12 minutes before shipment.
- 2.2.2.5 Rubber expansion joint to be Mason Type SAFEFLEX SFDEJ, SFEJ, SFDJR or SFU, control rods Type CR.
- 2.2.3 Provide braided hose type connectors in accordance with the following schedule.
 - 2.2.3.1 Low pressure service up to 121°C (250°F): bronze hose and copper sweat connection up to 65mm (2-½") dia., Mason Type CPSB; 304 stainless steel hose and carbon steel flanged connection 80mm (3") dia and up, Mason Type FFL.
 - 2.2.3.2 Medium pressure service up to 121°C (250°F): 304 stainless steel hose and carbon steel threaded nipple up to 65mm (2-½") dia., Mason Type MN, 304 stainless double-braided steel hose and carbon steel flanged connection 80mm (3") dia and up, Mason Type FFL-2B300.

Size I.D.	Operating Pressure Low	Length	Max. Lateral Offset	Operating Pressure Medium	Length	Max. Lateral Offset
mm (in.)	kPa (psi)	mm (in.)	mm (in.)	kPa (psi)	mm (in.)	mm (in.)
20 (¾")	1,793 (260)	450 (18")	63 (2-½")	2,944 (427)	450 (18")	88 (3-½")
25 (1")	1,717 (249)	450 (18")	56 (2-¼")	2,434 (353)	450 (18")	75 (3")
32 (1-¼")	1,689 (245)	450 (18")	44 (1-¾")	2,117 (307)	450 (18")	56 (2-¼")
40 (1-½")	1,413 (205)	600 (24")	88 (3-½")	1,841 (267)	450 (18")	50 (2")
50 (2")	992 (144)	600 (24")	81 (3-¼")	1,517 (220)	600 (24")	94 (3-¾")
65 (2-½")	972 (141)	600 (24")	50 (2")	1,241 (180)	600 (24")	75 (3")
80 (3")	1,193 (173)	450 (18")	50 (2")	1,586 (230)	300 (12")	19 (¾")
100 (4")	965 (140)	450 (18")	38 (1-½")	1,586 (230)	450 (18")	32 (1-¼")
150 (6")	875 (127)	600 (24")	50 (2")	1,586 (230)	450 (18")	22 (7/8")

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
 Project No.: 2019-0495
 Section Name: Expansion Compensation
 Section No.: 20 05 16
 Date: April 9, 2020

Size I.D.	Operating Pressure Low	Length	Max. Lateral Offset	Operating Pressure Medium	Length	Max. Lateral Offset
mm (in.)	kPa (psi)	mm (in.)	mm (in.)	kPa (psi)	mm (in.)	mm (in.)
200 (8")	875 (127)	600 (24")	38 (1-1/2")	992 (144)	600 (24")	32 (1-1/4")
250 (10")	738 (107)	600 (24")	32 (1-1/4")	889 (129)	600 (24")	28 (1-1/8")
300 (12")	738 (107)	600 (24")	25 (1")	717 (104)	600 (24")	22 (7/8")

2.2.4 When bellows type expansion joints are used:

2.2.4.1 For pipes DN100 (4") and smaller provide two-ply stainless steel bellows type expansion compensator complete with anti-torque device, limit stops, internal guides with male IPT ends (Flexonics Type H). For copper pipes, two-ply bronze bellows (Flexonics Type HB) may be used.

2.2.4.2 For pipes DN150 (6") and larger provide single or double externally pressurized type expansion joints (Flexonics Type SX/NDX) with multiply 304 S.S. bellows, self-draining steel shell, integral guide ring, cover and liner. Expansion joint to be leakproof packless type, and maintenance-free. The joint shall be used to compensate for axial movement only.

2.2.5 Grooved end expansion joints:

2.2.5.1 For pipe sizes DN50 (2") through DN150 (6") provide a packless, gasketed, telescoping expansion joint consisting of a carbon steel body and slide section, and Victaulic couplings. Slide section to be coated with PTFE modified PPS coating. Joint shall be suitable for axial end movement up to 88.9mm (3"). Victaulic Mover Style 150.

2.2.5.2 For pipe sizes DN20 (3/4") through DN300 (12") provide a joint consisting of a series of grooved end pipe spools joined in tandem with Victaulic Style 77 couplings. (The number of nipples/couplings dependent on the movement required.) Victaulic Style 155.

2.2.6 All-directional acoustical pipe anchors shall consist of two sizes of steel tubing separated by a minimum 12mm (1/2") thickness of 60 duro or softer neoprene. Vertical restraint shall be provided by similar material arranged to prevent up or down vertical travel. Allowable loads on the isolation material shall not exceed 3.45

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Expansion Compensation
Section No.: 20 05 16
Date: April 9, 2020

N/mm² (500 psi) and the design shall be balanced for equal resistance in any direction. All-directional anchors shall be Mason Type ADA.

- 2.2.7 Pipe guides shall consist of a telescopic arrangement of two sizes of steel tubing separated by a minimum 12mm (1/2") thickness of 60 durometer or softer neoprene. The height of the guides shall be preset with a shear pin to allow vertical motion due to pipe expansion or contraction. Guides shall be capable of ∇ 40mm (1-5/8") motion, or to meet location requirements. Pipe guides shall be Mason Type VSG.
- 2.2.8 Thrust restraint shall consist of a modified Type A spring mounting. Restraint springs shall have the same deflection as the isolator springs. The assembly shall be pre-set at the factory and fine-tuned in the field to allow for a maximum of 6mm (1/4") movement from stop to maximum thrust. The assemblies shall be furnished with rod and angle brackets for attachment to both the equipment and duct work or the equipment and the structure. Restraints shall be attached at the center line of thrust and symmetrically on both sides of the unit. Horizontal, vertical and diagonal thrust restraints shall be Mason Type WB.
- 2.2.9 Wall, floor and ceiling acoustical seals shall be split seals consisting of pipe halves with minimum 20mm (3/4") thick neoprene sponge cemented to the inner faces. The seal shall be tightened around the pipe to eliminate clearance between the inner sponge face and the piping. Concrete may be packed around the seal to make it integral with the floor, wall or ceiling if the seal is not in place prior to the construction of the building member. Seals shall project a minimum of 25mm (1") past either face of the wall. Where temperatures exceed 115°C (240°F), 160 kg/m³ (10 lb) density fiberglass may be used in lieu of the sponge. Seals shall be Mason Type SWS.

3 EXECUTION

3.1 GENERAL

- 3.1.1 Install compensators in accordance with manufacturer's written instructions. Compensators must not cause any change or position of equipment or piping resulting in piping stresses or misalignment.

3.2 EXPANSION COMPENSATION

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Expansion Compensation
Section No.: 20 05 16
Date: April 9, 2020

- 3.2.1 Provide all necessary expansion joints or loops to control all piping movement without imposing undue stress onto structure, apparatus, or piping systems.
- 3.2.2 All compensators shall be installed on the equipment side of the shut off valves.
- 3.2.3 Where possible, use loops or swing joints. Where loops or swing joints cannot be used due to space limitations and where shown, provide a manufactured expansion joint in accordance with the manufacturer's instructions, complete with all the necessary anchors and guides.
- 3.2.4 For water systems with grooved joints, use adequate numbers of Victaulic Style 77 or 177H flexible couplings in header piping to accommodate thermal growth and contraction, and elimination or reduction of expansion loops. Where expansion loops are required, use Victaulic Style 77 or 177H couplings on the loops.
- 3.2.5 In all branch piping to radiation, perimeter units, booster coils, unit heaters, cabinet unit heaters and risers, provide swing joints or braided hose connectors. Provide braided hose type in all connection joints in all connections to equipment where shown in the Contract Documents.
- 3.2.5.1 Three (3) Victaulic Style 77 or 177H flexible couplings may be used in equipment drops in lieu of braided-hose flexible connectors for stress relief and vibration attenuation. The couplings shall be placed in close proximity to the source of the vibration.
- 3.2.6 Where braided hose type connectors are installed, anchor or guide pipes to eliminate all weight onto connectors. Use braided hose type joints for lateral movement only. Select the length of hose to manufacturer's instructions.
- 3.2.7 For bellows type expansion joints adjust end fittings to suit pipe application.
- 3.2.8 Until all pressure leakage tests are complete in all piping systems, install steel spools instead of flexible connections.
- 3.3 MANUFACTURER'S REVIEW
- 3.3.1 On completion of installation of all expansion compensation devices herein specified, the manufacturer shall inspect the completed system, and report in writing any installation error,

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: **2019-0495**
Section Name: **Expansion Compensation**
Section No.: **20 05 16**
Date: April 9, 2020

improperly selected devices, or other faults in the system that could affect the performance of the system. A written report shall be submitted outlining corrective work necessary to comply with the above specifications. Corrective work shall be the responsibility of the respective installing Subcontractor (Division 21, 22 or 23).

END OF SECTION

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: **Meters and Gauges**
Section No.: 20 05 19
Date: April 9, 2020

INDEX

1	GENERAL
1.1	General
1.2	Scope of Work
1.3	Shop Drawings
2	PRODUCTS
2.1	Temperature Gauges
2.2	Gauge Glasses
2.3	Pressure Gauges
3	EXECUTION
3.1	Pressure Gauges
3.2	Thermometers

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Meters and Gauges
Section No.: 20 05 19
Date: April 9, 2020

1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools, equipment, training, and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 Temperature gauges

1.2.1.2 Pressure gauges

1.3 SHOP DRAWINGS

1.3.1 Submit Shop Drawings for the following equipment:

1.3.1.1 Temperature gauges

1.3.1.2 Pressure gauges

2 **PRODUCTS**

2.1 TEMPERATURE GAUGES

2.1.1 Provide thermometers of 229mm (9") straight shank, immersion type, with red liquid fill and adjustable pivot, installed complete with non-ferrous separable well. Provide 150mm (6") long extension neck socket for insulated pipes. Thermometers with plastic case are not acceptable.

2.1.2 Select all thermometers to suit the expected range of temperatures of the medium and ensure that normal working temperature occurs approximately at mid scale.

2.2 GAUGE GLASSES

2.2.1 Provide gauge glasses on all liquid reservoirs, normally not completely filled.

2.2.2 Provide fail-safe type gauge glasses with shut off valve, ball check, flushing facilities, and white enamelled brass backplates, suitable for the intended service.

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Meters and Gauges
Section No.: 20 05 19
Date: April 9, 2020

2.2.3 Provide gauge glasses complete with tri cocks. Extend tank gauge glasses the full tank height, if necessary through use of multiple gauge glasses in staggered arrangement.

2.3 PRESSURE GAUGES

2.3.1 Provide pressure gauges of the Bourdon type, minimum one percent accuracy through the entire range, complete with bronze Bourdon tube, brass socket, brass rotary movement, bronze bushings, tube and movement independently mounted from case, stainless steel case and ring, inherent shock protection. Furnish gauges having 114mm (4-½") dial, black graduations, black case, silver brazed joints, and adjustable black pointer.

2.3.2 Select gauges to suit fluid working pressure and, if possible, test pressure. If test pressure falls outside safe instrument range, attach a note to this effect on the installation instructions. Ensure that the normal working pressure occurs approximately at mid scale.

2.3.3 Install each gauge complete with DN6 (1/8") or DN8 (1/4") bar stock valve, rated 150°C (300°F) and 6,895 kPa (1,000 psi). Provide pressure snubber on all pump services and coil syphon for steam, air, gas service. Install pressure gauges as noted.

2.3.4 Provide a valved and capped gauge connection at inlet and discharge of all coils and tube bundles in heat exchangers.

2.3.5 Submit a schedule in shop drawing form showing service, location, range, make, and catalogue number for gauges.

3 **EXECUTION**

3.1 PRESSURE GAUGES

3.1.1 Install pressure gauges in the following locations and where shown or specified in the Contract Documents.

3.1.1.1 Suction and discharge of all pumps.

3.1.1.2 High and low sides of all pressure reducing or regulating stations (water, steam, air).

3.1.1.3 Where shown

3.1.2 Provide valved and capped gauge connection at:

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: **Meters and Gauges**
Section No.: 20 05 19
Date: April 9, 2020

- 3.1.2.1 Entering and leaving side of heat exchangers.
- 3.1.2.2 Entering and leaving side of heating water coils in air supply units.
- 3.1.2.3 Supply and return lines of condenser, chilled, and heating water systems at each branch.
- 3.1.2.4 Where shown.
- 3.2 THERMOMETERS
- 3.2.1 Thermometers to be installed with thermal paste to ensure accurate reading.
- 3.2.2 Install thermometers in the following locations and where shown or specified:
 - 3.2.2.1 Entering and leaving sides of all condenser, chilled, and hot water coils in air supply units.
 - 3.2.2.2 Return lines of main branches of heating, chilled, and condenser water systems.
 - 3.2.2.3 Entering and leaving sides of mixing valves.
 - 3.2.2.4 Supply and return lines at hot water boilers.
 - 3.2.2.5 Supply and return lines on primary heating water loops.
 - 3.2.2.6 Entering and leaving lines of heat exchangers.
 - 3.2.2.7 Where shown in the Contract Documents.

END OF SECTION

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Bases, Hangers and Supports
Section No.: 20 05 29
Date: April 9, 2020

INDEX

1	GENERAL
1.1	General
1.2	Shop Drawings
2	PRODUCTS
2.1	Pipe Attachments
2.2	Upper Attachments
2.3	Pipe SUpport
3	EXECUTION
3.1	General
3.2	Hangers
3.3	Anchors
3.4	Duct Support
3.5	Equipment Support

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Bases, Hangers and Supports
Section No.: 20 05 29
Date: April 9, 2020

1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SHOP DRAWINGS

1.2.1 Provide Shop Drawings for:

1.2.1.1 Hangers and supports

2 **PRODUCTS**

2.1 PIPE ATTACHMENTS

2.1.1 For pipe attachments, review Specification Section 20 07 00 - Mechanical Insulation. Otherwise, adhere to the following:

2.1.1.1 For uninsulated fire servicing piping – ULC and FM approved -, use Taylor Fig. 41 swivel ring hanger.

2.1.1.2 For uninsulated steel pipes, use Taylor Fig. 22Z adjustable clevis up to and including 100mm (4") pipe size, and Taylor Fig. 24 adjustable clevis for sizes 125mm (5") and larger.

2.1.1.3 For uninsulated copper pipes, use Taylor Fig. 52 epoxy coated copper-gard clevis hanger up to and including 100mm (4") pipe size.

2.1.1.4 For uninsulated copper tubing, use Taylor Fig. 42 epoxy coated copper-gard swivel ring hanger up to and including 25mm (1") pipe size.

2.1.1.5 For insulated pipes where the insulation is around the hanger and continuous vapour barrier is not required, use the same hangers as for uninsulated pipes.

2.1.1.6 For insulated pipes where hanger is around insulation, provide galvanized sheet metal insulation shield minimum 250mm (10") long, 1.3mm (18 gauge), between covering and Taylor Fig. 22Z or Fig. 24 clevis, or Taylor Fig. 24L extended clevis, sized to include insulation.

2.2 UPPER ATTACHMENTS

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Bases, Hangers and Supports
Section No.: 20 05 29
Date: April 9, 2020

- 2.2.1 Provide upper attachments as follows:
 - 2.2.1.1 Standard beam clamp for normal service, Taylor Fig. 425.
 - 2.2.1.2 Top beam clamp Taylor Fig. 407.
 - 2.2.1.3 C clamp with locknut, Taylor Fig. 301.
 - 2.2.1.4 Side beam bracket for light duty side mounting, Taylor Fig. 120.

2.3 PIPE SUPPORT

- 2.3.1 For vertical adjustment of hanger rods, provide Taylor Fig. 68 forged steel turnbuckle.
- 2.3.2 Where trapeze hanger is used for a group of pipes, use Taylor Fig. 14 U bolts, except where roller type hanger is indicated on the drawings or in the specifications.
- 2.3.3 For roller type hangers on both hot and cold pipes, provide Taylor Fig. 70 to 75 protection saddles to suit covering thickness. Use Taylor Fig. 93 adjustable roller hanger for pipe sizes up to and including 150mm (6") over insulation. For pipes 200mm (8") and larger over insulation, use Taylor Fig. 95 adjustable 2-rod roller hanger. On trapeze hangers and where pipe is supported from below, use Taylor Fig. 280S adjustable pipe roller stand.
- 2.3.4 For vertical pipe support, provide Taylor Fig. 82Z zinc plated steel riser clamp for steel pipe, and Taylor Fig. 85 epoxy coated copper-gard riser clamp for copper pipe.
- 2.3.5 For guides on vertical pipes, use manufactured pipe alignment guides (e.g. Flexonics). For horizontal pipes, use Taylor Fig. 255 pipe alignment guide. Field fabricated guides with rolled T-section welded to the pipe and guiding shoe, are also acceptable.

3 **EXECUTION**

3.1 GENERAL

- 3.1.1 Provide supports required for the erection and support of the mechanical work. Construct supports of steel, masonry or concrete, as noted or required. Ensure that steel supports in contact with water or high humidity are galvanized members bolted together using cadmium plated bolts, all others primed steel.
- 3.1.2 Ensure that housekeeping pads or concrete bases are provided for

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Bases, Hangers and Supports
Section No.: 20 05 29
Date: April 9, 2020

floor mounted equipment. Make the minimum size, 100mm (4") high for bases or pads, keyed to the floor slab, extending at least 100mm (4") all around the equipment, with 19mm ($\frac{3}{4}$) chamfered edges. Where concrete is provided by Division 03 – Concrete, provide all anchor bolts and setting templates to Division 03 – Concrete.

- 3.1.3 Support suspended equipment from the bottom. Support tanks and other equipment with cast or welded steel saddles having proper curvature and inherent beam strength. Support plenums and sheetmetal type air-handling units from auxiliary frames or beams under equipment. Support fans from structural steel frames with steel base plate. Read Division 05 – Metals, for further information.
- 3.1.4 Provide supports and suspended bases having ample strength to safely carry the load under all operating conditions and during testing. Submit support and base details to the Consultant for review. Design supports except springs with a minimum factor of safety of five (5) based on ultimate tensile strength at operating temperature.
- 3.1.5 Ensure that the load onto structures does not exceed the maximum loading as shown on structural drawings or as directed by the Consultant.
- 3.1.6 Take special care in locating hangers and supports to avoid introduction of undue reaction forces onto the structure of the building, to flanges of pumps and equipment, to expansion joints and to the pipe.
- 3.1.7 Install all piping supported from hangers or supports in a manner to ensure that building construction is not weakened or over-stressed, that pipes are secure, vibration free, free to expand and contract and properly graded, and that vertical adjustment of horizontal piping is possible after erection.
- 3.2 HANGERS
 - 3.2.1 For structure attachments, adhere to the following:
 - 3.2.1.1 Support hangers directly from the structure only. Do not support pipes or equipment from other pipes, ducts, equipment, suspended ceiling, etc.
 - 3.2.1.2 Suspend hanger rods generally from certified inserts in concrete or

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Bases, Hangers and Supports
Section No.: 20 05 29
Date: April 9, 2020

by beam clamps. Before welding to steel structure members obtain prior permission of welding method from the Consultant and ensure that loads do not exceed the limit set by the Consultant. Ensure that hanging from floors and roofs made from pre-cast concrete members is from inserts originally cast into the members and provided by this contractor, or by rods passing between the members connected to a steel plate resting on the upper surface.

- 3.2.2 Sliding guides must have sliding surfaces cleaned of all dirt, paint or corrosion and, except for Teflon, have coating of graphite paste added during erection. Adjust guides to allow for free sliding at operating conditions. After assembly, provide these guides with temporary protective cover or wrapping added to keep them free of debris during extent of construction work. When piping is ready to be put into service, remove this protective covering, blow out guides clean of all debris and add paste where applicable. Care must be taken that ample clearance is provided so as not to obstruct free sliding of guide.
- 3.2.3 Install copper, brass, and stainless steel pipes with 3mm ($\frac{1}{8}$ ") thickness of di-electric packing between the pipe and the pipe attachment or use Taylor plastic coated pipe attachments.
- 3.2.4 Install guides on pipes with expansion movement next to expansion joints. Consult expansion joint manufacturer's recommendations and follow his instructions for number and spacing of guides. Use a minimum of two guides on each side of expansion joints.
- 3.2.5 Set hanger rods on steel and copper lines with expansion movement out of plumb in ambient temperature position, a distance equal to one-half pipe movement calculated from anchor point. Base movement on 25mm (1") expansion per 30m (100 ft) of pipe length and 37°C (67°F) temperature difference. Use toggle type insert of beam clamp for such locations.
- 3.2.6 Use roller type hanger only where shown on the drawings.
- 3.2.7 Install all hangers close to points where pipes change direction or where branch piping drops or rises from main.
- 3.2.8 Install vertical riser suitably anchored and guided with manufactured or fabricated guides to maintain accurate vertical position. Protect insulated pipes with 2.2mm (12 gauge) galvanized steel jacket at guides. Guide pipes with expansion movement and definite anchor points up to and including 100mm

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
 Project No.: 2019-0495
 Section Name: Bases, Hangers and Supports
 Section No.: 20 05 29
 Date: April 9, 2020

(4") sizes, at every floor or 3m (10 ft). Guide larger pipes and vertical cast iron pipes at every second floor or 7.5m (25 ft).

