
DIVISION 15

MECHANICAL

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GENERAL MECHANICAL PROVISIONS

1. GENERAL

1.1 Intent

- .1 Provide complete, fully tested and operational mechanical systems to meet the requirements described herein and in complete accord with applicable codes and ordinances.
- .2 Contract documents and drawings of this Division are diagrammatic and approximately to scale unless detailed otherwise. They establish scope, material and installation quality and are not detailed installation instructions.
- .3 Follow manufacturers' recommended installation details and procedures for equipment, supplemented by requirements of Contract Documents.
- .4 Install equipment generally in locations and routes shown. Run piping and ductwork close to building structure, parallel to building lines to maximize headroom and with minimum interference with other services and free space. Remove and replace improperly installed equipment to satisfaction of the Engineer at no extra cost.
- .5 Install equipment to provide access and ease of maintenance.
- .6 Connect to equipment specified in other Sections and to equipment supplied and installed by other Contractors or by the Owner. Uncrate equipment, move in place and install complete; start-up and test.
- .7 Furnish a written guarantee stating that all work executed in this contract will be free from defective workmanship and materials for a period of one (1) year from the date of Substantial Performance. The Contractor shall, at his own expense, repair and replace any work which fails or becomes defective during the term of the guarantee/warranty, providing such work is not due to improper usage. The period of guarantee specified shall not in any way supplant any other guarantees of a longer period but shall be binding on work not otherwise covered. Coordinate with the requirements of Division 1.
- .8 If the equipment is used during construction, the guarantee or guarantee period shall not be shortened or altered.
- .9 'Provide' shall mean 'supply and install'.
- .10 Engineer shall mean Earth Tech Canada Inc. Designated Representative.

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1.2 Coordination of Work

- .1 Cooperate and coordinate with other trades on the project.
- .2 Make reference to electrical, mechanical, structural and architectural drawings when setting out work. Consult with respective Divisions in setting out locations for ductwork, equipment, and piping, so that conflicts are avoided and symmetrical even spacing is maintained. Jointly work out all conflicts on site before fabricating or installing any materials or equipment.
- .3 Where dimensional details are required, work with the applicable architectural and structural drawings.
- .4 Full-size and detailed drawings shall take precedence over scale measurements from drawings. Specifications shall take precedence over drawings.
- .5 Any areas indicated as space for future materials or equipment shall be left clear.

1.3 Quality of Work

- .1 All work shall be by qualified tradesmen with valid Trade Qualification Certificates. Spot checks will be made by the Engineer.
- .2 Work which does not conform to standards accepted by the Engineer and the trade may be rejected by the Engineer. The Contractor shall redo rejected work to the accepted standard at no cost to the Owner.

1.4 Metric Conversion

- .1 All units in this division are expressed in SI units.
- .2 Submit all shop drawings and maintenance manuals in SI units.
- .3 On all submittals (shop drawings etc.) use the same SI units as stated in the specification.
- .4 Equivalent Nominal Diameters of Pipes - Metric and Imperial:
 - .1 Where pipes are specified with metric dimensions and Imperial sized pipes are available, provide equivalent nominal Imperial sized pipe as indicated in the table, and provide at no extra cost adapters to ensure compatible connections to all metric sized fittings, equipment and piping.

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- .2 When CSA approved SI Metric pipes are provided, the Contractor shall provide at no extra cost adapters to ensure compatible connections between the SI Metric pipes and all new and existing pipes, fittings, and equipment.

mm Inches (NPS)	mm Inches (NPS)	mm Inches (NPS)
3 1/8	65 2-1/2	375 15
6 1/4	75 3	450 18
10 3/8	100 4	500 20
15 1/2	125 5	600 24
20 3/4	150 6	750 30
25 1	200 8	
30 1-1/4	250 10	
40 1-1/2	300 12	
50 2		

- .5 Metric Duct Sizes:

- .1 The Metric duct sizes are expressed as 25 mm = 1 inch.

