

Part One - General

1.01 GENERAL

- .1 Work in the Specifications is divided into descriptive Sections which are not intended to delegate functions or work to any specific Subcontractor or identify absolute contractual limits between Subcontractor, nor between the Contractor and his Subcontractor. The requirements of any one Section apply to all other Sections, for example: the motor service factor requirement.
- .2 The direction to 'provide' equipment, materials, products, labour and services shall be interpreted to 'supply, install and test' the Division 15 work indicated on the Drawings and specified in the Specifications.
- .3 Provide and include in the Contract Price Division 15 work including mechanical components and normal system accessories not shown on the Drawings or stipulated in the Specifications, and required to ensure completed operational systems and a fully coordinated standard of Work acceptable to the Consultant and all authorities having jurisdiction.

1.02 INTENT

- .1 Mention in the Specifications or the indication on the Drawings of equipment, materials, operation and methods, requires provision of the quality noted, the quantity required, and the systems complete in every respect.
- .2 Consider the Specifications as an integral part of the accompanying Drawings. Any item or subject omitted from one or the other, but which is either mentioned or reasonably implied, shall be considered as properly and sufficiently specified.
- .3 Be completely responsible for the acceptable condition and operation of all systems, equipment and components forming part of the installation or directly associated with it. Promptly replace defective materials, equipment and parts of equipment and repair related damages.

1.03 METRIC PRACTICE

- .1 Conform to Canadian Metric Practice Guide CSA CAN3-Z234.1-89.
- .2 Provide adapters between metric and Imperial installations.
- .3 Metric descriptions in this Division are nominal equivalents of Imperial values.

1.04 DRAWINGS AND SPECIFICATIONS

- .1 Drawings show general design and arrangement of mechanical system installation, and are diagrammatic. Obtain further clarification of Drawings or Specifications from Consultant prior to installation.

- .2 Drawings do not indicate exact Architectural, Civil Structural or Electrical features. Examine Drawings prior to laying out.
- .3 Do not scale Drawings to order materials. Take field measurements before ordering and fabricating materials.
- .4 Clarify 'roughing-in' requirements of equipment which is not part of Division 15 work before proceeding.
- .5 Leave areas clear where space is indicated as reserved for future equipment and where space is required to maintain equipment. Maintenance clearances in addition to providing for servicing of equipment, shall allow for removal and reinstallation of replaceable items such as motors, coils and filters.
- .6 The Contractor shall check the content of the drawings, specifications and dimensions, and before proceeding, report to the Consultant any error or omission between mechanical or electrical and architectural plans.
- .7 These specifications are to be considered as an integral part of the drawings which accompany them, neither the drawings nor the specifications shall be used alone. Any item which is omitted in one but which is reasonably implied in the other, shall be considered properly and sufficiently specified and must, therefore, be provided under the Contract.
- .8 Misinterpretation of drawings and specifications shall not relieve the Contractor of responsibility.
- .9 All contractors shall make themselves familiar with the overall intended operation of the mechanical systems prior to installation so that all necessary accessories such as dampers, vents, valves, controls, etc., can be installed during the normal progress of the work. Failure to do so will result in the contractor being responsible for providing such devices, at his expense, when the need for such devices becomes apparent during start-up.

1.05 SITE VISITS

- .1 Before commencing work, visit site and verify that requirements of plans and specifications are consistent with site conditions.
- .2 Advise Consultant, in writing, of any discrepancies or conflicts.
- .3 No allowance shall be made for failure to include items which a thorough investigation would have shown to be required.

1.06 GUARANTEES

- .1 The Contractor shall guarantee all his work free from defects for a period of one (1) year (unless specifically noted otherwise) after substantial completion of such work by the Owner and shall make good all defects other than normal wear and tear during the life of the guarantee. The Contractor shall guarantee all work and equipment supplied by him to work quietly and satisfactorily and to accomplish the work for which it was installed during the life of the above guarantee. At any time during the period, he shall make any necessary changes and adjustments, or replacements, to accomplish this at his own expense.

1.07 PERMITS AND REGULATIONS

- .1 All contractors shall comply with all regulations of Authorities having jurisdiction, where applicable, including but not limited to the following:
 - Provincial Department of Labour
 - Provincial Fire Marshal
 - Local Fire Authority
 - Provincial Plumbing Inspector
 - Provincial Department of Health
 - Provincial Department of the Environment
- .2 Contractor shall obtain and pay for any permits required by Local Codes and Regulations and arrange for inspections.
- .3 Any additional materials or labour required to conform to any of these rules and regulations shall be furnished under the contract with no additional cost to the owner.