- 3.2.9 For horizontal cast iron, glass, or polypropylene pipes where packed or friction type mechanical joints are used, provide a support at every joint in straight runs with maximum 1.5m (5 ft) between supports. Where fittings are joined together (elbows, wyes, etc.) provide a separate support for a minimum of every second fitting.
- 3.2.10 For horizontal cast iron, pipes where screwed or bolted type joints are used, the spacing or supports may be increased not to exceed 2.4m (8 ft) between supports, but provide a support for every joint and every second fitting as described above.
- 3.2.11 Use lockwasher with single nut on all bolted connections for pipe supports, anchors, guides and support steel, or use double nuts.
- 3.2.12 During hydrostatic test on all air and vapour piping supported by springs or counterweights, install temporary rigid supports, blocking, etc., or lock the spring against movement to prevent excessive strain on piping or equipment.
- 3.2.13 Use spring hangers where vertical movement of the horizontal pipes may occur due to expansion or contraction. Refer to Sections 20 05 16 – Expansion Compensation and 20 05 48 – Vibration Isolation, for further information.
- 3.2.14 For rod hangers use round steel threaded rod supports on horizontal pipes, spaced at the following maximum intervals and having the minimum diameter as directed.
- 3.2.14.1 For Steel Pipes:

Pipe Diameter mm (in)	Horizontal Spacing of Supports mm (ft)	Single Rod Diameter mm (in)	Double Rod Diameter mm (in)
DN15 (½)	1,524 (5)	9 (¾)	9 (¾)
DN20 (¾)	1,829 (6)	9 (¾)	9 (¾)
DN25 (1)	2,134 (7)	9 (¾)	9 (¾)

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
 Project No.: 2019-0495
 Section Name: Bases, Hangers and Supports
 Section No.: 20 05 29
 Date: April 9, 2020

Pipe Diameter mm (in)	Horizontal Spacing of Supports mm (ft)	Single Rod Diameter mm (in)	Double Rod Diameter mm (in)
DN32 (1-¼)	2,438 (8)	9 (¾)	9 (¾)
DN40 (1-½)	2,743 (9)	9 (¾)	9 (¾)
DN50 (2)	3,048 (10)	9 (¾)	9 (¾)
DN65 (2-½)	3,048 (10)	13 (½)	9 (¾)
DN80 (3)	3,658 (12)	13 (½)	9 (¾)
DN100 (4)	4,268 (14)	16 (⅝)	13 (½)
DN125 (5)	4,877 (16)	16 (⅝)	13 (½)
DN150 (6)	5,182 (17)	19 (¾)	16 (⅝)
DN200 (8)	5,791 (19)	22 (⅞)	19 (¾)
DN250 (10)	6,706 (22)	22 (⅞)	19 (¾)
DN300 (12)	7,010 (23)	22 (⅞)	19 (¾)
DN375 (15) and over	max. 7,620 (25)	to suit weight	to suit weight

3.2.14.2 For Copper or Stainless Steel Tubing:

Pipe Diameter mm (in)	Horizontal Spacing of Supports mm (ft)	Single Rod Diameter mm (in)	Double Rod Diameter mm (in)
DN15 (½)	1,524 (5)	9 (¾)	9 (¾)
DN20 (¾)	1,829 (6)	9 (¾)	9 (¾)
DN25 (1)	1,829 (6)	9 (¾)	9 (¾)
DN32 (1-¼)	2,134 (7)	9 (¾)	9 (¾)
DN40 (1-½)	2,438 (8)	9 (¾)	9 (¾)
DN50 (2)	2,743 (9)	9 (¾)	9 (¾)

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
 Project No.: 2019-0495
 Section Name: Bases, Hangers and Supports
 Section No.: 20 05 29
 Date: April 9, 2020

Pipe Diameter mm (in)	Horizontal Spacing of Supports mm (ft)	Single Rod Diameter mm (in)	Double Rod Diameter mm (in)
DN65 (2-½)	3,048 (10)	13 (½)	9 (¾)
DN80 (3)	3,048 (10)	13 (½)	9 (¾)
DN100 (4)	3,658 (12)	16 (⅝)	13 (½)

- 3.2.15 Do not use pipe hooks, chains, or perforated straps.
- 3.2.16 Use angle or channel iron welded frames for trapeze hangers.
- 3.2.17 For all drain pipe installed under structural slab on disturbed soil (up fill), suspend piping via galvanized clevis hangers embedded in structural slab. Hanger spacing shall be per pipe manufacturer recommendations, with minimum of two (2) hangers per pipe length.
- 3.3 ANCHORS
- 3.3.1 Design pipe anchors to restrain the movement of pipes in all directions.
- 3.3.2 Take special care in locating anchors to avoid introduction of undue reaction forces into the structure of the building, to flanges of pumps and equipment, to expansion joints and to the pipe.
- 3.3.3 Fabricate anchors and guides of structural steel channels, angles or plates secured to building structure. Size cylindrical type guides for full pipe insulation.
- 3.3.4 Submit for review by the Consultant prior to installation, a detailed design prepared in conjunction with the expansion joint manufacturer for anchors, guides, and their proposed connection to the structure, including reaction forces and loads imposed on structure. All Drawings must be signed by a Professional Engineer registered in the Province of Ontario. Do not proceed with installation until after receipt of reviewed drawings.
- 3.4 DUCT SUPPORT
- 3.4.1 Provide all foundations and supports required for the proper

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Bases, Hangers and Supports
Section No.: 20 05 29
Date: April 9, 2020

erection of the ductwork. Use concrete, masonry, and steel as specified, shown or required. Provide lightweight concrete fill around buried ductwork.

- 3.4.2 Co-operate with Division 03 – Concrete and Division 05 – Metals, and co-ordinate the work under this Division with those Divisions to ensure that opening required in floors, walls and partitions for the ducts are provided in the exact location required.
- 3.4.3 Where possible, use beam clamps, pre-set sleeves, and inserts for attachment to or passage through work under other Divisions. Do not weld to or cut into the work of other Specification Sections unless with the special permission of the Consultant.
- 3.4.4 Where vibration mountings are required, make necessary provisions in accordance with the recommendations of the equipment manufacturer. Refer to Sections 20 05 16 – Expansion Compensation and 20 05 48 – Vibration Isolation, for further information.
- 3.4.5 Install ducts securely supported from hangers or supports, in a manner to ensure that building construction is not weakened or over-stressed, that ducts are secure, free of vibration, free to expand and contract and properly graded.
- 3.4.6 Bolt steel frames to galvanized steel ducts. Rivet aluminum frames to aluminum ducts. Bolt steel frames to soldered lugs on copper ducts. Use di-electric gaskets. Bolt steel frames to welded lugs on stainless steel ducts.
- 3.4.7 Extend angles 50mm (2") to either side of ducts. For non-ferrous ducts, use di-electric gasket between duct and support. For additional stainless steel ducts use supports not directly attached to the duct. For watertight ducts, use supports not attached to the duct.
- 3.4.8 Support vertical ducts as follows:
 - 3.4.8.1 Support vertical ducts in duct shafts at the top and the bottom of the shafts and at every floor in between. Supply auxiliary steel structural steel, sized as required.
 - 3.4.8.2 Support other vertical ducts at the passage through every floor.
- 3.4.9 Support round and oval ducts using a 38mm by 3mm (1-1/2" x 1/8") split ring bolted at each end, extending minimum 75mm (3") on

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: **Bases, Hangers and Supports**
Section No.: 20 05 29
Date: April 9, 2020

each side.

- 3.4.10 Support rectangular ducts using a bolted or tack welded frame on 38mm by 38mm by 3mm (1-½" x 1-½" x 1/8") angle steel.
- 3.4.11 In T-bar ceilings, attach diffusers connected to flexible duct directly to the ceiling suspension system main runners. Use this method for diffusers or mechanical items weighing less than 9 kg (20 lbs.). Support diffusers or equipment weighing more than 9 kg (20 lbs.) directly from the roof or floor.
- 3.5 EQUIPMENT SUPPORT
- 3.5.1 Place all suspended equipment on welded steel bases of up to 150mm (6") profile steel, stiffened with 3mm (1/8") checkered steel plate. Co-ordinate with Division 05 – Metals.
- 3.5.2 Place floor plates on 100mm (4") concrete housekeeping pads. Ensure that the load on the structure does not exceed 488 kg per square meter (100 lbs. per square feet) projected floor area within the perimeter of the supports.

END OF SECTION

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Vibration Isolation
Section No.: 20 05 48
Date: April 9, 2020

INDEX

1 GENERAL

- 1.1 General
- 1.2 Scope of Work
- 1.3 Submittals
- 1.4 Quality Assurance

2 PRODUCTS

- 2.1 General
- 2.2 Type A Spring Isolators
- 2.3 Type B Spring Isolators
- 2.4 Type C Spring Hanger Rod Isolators
- 2.5 Type D Elastometer Mounting Types
- 2.6 Type E Elastometer Hanger Rod Isolators
- 2.7 Type F Pad Type Elastometer Mountings
- 2.8 Type G Pad Type Elastometer Mountings
- 2.9 Type H Combination Spring/Elastometer hanger Rod Isolators
- 2.10 Integral Structural Steel Base, Type B-1
- 2.11 Concrete Inertia Base, Type B-2
- 2.12 Spring Isolated Roof Curb, Type B-3
- 2.13 Mounting Types and Static Deflection Schedule

3 EXECUTION

- 3.1 General
- 3.2 Equipment Isolators
- 3.3 Piping Isolators
- 3.4 Duct Isolators
- 3.5 Isolator Position
- 3.6 Manufacturer's Review

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: **Vibration Isolation**
Section No.: 20 05 48
Date: April 9, 2020

1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools equipment, training commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 All necessary vibration isolation elements for piping and equipment, and vibration isolation bases for equipment to prevent noise levels from exceeding the room criteria listed in Table 1, Chapter 48 of the ASHRAE 2011 HVAC Applications Handbook.

1.2.2 Manufacturer of vibration isolation equipment shall have the following responsibilities:

1.2.2.1 Determine vibration isolation sizes and locations.

1.2.2.2 Provide piping and equipment isolation systems as scheduled or specified in the Contract Documents.

1.2.2.3 Guarantee specified isolation system deflection.

1.2.2.4 Provide installation instructions, drawings, and field supervision to assure proper installation and performance.

1.2.3 In addition to the work of this Section, comply with description of individual systems and general requirements of all other Specification Sections of this Division.

1.3 SUBMITTALS

1.3.1 The Contractor shall supply to the manufacturer approved drawings of all equipment to be isolated.

1.3.2 The manufacturer shall supply shop drawings of all vibration control components to be used on the project.

1.3.3 As a minimum provide the following information:

1.3.3.1 Catalogue cuts and data sheets on specific vibration isolators to be utilized showing compliance with the specifications.

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Vibration Isolation
Section No.: 20 05 48
Date: April 9, 2020

- 1.3.3.2 An itemized list showing the items of equipment or piping to be isolated, the isolator type of model number selected, isolator loading and deflection, and reference to specific drawings showing base and construction where applicable.
- 1.3.3.3 Grooved joint couplings and fittings shall be shown on drawings and product submittals, and shall be specifically identified with the applicable style or series designation.
- 1.3.3.4 Written approval of the base design to be used, obtained from the equipment manufacturer.
- 1.3.3.5 Drawings showing equipment base constructions for each machine, including dimensions, structural member sizes and support point locations.
- 1.3.3.6 Drawings showing methods for isolation of pipes and ductwork piercing walls and slabs.
- 1.3.4 Submit letter from manufacturer certifying that vibration isolation equipment have been installed in accordance with his recommendations and the Contract Documents, and that it operates to his satisfaction.
- 1.4 QUALITY ASSURANCE
- 1.4.1 It is the objective of this Specification Section to provide the necessary design for the control of excessive noise and vibration in the Building due to the operation of machinery or equipment, and/or due to interconnected piping, ductwork, or conduit. The installation of all vibration isolation units, and associated hangers and bases, shall be under the direct supervision of the vibration isolation manufacturer's representative.
- 1.4.2 All vibration isolators shall have either known undeflected heights or calibration markings so that, after adjustment, when carrying their load, the deflection under load can be verified, thus determining that the load is within the proper range of the device and that the correct degree of vibration isolation is being provided according to the design.
- 1.4.3 All isolators shall operate in the linear portion of their load versus deflection curve. Load versus deflection curves shall be furnished by the manufacturer and must be linear over a deflection range of not less than 50% above the design deflection.

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Vibration Isolation
Section No.: 20 05 48
Date: April 9, 2020

- 1.4.4 The theoretical vertical natural frequency for each support point, based upon load per isolator and isolator stiffness, shall not differ from the design objectives for the equipment as a whole by more than "10%.
- 1.4.5 All neoprene mountings shall have a Shore hardness of 30 to 60 "5, after minimum aging of 20 days or corresponding oven-aging.
- 1.4.6 All grooved joint couplings and specialties shall be the products of a single manufacturer.

2 PRODUCTS

2.1 GENERAL

- 2.1.1 All vibration isolation devices shall be the product of a single manufacturer.

2.2 TYPE A SPRING ISOLATORS

- 2.2.1 Spring isolators shall be free standing and laterally stable without any housing and complete with a molded neoprene cup or 6mm (1/4") neoprene acoustical friction pad between the baseplate and the support. All mountings shall have leveling bolts that must be rigidly bolted to the equipment. Installed and operating heights shall be equal. The ratio of the spring diameter divided by the compressed spring height shall be no less than 0.8. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection.
- 2.2.2 Corrosion resistance where exposed to corrosive/outdoor environment shall be with:
 - 2.2.2.1 Springs neoprene coated.
 - 2.2.2.2 Hardware cadmium plated.
 - 2.2.2.3 All other metal parts hot-dip galvanized.
- 2.2.3 Designed and installed so that ends of springs remain parallel.
- 2.2.4 Non-resonant with equipment forcing frequencies or support structure natural frequencies.
- 2.2.5 Submittals shall include spring diameters, deflection, compressed spring height and solid spring height.

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: **Vibration Isolation**
Section No.: 20 05 48
Date: April 9, 2020

2.2.6 Type A spring isolators to be Mason Type SLF.

2.3 TYPE B SPRING ISOLATORS

2.3.1 Isolators shall be same as Type A, except:

2.3.1.1 Provide built-in resilient vertical limit stops.

2.3.1.2 All restraining bolts shall have large rubber grommets to provide cushioning in the vertical as well as horizontal modes. The hole through the bushing shall be a minimum of 20mm (0.75") larger in diameter than the restraining bolt. Horizontal clearance on the sides between the spring assembly and the housing shall be a minimum of 12mm (0.5") to avoid bumping and interfering with the spring action. Vertical limit stops shall be out of contact during normal operation.

2.3.1.3 Provide tapped holes in top plate for bolting to equipment.

2.3.1.4 Isolators shall be capable of supporting equipment at a fixed elevation during equipment erection.

2.3.2 Housings and springs shall be powder coated and hardware electro-galvanized.

2.3.3 Type B spring isolators to be Mason Type SLR.

2.4 TYPE C SPRING HANGER ROD ISOLATORS

2.4.1 Hangers shall be manufactured with minimum characteristics as Type A isolators, but without the neoprene element:

2.4.1.1 Springs are seated in a steel washer reinforced neoprene cup that has a neoprene bushing projecting through the bottom hole to prevent rod to hanger contact.

2.4.1.2 Spring diameters and the lower hole sizes shall be large enough to allow the hanger rod to swing through a 30° arc from side to side before contacting the cup bushing.

2.4.1.3 If ducts are suspended by flat strap iron, the hanger assembly shall be modified by the manufacturer with an eye on top of the box and on the bottom of the spring hanger rod to allow for bolting to the hanger straps.

2.4.2 Submittals on either of the above hangers shall include a scaled drawing of the hanger showing the 30° capability.

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Vibration Isolation
Section No.: 20 05 48
Date: April 9, 2020

2.4.3 Where operating weight differs from installed weight provide built-in adjustable limit stops to prevent equipment rising when weight is removed. Stops shall not be in contact during normal operation.

2.4.4 Type C spring hanger rod isolators to be Mason Type 30 or for straps W30.

2.5 TYPE D ELASTOMETER MOUNTING TYPES

2.5.1 Neoprene mountings shall have a minimum static deflection of 9mm (0.35"). All metal surfaces shall be oil-resistant neoprene covered and have friction pads both top and bottom. Bolt holes shall be provided on the bottom and a tapped hole and cap screw on top. Steel rails shall be used above the mountings under equipment such as small vent sets to compensate for the overhang.

2.5.2 Neoprene to be compounded to hardness no greater than 70 durometer.

2.5.3 Mounts to have straight line deflection curve.

2.5.4 Type D elastomer isolators to be Mason Type ND.

2.6 TYPE E ELASTOMETER HANGER ROD ISOLATORS

2.6.1 Isolators shall incorporate a moulded unit type neoprene element and steel retainer box encasing the neoprene mounting.

2.6.2 Neoprene to be compounded to hardness no greater than 70 durometer.

2.6.3 Isolator to have sufficient clearance between mounting hanger rod and steel retainer box.

2.6.4 Type E hanger rod isolators to be Mason Type HD.

2.7 TYPE F PAD TYPE ELASTOMETER MOUNTINGS

2.7.1 Elastomer pads to incorporate the following:

2.7.1.1 20mm (3/4") minimum thickness per layer of pad.

2.7.1.2 Suitable top bearing plate provided to uniformly distribute load.

2.7.1.3 Ribbed or waffled design.

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Vibration Isolation
Section No.: 20 05 48
Date: April 9, 2020

- 2.7.1.4 15% deflection.
- 2.7.1.5 Standard neoprene with moderate oil-resistance, compounded to hardness no greater than 70 durometer.
- 2.7.1.6 1.6mm (16 ga.) galvanized steel plate between multiple layers of pad thickness.
- 2.7.1.7 Bolts through equipment and pad shall be oversized and provided with resilient washers and bushings.

2.7.2 Type F pad to be Mason Type Super W.

2.8 TYPE G PAD TYPE ELASTOMETER MOUNTINGS

2.8.1 Elastomer pads to incorporate the following:

2.8.1.1 High quality bridge bearing neoprene.

2.8.1.2 3mm (1/8") deflection.

2.8.1.3 Maximum loading 6,895 kPa (1000 psi).

2.8.1.4 Suitable bearing plate to distribute load.

2.8.1.5 Minimum thickness 25mm (1").

2.8.2 Type G pad to be Mason Type BBNR.

2.9 TYPE H COMBINATION SPTING/ELASTOMETER HANGER ROD ISOLATORS

2.9.1 Hangers shall consist of rigid steel frames containing minimum 32mm (1-1/4") thick neoprene elements at the top and a steel spring with general characteristics as described in Type C, seated in a steel washer reinforced neoprene cup on the bottom. The neoprene element and the cup shall have neoprene bushings projecting through the steel box. In order to maintain stability the boxes shall not be articulated as clevis hangers nor the neoprene element stacked on top of the spring. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30° arc from side to side before contacting the cup bushing and short circuiting the spring.

2.9.2 Neoprene to be compounded to hardness no greater than 70 durometer.

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: **Vibration Isolation**
Section No.: 20 05 48
Date: April 9, 2020

- 2.9.3 Submittals shall include a hanger drawing showing the 30° capability.
- 2.9.4 Type H isolator to be Mason Type 30N.
- 2.10 INTEGRAL STRUCTURAL STEEL BASE, TYPE B-1
- 2.10.1 Base to be reinforced as required to prevent base flexure at start-up and misalignment of drive and driven units. Rectangular bases are preferred for all equipment. Centrifugal refrigeration machines and pump bases may be T or L shaped. Pump bases for split case pumps shall be large enough to support suction and discharge elbows. Centrifugal fan bases to be complete with motor slide rails, drilled for drive and driven unit mounting template.
- 2.10.2 All perimeter members shall be steel beams with a minimum depth equal to 1/10 of the longest dimension of the base. Base depth need not exceed 350mm (14") provided that the deflection and misalignment is kept within acceptable limits as determined by the manufacturer. Height saving brackets shall be employed in all mounting locations to provide a base clearance of 25mm (1").
- 2.10.3 Type B-1 base to be Mason Type WF.
- 2.11 CONCRETE INERTIA BASE, TYPE B-2
- 2.11.1 Concrete inertia bases shall be formed in a structural steel perimeter base, reinforced as required to prevent flexure, misalignment of drive and driven unit or stress transfer into equipment.
- 2.11.2 The base shall be complete with motor slide rails, pump base elbow supports, and complete with equipment bolting provisions and isolators. Bases shall be a minimum of 1/12 of the longest dimension of the base but not less than 150mm (6"). The base depth need not exceed 300mm (12") unless specifically recommended by the base manufacturer for mass or rigidity. Forms shall include minimum concrete reinforcing consisting of 12mm (1/2") bars welded in place on 150mm (6") centers running both ways in a layer 40mm (1-1/2") above the bottom. Forms shall be furnished with steel templates to hold the anchor bolt sleeves and anchor bolts while concrete is being poured. Height saving brackets shall be employed in all mounting locations to maintain a 25mm (1") minimum clearance between base and housekeeping pad. Wooden formed bases leaving a concrete rather than a steel finish are not acceptable.