1.5 Shop Drawings

- .1 Refer to Section 01300.
- .2 Identify materials and equipment by manufacturer, trade name and model number. Include copies of applicable brochure or catalogue material. Do not assume applicable catalogues are available in the Engineer's office. Maintenance and operating manuals are not suitable submittal material.
- .3 Clearly mark submittal material using arrows, underlining or circling to show differences from specified, e.g., ratings, capacities and options being proposed. Cross out non-applicable material. Specifically note on the submittal specified features such as special tank linings, pumps seals materials or painting.
- .4 Include weights, dimensional, and technical data sufficient to check if equipment meets requirements. Include wiring, piping, and service connection data and motor sizes.
- .5 Installed materials and equipment shall meet specified requirements regardless of whether or not shop drawings are reviewed by the Engineer.
- .6 Do not order equipment or material until the Engineer has reviewed and returned shop drawings.
- .7 Prior to submission to the Engineer, the Contractor shall review all shop drawings. By this review, the Contractor certifies that he has determined and verified all field measurements, field construction criteria, materials, catalogue numbers and similar data, and certifies that he has checked and coordinated each shop drawings with the requirements of the work of the contract documents. The Contractor's review of each shop drawing shall be indicated by stamp, date and signature of the Contractor's designated project manager.

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- .8 Retain one copy of shop drawings on site for review.

1.6 Cutting, Patching and Coring

- .1 Provide holes and sleeves, cutting and fitting required for mechanical work. Relocate improperly located holes and sleeves.
- .2 Drill for expansion bolts, hanger rods, brackets, and supports.
- .3 Obtain written approval from the Structural Engineer before cutting or burning structural members.
- .4 Provide openings and holes required in precast members for mechanical work. Cast holes 100 mm or larger in diameter. Field-cut smaller than 100 mm.
- .5 Patch building where damaged from equipment installation, improperly located holes etc. Use matching materials as specified in the respective section.

1.7 Installation of Equipment

- .1 Pipe all equipment drains to building drains.
- .2 Unions and flanges shall be provided in piping or ductwork to permit easy removal of equipment.
- .3 Maintain permanent access to equipment for maintenance.

1.8 Equipment and Materials

- .1 Materials and equipment installed shall be new, full weight and of quality specified.
- .2 Each major component of equipment shall bear manufacturer's name, address, catalogue and serial number in a conspicuous place.
- .3 Where two or more products of the same type are required, products shall be of the same manufacturer.

1.9 Equipment Protection and Clean-Up

- .1 Protect equipment and materials in storage on site during and after installation until final acceptance. Leave factory covers in place. Take special precautions to prevent entry of foreign material into working parts of piping and duct systems.
- .2 Protect equipment with polyethylene covers and crates.
- .3 Operate, drain and flush out unsealed bearings and refill with new change of oil, before final acceptance.

GENERAL MECHANICAL PROVISIONS

- .4 Thoroughly clean piping, ducts and equipment of dirt, cuttings and other foreign substances.
- .5 Protect bearings and shafts during installation. Grease shafts and sheaves to prevent corrosion. Supply and install necessary extended nipples for lubrication purposes.
- .6 Ensure that existing equipment is carefully dismantled and not damaged or lost. Do not reuse existing materials and equipment unless specifically indicated.

1.10 Electrical Motors

- .1 Supply mechanical equipment complete with electrical motors.
- .2 Provide motors designed, manufactured, and tested in accordance with the latest edition of the following codes and standards: NEMA, EEMAC, CSA, CEC Part 1, IEEE and ANSI. All motors to be CSA labelled. All motors to be approved for use on the designated area classification by the Electrical Protection Branch of NWT.
- .3 Unless specified otherwise, provide motors designed for full voltage starting, EEMAC Design B. Motors driving high torque or high inertia loads may be EEMAC Design C or D.
- .4 Provide motors rated for continuous duty with 1.15 service factor unless specified otherwise in the driven equipment specifications. Provide all motors with thermal overload protection.
- .5 Motors $\frac{1}{2}$ hp and under shall be 120 V, 60 Hz, 1 phase. Motors greater than $\frac{1}{2}$ hp shall be 3 phase at the indicated voltage.
- .6 All motors shall be 1800 rpm unless indicated otherwise.
- .7 Provide motors with grease or oil lubricated anti-friction type ball or roller bearings.
- .8 Provide motors designed with Class B insulation; Class F insulation for totally enclosed motors.
- .9 Refer to electrical specifications, Division 16, for voltage, frequency, and phase data. This shall take precedence over any reference in Division 15.
- .10 Where motor power is stated in watts or kilowatts, nominal motor horsepower multiplied by 746 or 0.746 respectively, has been used as the conversion factor.