1.08 REFERENCE STANDARDS

- .1 Provide new materials and equipment of proven design and quality. Provide current models of equipment manufactured in Canada or the United States, unless specified otherwise, with published ratings certified by recognized North American testing and standards agencies.
- .2 Select Canadian made materials and equipment and other equipment to maximize the Canadian content of the Work.
- .3 Workmanship and installation methods shall conform to the best modern practice. Employ skilled tradesmen to perform work under the direct supervision of fully qualified personnel.
- .4 Install equipment in strict accordance with manufacturer's written recommendations.
- .5 Meet ASHRAE and other industry standards in the selection and provision of equipment, materials, pipe and duct components and systems.
- .6 Meet ASHRAE/IES 90.1, 1989 Standards for the supply and installation of all equipment.
- .7 Meet the additional selection, sizing and performance criteria specified in this Specification.

- .8 In general, and as applicable, the physical and chemical properties, the characteristics and the performance of Division 15 work shall meet the requirements of recognized agencies including those listed herein:

AABC	Associated Air Balance Council
AMCA	Air Moving and Conditioning Association
ARI	Air Conditioning and Refrigeration Institute
ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
American Society for Testing and Materials	ASTM
American Welding Society	AWS
AWWA	American Water Works Association
CBMA	Canadian Boiler Manufacturers Association
	CEMA
	Canadian Electrical Manufacturers Association
CFUA	Canadian Fire Underwriters' Association
CGA	Canadian Gas Association
CSA	Canadian Standards Association
CUA	Canadian Underwriters' Association
HRA	Heating, Refrigeration and Air Conditioning Institute of Canada
NBFU	National Board of Fire Underwriters'
NBS	National Bureau of Standards
NFPA	National Fire Protection Association
SBI	Steel Boilers Institute

SMACNA	Sheet Metal and Air Conditioning Contractors National Association Inc.
UL	Underwriters' Laboratories
ULC	Underwriters' Laboratories of Canada
CGSB	Canadian Government Standards Board

Local Bylaws As applicable

National Building Code of Canada

Propane Installation Code

Regulations of the P.E.I. Department of Technology and Environment

Occupational Health & Safety Act

Boiler and Pressure Vessel Act and Regulations of the Province of PEI

ASHRAE Standard 62-1989 Ventilation for Acceptable Indoor Air Quality

ASHRAE Standard 90.1-1989 Energy Efficient Design of New Buildings

OR

National Energy Code for Buildings

NFPA 101 Code for Safety to Life from Fire in Buildings and Structures

Insurers Advisory Organization Requirements

ASHRAE Guideline 1-1996 The HVAC Commissioning Process

1.09 CO-ORDINATION

- .1 Contractors are CAUTIONED that space is limited and close co-ordination of the work of all trades is required. Before fabrication or installation begins the contractor must do the following:

- .1 Become fully familiar with all architectural and structural details that affect his work.

- .2 Exchange information with other mechanical and electrical trades to identify potential areas of conflict.
 - .3 Arrange for and attend meetings as required to resolve conflicts.
 - .4 Prepare detailed co-ordination drawings showing actual location of pipes, ducts or conduits in relation to architectural and structural components and the work of other trades. Such locations are to be as agreed upon with other trades and shall be complementary to similar drawings by other trades.
 - .5 Dimension proposed location of Division 15 work with respect to building elevations and established grid lines.
 - .6 Base information used to prepare drawings on reviewed Shop Drawings.
 - .7 Provide field drawings with position of various services when required by Consultant.
 - .8 Submit a list of access doors and panels showing proposed type, size and location. Coordinate drawings with Architectural detail drawings and reflected ceiling plans prior to submission.
- .2 The order of precedence in congested areas shall be:
 - .1 Drainage piping.
 - .2 Trunk ducts.
 - .3 Heating mains.
 - .4 Main conduits.
 - .5 Water piping mains.
 - .6 Branch ducts, pipes and conduits.
 - .3 Location of outlets shall be in accordance with the architect's reflected ceiling plan. If an outlet is not shown thereon or is in conflict with work of another trade, obtain direction from the consultant before proceeding.
 - .4 Relocation of branch ducts, pipes or outlets within 3m of location shown on drawings to facilitate coordination with other trades shall not be considered extra work.

1.10 CHANGES TO CONTRACT WORK

- .1 Do not proceed with any changes to the Work without written authority from the Owner.
- .2 Follow procedures outlined in Tendering and Contract Requirements for administration and execution of Contract revisions.
- .3 Labour man hour quantities for changes to work shall be based on:
 - .1 Published industry labour calculators accepted by Consultant.

Example: Mechanical labour estimates published in the latest edition of The Plumbing, Heating, Cooling Contractors or Ottaviano National Mechanical Estimator.
 - .2 Methods directed by the Consultant.