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
 Project No.: 2019-0495
 Section Name: Vibration Isolation
 Section No.: 20 05 48
 Date: April 9, 2020

2.11.3 Minimum thickness of the inertia base shall be according to the following tabulation:

<u>Motor Size</u> kW (hp)	<u>Min. Thickness</u> mm (inches)
up to 11 (15)	150 (6)
15-37 (20-50)	200 (8)
45-55 (60-75)	250 (10)
75-185 (100-250)	300 (12)
225-375 (300-500)	400 (16)

2.11.4 Type B-2 inertia base to be Mason Type BMK or K.

2.12 SPRING ISOLATED ROOF CURB, TYPE B-3

2.12.1 Structural roof curb assembly to have a top and bottom frame resiliently connected by spring isolator complying with specification Type A.

2.12.2 The lower member shall consist of a sheet metal Z section containing adjustable and removable steel springs that support the upper floating section. The upper frame must provide continuous support for the equipment and must be captive so as to resiliently resist wind forces. All directional neoprene snubber bushings shall be a minimum of 6mm (1/4") thick. Steel springs shall be laterally stable and rest on 6mm (1/4") thick neoprene acoustical pads. Hardware must be plated and the springs provided with a rust resistant finish. The curb's waterproofing shall consist of a continuous galvanized flexible counter flashing nailed over the lower curb's waterproofing and joined at the corners by EPDM bellows. All spring locations shall have access ports with removable waterproof covers. Lower curbs shall have provision for 50mm (2") of insulation.

2.12.3 Type B-3 curb to be Mason Type RSC.

2.13 MOUNTING TYPES AND STATIC DEFLECTION SCHEDULE

Equipment	Slab on Grade	Suspended Slabs
-----------	---------------	-----------------

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
 Project No.: 2019-0495
 Section Name: Vibration Isolation
 Section No.: 20 05 48
 Date: April 9, 2020

Type	Category	HP or Other	RPM	Base Type	Isolator Type	Min. Defl. mm (in.)	Base Type	Isolator Type	Min. Defl. mm (in.)
Refrigeration Machines and Chillers	Reciprocating	All	All	(1)	D	6 (1/4")	(1)	B	38 (1-1/2")
	Centrifugal scroll	All	All	(1)	F	6 (1/4")	(1)	B	38 (1-1/2")
	Screw	All	All	(1)	F	25 (1")	(1)	B	64 (2-1/2")
	Absorption	All	All	(1)	F	6 (1/4")	(1)	B	38 (1-1/2")
	Air-cooled recip, scroll	All	All	(1)	D	6 (1/4")	(1)	B	38 (1-1/2")
	Air-cooled screw	All	All	(1)	B	25 (1")	B-1	B	64 (2-1/2")
Air Compressors and Vacuum Pumps	Tank-mtd horiz.	≤10	All	(1)	A	19 (3/4")	(1)	A	38 (1-1/2")
		≥15	All	B-2	A	19 (3/4")	B-2	A	38 (1-1/2")
	Tank-mtd vert.	All	All	B-2	A	19 (3/4")	B-2	A	38 (1-1/2")
	Base-mtd	All	All	B-2	A	19 (3/4")	B-2	A	38 (1-1/2")
	Large recip	All	All	B-2	A	19 (3/4")	B-2	A	38 (1-1/2")
Pumps	Close coupled	≤7.5	All	B-1	D	6 (1/4")	B-2	A	19 (3/4")
		≥10	All	B-2	A	19 (3/4")	B-2	A	38 (1-1/2")
	Inline	5 to 25	All	(1)	A	19 (3/4")	(1)	A	38 (1-1/2")
		≥30	All	(1)	A	38 (1-1/2")	(1)	A	38 (1-1/2")
	End suction, double suction	≤40	All	B-2	A	19 (3/4")	B-2	A	38 (1-1/2")
		50 to 125	All	B-2	A	19 (3/4")	B-2	A	38 (1-1/2")
	split case	≥150	All	B-2	A	19 (3/4")	B-2	A	64 (2-1/2")
	Packaged pump	All	All	(1)	A	19 (3/4")	B-2	A	38 (1-1/2")
Cooling towers	All	All	≤300	(1)	G	6 (1/4")	(1)	B	89 (3-1/2")
			301to500	(1)	G	6 (1/4")	(1)	B	64 (2-1/2")
			≥501	(1)	G	6 (1/4")	(1)	B	19 (3/4")
Boilers	Fire-tube	All	All	(1)	F	6 (1/4")	B-1	B	38 (1-1/2")
	Water-tube	All	All	(1)	F	3 (1/8")	(1)	F	3 (1/8")
	Steam	All	All	(1)	F	6 (1/4")	B-1	B	38 (1-1/2")
Fans: axial, plenum, cabinet, inline	≤ 22 in dia.	All	All	(1)	D	6 (1/4")	B-2	A	19 (3/4")
	≥ 24 in dia.	≤2 in SP	≤300	B-1	A	64 (2-1/2")	B-2	A	89 (3-1/2")
			301to500	B-1	A	19 (3/4")	B-2	A	64 (2-1/2")
			≥501	B-1	A	19 (3/4")	B-1	A	38 (1-1/2")
		>2 in SP	≤300	B-2	A	64 (2-1/2")	B-2	A	89 (3-1/2")
			301to500	B-2	A	38 (1-1/2")	B-2	A	64 (2-1/2")
			≥501	B-2	A	19 (3/4")	B-2	A	38 (1-1/2")
Centrifugal fans	≤ 22 in dia.	All	All	B-1	D	6 (1/4")	B-1	A	19 (3/4")
	≥ 24 in dia.	≤40	≤300	B-1	A	64 (2-1/2")	B-1	A	89 (3-1/2")
			301to500	B-1	A	38 (1-1/2")	B-1	A	64 (2-1/2")
			≥501	B-1	A	19 (3/4")	B-1	A	19 (3/4")
		≥50	≤300	B-2	A	64 (2-1/2")	B-2	A	89 (3-1/2")
			301to500	B-2	A	38 (1-1/2")	B-2	A	64 (2-1/2")
			≥501	B-2	A	25 (1")	B-2	A	38 (1-1/2")
Propeller	Wall-mounted	All	All	(1)	F	6 (1/4")	(1)	F	6 (1/4")

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
 Project No.: 2019-0495
 Section Name: Vibration Isolation
 Section No.: 20 05 48
 Date: April 9, 2020

fans	Roof-exhauster	All	All	(1)	F	6 (1/4")	B-3	B	38 (1-1/2")
Heat pumps, fan coils, CRAC units	All	All	All	(1)	A	19 (3/4")	(1)	A	19 (3/4")
Condensing units	All	All	All	(1)	F	6 (1/4")	(1)	B	38 (1-1/2")
AHUs, AC, heating and ventilation units	All	≤10	All	(1)	A	19 (3/4")	(1)	A	19 (3/4")
	All	≤15,	≤300	(1)	A	19 (3/4")	B-2	A	89 (3-1/2")
		≤4 in SP	301to500	(1)	A	19 (3/4")	(1)	A	64 (2-1/2")
			≥501	(1)	A	19 (3/4")	(1)	A	38 (1-1/2")
		>15,	≤300	B-1	A	19 (3/4")	B-2	A	89 (3-1/2")
		>4 in SP	301to500	B-1	A	19 (3/4")	B-2	A	64 (2-1/2")
			≥501	B-1	A	19 (3/4")	B-2	A	38 (1-1/2")
Packaged RTUs	All	All	All	(1)	G	6 (1/4")	B-3	A	19 (3/4")
Ducted rotating equipment	Small fans, fan powered boxes	≤600 cfm		(1)	A	13 (1/2")	(1)	A	13 (1/2")
		>600 cfm		(1)	A	19 (3/4")	(1)	A	19 (3/4")
Generators	All	All	All	(1)	A	19 (3/4")	B-2	A	64 (2-1/2")
Heat exchangers, tanks	Plate and frame			(2)	F	3 (1/8")	(2)	F	3 (1/8")
Piping (see specs)	Floor supported			-	B	25 (1")	-	B	25 (1")
	Suspended						-	H	32 (1-1/4")
Transformer, dry type	Floor mounted			(2)	D	6 (1/4")	(2)	D	6 (1/4")
	Suspended						(2)	E	6 (1/4")
	Wall mounted						(2)	D	6 (1/4")

2.13.1

Notes:

- (1) No base, isolator directly attached to equipment.
- (2) Base as recommended and/or provided by manufacturer.

3

EXECUTION

3.1

GENERAL

3.1.1

Have all materials and systems for vibration isolation designed and supplied by one company, referred to in this Section as the 'manufacturer'.

3.1.2

Install all products in accordance with manufacturer's written instructions. Vibration isolators must not cause any change or

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: **Vibration Isolation**
Section No.: 20 05 48
Date: April 9, 2020

position of equipment or piping resulting in piping stresses or misalignment.

- 3.1.3 Provide through the manufacturer all vibration isolation equipment work and measures to prevent the transmission of objectionable vibration to the building structure and from one area to another area. Provide all necessary drawings indicating isolator locations and base dimensions. Have the installation directed and supervised by the manufacturer. Supply to the manufacturer the necessary copies of all drawings of equipment to be isolated.
- 3.1.4 Consider the areas classified as follows for selection of vibration control devices:
 - 3.1.4.1 Mechanical rooms or equipment locations in basement or sub-basement areas only and not bordering areas regularly occupied are 'non-critical'.
 - 3.1.4.2 Mechanical rooms or equipment locations bordering habitable suites, boardrooms, conference rooms, private offices are 'ultra-critical'. This shall include all mechanical penthouses and all mechanical compartment rooms.
- 3.1.5 Vibration isolation is not required for the following equipment between equipment and building only, but provide isolated connection to these for pipes and ducts:
 - 3.1.5.1 Fire pumps
 - 3.1.5.2 Sump pumps, sewage pumps
- 3.1.6 All piping and ductwork to be isolated shall freely pass through walls and floors without rigid connections. Penetration points shall be sleeved using acoustical sleeves, or otherwise formed to allow passage of piping or ductwork, and maintain 20mm ($\frac{3}{4}$ ") to 32mm ($1\frac{1}{4}$ ") clearance around the outside surfaces. This clearance space shall be tightly packed with fiberglass, and caulked airtight after installation of piping or ductwork.
- 3.1.7 No rigid connections between equipment and building structure shall be made that degrades the noise and vibration isolation system specified in this Section.
- 3.1.8 Electrical conduit connections to isolated equipment shall be flexible to allow free motion of isolated equipment.

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: **Vibration Isolation**
Section No.: 20 05 48
Date: April 9, 2020

- 3.1.9 Do not install any equipment, piping, or conduit, which makes rigid contact with the building unless permitted in this Specification. Building includes, but is not limited to, slabs, beams, columns, studs, and walls.
- 3.1.10 Coordinate work with other trades to avoid rigid contact with the building. Inform other trades following work, such as plastering or electrical, to avoid any contact which would reduce the vibration isolation.
- 3.1.11 Bring to the Consultant's attention prior to installation any conflicts with other trades, which will result in unavoidable rigid contact with equipment or piping as described herein, due to inadequate space or other unforeseen conditions. Corrective work necessitated by conflicts after installation shall be at the responsible contractor's expense.
- 3.1.12 Obtain inspection and approval of any installation to be covered or enclosed, prior to such closure.
- 3.1.13 Diagonal restraints shall be attached at the centerline of thrust.
- 3.1.14 Vertical piping loads, including water strainers, valves between pump base elbow supports and the suction and discharge header piping, shall be supported by the pump base spring isolators without stress or strain to the pump housing.
- 3.1.15 Correct, at no additional cost, all installations, which are deemed defective in workmanship or materials.
- 3.2 EQUIPMENT ISOLATORS
- 3.2.1 Mount floor mounted equipment on 100mm (4") concrete housekeeping pads over complete floor area of equipment. Mount vibration isolating devices and related inertia blocks on concrete pad.
- 3.2.2 Each fan and motor assembly shall be supported on a single structural steel frame. Provide all ductwork connected to vibration-isolated equipment at both inlet and outlet with flexible connectors having sufficient length and flexibility to eliminate vibration transmission and to not short circuit the effectiveness of the vibration isolation. Make flexible connections of glass fibreglass cloth sleeves, sealed to prevent air leakage. Install a minimum length of flexible connection on both sides equal to static pressure of the fan in inches but not less than 150mm (6").

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Vibration Isolation
Section No.: 20 05 48
Date: April 9, 2020

- 3.2.3 The machine to be isolated shall be supported by a structural steel frame or concrete inertia base.
- 3.2.4 Brackets shall be provided to accommodate the isolator. The vertical position and size of the bracket shall be specified by the isolation manufacturer.
- 3.2.5 The minimum operating clearance between the equipment frame or rigid steel base frame and the housekeeping pad or floor shall be 25mm (1"). Minimum operating clearance between concrete inertia and base and housekeeping pad or floor shall be 50mm (2").
- 3.2.6 The equipment structural steel or concrete inertia base shall be placed in position and supported temporarily by blocks or shims, as appropriate, prior to the installation of the machine or isolators.
- 3.2.7 The isolators shall be installed without raising the machine and frame assembly.
- 3.2.8 After the entire installation is complete and under full operational load, the isolators shall be adjusted so that the load is transferred from the blocks to the isolators. When all isolators are properly adjusted, the blocks or shims shall be barely free and shall be removed.
- 3.2.9 Air handling equipment and centrifugal fans shall be protected using horizontal thrust restraints against excessive displacement weight which results from high air thrust when thrust forces exceed 10% of the equipment.
- 3.2.10 Rooftop equipment isolators must be bolted to the equipment and structure. Mountings must be designed to resist 160 km/h (100mph) wind loads.
- 3.2.11 Isolation mounting deflection shall be the minimum as specified or scheduled on the Drawings.
- 3.2.12 Verify that all installed isolator and mounting systems permit equipment motion in all directions. Adjust or provide additional resilient restraints to flexibly limit start-up equipment lateral motion to 6mm (¼").
- 3.2.13 Prior to start-up, clean out all foreign matter between bases and equipment. Verify that there are no isolation short circuits in the base or isolators.

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: **Vibration Isolation**
Section No.: 20 05 48
Date: April 9, 2020

3.3 PIPING ISOLATORS

3.3.1 All piping isolators are included under this Section.

3.3.2 Where piping connects to mechanical equipment install expansion joints, or stainless hoses if expansion joints are not suitable for the service. All piping passing through the equipment walls, floors or ceilings shall be protected against sound leakage by means of an acoustical seal.

3.3.3 Isolate piping outside the shafts as follows:

3.3.3.1 All water piping in machine rooms, including strainers, filters, valves and associated equipment with water systems.

3.3.3.2 Piping and associated equipment where exposed on roof.

3.3.3.3 Water piping within 12.2m (40 ft) or 100 x pipe diameters, whichever is greater, from connected rotating equipment, using Type H hangers with the same static deflection as specified for the equipment. If piping is connected to equipment located beneath occupied spaces and hangs from ceilings under occupied spaces, the first four hangers shall have a minimum deflection of 20mm ($\frac{3}{4}$ ") for pipe sizes up to and including 75mm (3"), 40mm (1-1/2") deflection for pipe sizes over 75mm (3") and up to and including 150mm (6"), and 65mm (2-1/2") deflection thereafter.

3.3.4 The isolators shall be installed with the isolator hanger box attached to, or hung as close as possible to, the main structural elements of the building.

3.3.5 The isolators shall be suspended from substantial structural members, not from slab diaphragm unless specifically permitted.

3.3.6 Hanger rods shall be aligned to clear the hanger box.

3.3.7 Horizontal suspended pipe 50mm (2") and smaller and all steam piping shall be suspended by Type E isolator with a minimum 6mm ($\frac{1}{4}$ ") deflection. Water pipe larger than 50mm (2") shall be supported by Type H isolator with a minimum 32mm (1-1/2") static deflection.

3.3.8 Horizontal pipe floor supported at slab shall be supported via Type A or B, with a minimum static deflection of 25mm (1") or same deflection as isolated equipment to which pipe connects whichever is the greater.

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Vibration Isolation
Section No.: 20 05 48
Date: April 9, 2020

3.3.9 All vertical risers shall be supported by spring isolators designed to support the riser filled with water, if it is a water line. Assigned loads must be within the building design limits at the support points. Neutral central resilient anchors shall direct movement up and down. The anchors shall be capable of holding an upward force equal to the water weight when the system is drained. If one level cannot accommodate this force, anchors can be located on two or three adjacent floors. Resilient guides shall be spaced and sized properly depending on the pipe diameter. The initial spring deflection shall be a minimum of 20mm ($\frac{3}{4}$ ") or four times the thermal movement at the isolator location, whichever is greater. Proper provision shall be made for seismic protection in seismic zones. Support spring mountings shall be Type A, anchors and telescoping guides as described under the Products section.

3.3.10 Pipe sway braces, where required, shall utilize two (2) neoprene elements (type D to accommodate tension and compression forces).

3.3.11 Pipe extension and alignment connectors: Provide connector at riser takeoffs, cooling and heating coils, and elsewhere as required to accommodate thermal expansion and misalignment.

3.4 DUCT ISOLATORS

3.4.1 All air ducts with a cross section of 0.19m² (2ft²) or larger shall be isolated from the building structure by Type C hangers or Type A floor supports with a minimum deflection of 20mm ($\frac{3}{4}$ "). Isolators shall continue for minimum 15m (50 ft) from the equipment. If air velocity exceeds 5.3 mps (1000 fpm), hangers or supports shall continue for an additional 15m (50 ft) or as shown on the Drawings

3.5 ISOLATOR POSITION

3.5.1 Close to building structure.

3.5.2 Between building structure and supplementary steel if required.

3.5.3 Suspend isolators from rigid and massive support points.

3.5.4 Supplementary steel to be sized for a maximum deflection of 1.6mm ($\frac{1}{16}$ ") at center span.

3.5.5 Support piping in shafts and floor supports entering shaft with Type B isolators or Type H hangers depending on piping loads and support point space conditions within shafts.

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: **Vibration Isolation**
Section No.: 20 05 48
Date: April 9, 2020

3.5.6 Guide piping in shafts as required with approved mounting designs incorporating Mason Type ADA mountings to building. Prevent direct contact of piping with building structure.

3.6 MANUFACTURER'S REVIEW

3.6.1 On completion of installation of all vibration isolation and expansion compensation devices specified in this Section, the manufacturer shall inspect the completed system; check the vibration levels in the areas as requested by the Consultant, and report in writing any installation error, improperly selected isolation devices, or other faults in the system that could affect the performance of the system. A written report shall be submitted outlining corrective work necessary to comply with the above specifications. Corrective work shall be the responsibility of the installing Subcontractor.

END OF SECTION

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Identification
Section No.: 20 05 53
Date: April 9, 2020

INDEX

1	GENERAL
1.1	General
2	PRODUCTS
3	EXECUTION
3.1	Pipe Systems
3.2	Valves
3.3	Equipment
3.4	Ductwork

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Identification
Section No.: 20 05 53
Date: April 9, 2020

1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

2 **PRODUCTS**

Not Used

3 **EXECUTION**

3.1 PIPE SYSTEMS

3.1.1 After finished painting is complete, identify each pipe with stencils and stencil paint. Alternatively, use SMS Coil-Mark or adhesive style building service pipe markers.

3.1.2 Use capital letters minimum 51mm (2") high for DN80 (3") diameter piping or larger, including insulation, and 19mm ($\frac{3}{4}$ ") size capital letters on smaller diameters.

3.1.3 Use flow arrows to indicate direction of flow. Use double arrow where flow is reversible. Arrow shall be solid black or white; minimum 152mm (6") long by 51mm (2") wide for DN80 (3") diameter piping or larger, including insulation, and 102mm (4") long by 19mm ($\frac{3}{4}$ ") wide on smaller diameters.

3.1.4 Locate identification and flow arrows as follows:

3.1.4.1 Behind each access door.

3.1.4.2 At each change of direction and take-off.

3.1.4.3 Not more than 12.2m (40 ft) apart on all pipes exposed and/or located behind accessible ceiling.

3.1.4.4 On both sides of sleeves.

3.1.4.5 Adjacent to valves.

3.1.4.6 Above each floor or platform for vertical exposed pipes approximately 1,524mm (5 ft.) above floor.

3.1.5 Stenciling to be performed in a neat, quality manner. Upon completion of project, provide one complete set of stencils used for

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
 Project No.: 2019-0495
 Section Name: Identification
 Section No.: 20 05 53
 Date: April 9, 2020

the Owner.

- 3.1.6 Use wording shown on the Legend on the Drawings or as instructed by the Consultant. Special system designations and abbreviations shall be submitted to Consultant for approval prior to use.
- 3.1.7 Colour coding to be as per the following schedule. For all other services, provide colour coding in conformance with CAN/CGSB-24.3 and ANSI A131.