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- .11 Minimum certified motor efficiency shall be as outlined in the following table.

MINIMUM EFFICIENCY (%) *

HP	3600 RPM	1800 RPM	1200 RPM	900 RPM
1	75.5	82.5	80.0	74.0
1.5	82.5	84.0	85.5	77.0
2	84.0	84.0	86.5	82.5
3	85.5	87.5	87.5	84.0
5	87.5	87.5	87.5	85.5
7.5	88.5	89.5	89.5	85.5
10	89.5	89.5	89.5	88.5

(*) As defined in CSA C390 or IEEE 112B Nominal Standards

1.11 Miscellaneous Metals

- .1 Provide all necessary miscellaneous metals to hang or support materials, equipment and provide access for work under this contract.
- .2 All miscellaneous metals shall be prime painted.
- .3 Miscellaneous metals shall include but are not limited to:
 - .1 Hangers for equipment, piping and ductwork.
 - .2 Support for equipment.

1.12 Pipe Sleeves

- .1 Pipe sleeves shall be provided for piping passing through walls and floors. Minimum 0.61 mm (24 ga) galvanised sheet metal. Sleeves shall extend 25 mm on either side of the wall.
- .2 Schedule 40 steel pipe shall be used as floor pipe sleeves in wet areas with a 50 mm up-stand.
- .3 Pipe sleeves are not required where pipes pass through cored concrete walls or floors.

1.13 Escutcheon and Plates

- .1 Provide escutcheon and plates on piping and ductwork passing through finished walls, floors and ceilings.
- .2 Escutcheons shall be split type, stainless or chrome plated steel.

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1.14 Painting and Identification

- .1 Colour code mechanical equipment, piping and exposed ductwork. Refer to colour schedule located in the GNWT Design Standards and Guidelines Standard Colour and Identification Chart #15190.101.

1.15 Temporary Heat

- .1 The existing heating system will be maintained in operation by the Owner.

1.16 Temporary or Trial Usage

- .1 Temporary or trial usage by the Owner or Engineer of mechanical equipment supplied under contract shall not represent acceptance.
- .2 Repair or replace permanent equipment used temporarily.
- .3 Repair or otherwise rectify damage caused by defective materials or workmanship during temporary or trial usage.
- .4 Avoid thermal shock to heating system by coordination with the Owner during planning, construction and operation of temporary heating system.

1.17 Interim and Final Completion

- .1 Prior to requesting an inspection for Substantial Completion, provide a complete list of items, which are deficient.
- .2 A certificate of Final Completion will not be granted unless the following items are completed:
 - .1 Ventilating and plumbing systems have been commissioned and are capable of operation with alarm controls functional and automatic controls in operation.
 - .2 The necessary tests on equipment and systems including those required by authorities have been completed with certificates of approval.
 - .3 Air systems have been balanced with draft report submitted to Engineer.
 - .4 Valve tagging and equipment identification is complete.
 - .5 Warranty forms have been mailed to the manufacturer. Provide copy of original warranty for equipment which has warranty period longer than one year.
 - .6 Systems have been cleaned. Flush and initiate water treatment. Provide report from manufacturer's representative to confirm status of treatment.
 - .7 Draft Operating/Maintenance Manuals have been submitted.
 - .8 Operating and Maintenance demonstrations have been provided to the Owner.

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- .9 Record drawings have been submitted
- .10 Fan plenums have been cleaned, and temporary filters have been replaced with permanent filters.
- .11 All previously identified deficiencies have been corrected.
- .3 Prior to Final Completion Inspection provide declaration in writing that deficiencies noted at time of substantial performance inspection have been corrected and the following items completed prior to the total performance inspection:
 - .1 Submit final air and water balance reports.
 - .2 Submit final operating and maintenance manuals.
 - .3 Complete final calibration.
- .4 The Engineer shall provide one (1) visitation for the purpose of final inspection if requested by Government of NWT. The Engineer will perform one final inspection. Subsequent visitations if required, shall be at the expense of the Contractor.
- .5 The Contractor shall provide qualified personnel in appropriate numbers to operate the facility until substantial performance is declared.