1.11 ACCEPTABLE PRODUCTS

- .1 Acceptable Products will be listed in the Specification or Addendum.
- .2 The contractor is cautioned that all layouts on the mechanical drawings are based on the specified equipment. Any changes necessary, using Acceptable Products, will be done at the contractors expense. Furthermore, if it is found that the provisions made regarding space conditions are not met, the right is reserved by the Consultant to require installation of the equipment used on the layout.
- .3 Contractors are cautioned that it is the responsibility of the suppliers of Acceptable Products to select products that meet the specifications of the specified products in all significant respects. Contractors are to satisfy themselves that Acceptable Products offered meet the specifications and fit in the available space as no extra charge will be considered if they are later found to be on suitable.

1.12 SHOP DRAWINGS

- .1 The Contractor shall prepare a minimum of twelve (12) copies of shop drawings of the equipment called for hereinafter and also for all equipment or materials which he wishes to substitute for specified items, provided such alternative equipment has had prior approval.
- .2 All such drawings shall be submitted to the Architect for review and the work shall not commence until such approval has been obtained.
- .3 The Engineer's review of these drawings is general. It is not intended to release the Contractor from the necessity of furnishing materials and performing the work as required by the plans and specifications.
- .4 All shop drawings must be checked against the requirements of the plans and specifications by the Contractor prior to forwarding them to the Architect. Drawings not checked and stamped will be returned without approval.
- .5 All shop drawings must be first quality reproductions with all details, lettering, etc. distinct and legible. Drawings sent by FAX are not acceptable and will not be reviewed except by prior arrangement.
- .6 Where drawings and specifications are in metric or in both imperial and metric, all design, data capacities, sizes and dimensions specifically called for on the drawing or in the specifications shall be submitted in like terms on the shop drawings.

1.13 TEMPORARY HEAT

- .1 Temporary heat for the project shall be the responsibility of other Trade Contractor. The use of any equipment installed on the job will only be permitted as noted in the Architectural General Conditions or in the Instructions to Bidders.
- .2 Before using any of the mechanical equipment for temporary heat service, the equipment must be installed complete with all accessories. Such equipment shall be installed and operated with all component parts in working order.

- .3 The Owner shall not be liable for service charges and calls for any piece of mechanical equipment being used for temporary heat.
- .4 Upon completion of the work, this Contractor shall be responsible for cleaning all equipment and forwarding to the Architect, letters from equipment suppliers stating that such equipment used for temporary heat is in satisfactory operating condition and acceptable for the year guarantee. The guarantee on all equipment shall be from the date of acceptance of the equipment by the Owner.
- .5 All costs for temporary heat shall be the responsibility of other Trade Contractors.

1.14 ACCESS AND ACCESS DOORS

- .1 All equipment and system components requiring servicing, inspection or adjusting must be easily accessible. Where equipment may be required to be removed for repair or servicing adequate access must be provided.
- .2 Where equipment or system components are concealed in furred ceilings or in walls or partitions access doors will be supplied by the Mechanical Contractor for installation by the general contractor.
- .3 All openings shall be sufficient size for both removal and maintenance of the concealed equipment, and shall be a minimum size of 450mm x 450mm.
- .4 Access doors are not required where there is a removable acoustic tile ceiling.
- .5 The contractor shall arrange with the appropriate package Contractor to install any panels found necessary during the course of construction.
- .6 Doors shall open 180 degrees, have rounded safety corners, concealed hinges, anchor straps and allen head cam locks.
- .7 Provide stainless steel access doors for tile, marble or terrazzo surfaces.
- .8 Doors in block walls or in tile shall be sized to suit the wall module.

1.15 PACKAGE EQUIPMENT

- .1 The contractor shall note that whenever package equipment is specified it is intended that this equipment shall be a complete package with all necessary accessories to allow for safe automatic operation.
- .2 These accessories shall include all necessary starters, disconnects, relays, transformers, pressure switches, sensors, timers, etc. Where subject to the weather, the device shall be enclosed in a "weatherproof" enclosure.
- .3 The contractor shall be responsible for checking with the supplier of the equipment to ensure that the package equipment is complete with all necessary accessories. He shall also determine which accessories are factory mounted and which ones are shipped loose with the equipment. The contractor shall include in his tender an amount for all necessary wiring and piping, etc. required to incorporate loose pieces of equipment into the job at no additional cost to the owner.

- .4 The contractor shall note that the above refers to all package equipment including boilers, chiller, heat reclaim units, pump sets, condensing units, etc. It shall be his responsibility to co-ordinate this with the supplier of the equipment to ensure the supply and installation of any accessories necessary for the operation of this equipment.

1.16 ELECTRICAL CONNECTIONS, MOTORS AND STARTERS

- .1 Electrical equipment shall bear CSA Label. Obtain special inspection labels required by Provincial Authority having jurisdiction.
- .2 Use 3 phase, 575 volts for motors 3/4 h.p. and larger. Use single phase 115 volts for motors less than 3/4 h.p.
- .3 Use 1750 rpm, open drip-proof, ball bearing motors manufactured to CEMA standards for 40 degrees C temperature rise and designed for continuous service and vibration free, quiet operation.
- .4 All motors 1 h.p. and larger shall be of the high efficiency type with a guaranteed minimum efficiency by the manufacturer as outlined in the following Table. Quoted efficiency shall be those as tested by IEEE-112 Method B.