MARKER LEGEND

CLASSIFICATION COLOUR

Description and Service	Primary	Secondary
City Water	Green	
Cold Water	Green	
Cooling Tower Water	Green	
Chilled Water	Green	
Ice Water	Green	
Domestic Hot Water	Green	
Domestic Hot Water Recirculation	Green	
Low Temp. Heating Water (Up To 121°C / 250°F)	Yellow	Black
High Temp. Heating Water (Over 121°C / 250°F)	Yellow	Black
Make-Up Water	Yellow	Black
Boiler Feed Water	Yellow	Black
Condensate	Yellow	Black
Blow-Off Water	Yellow	Black
Treated Water	Green	
Brine	Green	
Waste Water	Green	

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
 Project No.: 2019-0495
 Section Name: Identification
 Section No.: 20 05 53
 Date: April 9, 2020

MARKER LEGEND

CLASSIFICATION COLOUR

Description and Service	Primary	Secondary
Storm Water	Green	
Acid Drain	Yellow	Black
Fire Protection Water	Red	White
Sprinkler Water	Red	White
Carbon Dioxide (Fire Protection)	Red	White
Plumbing Vent	Green	
Heating Vent	Yellow	Black
Low Pressure Steam (103 kPa / 15 psi Or Less)	Yellow	Black
High Pressure Steam (Above 103 kPa / 15 psi)	Yellow	Black
Hydraulic Oil	Yellow	Black
Instrument Air	Green	
Diesel Exhaust	Yellow	Black
Fuel Oil	Yellow	Orange
LP Gas	Yellow	Orange
Natural Gas	Yellow	Orange
Chlorine	Yellow	Black
Nitrogen	Blue	Yellow
Vacuum	Green	
Compressed Air (690 kPa / 100 psi Or Less)	Green	
Compressed Air (Above 690 kPa / 100 psi)	Yellow	Black

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Identification
Section No.: 20 05 53
Date: April 9, 2020

3.1.8 Use primary colours for full length of piping or in minimum 914mm (36") long sections; use minimum 457mm (18") long sections on each side of valves. Use secondary colours in min. 51mm (2") wide bands.

3.1.9 Install pipe identification in accordance with the manufacturer's recommendations.

3.2 VALVES

3.2.1 Supply and attach to each valve (except fixture stops) a lamacoid tag 32mm (1-¼") in diameter or 38mm (1-½") square, similar to SMS RP/SP-1500 series. The system code to be 5mm (³/₁₆") high characters on the top line, valve numbers to be 9mm (³/₈") high on the bottom line. Tags to be colour coded in conformance with piping system colours as per CAN/CGSB-24.3.

3.2.2 Attach tag to valve with a brass chain.

3.2.3 Schedule the valve numbers using a sequential numbering system. For fire protection valves, co-ordinate valve numbers with the annunciator panel numbering system.

3.2.4 Prepare and submit valve directories and charts giving number, size, location, purpose, and normal position (opened or closed) for each valve.

3.2.5 Provide two (2) framed copies of the valve charts and locate where directed by the Consultant.

3.2.6 All control, drain, and test connection valves shall be provided with signs indicating their purpose.

3.3 EQUIPMENT

3.3.1 Identify all fans, pumps, controls, starters, switches, pushbuttons, and all other equipment as to service by a white lamacoid engraved nameplate on black background. Submit sample plates and lettering to the Consultant. Attach plates only after all painting work is completed. Use mechanical fastening devices acceptable to the Consultant.

3.3.2 Manufacturer's nameplates shall be affixed to all equipment, serial number and all information usually provided, including voltage, cycle, phase, motor power, etc., name of the manufacturer and his address. All stamped etched or engraved lettering on plates shall

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Identification
Section No.: 20 05 53
Date: April 9, 2020

be perfectly legible. Do not paint over nameplates and, where apparatus is to be concealed, attach the nameplates in an approved location on the equipment support or frame.

- 3.3.3 Identify all equipment with the corresponding remote controls.
- 3.3.4 Equipment plates shall have 9mm ($\frac{3}{8}$ ") capital letters; starter plates shall have 3mm ($\frac{1}{8}$ ") capital letters. All plates shall be sized to accommodate required description. Locate plates conspicuously and secure with self-tapping sheet metal screws where possible, or with double sided adhesive tape. Recognizable abbreviations will be acceptable, other proposed abbreviations to be approved by Consultant.
- 3.4 DUCTWORK
- 3.4.1 Identify all ductwork with 51mm (2") high stencils using black or white ink to contrast surface being identified.
- 3.4.2 Identification location shall conform to guidelines for pipe systems, and shall indicate flow medium, function, and direction.
- 3.4.3 Stenciling to be performed in a neat, quality manner. Upon completion of project, provide one complete set of stencils used for the Owner.

END OF SECTION

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Testing, Balancing and Adjusting
Section No.: 20 05 93
Date: April 9, 2020

INDEX

1.	GENERAL
1.1	General
1.2	General REquirements
1.3	Qualification
1.4	Scope of Work
1.5	Co-Ordination
2	PRODUCTS
3	EXECUTION
3.1	General
3.2	Air System Balancing
3.3	Water System Balancing
3.4	Demonstration
3.5	Reports
3.6	Quality Assurance

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Testing, Balancing and Adjusting
Section No.: 20 05 93
Date: April 9, 2020

1. **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this Section.

1.2 GENERAL REQUIREMENTS

1.2.1 Test, balance and adjust all systems to the Drawings and Specifications, in accordance with the intent and requirements of the ASHRAE Guide - Testing, Adjusting and Balancing (TAB) (Chapter 38, 2011 ASHRAE Application Handbook).

1.3 QUALIFICATION

1.3.1 The Testing, Balancing and Adjusting (TAB) Contractor must be a member in good standing with the National Environmental Balancing Bureau (NEBB), the Canadian Associated Air Balance Council (CAABC) or the National Building Comfort Testing Association (NBCTA).

1.4 SCOPE OF WORK

1.4.1 The TAB Contractor shall:

1.4.1.1 Within fourteen (14) days after award of contract, submit proof of certification for CAABC / NBCTA / NEBB.

1.4.1.2 Within thirty (30) days after award of contract, submit a report to the consultant summarizing the TAB Contractor's comments and recommendations regarding their review of the contract documents. Meet with the Contractor, Owner and Consultant as necessary to discuss.

1.4.1.3 Within thirty (30) days after Contract award, submit an outline of proposed TAB procedures, or alternatively, provide a copy of the latest edition of CAABC / NBCTA / NEBB Procedural Standards.

1.4.1.4 Conduct ongoing reviews of all related construction documentation, including co-ordination Drawings and shop drawings.

1.4.1.5 Visit the Site a minimum of once per month during construction, commencing when the pipe and/or duct installation starts. Submit a written report to the Consultant, including date of visit, areas observed, and any anticipated problems, which could adversely affect the TAB work.

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Testing, Balancing and Adjusting
Section No.: 20 05 93
Date: April 9, 2020

- 1.4.1.6 Prior to commencing the TAB work, the TAB Subcontractor shall submit the list of instruments he will use on the project, together with a record of calibration dates and procedures.
- 1.4.1.7 Perform all prebalancing work as specified in respective procedures.
- 1.4.1.8 Furnish all TAB labour, instruments and services necessary to complete the TAB work for air systems and water systems to achieve the required air and water flow rates. For fans with fixed drives, provide preliminary balance for first set of sheaves, advise the Division 23 - HVAC Subcontractor of results, install new sheaves, and rebalance system following installation of second set of sheaves. Adjust adjustable drives for required rpm and airflow. Adjust VAV box minimum and maximum airflows. Adjust and set all volume control devices to achieve proper air distribution, pressures and patterns in all parts of supply return and exhaust air systems. Adjust and set all pumps, balancing valves and other flow devices to achieve optimum water distribution in all parts of the circulating water systems.
- 1.4.1.9 Document any deficiencies that prevent the system from being properly balanced and advise the respective installing Subcontractor (Division 21, 22 or 23). Rebalance all affected systems following correction by the respective installing Subcontractor (Division 21, 22 or 23) at no additional cost to the Owner.
- 1.4.1.10 Report on any noise and vibration problems that are discovered during the course of balancing.
- 1.4.1.11 Submit a Balancing Report to the Consultant.
- 1.4.1.12 Repeat the balancing procedures for up to 10% of the system at the request of the Consultant. Should the retest data differ by more than $\pm 5\%$ from the originally reported values, the TAB Contractor shall be obligated to repeat the balancing of the entire system or systems at no additional cost to the Owner, if so requested by the Consultant.
- 1.4.1.13 Include for premium time where schedule requires that TAB work be undertaken after hours.
- 1.5 CO-ORDINATION
- 1.5.1 The respective installing Subcontractor (Division 21, 22 or 23) shall

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Testing, Balancing and Adjusting
Section No.: 20 05 93
Date: April 9, 2020

be responsible to ensure that all systems are complete and ready for testing, balancing and adjusting by the TAB Contractor. The respective installing Subcontractor (Division 21, 22 or 23) shall:

- 1.5.1.1 Confirm the complete operational readiness of the building, including sealed walls, doors, and ceilings to allow the balancing to be performed and required pressures to be set and maintained.
- 1.5.1.2 Allow access to all components requiring testing, balancing, and servicing. This includes permanently installed ladders and catwalks.
- 1.5.1.3 Maintain a construction schedule that allows the test and balance (TAB) firm to complete contract work prior to occupancy.
- 1.5.1.4 Verify the installation conformity to the design drawings and specifications.
- 1.5.1.5 Promptly correct deficiencies of materials and work that may delay completion of the TAB work.
- 1.5.1.6 Provide operation and maintenance manuals. Manuals must include the following:
 - 1.5.1.6.1 The manufacturers' method for adjusting and setting components for correct operation under actual load conditions.
 - 1.5.1.6.2 The manufacturers' recommended tolerance for maximum and minimum operating conditions.
 - 1.5.1.6.3 The recommended correction or A_k factors, to allow adjustment of flow, rpm, etc.
 - 1.5.1.6.4 A list of spare parts, identification numbers, and diagrams of their proper locations.
 - 1.5.1.6.5 Pressure drops for air and hydronic flows through the component or unit at design flow rate.
- 1.5.1.7 Start up all HVAC systems, according to the following conditions:
 - 1.5.1.7.1 Proper lubrication of rotating or sliding parts is verified.
 - 1.5.1.7.2 Motors, fans, and all HVAC equipment have the correct rotation.
 - 1.5.1.7.3 Installation of the correct drive (package) is checked.

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Testing, Balancing and Adjusting
Section No.: 20 05 93
Date: April 9, 2020

- 1.5.1.7.4 Belt tension is appropriate for the type of drive.
- 1.5.1.7.5 Vibration isolators and bases are properly installed and are the correct type.
- 1.5.1.7.6 Smoke and fire damper operation (left in full open position) is correct.
- 1.5.1.7.7 Volume and control dampers (left in a neutral or wide-open position) function properly.
- 1.5.1.7.8 Verification that duct-leakage test has been performed and ducts are sealed to the minimum tolerance specified in the Contract Documents.
- 1.5.1.7.9 Verification that all registers, grilles, and diffusers are of the correct type, are properly installed, and are in the open position.
- 1.5.1.7.10 Verification that all terminal boxes are the correct type and are properly installed according to the manufacturer's recommendations.
- 1.5.1.7.11 Verification that motors, starters, and variable speed controllers with overload safety devices are the correct size and are operating properly.
- 1.5.1.7.12 Verification that automatic controls are installed correctly and include all components specified, including interlocks, freeze stats, damper controllers, minimum positioning switches, control valves, actuators, and sensors.
- 1.5.1.7.13 Verification that hydronic pumps and related components are properly installed and operate correctly.
- 1.5.1.7.14 Verification that strainers are clean and that the system is vented and free of air.
- 1.5.1.7.15 Verification that expansion tanks are properly installed and working.
- 1.5.1.7.16 Verification that coils are piped correctly and are clean.
- 1.5.1.7.17 The motor, amps, volts, and rpm, are compared with nameplate data and are adjusted within a motor-rated hp or amperes.
- 1.5.1.7.18 Verification that fan and pump power and speed are within design range.

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Testing, Balancing and Adjusting
Section No.: 20 05 93
Date: April 9, 2020

- 1.5.1.7.19 Verification that the controls are complete and operational.
- 1.5.1.7.20 Verification of the correct type, quantity, and cleanliness of installed filters.
- 1.5.2 During testing and balancing; the respective installing Subcontractor (Division 21, 22 or 23) shall:
 - 1.5.2.1 Operate and maintain all systems requiring balancing during the balancing period.
 - 1.5.2.2 Ensure that the control system responds to the testing and balancing requirements. Provide all necessary personnel, equipment and software to make adjustments to controls as required to achieve design condition.
 - 1.5.2.3 Furnish and install drives and motors as required to accomplish design requirements.
 - 1.5.2.4 Provide all equipment, labour, instruments and incidentals and pay for all power and fuel to carry out the tests.
- 1.5.3 Start-Up Report:
 - 1.5.3.1 The Contractor shall provide a copy of a detailed start-up report, including initial tabulated data required for the start-up of systems, to the test and balance agency for reference in the balancing work.
- 1.5.4 Joint effort of Contractors:
 - 1.5.4.1 Upon completion of balancing, the TAB Subcontractor shall provide flows, pressures, and temperatures to the control contractor for final calibration of the automatic control system. The Division 25 – Integrated Automation Subcontractor shall provide access to computerized data and equipment and/or provide operating personnel.
 - 1.5.4.2 After balancing, the TAB Subcontractor shall provide water flow rates, etc. to the chiller, cooling tower, and boiler suppliers for final setup and performance verification.

2 PRODUCTS

Not Used

3 EXECUTION

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Testing, Balancing and Adjusting
Section No.: 20 05 93
Date: April 9, 2020

3.1 GENERAL

- 3.1.1 TAB work shall be undertaken in accordance with the following descriptions. Procedures not specifically described herein or requiring amplification shall be in accordance with CAABC / NBCTA / NEBB standards, as applicable.

3.2 AIR SYSTEM BALANCING

- 3.2.1 Air quantities in main ducts shall be measured by Pitot tube traverses of the entire cross section area of the duct. Openings in ducts for Pitot tube insertion shall be sealed with approved plugs. Outlet and inlet air quantities shall be determined in accordance with CAABC / NBCTA / NEBB procedures.
- 3.2.2 Total air quantities shall be obtained by adjustment of fan speeds. Branch duct air quantities shall be adjusted by volume dampers. Damper positions shall be permanently marked after TAB work is complete.
- 3.2.3 For systems handling outdoor air, the system shall be balanced at the normal minimum outdoor air condition. Where the system is designed to deliver 100% return air or a variable amount of outdoor air, the total airflow tests shall be repeated for 100% maximum outdoor air and shall agree with conditions measured under minimum outdoor air operation before the system is considered to be in balance.
- 3.2.4 Adjusting of individual outlets shall be performed as per CAABC / NBCTA / NEBB procedures or as otherwise approved by the Consultant. Outlets shall be set for the air pattern required and all main supply air dampers shall be adjusted and set for the design indicated. All required changes in air patterns or setting necessary to achieve correct air balance and to minimize drafts shall be performed by the TAB Subcontractor.
- 3.2.5 All measured air quantities shall be within $\pm 5\%$ of design air quantities where achievable.
- 3.2.6 Each Variable Air Volume (VAV), and Constant Volume (CV) supply, return air and exhaust terminal unit shall be adjusted to deliver the maximum and minimum air quantities specified in all specified modes of operation. (Use the prescribed procedures for each type terminal device). The individual supply outlets for each zone shall be adjusted after the respective control unit is manually set (Pneumatic and/or Direct Digital Control (DDC)) to design

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Testing, Balancing and Adjusting
Section No.: 20 05 93
Date: April 9, 2020

airflow settings (Minimum and Maximum). Factory calibration of all types of VAV and High Velocity Fan Powered/Reheat Units shall be verified and reset as required by the TAB Subcontractor.

- 3.2.7 The TAB Subcontractor shall perform the test and compile the data required. In addition to the tabulation forms, the TAB Subcontractor shall provide schematic diagrams showing all system components cross-referenced to form tabulations. The lists provided hereinafter shall be considered minimum requirements. All information required to prove system balance shall be provided by the TAB Subcontractor.
- 3.2.8 Air Handling Equipment Tests and Data
- 3.2.8.1 Tabulate design conditions from documents and installed conditions from shop drawings:
- 3.2.8.1.1 Fan, unit or system number.
- 3.2.8.1.2 Location.
- 3.2.8.1.3 Area served.
- 3.2.8.1.4 Manufacturer, model and serial number of air unit, motor(s), pulley and belts.
- 3.2.8.1.5 Motor nameplate power (kilowatts), amperage, voltage, phase, hertz, frame type, and service factor.
- 3.2.8.1.6 Sheave Manufacturer, model number, grooves, and pitch diameter, adjustable or fixed. Include pitch diameter settings on adjustable sheaves.
- 3.2.8.1.7 Fan and motor rpm.
- 3.2.8.1.8 Fan or unit static pressure profile. Measure and record pressure differentials across coils, filters, dampers, etc.
- 3.2.8.1.9 Total airflow, Outdoor Air, Return Air, Exhaust Air, Relief Air, and Outlet Air (Maximum and Minimum).
- 3.2.8.1.10 Terminal Manufacturer and type.
- 3.2.8.1.11 Outlet or inlet size, effective area and A_k Factor, except when using a direct reading flow hood.
- 3.2.8.1.12 Design temperature differences.

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Testing, Balancing and Adjusting
Section No.: 20 05 93
Date: April 9, 2020

- 3.2.8.1.13 Design brake horsepower (kilowatts).
- 3.2.8.1.14 Check that stratification has been eliminated before taking measurements. Make temperature traverse readings after each mixing compartment. Advise the Division 23 – HVAC Subcontractor if any stratification is present.
- 3.2.8.2 Tabulate from equipment field tests.
 - 3.2.8.2.1 Fan and motor rpm.
 - 3.2.8.2.2 Motor amperage for each phase.
 - 3.2.8.2.3 Voltage for each phase.
- 3.2.8.3 Tabulate from air data from field test (for each required condition).
 - 3.2.8.3.1 Total air quantity for each outlet or inlet and for Supply air, Return Air, Exhaust Air, Relief Air and Outdoor Air for each system.
 - 3.2.8.3.2 Pressure reading at most distant point of system (Pa / mm w.g. for VAV systems only).
 - 3.2.8.3.3 Pressure drops across filters, boxes, coils and air-to-air heat exchangers.
 - 3.2.8.3.4 Supply, Return and Exhaust fan pressure differentials.
 - 3.2.8.3.5 Temperature differences across coils and air-to-air heat exchangers.
 - 3.2.8.3.6 Traverse locations and grid with actual velocities. Record duct static pressure at each traverse location. Provide traverses at all points necessary for balancing.
- 3.3 WATER SYSTEM BALANCING
 - 3.3.1 Water flows shall be balanced by venturi and calibrated orifices with portable type flow meters, where provided by the respective installing Subcontractor (Division 21, 22 or 23), or calibrated meters provided by the TAB Subcontractor.
 - 3.3.2 Pump flow capacities shall be determined by venturies, orifices, or multi-duty valves. All settings of balancing valves shall be permanently marked after balance is complete.
 - 3.3.3 The TAB Subcontractor shall compare design documents with the

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Testing, Balancing and Adjusting
Section No.: 20 05 93
Date: April 9, 2020

shop drawings. If discrepancies are found, TAB Subcontractor shall submit a request for information to resolve the discrepancies.

- 3.3.4 Pump Test and Data.
 - 3.3.4.1 Tabulate tests and data: (Confirm in field)
 - 3.3.4.1.1 Pump number and service.
 - 3.3.4.1.2 Location.
 - 3.3.4.1.3 Area served and type of system served.
 - 3.3.4.1.4 Manufacturer, model, serial number of pump.
 - 3.3.4.1.5 Motor nameplate power (watts), amperage, voltage, phase, Hertz, frame type and service factor.
 - 3.3.4.1.6 Pump and motor rpm.
 - 3.3.4.1.7 Pump suction and discharge pressure at operating conditions.
 - 3.3.4.1.8 System flow.
 - 3.3.4.2 Tabulate from field tests:
 - 3.3.4.2.1 Pump and motor rpm.
 - 3.3.4.2.2 Motor amperage for each phase.
 - 3.3.4.2.3 Voltage for each phase.
 - 3.3.4.3 Tabulate from pump field test:
 - 3.3.4.3.1 Total flow.
 - 3.3.4.3.2 Discharge and suction pressure for operating and shut off conditions.
- 3.3.5 Heat Transfer Equipment Tests and Data
 - 3.3.5.1 Tabulate design conditions from documents and installed conditions from shop drawings.
 - 3.3.5.1.1 Identification, location and service.
 - 3.3.5.1.2 Transferred heat (kW).

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
 Project No.: 2019-0495
 Section Name: Testing, Balancing and Adjusting
 Section No.: 20 05 93
 Date: April 9, 2020

- 3.3.5.1.3 Manufacturer.
- 3.3.5.1.4 Model and serial number.
- 3.3.5.1.5 Pipe size (mm).
- 3.3.5.1.6 Design pressure differential (kPa / psi) and flow rates (L/s / USgpm).
- 3.3.5.1.7 Design leaving and entering conditions.
- 3.3.5.1.8 Type motor used.
- 3.3.5.2 Tabulate from field tests:
 - 3.3.5.2.1 Pressure differential (kPa / psi).
 - 3.3.5.2.2 Total flow (L/s / USgpm).
 - 3.3.5.2.3 Entering and leaving temperature and conditions.
- 3.3.5.3 For heating systems where automatic control valves are not used for each radiator or convector, adjust to equal temperature drop through each unit. Submit the temperature readings taken by contact pyrometer on inlet and outlet pipes to the top and bottom units on each riser.
- 3.3.6 Cooling Tower Test and Tabulations:
 - 3.3.6.1 The tower water distribution system shall be balanced to ensure an even water flow to each tower cell. The fan(s) speed, rotation, motor voltage and amperage shall be checked and recorded.
 - 3.3.6.2 The TAB Subcontractor shall perform tests on cooling towers in accordance with CAABC / NBCTA / NEBB procedures and shall provide the following information:
 - 3.3.6.2.1 Pump and cooling tower nomenclature.
 - 3.3.6.2.2 Size and capacities.
 - 3.3.6.2.3 Pump motor and fan motor operating information and characteristics.
 - 3.3.6.2.4 Pump flows, discharge head, and Total Dynamic Head (TDH).
 - 3.3.6.2.5 Fan airflow and velocities if applicable.