1.18 Acceptable Manufacturers

- .1 The following listed manufacturers are acceptable for their ability to meet the general design intent, quality and performance characteristics of the specified product. The list does not endorse the acceptability of all products available from the listed manufacturers/suppliers.
- .2 It remains the responsibility of the contractor to ensure the products supplied are equal to the specified products in every respect, operate as intended, and meet the performance specifications and physical dimensions of the specified product.
- .3 The contractor shall be fully responsible for any additional work or materials, to accommodate the use of equipment from the acceptable manufacturers and suppliers list.
- .4 Submit within fourteen (14) days of contract award a copy of the list underlining the name of the manufacturer whose price was carried in the tender. If no manufacturer's names are submitted, it will be assumed that the price carried in the tender was that of the specified manufacturer or where the specified product is generic, the first acceptable manufacturer listed for each item and equipment.

GENERAL MECHANICAL PROVISIONS

.5 List of acceptable Manufacturers:

- | | |
|--|--|
| • Air Terminals - Grilles Registers, Diffusers | E.H. Price, Titus, Anemostat, Nailor |
| • Air Handling Units | Trane, Engineered Air, Pace, Haakon, Scott Springfield, Commercial Aire |
| • Air Separators, Relief Valves | Armstrong, Bell & Gossett, Taco, Wheatley |
| • Air Vents | Hoffman, Maid-O-Mist, Taco |
| • Backdraft Dampers | Airolite, Vent-Aire, Penn, T.A. Morrison |
| • Backflow Preventers | Febco, Watts, Hersey, Singer, Ames |
| • Balancing Dampers | Maxam, Ruskin |
| • Boilers - Cast Iron | Weil McLein, Peerless, HB Smith, Burnham, Brian |
| • Chimney and Breeching | Metalbestos P/S, Van Packer P/S, Metal Fab PIL |
| • Coils - Heating | Trane, Aerofin, Engineered Air, Colmac, Heatcraft |
| • Dampers - Control, Backdraft | Ruskin, Tamco |
| • Domestic Water Heaters - Electric | Jetglas, Aerco, AO Smith, Ruud-Rheem, State |
| • Drains - Floor, Roof, Cleanouts Trap Primers, Water Hammer Arrestors | Zurn, Ancon, PPP, J.R. Smith, Mifab |
| • Fans - Cabinet | Greenheck, Penn, Cook |
| • Fans - Centrifugal | Buffalo, Twin City, Trane, Chicago, Barry Blower, Northern |
| • Filters | Cambridge, AAF, Pacific, FARR |
| • Fire Dampers | Controlled Air, Ruskin, Canadian Advanced Air, Maxam, Nailor |
| • Fire Extinguishers | NFE, Grigor, Wilson & Cousins, Flag |
| • Flexible Connectors - Ducting | Thermaflex, G.I. Industries Type IHP |
| • Flexible Connectors - Piping | Flexonics, Tube Turn, Atlantic, Hyspan, Hydroflex, Metraflex, United Flexible, Mason |
| • Flexible Duct | Thermaflex, Wiremold, GI Industries Type H.P. |
| • Gauges - Air | Dwyer, Magnehelic |
| • Hose Bibbs | Jenkins, Dahl, Crane, Toyo, Kitz, Mifab |
| • Insulation - Piping and Duct | Fibreglass Canada, Manson, Knauf |

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	Fibreglass, Plasti-Fab, Manville
• Piping Hangers and Saddles	Grinnell, Myatt
• Plug Cocks	DeZurik, Newman-Milliken
• Plumbing Brass	Crane, American Standard, Cambridge Brass, Waltec, Kohler, Symmons
• Plumbing: Floor Drains, Trench Drains	Mifab, Zurn, Smith
• Pumps - In-Line Circulators	Armstrong, B & G, Taco, Grundfos
• Radiation - Wall Fin	Engineered Air, Trane, Slant/Fin, Rosemex, Dunham Bush, Sigma
• Sinks - Stainless Steel	KIL, American Standard, Elkay, AMI
• Strainers	Armstrong, Sarco, Mueller, Toyo, Anderson, Metraflex, Yarway
• Tanks - Diaphragm Type Expansion	Amtrol, Hamlet and Garneau Inc.
• Tanks - Domestic Water Storage	Zeebest Plastics
• Tanks - Steel Fuel Oil Storage	Westeel, AMG, Northern Steel, Durex, Kirkland, AGI Envirotank
• Thermometers	Terice, Marsh, Ashcroft, Winters
• Unit Heaters - HW	Engineered Air, Trane, Rosemex, McQuay, Dunham Bush, Heatcraft, Sigma
• Valves - Butterfly	Jenkins, Keystone, DeZurik, Centreline, Monotight, Dresser, Lunkenheimer, Crane, Bray, Toyo, Grinnell
• Valves - Drain, Radiator	Jenkins, Dahl, Crane, Toyo, Kitz
• Valves - Eccentric Plug	DeZurik, Homestead
• Valves - Gate, Globe, Swing Check, Ball	Jenkins, Toyo, Crane, Kitz, Milwaukee
• Valves - Relief	Armstrong, Bell & Gossett, Taco, Wheatley
• Valves - Silent Check	Val-matic, APCO, StreamFlo
• Valves - Suction Diffusers Combination Check and Balance	Armstrong, B&G, Taco
• Valves - Thermostatic Mixing	Symmons, Powers, Lawler
• Vent Caps	Jenn-Air, Penn Ventilator
• Vibration Isolation	Mason, Vibro Acoustic

.6 Contractors to follow Northern Manufactured Product Directive.

GENERAL MECHANICAL PROVISIONS

- 2. PRODUCTS – NOT APPLICABLE**
- 3. EXECUTION – NOT APPLICABLE**

END OF SECTION

DOCUMENTATION

1. GENERAL

1.1 Scope

- .1 Operating and Maintenance Manuals.
- .2 Record Drawings.

1.2 Quality Assurance

- .1 Work specified in this section shall be performed by the Contractor.

2. PRODUCTS

2.1 Operating and Maintenance Manuals

- .1 Refer to Section 01300.

2.2 Record Drawings

- .1 Refer to Section 01720.

3. EXECUTION

3.1 General

- .1 Submit documents to the Engineer for approval prior to Interim Completion.

END OF SECTION

COMMISSIONING

1. GENERAL

1.1 General

- .1 This section describes the commissioning of the mechanical system and outlines the duties and responsibilities of the team.
- .2 The commissioning of the mechanical system shall be in accordance with the Code of Practice for Commissioning Mechanical Systems in Buildings and as described in this section.
- .3 The commissioning process shall be applied to all products, equipment and systems provided under this Division.
- .4 Work specified in this section shall be performed by the contractor.
- .5 Refer to Division 1.

1.2 Scope

- .1 Demonstration of equipment and systems operations.
- .2 Instruction seminars for Owner's personnel.

1.3 Quality Assurance

- .1 Work specified shall be performed by the Contractor.

2. THE COMMISSIONING PROCESS

2.1 The Commissioning Team

- .1 The Commissioning Team shall be formed and consist of:
 - .1 The Contractor.
 - .2 The Engineer's representative.
 - .3 The Owner's staff representative.

2.2 Duties of the Team

- .1 The duties of the team are summarised below:
 - .1 The Contractor shall plan, organise and implement the commissioning process.

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- .2 The Contractor shall provide a complete description of the systems operation, performance and flow data to the Engineer for review.
- .3 The Contractor shall prepare the commissioning plan and provide demonstration and instructions to the Owner's staff over a period of time to enable the staff to become familiar with the systems.

2.3 Commissioning Schedule

- .1 Within three (3) months of commencing with the project work the commissioning co-ordinator shall review design intent and intended commissioning procedures with the Engineer. Six months prior to the date of scheduled substantial performance submit a detailed plan identifying the orderly progression of the prestart commissioning check and subsequent commissioning performance check of each sub-system, leading up to the ultimate commissioning of entire systems.
- .2 Submit a schedule for the commissioning phase of the work. This schedule shall show:
 - .1 Completion dates for each trade in each major section of the building.
 - .2 Timing of the various phases of the commissioning, testing, balancing and demonstration process.
 - .3 Submission dates for the various documents required prior to verification of commissioning by the Engineer.
 - .4 Prepare a commissioning statement in which each of the four (4) phases that the process is perceived to be worked through. In sequence, the phases are expected to be:

Phase 1 - System Readiness.