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Testing, Balancing and Adjusting
Section No.: 20 05 93
Date: April 9, 2020

- 3.3.6.2.6 Wet and dry bulb air temperatures of inlet and outlet.
- 3.3.6.2.7 Water temperature of hot water, cold water and make-up water.
- 3.3.7 Boilers and Furnaces
 - 3.3.7.1 For boilers and furnaces, test flue gas using Orsat flue gas analyzer for carbon dioxide, oxygen and carbon monoxide. Measure and record fuel consumption. Perform test at each firing rate.
- 3.3.8 Systems installed with pressure independent control valves shall not require terminal level hydronic system balancing. Total system flow shall be verified to be within +/-10% of system design. 10% of the total installed product shall be randomly checked for individual conformance. Exact locations of tested product to be coordinated with the design engineer. Any individual adjustments for the pressure independent valve assembly (valve and actuator combination) for field conditions shall be performed using the pressure independent control valve manufacturer's documented procedure following the guidelines of CAABC / NBCTA / NEBB.
- 3.4 DEMONSTRATION
 - 3.4.1 At the request of the Consultant, the TAB Subcontractor shall repeat the balancing procedure for any system or portion of a system. The TAB Subcontractor shall repeat the balancing procedure on 10% (as selected by the Consultant) of systems. If the data is within $\pm 5\%$ of the reported data, the system shall be considered acceptable and the report accepted. If the data is not within $\pm 5\%$ of the reported data, the Consultant can request that the entire system or systems be rebalanced.
- 3.5 REPORTS
 - 3.5.1 Submit written reports, during the course of construction, of potential developing problems relating to the work being provided under other sections of the specifications where such problems may adversely affect the proper balancing of the equipment or systems.
 - 3.5.2 Submit written reports for review upon completion of each major phase of the balancing work.
 - 3.5.3 The TAB Subcontractor shall prepare and submit three (3) copies of the Balancing Report to the Consultant for review and evaluation

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Testing, Balancing and Adjusting
Section No.: 20 05 93
Date: April 9, 2020

prior to final acceptance of the project. The Balancing Report shall include the data outlined above, but may be expanded or modified to be compatible with the requirements of the installed equipment and systems.

- 3.5.3.1 The cover of the TAB Report must show the “CAABC / NBCTA / NEBB” Logo, Name and Address of the project, Architect, Mechanical Engineer, Installing Contractor, Date the report is issued, Address and Phone Number of the TAB Subcontractor. The CAABC / NBCTA / NEBB Seal and Signature of the TAB Supervisor who is in charge of the reported project must be submitted on the “Certification” Report Form (TAB 2-98)
- 3.5.3.2 Identification of all types of instruments used and their last dates of calibration shall be submitted with the Final Report.
- 3.5.3.3 Once the Consultant’s comments have been incorporated in the report, submit four (4) copies of the Final Report to the Consultant.
- 3.6 QUALITY ASSURANCE
- 3.6.1 The Tab Subcontractor shall guarantee that all work will be performed in accordance with the applicable CAABC / NBCTA / NEBB Standards and Procedures. The TAB Subcontractor’s Certification Number must be provided to the Consultant.

END OF SECTION

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Mechanical Insulation
Section No.: 20 07 00
Date: April 9, 2020

INDEX

1 GENERAL

- 1.1 General
- 1.2 Scope of Work
- 1.3 Submittals
- 1.4 LEED Submittals
- 1.5 Quality Assurance

2 PRODUCTS

- 2.1 insulation Material
- 2.2 Application
- 2.3 Cold Piping
- 2.4 Hot Piping
- 2.5 Ducts
- 2.6 Boiler Breeching, Generator Exhaust Pipes and Muffler
- 2.7 Cold Equipment
- 2.8 Hot Equipment

3 EXECUTION

- 3.1 Application

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Mechanical Insulation
Section No.: 20 07 00
Date: April 9, 2020

1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 – General Requirements, shall apply to and govern this Section.

1.1.2 All insulation shall comply with minimum R-value requirements listed in ASHRAE Energy Standard 90.1, 2013 edition.

1.1.3 All insulation materials and installation must meet the requirements of applicable codes and standards, and be appropriately labeled.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools, equipment, training, commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 Piping insulation.

1.2.1.2 Equipment insulation, including tanks.

1.2.1.3 Breeching insulation.

1.2.1.4 Engine exhaust insulation.

1.2.1.5 Thermal duct insulation.

1.2.1.6 Adhesives, tie wires, tapes.

1.2.1.7 Recovery jackets.

1.3 SUBMITTALS

1.3.1 Submit Shop Drawings for:

1.3.1.1 Insulation products.

1.3.1.2 Recovery jackets.

1.3.1.3 Adhesives and sealants.

1.3.2 Submittal to include product description, manufacturer's installation instructions, and appropriate specification compliance.

1.3.3 Submit samples of all insulation materials to the Consultant mounted on a board, and labeled for intended services, including

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Mechanical Insulation
Section No.: 20 07 00
Date: April 9, 2020

'k' factors. Obtain the Consultant's comments prior to ordering insulation and proceeding with the installation.

1.4 LEED SUBMITTALS

1.4.1 Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of Volatile Organic Compounds (VOC) content and chemical components.

1.4.2 Laboratory Test Reports for Credit IEQ 4: For adhesives and sealants, documentation indicating that product complies with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small Scale Environmental Chambers."

1.4.3 LEED v 4, Product Data for Credit EQ 2: For products and materials to comply with low emittance standards, provide documentation substantiating that insulation products comply with requisite low emittance standards.

1.5 QUALITY ASSURANCE

1.5.1 Glass mineral wool insulation products to have UL GREENGUARD Gold Certification and be formaldehyde free as certified by UL Environment; whenever possible.

1.5.2 Products shall contain no polybrominated diphenyl ethers (PBDE) such as Penta-BDE, Octa-BDE or Deca-BDE fire retardants.

1.5.3 The Contractor shall take precaution to protect insulation materials from moisture exposure or physical damage. Any glass mineral wool insulation that becomes wet or damaged shall be replaced at no additional cost.

1.5.3.1 HVAC ductwork insulation used in the air stream must be discarded if exposed to liquid water.

1.5.3.2 Pipe insulation with factory applied all service jacket with self-sealing lap (ASJ+) facing having been installed per manufacturer's installation recommendation which may experience intermittent exposure to liquid water after installation may be exempted from removal and replacement requirements.

2 **PRODUCTS**

2.1 INSULATION MATERIAL

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Mechanical Insulation
Section No.: 20 07 00
Date: April 9, 2020

- 2.1.1 Unless otherwise noted, insulating materials are based on Knauf Fiber Glass GmbH.
- 2.1.2 All insulation materials, adhesive sealants and coatings, shall be ULC listed, non-hygroscopic, and mould-proof. Insulation products shall not contain asbestos, lead, mercury, mercury compounds, or formaldehyde.
- 2.1.3 All insulation system materials inside the building must meet the requirements of NFPA 90A, with a flame spread rating of less than 25, and smoke developed rating of less than 50, when tested in accordance with CAN/ULC-S102. Insulation materials shall not flame, smolder, glow or smoke at their service temperatures.
- 2.1.4 Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795. Insulation materials applied to carbon steel shall be Mass Load Corrosion Rate (MLCR) tested per ASTM C 1617.
- 2.1.5 Pipe insulation: Knauf Earthwool™ 1000° glass mineral wool pipe insulation, UL/ULC classified, rigid, molded, k value: 0.033 (0.23) at 24°C (75°F) mean temperature; 0.049 (0.34) at 149°C (300°F) mean temperature. Maximum service temperature 538°C (1000°F). Vapor retarder jacket: ASJ+ conforming to ASTM C 1136 Type I, II, III, IV, & VIII secured with self-sealing longitudinal laps and matching ASJ+ butt strips.
- 2.1.6 Semi-rigid pipe and tank insulation: Knauf Pipe & Tank glass mineral wool insulation, limited combustible, k value: 0.036 (0.25) at 24°C (75°F) mean temperature. Maximum service temperature 454°C (850°F). Compressive strength: not less than 5.75 kPa (120 PSF) @ 10% deformation per ASTM C 165. Vapor retarder jacket: ASJ conforming to ASTM C 1136 Type II.
- 2.1.7 Semi-rigid blanket for equipment: Knauf KwikFlex™ glass mineral wool; in roll form, k value: 0.035 (0.24) at 24°C (75°F) mean temperature; 0.056 (0.39) at 149°C (300°F) mean temperature. Maximum service temperature 454°C (850°F), maximum surface temperature for faced product: 66°C (150°F), maximum thickness @ 454°C (850°F): 102mm (4"). Compressive strength: not less than 1.2 kPa (25 PSF) @ 10% deformation per ASTM C 165. Vapor retarder jacket: ASJ, FSK or PSK conforming to ASTM E 96, Procedure A.
- 2.1.8 Fitting insulation: insulate using pre-formed PVC fitting covers with glass mineral wool inserts. Alternatively, preformed molded,

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Mechanical Insulation
Section No.: 20 07 00
Date: April 9, 2020

formaldehyde free glass mineral wool; minimum 50% post-consumer recycled glass content, or mitered glass mineral wool pipe insulation sections. These fittings shall be further protected by field-applied PVC fitting covers, metal fitting covers, or glass fabric and mastic sealed as necessary.

- 2.1.9 Duct wrap: Knauf Friendly Feel® glass mineral wool blanket; flexible, limited combustible, k value: 0.042 (0.29) at 24°C (75°F) mean temperature. Maximum service temperature: faced 121°C (250°F), unfaced 177°C (350°F). Maximum allowable compression is 25%. Density: concealed areas: minimum 12 kg/m³ (0.75 PCF); exposed areas: minimum 16 kg/m³ (1.0 PCF). Vapor retarder jacket: FSK or PSK conforming to ASTM C 1136 Type II.
- 2.1.10 Rigid duct insulation: Knauf Insulation Board, rigid glass mineral wool board. Maximum service temperature 232°C (450°F). Concealed areas: Density: Minimum 48 kg/m³ (3 PCF). k value: 0.033 (0.23) at 24°C (75°F) mean temperature. Vapor retarder jacket: ASJ conforming to ASTM C 1136 Type I, or FSK or PSK conforming to ASTM C 1136 Type II. Exposed Areas: Density: Minimum 96 kg/m³ (6 PCF). k value: 0.032 (0.22) at 24°C (75°F) mean temperature. Vapor retarder jacket: ASJ conforming to ASTM C 1136 Type I, or FSK or PSK conforming to ASTM C 1136 Type II in combination with protective jacket where necessary.
- 2.1.11 Factory applied jackets:
- 2.1.11.1 All service jacket with advanced closure system self-sealing lap (ASJ+). All service jacket composed of aluminum foil reinforced with glass scrim bonded to a kraft paper interleaving with an outer film layer leaving no paper exposed.; conforming to ASTM C 1136 Type I, II, III, IV, and VIII; vapor retarder; with a self-sealing adhesive.
- 2.1.11.2 All service jacket (ASJ). White kraft paper bonded to aluminum foil and reinforced with glass fibers; conforming to ASTM C 1136; vapor retarder.
- 2.1.11.3 Foil scrim kraft (FSK). Aluminum foil, fiberglass reinforced scrim with kraft backing; conforming to ASTM C 1136 Type 1; vapor retarder.
- 2.1.11.4 Poly scrim kraft (PSK). Metalized polypropylene, fiberglass reinforced scrim with kraft backing; conforming to ASTM C 1136 Type 1; vapor retarder.

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
 Project No.: 2019-0495
 Section Name: Mechanical Insulation
 Section No.: 20 07 00
 Date: April 9, 2020

- 2.1.11.5 Redi-Klad Jacket: VentureClad 5-ply weather and abuse resistant with self-seal lap, zero permeability per ASTM E 96-05; puncture resistance 35.4 kg (189.3 N) per ASTM D 1000; tear strength 19.4 N (4.3 lbs) per ASTM D 624; thickness 14.5 mils (0.0145"); tensile strength 306 N (31 kg)/25 mm (68.0 lb./inch) width.
- 2.1.12 Field applied jackets:
 - 2.1.12.1 PVC: Proto Corporation 25/50 or Indoor/Outdoor, UV resistant fittings, jacketing and accessories, white or colored. Fitting cover system consists of pre-molded, high-impact PVC materials with glass mineral wool inserts. Glass mineral wool insert has a thermal conductivity (k value) of 0.037 (0.26) at 24°C (75°F) mean temperature. Closures: stainless steel tacks, matching PVC tape, or PVC adhesive per manufacturer's recommendations.
 - 2.1.12.2 Aluminum Jacket: Alloy 3003 or 3105, minimum thickness per ASTM C 1729, smooth, corrugated or stucco embossed with factory-applied moisture barrier. Overlap shall be 50mm (2 inch) minimum. Jacket shall be banded in place with 12mm x 5mm (½" x 0.20") aluminum strapping fastened with aluminum wing seals.
 - 2.1.12.3 Stainless Steel Jacket: T-304, minimum per ASTM C 1729, smooth, corrugated or embossed with factory-applied moisture barrier. Overlap shall be 50mm (2 inch) minimum. Jacket shall be banded in place with 10mm x 5mm (⅜" x 0.20") aluminum strapping fastened with stainless steel wing seals.
 - 2.1.12.4 Laminated Self-Adhesive Water and Weather Seals: permanent acrylic self-adhesive system; weather resistant, high puncture and tear resistance; meeting or exceeding requirements of UL 723; and applied in strict accordance with manufacturers' recommendations.
 - 2.1.12.5 Canvas jackets: 1.83kg/m2 (6oz./sq.ft) plain weave cotton fabric sealed with dilute fire retardant, waterproof, ULC listed lagging adhesive.
- 2.1.13 Jacketing for outdoor ductwork
 - 2.1.13.1 Aluminum Jacket: 0.406mm (0.016 inch) thick in smooth, corrugated, or embossed finish with factory applied moisture barrier. Overlap shall be 50mm (2 inch) minimum.
 - 2.1.13.2 PVC Jacket: Proto Corporation Indoor/Outdoor, UV resistant, white. Closure shall be solvent weld adhesive or per manufacturers' recommendations.

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Mechanical Insulation
Section No.: 20 07 00
Date: April 9, 2020

- 2.1.13.3 Laminated Self-Adhesive Water and Weather Seals: applied per manufacturer's recommendations.
- 2.1.14 Mastics:
 - 2.1.14.1 Vapor Retarder Mastics: Knauf Insulation EXPERT Mastics: KI-900 ASJ or KI-905 ASJ+; water vapor permeance: 0.026 metric perm (0.04 perm) at 40 mil dry film thickness. Service Temperature Range: -29°C to 82.2°C (-20°F to 180°F). Color: White
 - 2.1.15 Weather Barrier Mastics: Knauf Insulation EXPERT Mastics: KI-700 ASJ or KI-705 ASJ+; water vapor permeance: 1.2 metric perm (1.8 perm). Service Temperature: -17.8°C to 82.2°C (0°F to 180°F) constant; -29°C to 93°C (-20°F to 200°F) intermittent. Solids: 58% by weight; 50% by volume. Color: White
- 2.1.16 Tapes:
 - 2.1.16.1 ASJ Tape: Knauf Insulation EXPERT ASJ Tape or ASJ+ Tape. Width: 75mm (3 inches) or 102mm (4 inches). Thickness (Total): 0.36 mm (14.3 mil) – ASJ; 0.34mm (13.3 mil) – ASJ+. Adhesion: >840 N/m (4.8 Lbf / in.)
 - 2.1.16.2 FSK Tape: Knauf Insulation EXPERT FSK Tape. Width: 75mm (3 inches) or 102mm (4 inches). Thickness (Total): 0.34mm (13.3 mil). Adhesion: 1,138 N/m (6.5 Lbf / in.)
 - 2.1.16.3 Aluminum Foil Tape: Knauf Insulation EXPERT 2 Mil Foil Tape. Width: 75mm (3 inches) or 102mm (4 inches). Thickness (Total): 0.19mm (7.3 mil). Adhesion: 700 N/m (4.0 Lbf / in.)
- 2.2 APPLICATION
 - 2.2.1 The following areas are designated as “exposed” where the term is applied to covering:
 - 2.2.1.1 Mechanical and electrical equipment rooms, penthouses, parking garage, loading dock, shipping/receiving areas.
 - 2.2.1.2 Mechanical plenum spaces.
 - 2.2.1.3 Below suspended ceiling level in occupied areas or below slab where no ceiling occurs.
 - 2.2.1.4 Duct shafts and/or pipe shafts serviced via “walk-in” type access doors.

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Mechanical Insulation
Section No.: 20 07 00
Date: April 9, 2020

2.2.1.5 Crawl spaces, tunnels.

2.2.2 Cover duct and pipes exposed to weather or dampness with 75mm (3") thick insulation and a final application of tape adequately overlapped to render it water tight. The following areas are designated as "exposed to weather or dampness" and are applicable for this treatment:

2.2.2.1 Air intake, relief, and exhaust plenums directly connected to the outside of the building.

2.2.2.2 Underground service trenches.

2.2.2.3 Buried below ground level.

2.2.2.4 Areas subject to high humidity.

2.2.2.5 Ductwork and piping exposed on the roof.

2.3 COLD PIPING

2.3.1 Cover 'cold' piping (operating temperature below 16°C/61°F) with rigid pipe insulation with factory applied vapour barrier jacket and aluminum foil vapour barrier with self-sealed lap. Butt joints sealed with butt strips or aluminum tape. Recover pipe in exposed areas with field applied jacket.

2.3.2 Insulation thickness shall be as follows:

- 2.3.2.1 25mm (1")
- unburied domestic cold water piping
 - chilled drinking water
 - unburied apparatus drains
 - horizontal unburied rain water piping, including the piping up to and including roof hoppers or drain fixtures
 - horizontal unburied sanitary drains
 - cast iron fittings on transite rainwater piping
 - gray water piping

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
 Project No.: 2019-0495
 Section Name: Mechanical Insulation
 Section No.: 20 07 00
 Date: April 9, 2020

- fire standpipe, wet sprinkler and drainage piping in loading dock, parking garage and other unheated areas
- refrigerant suction piping
- auxiliary water piping on refrigeration compressors
- cooling tower make-up water, overflow, bleed and drain pipes inside and outside building
- chilled water/glycol supply and return at 5°C (41°F) and above
- condenser water used for low temperature cooling (water side free cooling) inside building

- | | | |
|---------|--|--|
| 2.3.2.2 | 40mm (1-½") | - chilled water/glycol supply and return below 4°C (39°F) for pipes equal to or greater than DN200 (8") dia. |
| 2.3.2.3 | 40mm (1-½") | - chilled water/glycol supply and return below 5°C (41°F) for pipes greater than DN25 (1") dia. |
| 2.3.2.4 | 50mm (2") | - electrically traced piping, including drum drips of dry sprinkler system |
| 2.3.3 | Cover 'cold' piping running outside the building envelope with insulation thickness as follows: | |
| 2.3.3.1 | 65mm (2-½") | - pipes up to and including DN50 (2") dia. |
| 2.3.3.2 | 80mm (3") | - pipes DN65 (2-½") up to and including DN100 (4") dia. |
| 2.3.3.3 | 90mm (3-½") | - pipes above DN100 (4") dia. |
| 2.3.4 | In lieu of the above specified insulation, Armstrong AP/Armaflex flexible elastomeric expanded closed-cell insulation with same thickness may be substituted for the following services: | |
| | | - horizontal unburied rain water piping, including the piping up to and including roof hoppers or drain fixtures |

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
 Project No.: 2019-0495
 Section Name: Mechanical Insulation
 Section No.: 20 07 00
 Date: April 9, 2020

- horizontal unburied sanitary drains
- refrigerant suction piping, 16mm ($\frac{5}{8}$ ") thickness
- auxiliary water piping on refrigeration compressors

2.4 HOT PIPING

2.4.1 Cover 'hot' piping – heating water/glycol, domestic hot water supply and recirculation, condenser water, hot-gas bypass, drip and blowdown lines, steam and condensate, at operating temperatures above 41°C/106°F – with rigid pipe insulation with factory applied kraft paper jacket bonded to aluminum foil vapour barrier with self-sealed lap. Hold insulation in place with flare type staples. Recover pipe in exposed areas with field applied jacket.

2.4.2 Insulation thickness shall be as follows:

SPEC NOTE: ASHRAE 90.1-2013

- | | | |
|---------|---------------|---|
| 2.4.2.1 | 25mm (1") | - 'hot' piping up to 60°C (140°F) operating temperature, for pipes less than 40mm (1-1/2") dia. |
| 2.4.2.2 | 40mm (1-1/2") | - 'hot' piping up to 60°C (140°F) operating temperature, for pipes equal to or greater than 40mm (1-1/2") dia.

- 'hot' piping up to 93°C (180°F) operating temperature, for pipes less than 40mm (1-1/2") dia. |
| 2.4.2.3 | 50mm (2") | - 'hot' piping up to 93°C (180°F) operating temperature, for pipes equal to or greater than 40mm (1-1/2") dia.