Phase 2 - System Start-up, Testing, Balancing, Etc.

Phase 3 - Verification of System Commissioning

Phase 4 - Demonstration and Instruction.
- .3 Each phase is applicable to each major and separate system making up the work in Division 15 including controls and Division 16 interface as applicable.

2.4 Commissioning Phases

- .1 **Phase 1** - Before starting any of the separate systems, provide written verification stating that the specific system is ready for start-up and the following conditions have been met:
 - .1 Copies of all test and certificates have been submitted to the Engineer.

COMMISSIONING

- .2 All safety controls installed and fully operational (dry run test).
- .3 Flushing, chemical cleaning (as required), charging, fluid operating (as required), are complete.
- .4 Equipment lubrication and pre-start checks are complete.
- .5 Air system cleaning complete.
- .6 Filter systems installed and sealed in place.
- .7 Adjusting vibration isolation completed.
- .8 Alignment of drives (direct and belt) completed.
- .9 Control functional checks, including all alarms performed.
- .10 Start-up verification checks by manufacturers representatives completed.
- .11 All deficiencies to be recorded, reviewed by the commissioning team and, subsequently corrected before proceeding to the next phase, Phase 2.
- .2 **Phase 2 - System Commissioning shall include but not necessarily be limited to:**
 - .1 Activation of all systems.
 - .2 Testing and adjustment of all systems.
 - .3 As in the case of the System Readiness Phase, all deficiencies are to be recorded, reviewed by the Commissioning team and, subsequently, corrected. The process at the point of the deficiency shall be repeated before proceeding forward.
 - .4 Phase 2 is concluded when the installation is in full working order and acceptable for use. The work will include the following:
 - ! Position all balance dampers in ductwork.
 - .2 Make provisions for testing air pressures and flow rates.
 - .3 Set up all automatic temperature control devices.
 - .4 Set up fans.
 - .5 Plug all air pressure and flow measuring holes.
 - .6 Adjust vibration isolators as necessary.
 - ~ Air balance complete.

COMMISSIONING

.5 Fine Tuning:

- .1 Setting up automatic controls for accurate response and precise sequencing.

.6 Testing:

- .1 The Contractor shall perform a detailed check of the following:

- .1 All items and functions to be later demonstrated to the Owners representatives.

.3 **Phase 3 - Verification of Commissioning.**

- .1 Verification of commissioning by the Engineer shall not commence until the commissioning process, Phase 2, has been totally completed. Submit test procedure completion test certificates at the time of requesting the commencement of the verification procedure.

- .2 In general, all systems shall be fully tested and operational prior to the commissioning witnessing by the Owner and the Engineer. Failure on the Contractor's part to have the systems prepared for commissioning may result in additional site visits required by the Owner and the Engineer. The Contractor shall be responsible for these additional costs.

- .3 The verification process will include the demonstration of the following:

- .1 Location of and opening and closing of all access panels.
- .2 Operation of all automatic control dampers and automatic temperature/volume adjustment controls.
- .3 Proper response of all thermostats and adjustment controls.
- .4 Operation of all equipment and systems, under each mode of operation, including:
 - .1 Automatic control features.
 - .2 Summer exhaust systems.
 - .3 Pumps.
 - .4 Fans.

COMMISSIONING

- .4 At the completion of Phase 3, the Contractor shall submit the following to the Engineer:
 - 1 A letter certifying that all work specified under this contract is complete, clean and operational in accordance with the specification and drawings.
 - .2 A copy of Phase 2 Verification Certificates provided by the specialist trades for submission to the Engineer.
 - .3 Record drawings as specified.
 - .4 A letter from the testing and balancing agency certifying that all necessary data for inclusion in operating and maintenance manuals has been received.
 - .5 A statement confirming completion of controls acceptance test, Section 15900.
- .5 Upon receipt of all documents and a satisfactory outcome of the verification procedure, the Engineer will provide a Certificate of Verification for Phase 3.
- .6 Substantial Performance may, thereupon, be declared.
- .4 **Phase 4 - Demonstration and Acceptance** shall not commence until the commissioning process Phase 3 has been successfully completed - verification certificate issued and Substantial Performance declared. The demonstration process is a statement of satisfaction from the Engineer and Owner upon completion. Total Performance will not be accomplished without this achievement.