- electrically traced piping |
| 2.4.2.4 | 65mm (2-1/2") | - 'hot' piping up to 121°C (250°F) operating temperature, for pipes less than 40mm (1-1/2") dia. |

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
 Project No.: 2019-0495
 Section Name: Mechanical Insulation
 Section No.: 20 07 00
 Date: April 9, 2020

- | | | |
|---------|--|---|
| 2.4.2.5 | 80mm (3") | - 'hot' piping up to 121°C (250°F) operating temperature, for pipes equal to or greater than 40mm (1-1/2") dia. |
| 2.4.2.6 | 25mm (1") | - 'hot' piping up to 60°C (140°F) operating temperature, for pipes less than or equal to 100mm (4") dia.

- 'hot' piping up to 93°C (180°F) operating temperature, for pipes less than or equal to 50mm (2") dia. |
| 2.4.2.7 | 40mm (1-1/2") | - 'hot' piping up to 60°C (140°F) operating temperature, greater than 100mm (4") dia.

- 'hot' piping up to 93°C (180°F) operating temperature, greater than 50mm (2") dia.

- 'hot' piping up to 121°C (250°F) operating temperature, less than or equal to 50mm (2") dia. |
| 2.4.2.8 | 50mm (2") | - 'hot' piping up to 121°C (250°F) operating temperature, greater than 50mm (2") dia.

- electrically traced piping |
| 2.4.3 | Cover 'hot' piping running outside the building envelope with insulation thickness as follows: | |
| 2.4.3.1 | 65mm (2-1/2") | - pipes up to and including DN50 (2") dia. |
| 2.4.3.2 | 80mm (3") | - pipes DN65 (2-1/2") up to and including DN100 (4") dia. |
| 2.4.3.3 | 90mm (3-1/2") | - pipes above DN100 (4") dia. |

2.5 DUCTS

- | | |
|-------|---|
| 2.5.1 | Insulate round supply ducts up to 750mm (30") diameter and rectangular supply ducts up to 750mm (30") width with 25mm (1") thick flexible duct insulation. Adhere insulation to duct surface with adhesive applied in strips 150mm (6") wide on 300mm (12") centres. Use fiberglass tying cord or 16 gauge annealed wire until the adhesive sets. Butt edges of insulation tightly together, and seal all breaks and joints with self-adhering aluminum tape. |
| 2.5.2 | Insulate round supply ducts over 750mm (30") diameter and |

rectangular supply ducts over 750mm (30") width with 25mm (1") thick rigid duct insulation board. Fasten the insulation with welded pins and speed washers on maximum 300mm (12") centres. Use a minimum of two (2) rows of fasteners per side. Butt edges of insulation tightly together, and seal all breaks and joints with self-adhering aluminum tape.

- 2.5.3 Where angles or standing seams extend beyond the insulation and before the final finish, apply a compressed layer of 25mm (1") flexible duct insulation over the angles and standing seams. Extend the insulation 75mm (3") on each side of the angle and place tightly around the projecting leg of the angle. Apply the insulation overlapping the edge so that the vertical part of the insulated angle will project throughout the work.
- 2.5.4 Where interior acoustic insulation is required, decrease the exterior insulation by equal thickness. Overlap the exterior insulation by at least 300mm (12"), upstream and downstream.
- 2.5.5 Apply vapour barrier over insulation on cold and dual temperature ducts.
- 2.5.6 Insulate all ductwork running outside the building with 75mm (3") rigid board insulation and weatherproof jacket.
- 2.5.7 Insulate the following duct:
 - 2.5.7.1 Air conditioning supply ducts from apparatus casings to air terminal control units, reheat coils, or duct termination.
 - 2.5.7.2 Tempered air supply ducts in unheated space.
 - 2.5.7.3 Air supply duct downstream of energy/heat recovery ventilators.
 - 2.5.7.4 All rigid supply ducts downstream from air terminal control units, reheat coils and hydronic terminal units.
- 2.5.8 Air intakes and exhaust:
 - 2.5.8.1 Insulate with rigid vapour seal insulation board.
 - 2.5.8.2 Impale the insulation in place with suitable speed washers or clips. Where angles or standing seams extend beyond the insulation, apply a compressed layer of 25mm (1") flexible duct wrap over the angles and standing seams. The wrap shall extend 75mm (3") on each side of the angle and placed tightly around the projecting leg of the angle. Apply the insulation overlapping the edge of the wrap

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Mechanical Insulation
Section No.: 20 07 00
Date: April 9, 2020

on the angle so that the vertical part of the insulated angle will project throughout the work.

- 2.5.8.3 Seal all breaks and joints by adhering a 75mm (3") aluminum foil vapour barrier tape with fire retardant adhesive. Cover with canvas adhered with resin base lagging adhesive. Finish with one coat of the same lagging adhesive.
- 2.5.8.4 Insulate the following intakes and exhaust:
 - 2.5.8.4.1 All outdoor air intake ductwork from outside louvres to air handling units.
 - 2.5.8.4.2 All exhaust and relief ductwork from outside louvres to 1.5m (5 ft) upstream of motorized dampers or where there are no motorized dampers, from louver to fan discharge in 50mm (2") thickness.
 - 2.5.8.4.3 All exhaust and relief ductwork from outside louvres to heat recovery units located inside mechanical spaces/rooms in 50mm (2") thickness.
 - 2.5.8.4.4 All exhaust and relief ductwork from outside louvres to energy/heat recovery ventilators inside ceiling bulkheads and spaces in 40mm (1-½") thickness.
 - 2.5.8.4.5 Mixed air plenums in 50mm (2") thickness.
 - 2.5.8.4.6 Behind unused portion of louvers in 50mm (2") thickness.
- 2.5.9 Ensure that access doors of casings and plenums are supplied pre-insulated. Do not apply additional insulation.
- 2.6 BOILER BREECHING, GENERATOR EXHAUST PIPES AND MUFFLER
 - 2.6.1 Up to 482°C (900°F) operating temperature: Cover uninsulated boiler breeching, generator exhaust pipes and muffler with 128 kg/m³ (8.0 lb/ft³) density, 50mm (2") thick Roxul ProRox PS 960 pre-formed mineral fiber pipe insulation. For irregular shapes, use 50mm (2") thick Roxul MA 940 high temperature rated mineral fiber flexible wrap insulation.
 - 2.6.2 Between 482°C (900°F) and 650°C (1,200°F) operating temperature: Use the same insulation types as noted under Paragraph 2.6.1 however in 75mm (3") thickness.
 - 2.6.3 Between 650°C (1,200°F) and 1,093°C (2,000°F) operating

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Mechanical Insulation
Section No.: 20 07 00
Date: April 9, 2020

temperature: Cover uninsulated boiler breeching, generator exhaust pipes and muffler with 96 kg/m³ (6.0 lb/ft³), 25mm (1") thick Morgan Thermal Ceramics model Kaowool S ceramic fiber blanket insulation. Outside the blanket, apply 128 kg/m³ (8.0 lb/ft³) density Roxul ProRox PS 960 pre-formed mineral fiber pipe insulation in 50mm (2") thickness.

2.7 COLD EQUIPMENT

- 2.7.1 Cover 'cold' equipment with 25mm (1") thick Armstrong AP/Armaflex flexible elastomeric expanded closed-cell insulation. Apply to clean and dry surfaces, using 100% Armstrong 520 adhesive coverage on both surfaces to be joined. Use manufacturer's compression fit method of butt joining sheets.
- 2.7.2 Insulate the following equipment as 'cold' equipment. Finish insulation with two coats of Armaflex Finish. Color selection to be determined.
 - 2.7.2.1 Refrigeration machine evaporators, suction lines, chiller shells, shell ends and sumps, except pre-insulated units
 - 2.7.2.2 Water meters and irregular shapes.
 - 2.7.2.3 Strainer heads in cold lines.
 - 2.7.2.4 Cold water booster pumps.
 - 2.7.2.5 Condensation trays.
 - 2.7.2.6 Spray pumps, piping, valves, and fittings.
 - 2.7.2.7 Flat plate heat exchangers.
- 2.7.3 Provide removable 1.3mm (16 ga.) aluminum sheet metal enclosure with insulation applied as above to inside of cover, for the following 'cold' equipment:
 - 2.7.3.1 Chilled water pumps
 - 2.7.3.2 Chilled water pump suction and discharge guides
 - 2.7.3.3 Condenser water pumps
 - 2.7.3.4 Condenser water pump suction and discharge guides
- 2.7.4 Cover cooling tower sumps (if electrically traced) with 50mm (2")

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Mechanical Insulation
Section No.: 20 07 00
Date: April 9, 2020

thick semi-rigid fiberglass board insulation with factory applied vapour barrier. Cut and mitre insulation to suit surface contours. Impale insulation on mechanically fastened pins, located at not greater than 300mm (12") centres. Apply expanded metal lath and lace edges with 1.63mm (16 ga.) galvanized annealed wire. Secure insulation and metal lath with speed washers.

2.7.4.1 Recover sumps with 0.5mm (24 ga.) thick sheet aluminum fabricated to the shape of the sump. Mechanically fasten in place with bands, sheet metal screws or pop rivets. All corners shall be square and raw metal edges concealed.

2.7.5 Under each dehumidifier and cooling coil drip pan, place 50mm (2") thick foam glass with all joints sealed with cold adhesive cement.

2.7.6 Cover chilled water storage tanks with 50mm (2") thick rigid fiberglass board insulation, scored to suit curved surface. Impale insulation on suitable welded fasteners on 300mm (12") centres secured in place with speed washers. Recover with field applied jacket.

2.8 HOT EQUIPMENT

2.8.1 Cover 'hot' equipment (for temperatures not exceeding 232°C/450°F) with 50mm (2") thick semi-rigid fiberglass board insulation. The insulation shall be held in place with 19mm (¾") metal bands on maximum 450mm (18") centres. For large, flat or irregular surfaces, impale the insulation over suitable welded fasteners on 300mm (12") centres secured in place with speed washers. Lace the metal edges that butt together with 1.63mm (16 ga.) galvanized annealed wire. Insulation shall not be compressed beyond a maximum of 5% at any point. Recover with field applied jacket.

2.8.2 Insulate the following equipment as 'hot' equipment:

2.8.2.1 Converters, shell and tube heat exchangers (including glycol).

2.8.2.2 Domestic hot water tanks and water heaters except pre-insulated units.

2.8.2.3 Refrigeration condensers, except pre-insulated units.

2.8.2.4 Steam ancillaries.

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Mechanical Insulation
Section No.: 20 07 00
Date: April 9, 2020

- 2.8.3 Insulate flat plate heat exchangers with 25mm (1") thick Armaflex insulation. Refer to Paragraph 2.7.1 for details.

3 EXECUTION

3.1 APPLICATION

- 3.1.1 Do not apply insulation before piping ductwork and equipment has been tested and accepted.
- 3.1.2 All insulation shall be supplied and installed by a qualified insulation applicator in accordance with the latest MICA Commercial and Industrial Insulation Standard.
- 3.1.3 All insulation shall be applied in full accordance with the insulation manufacturer's recommendations, and shall present a neat workmanlike appearance upon completion.
- 3.1.4 Apply all insulation in a manner to facilitate replacing and/or servicing of equipment. All insulation for equipment shall be removable and reusable.
- 3.1.5 Use insulation, wrapping, vapour barriers and adhesive materials having flame spread, fuel contributed and smoke developed ratings in accordance with rulings and regulations of authorities. Follow all rules, regulations, and instructions of the Fire Marshall's office and all authorities having jurisdiction.
- 3.1.6 Do not apply any insulation or finishing when the ambient temperature in the space is less than 10°C (50°F).
- 3.1.7 Apply insulation only on clean and dry surfaces.
- 3.1.8 On cold surfaces where a vapor seal must be maintained, insulation shall be applied with a continuous, unbroken moisture and vapor retarder. All hangers, supports, anchors, or other projections secured to cold surfaces shall be insulated and vapor sealed to prevent condensation. Wheatpaste must not be used.
- 3.1.9 All pipe insulation shall be continuous through walls, ceiling or floor openings or sleeves except where firestop materials are required.
- 3.1.10 Install multiple layers of insulation with longitudinal and circumferential joints staggered.
- 3.1.11 Galvanized sheet metal shields, minimum 250mm (10") long and 1.3mm (18 gauge) thickness, shall be installed between hangers or

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
 Project No.: 2019-0495
 Section Name: Mechanical Insulation
 Section No.: 20 07 00
 Date: April 9, 2020

supports and the piping insulation. Rigid insulation inserts shall be installed as required between the pipe and the insulation shields. Inserts shall be of equal thickness to the adjacent insulation and shall be vapor sealed as required. Inserts made of wood are not acceptable. Insulation inserts shall be no less than the following lengths:

- 3.1.11.1 40mm (1½") to 65mm (2½") IPS 250mm (10") long
- 3.1.11.2 75mm (3") to 150mm (6") IPS 300mm (12") long
- 3.1.11.3 200mm (8") to 250mm (10") IPS 400mm (16") long
- 3.1.11.4 300mm (12") and over IPS 550mm (22") long
- 3.1.12 For piping, ductwork or equipment exposed in mechanical rooms or high traffic areas, insulation shall be protected from abuse by the use of appropriate thickness of PVC jacketing, metal jacketing or laminated self-adhesive water and weather seals.
- 3.1.13 On boiler breeching, generator exhaust pipes and mufflers stagger half sections and butt one-piece sections firmly together. Recover insulation with glassfiber cloth, adhered with fire retardant and high temperature rated adhesive. Insulation shall be banded securely in place with 20mm x 0.5mm (¾" x 0.02") stainless steel bands on maximum 300mm (12") centres and recovered with metal jacketing secured using additional banding or sheet metal screws. Position bands at butt joint overlaps and in between joints to secure jacket.
- 3.1.14 Insulate over flanges and mechanical couplings with specified insulation and thickness, sized to suit flange diameters. Fill spaces between insulation and adjoining pipe insulation with similar material. Recover in exposed areas with canvas or PVC jackets.
- 3.1.15 If not using preformed insulation, wrap all valves and inline components in cold piping and in hot piping above 60°C (140°F) operating temperature with flexible duct insulation, under compression at 2 to 1 ratio. Recover in exposed areas with field applied jackets.
- 3.1.16 Cover the first 150mm (6") of hanger rods directly connected to cold piping, with block or sectional insulation. Finish to match jacket on piping. Recover in exposed areas with canvas jacket.
- 3.1.17 Cover all insulated electrically traced piping, and all insulated piping, ductwork or equipment exposed to the outside with

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Mechanical Insulation
Section No.: 20 07 00
Date: April 9, 2020

weatherproof field applied jacket.

- 3.1.18 Insulate all silencer casings where no internal media contacts wall.
- 3.1.19 All aluminum and PVC recovery jackets shall be removable and reusable.
- 3.1.20 Dampers, supports, anchors, etc. that are secured directly to cold surfaces must be adequately insulated and vapour sealed to prevent condensation.
- 3.1.21 Cover expansion joints first with a 0.7mm (24 gauge) galvanized metal sleeve and then insulate to provide equivalent thickness to that on adjoining pipe.
- 3.1.22 Ensure insulation is continuous through non-fire rated walls and floors. Terminate insulation neatly on either side of a fire rated barrier. Fill space between pipe and construction with fire retardant sealant. Insulation or recovery jacket shall not penetrate fire-rated construction.
- 3.1.22.1 Outdoor ductwork or insulation shall be installed so as to shed water and not allow standing water.
- 3.1.23 Insulate electrically traced piping and equipment only after pipe tracing has been installed and tested.
- 3.1.24 Repair/replace all insulation damaged during construction with the thickness, quality, and finish of original insulation.
- 3.1.25 Make good and refinish cracks, undulation or any other deficiencies occurring in the insulation or vapour barrier. Priming or painting of insulation will be done under Division 9 – Finishes.

END OF SECTION

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Commissioning
Section No.: 20 08 00
Date: April 9, 2020

INDEX

1	GENERAL
1.1	General
1.2	Commissioning Coordinator
1.3	Commissioning Contractor
1.4	Scope of Work
1.5	Coordination
1.6	Quality Assurance
1.7	Specialist Commissioning Company
2	PRODUCTS
2.1	Instruments
3	EXECUTION
3.1	Schedule and Completion of Installation of Systems
3.2	Record Documentation
3.3	Start-Up
3.4	Troubleshooting
3.5	Operation and Testing
3.6	Demonstration
3.7	Training
3.8	Operating and Maintenance Manuals
3.9	Record Drawings
3.10	Spare Parts
3.11	Commissioning Tests
3.12	Functional Performance Tests
3.13	Site Acceptance Testing for BAS & Controls
3.14	Post Substantial Performance Visits

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Commissioning
Section No.: 20 08 00
Date: April 9, 2020

1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 - General Requirements, shall apply to and govern this section.

1.1.2 This Section of the specification shall be read in conjunction with all other Sections of the Division 21, 22, 23 and 25 Specifications, which include details of specific tests / inspections to be performed on various equipment / systems in addition to those specified in this Section.

1.1.3 The Appendix A to this Section details _____ (Owner's) requirements for training of their Operation and Maintenance (O&M) personnel. The Appendix B to this section details _____ (Owner's) requirements for O&M Manuals. The Contractor shall meet the requirements of these Appendices, which are to be read in conjunction with the Division 21, 22, 23 and 25 Specifications. In the even of a conflict between Division 21, 22, 23 and 25 Specifications and the Appendices, the more stringent shall apply and the Commissioning Coordinator's decision shall be final. The scope and responsibilities of various parties mentioned in the Appendices do not in any way reduce the Contractors' scope or responsibilities as defined in the Division 21, 22, 23 and 25 Specifications.

1.2 COMMISSIONING COORDINATOR

1.2.1 The Owner shall directly employ the services of a Commissioning Coordinator (who will act on behalf of the Owner as the Commissioning Authority) whose responsibilities include:

1.2.1.1 Organize all necessary meetings of the commissioning team, act as chairman at all commissioning meetings and events, prepare agenda for the events, and issue minutes of meeting.

1.2.1.2 Report to the Owner and Construction Manager on the status, integration, and performance of mechanical systems provided as a part of the Works.

1.2.1.3 Review Contractor's Commissioning Plan.

1.2.1.4 Review shop drawings approved by the Consultants for compatibility with commissioning requirements.

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Commissioning
Section No.: 20 08 00
Date: April 9, 2020

- 1.2.1.5 Review Commissioning Schedule, prepared, coordinated, and submitted by the Contractor.
- 1.2.1.6 Ensure that the Contractor successfully conducts all specified and/or necessary tests on systems, equipment, and components during construction and that all tests are recorded by the Contractor for retention as part of Commissioning Documents. Witness or verify tests as appropriate.
- 1.2.1.7 Review and approve all Commissioning Report Forms, record sheets etc. proposed by the Contractor.
- 1.2.1.8 Periodically monitor assembly of material for O&M Manuals by the Contractor to ensure timely completion of manuals.
- 1.2.1.9 Periodically monitor preparation of Record Drawings by the Contractor to ensure timely completion of drawings.
- 1.2.1.10 Monitor progress of commissioning relative to the Commissioning Schedule and periodically report the status, pending problems and/or disputes to the Owner and Construction Manager.
- 1.2.1.11 Witness, check, and verify a percentage of all reported results of commissioning tests and procedures including Testing Adjusting and Balancing (TAB), start-up, verification and Functional Performance Tests (FPT).
- 1.2.1.12 Examine all deviations in test results and in performance, confirm as acceptable or otherwise, and advise Owner and Construction Manager of corrective action required from the Contractor.
- 1.2.1.13 Ensure that all deficiencies discovered during commissioning testing are identified, documented and assessed for their severity and impact on proper system performance and forwarded to the Owner and Construction Manager.
- 1.2.1.14 Review of Final Commissioning Report prepared by the Contractor for completeness including identification of all problems encountered during commissioning and operation phases.
- 1.2.1.15 Review of O&M Manuals prepared by Contractor for completeness and submission to Consultant for approval.
- 1.2.1.16 Review of Record Drawings to ensure that they reflect the approved results of commissioning and submission to Consultant for approval.

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Commissioning
Section No.: 20 08 00
Date: April 9, 2020

1.2.1.17 Assist in the scheduling of training for Owner's O&M personnel.

1.2.1.18 Ensure completion and documentation of commissioning activities not concluded during the commissioning phase due to seasonal operation constraints or testing which requires long term monitoring and analysis.

1.3 COMMISSIONING CONTRACTOR

1.3.1 The Division 21, 22, 23 and 25 Contractors shall be the Commissioning Contractors (Contractors) for all systems and equipment provided under their respective Divisions.

1.3.2 Division 21, 22, 23 and 25 each shall provide a single person to act as a Commissioning Manager for their respective Division. The Commissioning Managers shall be responsible for progressing the activities of each Division trade, and report to the Commissioning Coordinator.

1.3.3 Supply the name, qualifications, and experience of the proposed Commissioning Manager to the Commissioning Coordinator prior to commencement of the work. Selection shall be subject to the review and approval of the Commissioning Coordinator. Supply alternate person(s) when requested by the Commissioning Coordinator.

1.4 SCOPE OF WORK

1.4.1 The Contractor shall provide all labour, materials, tools, equipment, documentation, training, and certification required to commission all mechanical systems provided for the Works including, but not limited to, the following:

1.4.1.1 HVAC terminals including fan coil units, heat pump units, VAV and Fan Powered VAV boxes, and perimeter radiation.