3. EXECUTION

The following systems are to be commissioned:

3.1 Plumbing

- .1 Domestic hot and cold water systems - system pressure tests, flush and clean lines, system pressures at fixtures, water delivery at each fixture; identification of piping systems.
- .2 Sanitary drainage - system pressure tests, pipe identification.
- .3 Fixtures - cleaning, test hot and cold water and drain, installation.

3.2 HVAC Systems

- .1 Duct System - insulation, identification.
- .2 Exhaust Fans - installation, rotation, motor current draw, accessories dampers, etc., identification.

COMMISSIONING

- .3 Control Dampers - installation, operation, identification, capacity modulation, connection to PLC.
- .4 Glycol Heating System – boilers, pumps, system pressure tests, flush and clean lines, etc.
- .5 Controls - See Section 15900.

3.3 General

- .1 Contractor shall arrange for presentation and demonstration of mechanical equipment and systems by appropriate specialists and shall ensure that required manufacturer's representatives are in attendance.

3.4 Demonstrations

- .1 Demonstrate specific starting and general maintenance requirements for each major piece of equipment. Ensure all labelling and identification is completed.
- .2 Demonstrate the following systems, in the form of instruction seminars and contractor-guided tour of the facility.
 - Air Systems;
 - Heating Systems;
 - Plumbing Systems;
 - Control Systems;
 - Summer Ventilation Systems.
- .3 Demonstrate the following pieces of equipment:
 - Fans
 - Boilers.
- .4 Prepare a schedule identifying the proposed sequence of demonstration. Sequence of demonstration shall correspond to full system starting. Submit for review by Engineer one month prior to demonstration.
- .5 Answer all questions raised by Owner at demonstrations; if unable to satisfactorily answer questions immediately, provide written response within three (3) days.

END OF SECTION

TESTING

1. GENERAL

1.1 Scope

- .1 Test domestic water piping.
- .2 Test sanitary sewer piping.
- .3 Test fuel oil piping.
- .4 Test glycol piping.
- .5 Performance testing of equipment.
- .6 Manufacturer's start-up of equipment.

1.2 Quality Assurance

- .1 Test equipment and material where required by specification or authority having jurisdiction to demonstrate its proper and safe operation.
- .2 Test procedures in accordance with the current applicable portions of ASME, ASHRAE, and other recognised test codes as far as field conditions permit.
- .3 Perform tests on site to the satisfaction of the Engineer.
- .4 Piping, fixtures or equipment shall not be concealed or covered until inspected and approved by the Engineer. Provide ample written notice (two working days) to the Engineer before tests.
- .5 Co-ordinate with Engineer at start of project, those tests that will require witnessing by the Engineer.
- .6 Prior to starting, testing, balancing, adjusting and cleaning processes, verify with Engineer any tests required to be witnessed. Provide sufficient notice to Engineer prior to commencement of procedures.
- .7 Engineer shall be allowed to witness any testing, adjusting, starting, balancing and cleaning procedures.
- .8 Assume all costs associated with starting and testing, including the supply of testing or cleaning medium.
- .9 Prior to starting equipment or systems, secure and review manufacturer's installation, operation and starting instructions. Read in conjunction with procedures defined herein.

TESTING

- .10 Use manufacturer's or supplier's starting personnel where required to ensure integrity of manufacturer's warranty.
- .11 Compare installations to published manufacturer's data and record discrepancies. Items proving detrimental to equipment performance shall be corrected prior to equipment starting.
- .12 Some processes involved in starting procedures defined in this section may be duplications of authorities' verification. To facilitate expedient completion of project, arrange for authorities to assist or witness these procedures.
- .13 All starting, testing procedures shall be in accordance with applicable portions of the latest, current ASME, ASHRAE, AABC, CSA, NFPA, SMACNA, ASTM and ASPE codes and standards.
- .14 Personnel involved in starting, testing, balancing and adjusting procedures shall be experienced in the design and operation of mechanical equipment and systems being checked and shall be able to interpret results of the reading and tests.
- .15 Assume all liabilities associated with starting, testing and balancing procedures.