1.4.1.2 Air handling / air distribution systems.

1.4.1.3 Kitchen exhaust, Washroom exhaust, Laundry exhaust, and General exhaust systems.

1.4.1.4 Building Automation System (BAS) and controls.

1.4.1.5 Domestic cold water system.

1.4.1.6 Domestic hot water system.

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Commissioning
Section No.: 20 08 00
Date: April 9, 2020

- 1.4.1.7 Sanitary drainage system.
- 1.4.1.8 Storm water drainage system.
- 1.4.1.9 Sprinkler system.
- 1.4.1.10 Fire standpipe system.
- 1.4.1.11 Natural gas supply system.
- 1.4.1.12 Motor Control Centres.
- 1.4.1.13 Variable Frequency Drives.
- 1.4.1.14 Electric power supplies included under Division 21, 22, 23 and 25's scope.
- 1.4.1.15 Site services.
- 1.4.2 Commissioning work shall include, but not be limited to:
 - 1.4.2.1 Attendance at all Commissioning Meetings.
 - 1.4.2.2 Preparation of Commissioning Plan.
 - 1.4.2.3 Preparation of Commissioning Schedule.
 - 1.4.2.4 Development and completion of Commissioning Report forms and check sheets for each system and piece of equipment.
 - 1.4.2.5 Demonstration to the Owner and Consultant(s) that the equipment/system have been installed per contract documents.
 - 1.4.2.6 Preparation of O&M Manual.
 - 1.4.2.7 Preparation of Record Drawings.
 - 1.4.2.8 Start-up and verification of systems and equipment.
 - 1.4.2.9 Performance testing of equipment.
 - 1.4.2.10 Review and verification of Testing, Adjusting and Balancing work and report.
 - 1.4.2.11 Correction of all deficiencies and performance deviations.
 - 1.4.2.12 Demonstration and training to Owner and Consultant of all systems and equipment provided in this Division.

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Commissioning
Section No.: 20 08 00
Date: April 9, 2020

- 1.4.2.13 Preparation and assembly of Commissioning Documentation.
- 1.4.2.14 Coordination of Division 21, 22, 23 and 25 commissioning activities with all other trades.
- 1.4.2.15 Coordinate with and assist Division 26 – Electrical for Commissioning of Division 26 – Electrical works.
- 1.4.3 Provide qualified personnel and all necessary equipment / measuring / recording instruments etc. to perform commissioning tests (including seasonal testing required after the initial testing) and their verification / witnessing by the Commissioning Coordinator.
- 1.4.4 Provide equipment, materials, and labour as necessary to correct construction and/or equipment deficiencies found during the commissioning process. Repeat the necessary tests to the satisfaction of Consultants and the Commissioning Coordinator.
- 1.4.5 Perform detailed testing on all installed equipment and systems to ensure that operation and performance conform to Contract Documents. All tests shall be offered for witnessing by the Commissioning Coordinator and Consultant. Apart from tests and inspections specified elsewhere in this division, perform the following tests as part of the commissioning process:
 - 1.4.5.1 Verification tests including a full range of checks and tests to determine that all components, equipment, systems, and interfaces between systems are installed and operate in accordance with Contract Documents. This includes all operating modes, interlocks, control responses, and specific responses to abnormal or emergency conditions.
 - 1.4.5.2 Functional Performance Tests (FPT) to determine if the Mechanical systems provide the required services in accordance with the finalized design intent.
- 1.4.6 Comprehensive training of Owner's O&M personnel shall be performed by the Contractor, and where appropriate, by other sub-contractors, and vendors prior to turnover of building to the Owner. The training shall include on-site familiarization, classroom instruction and with hands-on instruction on the installed equipment and systems. The Contractor shall provide all necessary training material and documents.
- 1.4.7 Provide attendance at the site at minimum once each month from

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Commissioning
Section No.: 20 08 00
Date: April 9, 2020

Substantial Completion up to one (1) month after the first year warranty review, at a date and time to be arranged by the Consultant or Commissioning Coordinator. Follow up and rectify deficiencies and other issues raised during this site review.

- 1.4.8 Attend all commissioning meetings organized by the Commissioning Coordinator or Consultant. The meetings will commence no later than two (2) months after award of contract, will be held (as a minimum) once a month during the first half of the construction period, and thereafter, the frequency will increase as deemed necessary by the Commissioning Coordinator or Consultant to accomplish timely commissioning.
- 1.4.9 Ensure and pay for attendance at all commissioning meetings by the sub-contractors (including, but not limited to, the sheet metal, piping, sprinkler, BAS and controls, water treatment, TAB sub-contractors) and major equipment suppliers as required by the Commissioning Coordinator or Consultant.
- 1.4.10 Prepare a detailed Commissioning Schedule for commissioning of all mechanical systems and equipment in coordination with the General Contractor's / Construction Manager's schedule and to the approval of Commissioning Contractor. Update the schedule as appropriate through the construction period.
- 1.4.11 Prepare all documents related to commissioning of the mechanical systems. Documentation required as part of the Commissioning process shall include, but not limited to:
 - 1.4.11.1 Commissioning Plan.
 - 1.4.11.2 Commissioning Schedule.
 - 1.4.11.3 Design intent narrative, systems descriptions, Basis of Design including the design criteria, setpoints, design conditions, etc. These documents shall be based, where appropriate, on Division 21, 22, 23 and 25 Specifications, Drawings, approved shop drawings, and input from the Consultant.
 - 1.4.11.4 Completed commissioning check sheets.
 - 1.4.11.5 Independent test reports, including Testing, Adjusting and Balancing (TAB), equipment manufacturers' certification letters, reports from Authorities having jurisdiction (AHJ), etc.
 - 1.4.11.6 Inspection and performance test reports.

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Commissioning
Section No.: 20 08 00
Date: April 9, 2020

- 1.4.11.7 Operation and Maintenance Manuals.
- 1.4.11.8 User and Operator Training Manuals.
- 1.4.11.9 Tender drawing and specifications.
- 1.4.11.10 Change orders.
- 1.4.11.11 Record drawings.
- 1.4.11.12 Permits and licenses.
- 1.4.11.13 Warranties.
- 1.4.11.14 Post occupancy optimization reports.
- 1.4.11.15 Other documents as required.
- 1.4.12 The Commissioning Coordinator may, at his discretion, advise in the commissioning process. Meet all requirements of the Commissioning Coordinator and provide cooperation.
- 1.5 COORDINATION
- 1.5.1 Coordinate the work of this Section with all other Divisions to ensure complete and operational mechanical systems at completion of this work.
- 1.5.2 Review the design intent of the project and the intended operation of systems with the Commissioning Coordinator and Consultant before proceeding with commissioning.
- 1.6 QUALITY ASSURANCE
- 1.6.1 The commissioning process shall meet the requirements of CAN/CSA Z31 series, the Code of Practice for Commissioning Mechanical Systems in Buildings and ASHRAE Guideline 1.1 - 2007 The HVAC Commissioning Process except as specifically modified by this specification.
- 1.7 SPECIALIST COMMISSIONING COMPANY
- 1.7.1 Division 21, 22, 23 and 25 may elect to source start-up and handover by a specialist commissioning company. Supply to the Commissioning Coordinator, the following details regarding the proposed firm:

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Commissioning
Section No.: 20 08 00
Date: April 9, 2020

- 1.7.1.1 Principle representative and qualifications.
- 1.7.1.2 Proposed personnel and relevant project experience.
- 1.7.1.3 Previous similar assignments and references.
- 1.7.1.4 Scope of work to be undertaken.
- 1.7.1.5 Company resources and equipment.
- 1.7.2 Use of a commissioning specialist shall not relieve Division 21, 22, 23 and 25 Contractors of the obligation to name one of their own employees as the person responsible for progressing commissioning, i.e. the Commissioning Manager.

2 **PRODUCTS**

2.1 INSTRUMENTS

- 2.1.1 Prior to commencing commissioning activities on site, the contractor shall submit list of all measuring / recording instruments to be used on the project, along with calibration certificates, for Commissioning Coordinator's approval.

3 **EXECUTION**

3.1 SCHEDULE AND COMPLETION OF INSTALLATION OF SYSTEMS

- 3.1.1 Submit to the Commissioning Coordinator, within 90 days of award of contract, a detailed and comprehensive installation completion / start-up / testing schedule, identifying all trades and suppliers to be involved. Coordinate the schedule with General Contractor's / Construction Manager's overall Construction schedule. Update the schedule and resubmit for review, periodically as required, and on a biweekly basis during the course of commissioning. If found to be unacceptable, revise the schedule and the construction forces to suit the reviewed schedule. This schedule shall include, but is not limited to the following items:
 - 3.1.1.1 Installation and testing of pipe systems.
 - 3.1.1.2 Installation, leak testing, and cleaning of duct systems.
 - 3.1.1.3 Chemical clean out and treatment of pipe systems, including disinfection of domestic water piping.

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Commissioning
Section No.: 20 08 00
Date: April 9, 2020

- 3.1.1.4 Control system wiring (by Controls Contractor).
- 3.1.1.5 Electrical works under Scope of Division 21, 22, 23 and 25 Contractors.
- 3.1.1.6 Air and water balancing (by Balancing Contractor).
- 3.1.1.7 Electrical service connections (by Electrical Contractor).
- 3.1.1.8 Equipment suppliers' prestart checkout and certification of the equipment installations, including controls.
- 3.1.1.9 Start up of various pieces of equipment and systems.
- 3.1.1.10 Operational testing of system components.
- 3.1.1.11 Performance testing of equipment and systems.
- 3.1.1.12 Acceptance testing of equipment installations and system including fire and sprinkler systems, by authorities having jurisdiction and Owner's insurance company.
- 3.1.1.13 Troubleshooting.
- 3.1.1.14 Calibration of controls and point checkout (by Division 25 Contractor).
- 3.1.1.15 Control software setup and checkout including seasonal and response checkout or operating sequences, PID optimization (By Division 25 Contractor).
- 3.1.1.16 Emergency system checkout.
- 3.1.1.17 Fire alarm and control system interfacing (by Division 25 Contractor & Division 26 - Electrical).
- 3.1.1.18 Submittal of completed equipment and system check sheets.
- 3.1.1.19 Demonstration of systems and equipment.
- 3.1.1.20 Record Drawing preparation and submittal.
- 3.1.1.21 O&M manual preparation and submittal.
- 3.1.1.22 O&M personnel training program.
- 3.1.1.23 Stair pressurization testing.

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Commissioning
Section No.: 20 08 00
Date: April 9, 2020

3.1.1.24 Verification / witnessing of commissioning tests and TAB by the Commissioning Coordinator and/or Consultant.

3.2 RECORD DOCUMENTATION

3.2.1 Prepare record documentation for each equipment installation covering:

3.2.1.1 Equipment identification and supplier.

3.2.1.2 Shop Drawing submittal, review, production release, and delivery dates.

3.2.1.3 Dates for completion of all work required preparing for equipment installation.

3.2.1.4 Dates for equipment installation, supplier prestart checkout, and system availability for start-up.

3.2.1.5 Dates for equipment start-up, performance testing, proposal for temporary use, acceptance testing, demonstration, turnover and warranty start / finish.

3.2.2 Submit proposed record sheets and procedures to Commissioning Coordinator for review, when requested.

3.2.3 List all specialist personnel and equipment required for the tests, and ensure that these are available by the test dates.

3.2.4 Provide documentation of the commissioning process and include in maintenance manuals. These are to include check sheets, equipment data sheets, start-up certificates from suppliers involved in start-up, and documentation concerning demonstration to the Owner's O&M Personnel. Include all record and result sheets from commissioning tests.

3.2.5 Maintain a log of key operating parameters, problems encountered, solutions employed and verification of effectiveness of solutions. Include log in maintenance manuals.

3.2.6 Submit templates for all documentation including record sheets, check sheets, commissioning reports etc to Commissioning Coordinator for approval. Meet Commissioning Coordinator's requirements for level of reporting.

3.3 START-UP

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Commissioning
Section No.: 20 08 00
Date: April 9, 2020

- 3.3.1 Coordinate and supervise the start-up of the various pieces of equipment and systems. Utilize the start-up services of the manufacturer's representative. Ensure that the equipment is operating in a satisfactory manner. Check the following items:
 - 3.3.1.1 Direction of rotation.
 - 3.3.1.2 Grease and lubricants.
 - 3.3.1.3 Noise, if deemed to be a problem.
 - 3.3.1.4 Seals.
 - 3.3.1.5 Alignment of pump and fan drives by a millwright.
 - 3.3.1.6 Piping connections and safeties.
 - 3.3.1.7 Electrical amp draw, starting inrush current and trip / heater settings.
- 3.3.2 Meet Section 20 00 00 - General Requirements criteria for Temporary Services, Trial Use, and Early Occupancy.
- 3.4 TROUBLESHOOTING
 - 3.4.1 Resolve inter-division coordination problems.
 - 3.4.2 Where problems become apparent during the commissioning process, identify and resolve these problems. The basic functions in troubleshooting shall include:
 - 3.4.2.1 What – identification and definition of the problem.
 - 3.4.2.2 Why – determination and evaluation of the causes.
 - 3.4.2.3 When – determine the time available to resolve the problem.
 - 3.4.2.4 Involve the Consultant in the review of the problem and proposed resolution, and keep Commissioning Coordinator informed.
 - 3.4.2.5 Coordinate remedial action with the appropriate parties.
 - 3.4.2.6 Evaluate the effectiveness of the remedial action.
 - 3.4.2.7 Record the problem, cause, remedial action, and result.
- 3.5 OPERATION AND TESTING

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Commissioning
Section No.: 20 08 00
Date: April 9, 2020

- 3.5.1 Meet Section 20 00 00 – General Requirements and 20 05 93 – Testing, Balancing and Adjusting requirements for inspection, testing and certificates.
- 3.5.2 Test the operation of the individual components and systems. Go through each step of the sequence of operation and verify that each component operates correctly. Direct and ensure that all trades involved make the required changes and adjustments to effect the proper operation of all components and systems. Meet commissioning test requirements.
- 3.5.3 Document operation and testing.
- 3.5.4 Carry out operational tests for the current season and simulate operation of summer, winter, and intermediate seasons.
- 3.6 DEMONSTRATION
- 3.6.1 Demonstrate to the Owner the proper operation of all equipment and systems supplied under this Division. Demonstrations shall occur only after the operation and testing has been successfully completed. Ensure that Trade Contractor and equipment suppliers participate in the demonstration as required.
- 3.6.2 Meet Section 20 00 00 – General Requirements criteria for instruction to Owners and requirements of Appendix A to this section.
- 3.7 TRAINING
- 3.7.1 Organize and provide comprehensive training to the _____ (Owner's) O&M Personnel on all mechanical equipment, systems and components provided for the Works. Training shall be carried out by the Contractor (and vendors / suppliers where appropriate) to meet the requirements of Appendix A and this Specification.
- 3.7.2 Secure and pay for the services of all manufacturer's of major equipment / systems for providing training on their respective systems. Such equipment / systems include:
 - 3.7.2.1 Domestic water boilers
 - 3.7.2.2 BAS and controls.
 - 3.7.2.3 Air handling and make-up air units

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Commissioning
Section No.: 20 08 00
Date: April 9, 2020

- 3.7.2.4 Fire pump.
- 3.7.3 The training shall include:
 - 3.7.3.1 Familiarization sessions organized during the construction and commissioning stages as necessary. The intent of these sessions is to fully familiarize the O&M personnel with the installation.
 - 3.7.3.2 Hands-on training shall be provided on all systems, components and equipment and all commissioning procedures explained. This training shall be provided during the commissioning stage.
 - 3.7.3.3 Classroom sessions during the commissioning stage to instruct the O&M personnel in the use of O&M Manuals and other commissioning documentation.
 - 3.7.3.4 All classroom training, field training and demonstrations shall be video recorded for future reference. All recordings shall be delivered to the Commissioning Coordinator on DVD format for review with seven (7) days of the session. All recordings shall be formatted to be played on a standard DVD player and include electronic copies of all classroom materials used throughout the training.
- 3.7.4 The Contractor shall prepare all necessary system descriptions, sequence of operation documents, schematic diagrams, control schematics, catalogue cuts, wiring diagrams and similar documents as required for imparting training. As far as practical, the documents should be same as those intended for use in O&M manuals. The Contractor shall compile all training documents and make them available to O&M personnel prior to training and for retention throughout training period.
- 3.7.5 Contractor shall pay for all audio / visual training aids (such as video presentations, slides, projectors and similar equipment) and space for imparting training.
- 3.7.6 The training shall be imparted during normal working hours and the duration shall be as necessary to meet the _____ (Owner's) requirements, but in any case not less than 15 hours for familiarization and 35 hours for classroom and hands-on sessions.
- 3.7.7 Training for Mechanical Services shall be imparted to up to ten (10) O&M Personnel.
- 3.8 OPERATING AND MAINTENANCE MANUALS

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Commissioning
Section No.: 20 08 00
Date: April 9, 2020

3.8.1 Meet requirements of Section 20 00 00 – General Requirements, of this Section, and of Appendix B. Documents such as system description, sequence of operation (including start-up and shut-down procedures) shall be compiled by the Contractor from the specification, drawings and approved shop drawings and included in the manuals after Consultant's approval.

3.9 RECORD DRAWINGS

3.9.1 Meet requirements of Section 20 00 00 – General Requirements and of this Section.

3.10 SPARE PARTS

3.10.1 Provide a list of spare parts, special tools, lubricants, etc. for each item of equipment, which has been purchased as part of the Contract.

3.10.2 Provide a listing of recommended spare parts for all equipment installed under Division 21, 22, 23 and 25, to cover a period from Substantial Completion to Warranty end.

3.10.3 Provide at minimum, the following information for recommended spare parts:

3.10.3.1 Manufacturer's name, address, phone and fax numbers.

3.10.3.2 Manufacturer's part name, part number, unit price, lead time, shelf life.

3.10.3.3 Quantity recommended for one (1) year.

3.10.3.4 Alternative suppliers of compatible parts, including local supplier name, address, phone and fax numbers.

3.10.4 Submit preliminary list of spare parts and tools to Owner to least 30 days prior to intended system handover to Owner. The Owner reserves the right to add to, reduce, or omit entirely, the recommendations contained on these lists.

3.10.5 Meet requirements of Appendix B.

3.11 COMMISSIONING TESTS

3.11.1 Verify readings, calibration and setup of sensors and equipment, including, but not limited to, the following:

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Commissioning
Section No.: 20 08 00
Date: April 9, 2020

- 3.11.1.1 Temperature sensors.
- 3.11.1.2 Freeze protection devices.
- 3.11.1.3 Flow switches.
- 3.11.1.4 Status switches.
- 3.11.1.5 Temperature and pressure gauges and gauge connection utilization.
- 3.11.1.6 Control damper positioning, including tightness when closed and full open / balance position.
- 3.11.1.7 Alarm contacts.
- 3.11.1.8 Pressure sensors.
- 3.11.1.9 Refrigerant sensors.
- 3.11.2 Verify correct sensors are reporting accurately to the distributed field panels and operator workstation.
 - 3.11.2.1 Full checkout by manufacturer's start-up representative.
 - 3.11.2.2 Start / stop from local MCC and from BAS.
 - 3.11.2.3 Safety interlocks.
- 3.11.3 Operate each air handling unit. Verify operation with respect to sequence of operation. As a minimum, verify the following:
 - 3.11.3.1 Start / stop from local panel and BAS terminal.
 - 3.11.3.2 Correct open / close and modulation procedures with valves and dampers.
 - 3.11.3.3 Stable operation of controls under normal conditions and with change
- 3.11.4 Verify pipe cleaning and chemical treatment condition for all systems.
- 3.11.5 Verify duct cleaning, air and water balancing and air pattern adjustments.
- 3.11.6 Verify access to each fire damper.

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Commissioning
Section No.: 20 08 00
Date: April 9, 2020

- 3.11.7 Verify that all cooling coil drain pans and condensate piping operate.
- 3.11.8 Verify backflow preventer operation.
- 3.11.9 Verify operation of fire protection system including flow switches and supervisory switches.
- 3.11.10 Demonstrate access to all valves, equipment, and components for servicing.
- 3.11.11 Coordinate with Division 26 - Electrical, a power failure test with emergency generator start-up. Verify the following (as a minimum):
 - 3.11.11.1 Miscellaneous equipment on emergency power, with Division 26 - Electrical.
 - 3.11.11.2 Stability of control equipment with start-up power surge.
 - 3.11.11.3 Controls systems recovery.
 - 3.11.11.4 Generator cooling air intake, exhaust, and re-circulation system.
 - 3.11.11.5 Division 23 – HVAC to refill fuel oil system following the completion of tests.
- 3.11.12 Verify operation of domestic cold water system including full checkout by booster pump manufacturer's start-up representative. Verify flow at sanitary fixtures.
- 3.11.13 Verify operation of domestic hot water system including temperature control stability and flow at sanitary fixtures.
- 3.11.14 Verify the operation of all other equipment provided under Division 21, 22, 23 and 25.
- 3.11.15 Verify that interfacing to the work of other Divisions results in complete and operational systems.
- 3.11.16 Test all individual equipment and system responses to power fluctuations and interruptions.
- 3.11.17 Test the ability of the BAS system to perform a power fail restart of the systems effectively and in coordination with the electrical system to prevent electrical system overloading. (This depends on the electrical system response and degree of BAS monitoring.)

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Commissioning
Section No.: 20 08 00
Date: April 9, 2020

3.11.18 Test redundant systems to ensure they provide the required back-up in the event of a primary system failure.

3.11.19 Test the system response to the loss of communication between the various levels of control system architecture.

3.11.20 Test the system response to the loss of cooling.

3.11.21 Test the system response to the loss of heating.

3.12 FUNCTIONAL PERFORMANCE TESTS

3.12.1 Carry out, record, document and offer for witnessing all measurements necessary to determine the capacity of all heating / cooling equipment and heat exchangers provided for the works including, but not limited to, the following:

3.12.1.1 Boilers.

3.12.1.2 All heat exchangers.

3.12.2 Contractor shall include for all costs related with simulating the internal loads if necessary and/or for deferring the tests to the appropriate season. However all tests must be completed satisfactorily within twelve (12) months of substantial completion.

3.12.3 Measure and record the temperature in all occupied spaces of the Works. Also record the setpoint temperatures. Measurements shall be carried out on two occasions within the first year of operation at times to be determined by the Commissioning Coordinator; once during summer and once during winter.

3.12.4 Rectify any deficiencies noted in the above tests and include comprehensive report in the commissioning documents.

3.12.5 Contractor shall employ the services of the TAB contractor to carry out the FPT's. TAB contractors scope as defined in Section 20 05 93 - Testing, Balancing and Adjusting shall be extended to include these works.

3.12.6 Ensure all other performance tests specified elsewhere in the specifications (including, but not limited to, sound levels and vibrations) are carried out at this stage, offered for witnessing and all test sheets are included in the commissioning documents.

3.13 SITE ACCEPTANCE TESTING FOR BAS & CONTROLS

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Commissioning
Section No.: 20 08 00
Date: April 9, 2020

- 3.13.1 In addition to the tests / demolition specified under Division 25 and elsewhere in this Section, the following requirements apply for BAS and Control system:
 - 3.13.1.1 Perform a complete demonstration of the BAS real-time responsibilities of surveillance and command prior to online operation.
 - 3.13.1.2 Advise the Commissioning Coordinator, Consultant, and Owner, in writing, at least two (2) weeks in advance of readiness to perform tests.
 - 3.13.1.3 Note deficiencies and correct starting and continuing tests. Perform calibration and operational checks prior to the commencement of final acceptance testing for all relevant system parts.
 - 3.13.1.4 Perform final acceptance testing at the following defined levels:
 - 3.13.1.4.1 Per point basis.
 - 3.13.1.4.2 Per system basis.
 - 3.13.1.4.3 Software functions and packages basis.
 - 3.13.1.4.4 Per building basis.
 - 3.13.1.4.5 Total BAS basis.
 - 3.13.1.5 Make available on site for the duration of these tests, all installation, engineering, software, system and personnel, required to enable test completion.
 - 3.13.1.6 Demonstrate the specified performance of the BAS software and hardware, at all levels from individual end devices through to total system operation and the proper operation / undertaking of all other items of work performed under this Contract.
 - 3.13.1.7 Specifically orient acceptance test procedures to demonstrate the satisfactory operation of aspects of the operator interface terminals.
 - 3.13.1.8 Perform and complete and detailed calibration and operational check for each individual BAS point and control function contained within the supplied system. Check to ensure that all equipment, software, network elements, modules and circuits provided are functioning to meet the Specification and record on long sheets.

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Commissioning
Section No.: 20 08 00
Date: April 9, 2020

- 3.13.1.9 Randomly test the response to the following sensor failures:
 - 3.13.1.9.1 Space temperature.
 - 3.13.1.9.2 Fluid temperature (air and water).
 - 3.13.1.9.3 Flow sensor (air and water).
 - 3.13.1.9.4 Pressure sensor (air and water).
- 3.13.1.10 Repeat acceptance testing until acceptance performance has been established.
- 3.14 POST SUBSTANTIAL PERFORMANCE VISITS
 - 3.14.1 Visit the site and the Owner's representative with the Consultant each month after Substantial Completion up to one (1) month after the first year warranty review.
 - 3.14.2 Review the operation of the system.
 - 3.14.3 Correct any operating problems, if problem is related to warranty issues, and follow up on deficiencies and other issues raised.
 - 3.14.4 Prepare a report for the Consultant and Construction Manager for inclusion in the Operating Manuals of the problems and issues that have arisen and the corrective action(s) recommended and implement.

END OF SECTION

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Variable Frequency Drives
Section No.: 20 09 49
Date: April 9, 2020

INDEX

1 GENERAL

- 1.1 General
- 1.2 Scope of Work
- 1.3 Submittals
- 1.4 Electrical Equipment and Work

2 PRODUCTS

- 2.1 Design
- 2.2 Protection
- 2.3 Environment
- 2.4 Performance
- 2.5 Operator Interface
- 2.6 Bypass (Optional)
- 2.7 Communication and Control
- 2.8 System Operation
- 2.9 Warranty

3 EXECUTION

- 3.1 Installation

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Variable Frequency Drives
Section No.: 20 09 49
Date: April 9, 2020

1 **GENERAL**

1.1 GENERAL

1.1.1 Section 20 00 00 – General Requirements, shall apply to and govern this Section.

1.2 SCOPE OF WORK

1.2.1 Provide all labour, materials, tools equipment, training commissioning and certification required to complete the work as shown on the Drawings and specified in this Section, including:

1.2.1.1 Variable frequency drives (VFDs).

1.2.1.2 Line filters

1.2.2 Power wiring from power supply to each VFD shall be by Division 26 - Electrical. Power wiring from the VFDs to the motors shall be provided under this Division, by the Subcontractor responsible for the provision of the respective motor.

1.3 SUBMITTALS

1.3.1 Provide shop drawings for VFDs, including performance data, dimensions, shipping section dimensions, weight, control schematics, external connection diagram showing function and identification of all terminals requiring field connections.

1.3.2 Provide operating and maintenance information and commissioning report prepared by authorized manufacturer's representative.

1.3.3 Manufacturer shall submit a computerized harmonics analysis of the facility system based on the most recent single line diagram. Analysis shall illustrate the effect of VFDs on system harmonics.

1.4 ELECTRICAL EQUIPMENT AND WORK

1.4.1 Read together with Division 26 - Electrical and adhere to its requirements. Supply and install all electrical apparatus, which is required and is not covered by Division 26 - Electrical.

1.4.2 All VFDs shall be cUL or CSA/UL approved.

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Variable Frequency Drives
Section No.: 20 09 49
Date: April 9, 2020

2 PRODUCTS

2.1 DESIGN

- 2.1.1 Manufacturer shall provide passive matrix-type line filters at the input of each VFD to reduce the total harmonic current level (THID) to less than 5% at the VFD input where the analysis has shown that the incremental effect of the addition of the VFDs would cause the THID to exceed the allowable values per IEEE 519-2014.
- 2.1.2 The VFD shall convert incoming fixed frequency three-phase AC power into an adjustable frequency and voltage for controlling the speed of three-phase AC induction motors. The motor current shall closely approximate a sine wave.
- 2.1.3 The VFD shall be UL listed for a short circuit current rating (SCCR) of 100 kA and labeled with this rating.
- 2.1.4 The VFD shall have a dual 5% impedance DC link reactor on the positive and negative rails of the DC bus to minimize power line harmonics and protect the VFD from power line transients. The chokes shall be non-saturating. Swinging chokes that do not provide full harmonic filtering throughout the entire load range are not acceptable. VFDs that do not include 5% DC link impedance shall include 5% AC line reactors in the options enclosure.
- 2.1.5 The VFD must be able to produce full torque at low speed to operate direct drive fans.
- 2.1.6 The VFD must be capable of connection and disconnection to motor while the VFD is under load. This switching shall be accomplished without interlocks or damage to the VFD.
- 2.1.7 All VFDs shall contain integral electromagnetic interference (EMI) filters to attenuate radio frequency interference conducted to the AC power line.
- 2.1.8 Provide sine wave output filters on all 460 Volt and 575 Volt VFDs to limit the dV/dt to 1,000 Volts/0.5 micro seconds at the motor terminals where the developed wiring length between the VFD and the motor exceeds 30m (100 ft).
- 2.1.9 Provide incoming, horsepower rated, disconnect switch with an operating mechanism, door interlocked and padlockable in the open position.

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Variable Frequency Drives
Section No.: 20 09 49
Date: April 9, 2020

2.1.10 AC line voltage variation, -10 to +10% of nominal with full output

2.1.11 All VFDs shall be plenum rated.

2.2 PROTECTION

2.2.1 Provide the following VFD protection features as a minimum:

2.2.1.1 Line over and under voltage protection.

2.2.1.2 Phase loss and unbalance protection.

2.2.1.3 Short circuit protection for line to line and line to ground faults.

2.2.1.4 Electronic instantaneous overcurrent protection.

2.2.1.5 Current sensors on all three output phases to accurately measure motor current, protect the VFD from output short circuits, output ground faults, and act as a motor overload.

2.2.1.6 Motor preheat feature to keep the motor warm and prevent condensation build up in the motor when it is stopped in a damp environment by providing the motor stator with a controlled level of current.

2.2.1.7 Internal over temperature protection.

2.2.1.8 Electronic motor stall protection to trip the VFD off should a motor overload or stall occur.

2.2.1.9 VFD shall catch a rotating motor operating forward or reverse up to full speed without VFD fault or component damage.

2.2.1.10 The VFD shall store in memory the last 10 alarms. A description of the alarm, and the date and time of the alarm shall be recorded. The VFD shall include graphing capability for the last 2 alarms to provide additional diagnostic analysis.

2.2.1.11 When used with a pumping system, the VFD shall be able to detect no-flow situations, dry pump conditions, and operation off the end of the pump curve. It shall be programmable to take appropriate protective action when one of the above situations is detected.

2.2.1.12 The VFD shall be able to provide full rated output current continuously, 110% of rated current for 60 seconds and 135% of rated torque for up to 0.5 second while starting.

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Variable Frequency Drives
Section No.: 20 09 49
Date: April 9, 2020

2.3 ENVIRONMENT

- 2.3.1 The VFD shall have the following minimum environmental tolerances.
- 2.3.1.1 Ambient temperature range of 0°C to 45°C (32°F to 113°F). Units located in non-heated areas shall be provided with thermostatically controlled heater weather enclosure.
- 2.3.1.2 Maximum humidity of 95% non-condensing.
- 2.3.1.3 Maximum altitude of 1,000m (3,300ft) for rated output.

2.4 PERFORMANCE

- 2.4.1 The VFD shall have the following performance features as a minimum:
- 2.4.1.1 Minimum line side displacement power factor of 0.96 at all speeds and loads.
- 2.4.1.2 Adjustable minimum and maximum motor frequency of 0 to 120 Hz.
- 2.4.1.3 Separately adjustable acceleration and deceleration ramps from 0.1 to 3,600 seconds with damping and smoothing parameters for (0% to 100% speed).
- 2.4.1.4 DC Injection Braking.
- 2.4.1.5 Automatic restart after an inverter fault trip. The VFD shall attempt to restart automatically 5 times with Lock-Out after the fifth attempt if a restart has not occurred.
- 2.4.1.6 The VFD shall restart the motor at the speed at which it is rotating and then re-accelerate to the speed called for by the speed reference signal.
- 2.4.1.7 Capable of running without a motor connected for setup and testing.
- 2.4.1.8 Capable of accepting the opening of a remote motor disconnect while running without causing damage to the VFD.
- 2.4.1.9 Auto restart after power outage.
- 2.4.1.10 Skip frequency reject point to prevent the fan/pump from operating

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Variable Frequency Drives
Section No.: 20 09 49
Date: April 9, 2020

at a resonant speed. Adjustable centre frequency with a band width of 0 - 10 Hz.

2.4.1.11 Automatic/manual signal follower for 4-20 mA, 0-20mA, 0-10 VDC or 2-10 VDC reference.

2.5 OPERATOR INTERFACE

2.5.1 Provide a door mounted keypad with an Alpha-numeric high resolution display to allow the operations personnel to set up and monitor the VFD parameters, observe output speed, load or other programmable values and monitor status and fault information, complete with tactile keys and backlit display.

2.5.2 The VFD shall be programmable to provide a digital output signal to indicate whether the VFD is in Hand or Auto mode. This is to alert the Building Automation System whether the VFD is being controlled locally or by the Building Automation System

2.5.3 Provide maintenance monitoring to display the time since starting, total elapsed run time and total power consumed in kWh. Also provide maintenance target alarm to alert the operator with a displayed message.

2.5.4 Provide the following control functions on the door mounted keypad:

2.5.4.1 Run (Hand and Auto Mode)

2.5.4.2 Stop (Hand and Auto Mode)

2.5.4.3 Parameterization button (to toggle between parameters)

2.5.5 Provide a selectable display to observe the following parameters:

2.5.5.1 Frequency

2.5.5.2 Motor Current

2.5.5.3 Motor Voltage

2.5.5.4 VFD Output Power

2.5.5.5 VFD Output Energy

2.5.5.6 VFD Temperature

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Variable Frequency Drives
Section No.: 20 09 49
Date: April 9, 2020

- 2.5.6 Controller shall accept up to three feedback signals. It shall be programmable to compare the feedback signals to a common setpoint or to individual setpoints and to automatically select either the maximum or the feedback signal as the controlling signal. It shall also be possible to calculate the controlling feedback signal as the average of all feedback signals or the difference between a pair of feedback signals.
- 2.5.7 The VFD shall have three additional PID controllers which can be used to control damper and valve positioners in the system and to provide setpoint reset. Floating point control interface shall be provided to increase/decrease speed in response to contact closures.
- 2.5.8 A run permissive circuit shall be provided to accept a “system ready” signal to ensure that the VFD does not start until dampers or other auxiliary equipment are in the proper state for VFD operation. The run permissive circuit shall also be capable of initiating an output “run request” signal to indicate to the external equipment that the VFD has received a request to run.
- 2.5.9 VFD shall be programmable to display feedback signals in appropriate units, such as inches of water column (in-wg), pressure per square inch (psi) or temperature (°F).
- 2.5.10 VFD shall be programmable to sense the loss of load. The VFD shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communications bus. To ensure against nuisance indications, this feature must be based on motor torque, not current, and must include a proof timer to keep brief periods of no load from falsely triggering this indication.
- 2.6 BYPASS (OPTIONAL)
- 2.6.1 Provide components and circuitry necessary to safely bypass the motor from the VFD to line, or from the line to the VFD at zero speed.
- 2.6.2 Provide a door interlocked input circuit breaker to ensure positive shutdown of all input power to both the VFD and bypass. Motor protection to be provided in both modes of operation by a common thermal motor overload relay.
- 2.6.3 Provide mechanically interlocked contactors on the output of the VFD and in the bypass circuit.

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Variable Frequency Drives
Section No.: 20 09 49
Date: April 9, 2020

- 2.6.4 Protective features:
 - 2.6.4.1 Main input disconnect shall be provided that removes power from both the bypass and VFD.
 - 2.6.4.2 Main input motor rated fuses that protect the entire package.
 - 2.6.4.3 VFD only fast acting input fuses shall be provided. Packages that include only main input motor rated fusing or circuit breaker are not acceptable.
 - 2.6.4.4 Overload protection shall be supplied in bypass mode.
 - 2.6.4.5 This overload shall supply minimum class 20 protection as well as wide adjustable current setting for complete motor protection when operating on line power. Those overloads that are not class 20 or current selectable will not be acceptable.
 - 2.6.4.6 Overload protection shall include phase loss and phase imbalance protection.
 - 2.6.4.7 For 600V units 75 HP and below and 208V/230V units 40 HP and below, low voltage contactor operation shall be maintained down to 70% of the unit's nominally rated voltage, to ensure VFD operation.
 - 2.6.4.8 For 600V units 75 HP and below and 208V/230V units 40 HP and below, the VFD shall be able to operate the motor at a reduced load with the loss of any one of the three phases of power. Contactors shall remain closed regardless of which phase is lost to ensure VFD operation.
- 2.7 COMMUNICATION AND CONTROL
 - 2.7.1 Four dedicated, programmable digital inputs shall be provided for interfacing with the systems control and safety interlock circuitry.
 - 2.7.2 Two terminals shall be programmable to act as either as digital outputs or additional digital inputs.
 - 2.7.3 Two programmable relay outputs, Form C 240 V AC, 2 A, shall be provided for remote indication of VFD status.
 - 2.7.4 Two programmable analog inputs shall be provided that can be either direct-or-reverse acting.
 - 2.7.4.1 Each shall be independently selectable to be used with either an analog voltage or current signal.

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Variable Frequency Drives
Section No.: 20 09 49
Date: April 9, 2020

- 2.7.4.2 The maximum and minimum range of each shall be able to be independently scalable from 0 to 10 V dc and 0 to 20 mA.
- 2.7.4.3 A programmable low-pass filter for either or both of the analog inputs must be included to compensate for noise.
- 2.7.4.4 The VFD shall provide front panel meter displays programmable to show the value of each analog input signal for system set-up and troubleshooting,
- 2.7.5 One programmable analog current output (0 to 20 mA) shall be provided for indication of VFD status. This output shall be programmable to show the reference or feedback signal supplied to the VFD and for VFD output frequency, current and power. It shall be possible to scale the minimum and maximum values of this output.
- 2.7.6 It shall be possible through serial bus communications to read the status of all analog and digital inputs of the VFD.
- 2.7.7 Standard programmable firefighter's override mode allows a digital input to control the VFD and override all other local or remote commands. It shall be possible to program the VFD so that it will ignore most normal VFD safety circuits including motor overload. The VFD shall display FIREMODE whenever in firefighter's override mode. Fire-mode shall allow selection of forward or reverse operation and the selection of a speed source or preset speed, as required to accommodate local fire codes, standards and conditions.
- 2.7.8 The VFD shall include a standard EIA-485 communications port and capabilities to be connected to the following serial communication protocols at no additional cost and without a need to install any additional hardware or software in the VFD:
 - 2.7.8.1 Johnson Controls Metasys N2
 - 2.7.8.2 Modbus RTU
 - 2.7.8.3 Siemens FLN
 - 2.7.8.4 BACnet MS/TP
- 2.7.9 Option boards for the following protocols shall be available:
 - 2.7.9.1 BACnet

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Variable Frequency Drives
Section No.: 20 09 49
Date: April 9, 2020

- 2.7.9.2 Ethernet
- 2.7.9.3 DeviceNet
- 2.7.9.4 Profibus DP V1
- 2.7.9.5 Profinet SRT
- 2.7.9.6 Modbus TCP
- 2.7.9.7 LonWorks Free Topology (FTP) certified to LonMark standard 3.3
- 2.7.10 VFD shall have standard USB port for direct connection of Personal Computer (PC) to the VFD. The manufacturer shall provide no-charge PC software to allow complete setup and access of the VFD and logs of VFD operation through the USB port. It shall be possible to communicate to the VFD through this USB port without interrupting VFD communications to the building management system.

- 2.7.11 The VFD shall have provisions for an optional 24 V DC back-up power interface to power the VFD's control card. This is to allow the VFD to continue to communicate to the building automation system even if power to the VFD is lost.

2.8 SYSTEM OPERATION

- 2.8.1 If "Manual" mode is selected the VFD/motor shall start when the run key is depressed. The speed shall be controlled by depressing the Accelerate or Decelerate keys on the keypad or by the direct speed set mode.
- 2.8.2 If "Auto" mode is selected the VFD/motor shall start when a contact closure run command is received from the BAS. The speed shall be controlled by a speed reference signal from the BAS.
- 2.8.3 In the event of a power outage the VFD shall automatically restart when the power returns provided the run command is maintained.
- 2.8.4 In the event of an inverter fault trip, the VFD shall attempt to restart automatically up to maximum of five attempts. If, after five attempts, restart does not occur, the VFD shall lock out.

2.9 WARRANTY

- 2.9.1 The complete VFD shall be warranted by the manufacturer for a period of 12 months from the date of start-up. The warranty shall

Project Name: THE CITY OF TORONTO SHELTER FACILITIES
Project No.: 2019-0495
Section Name: Variable Frequency Drives
Section No.: 20 09 49
Date: April 9, 2020

be provided by the VFD manufacturer and not a third party. A written warranty statement shall be provided with the submittals.

- 2.9.2 (Optional) The manufacturer shall offer an optional, extended warranty allowing the VFD warranty to be extended to up to 6 years.

3 EXECUTION

3.1 INSTALLATION

- 3.1.1 Install each VFD in accordance with manufacturer's recommendations and local, provincial and national safety codes.
- 3.1.2 Use motors with a minimum of class F insulation. Motor shall meet NEMA MG-1 Part 31. Motor shall be rated for inverter duty.
- 3.1.3 Provide on-site commissioning (start-up) of the VFDs by a factory-authorized technician. Allow a minimum of 1/2 day per system. Also, include an allowance for a second visit to site of one-day duration to train operating personnel in the operation and maintenance of the VFDs.
- 3.1.4 Upon completion of the installation, the supplier of VFDs shall supply four complete sets of operation and maintenance manuals including wiring and connection diagrams.
- 3.1.5 Upon completion of the start-up, the supplier of VFDs shall supply four complete sets of typed report and one USB drive with parameters ready for uploading for future use.

END OF SECTION