1.3 Submittals

- .1 Obtain certificates of approval, acceptance, and comply with current rules and regulations from authorities having jurisdiction and include in Operating and Maintenance Manuals.
- .2 Perform tests as specified and upon completion of mechanical installation. Provide certification of tests with detailed data as required. Itemise each test as to time performed and personnel responsible. Include in Operating and Maintenance Manuals.

1.4 Liability

- .1 Take charge of plant during tests, assume responsibility for damages in event of injury to personnel, building or equipment and bear costs for liability, repairs, and restoration in this connection.

2. PRODUCTS

- .1 Not Applicable.

TESTING

3. EXECUTION

3.1 Pressure Tests

- .1 Provide equipment, materials and labour for tests and pay expenses. Use test instruments from approved laboratory or manufacturer and furnish certificate showing degree of accuracy. Install permanent gauges and thermometers used for tests just prior to tests to avoid possible changes in calibration.
- .2 Carry out tests for eight-hour period and maintain pressure with no appreciable pressure drop. Where leakage occurs, repair and re-test and pay necessary costs for re-witnessing.
- .3 Drainage Systems: Test by filling with water to produce water pressure to 30 kPa minimum and 62 kPa maximum.
- .4 Water Piping: Test to 1-1/2 times maximum working pressure or 1033 kPa, whichever is greater, water pressure measured at system low point.
- .5 Fuel Oil Piping: Test as required by current edition of CSA B139, and authority having jurisdiction.
- .6 Ducts: Test ducts as per current edition of SMACNA Manual.
- .7 Check systems during application of test pressure including visual check for leakage of water test medium, soap bubble test for air.
- .8 During heating piping system tests, check linear expansion at elbows, U bends, expansion joints and offsets for proper clearance.
- .9 When using water as test medium for system not using water, evacuate and dehydrate the piping and certify the lines are dry. Use agency specialising in this type of work.
- .10 Should tests indicate defective work or variance with specified requirements, make changes immediately to correct the defects. Correct leaks by re-making joints in screwed fittings, cutting out and re-welding welded joints, re-making joints in copper lines. Do not caulk.

3.2 General

- .1 Conduct performance tests to demonstrate equipment and systems meet specified requirements after mechanical installations are completed and pressure tested. Conduct tests as soon as conditions permit. Make changes, repairs, and adjustments required prior to operating tests.
- .2 Meet with Division 16 manufacturers, suppliers, and other specialists as required to ensure all phases of work are properly co-ordinated prior to the commencement of each particular testing procedure. Establish all necessary manpower requirements.

TESTING

- .3 Operate and test motors and speed switches for correct wiring and sequences and direction of rotation. Check and record overload heaters in motor starters.
- .4 Confirm voltages and operating amperages at full load.
- .5 Failure to follow instruction pertaining to correct starting procedures may result in re-evaluation of equipment by an Independent Testing Agency selected by Owner at Contractor's expense. Should results reveal equipment has not been properly started, equipment may be rejected, removed from site, and replaced. Replacement equipment shall also be subject to full starting procedures, using same procedures specified on the originally installed equipment.

3.3 Procedures

- .1 Procedures shall be identified in the following five (5) distinct phases:
 - .1 Pre-Starting: Visual inspection.
 - .2 Starting: Actual starting procedure.
 - .3 Post-Starting: Operational testing adjusting or balancing, and equipment run-in phase.
 - .4 Pre-Interim Acceptance of the Work: Final cleaning, re-testing, balancing and adjusting, and necessary maintenance.
 - .5 Post-Interim Acceptance of the Work: Repeat tests and fine-tuning resulting from corrective action of deficiency clean-up.
- .2 Check specified and shop drawing data against installed data.
- .3 Check the installation is as defined by contract documents and as per manufacturer's recommendations including manufacturer's installation check sheets.

END OF SECTION