Motor Size (HP/kw)	Minimum Efficiency
1.0	82.4
1.5	82.8
2.0	83.8
3.0	86.1
5.0	86.9
7.5	88.4
10.0	89.4
15.0	90.1
20.0	90.9
25.0	91.1
30.0	91.5
40.0	92.0
50.0	92.5

- .5 If delivery of specified motor will delay delivery or installation of any equipment, install a motor for temporary use. Final acceptance of equipment will not occur until specified motor is installed.
- .6 Where motors may be subject to high moisture levels such as in the boiler room and in the air stream after cooling coils or in areas subject to wash-down, such motors shall be splashproof or totally enclosed fan cooled.
- .7 Conform to requirements of Canadian Electrical Code, Local and Municipal and Provincial Authorities, and specified standards.

.8 All exterior equipment shall be supplied complete with a disconnect switch. Where exposed to the weather, "weatherproof" disconnects shall be provided.

.9 All two speed motors shall be dual winding type.

1.17 CUTTING AND PATCHING

.1 Cutting and patching will be the responsibility of the General Contractor, refer to Section 017303. This Contractor to provide dimensions, locations and other data to allow opening to be left as construction proceeds. Provide sleeves as specified in subsequent paragraphs.

.2 This Contractor is to provide layout and supervision for all openings required for the installation of this work. Contractors are CAUTIONED that all openings through the floor slabs have to be closely co-ordinated with other trade package Contractors.

.3 Cutting and patching required for any corrective action necessary for mechanical work not laid out properly shall be the responsibility of this Contractor.

1.18 EXCAVATION AND BACKFILLING

.1 Excavation and backfilling will be the responsibility of the General Contractor, supervision by this Contractor. Refer to Section 312310.

1.19 SLEEVES AND ESCUTCHEONS

.1 Sleeves:

.1 This trade shall provide galvanized sleeves extending 19mm above the finished floor level for any openings required for the mechanical systems.

.2 Unless otherwise specified, construct sleeves of galvanized sheet steel with lock seam joints of minimum 22 gauge.

.2 Sizes:

.1 Provide approximately 12mm clearance, all around, between sleeve and pipes or between sleeve and insulation.

.2 Through footings use sleeves large enough to accommodate hub of CI soil pipe.

.3 Where piping passes below footings, provide minimum all round clearance of 50mm between piping and sleeves. Backfill up to underside of footing with concrete of same strength as footing.

.4 Unless otherwise specified, terminate sleeves flush with walls.

.5 Sleeves shall be sized to accommodate the insulated pipe diameter.

.3 Unless otherwise indicated for pipes passing through roofs, use galvanized cast iron sleeves with caulking recess and flashing clamp device. Anchor sleeves in roof construction; caulk between sleeve recess and pipe; fasten roof flashing to clamp device; make watertight durable joint.

- .4 Caulking:
 - .1 Caulk sleeves in foundation walls and below grade floors with oakum and lead between sleeve and pipe or manufactured seals equal to "Link-Seal".
 - .2 Where sleeves pass through foundation walls or on grade slab floors, caulk space between insulation and sleeve or between pipe and sleeve with dry oakum. Seal space at each end of sleeve with non-hardening mastic.
 - .3 Ensure no contact between copper tube or pipe and ferrous sleeve.
- .5 Escutcheons and Plates:
 - .1 Provide on pipes passing through finished walls, partition floors and ceilings.
 - .2 Use chrome or nickel plated brass, with set screws for ceiling or wall mounted. For equipment room use cast-iron type. Where split escutcheons are used they shall be installed to provide continuous appearance.
 - .3 Inside diameter shall fit around pipe insulation or uninsulated pipe. Outside diameter shall cover sleeve.
 - .4 Where sleeve extends above finished floor, escutcheons or plates shall clear sleeve extension.
 - .5 Secure to pipe or sleeve but not to insulation.
- .6 Penetration of Fire Separations:
 - .1 Contractors are CAUTIONED that all penetrations of fire separations are to be firestopped under this Contractor, but must be performed by a Contractor certified in this trade. Refer to Section 078400 of the specification.

1.20 PAINTING

- .1 Finish painting is generally provided by others except for the following which shall be provided by Division 15 Contractor:
 - .1 Piping, ductwork and equipment identification, glue and sizing and touch-up painting is the responsibility of Division 15 Contractors.
 - .2 Apply at least one (1) coat of corrosion resistant primer, and two (2) coats of suitable industrial corrosion resistant paint before shipment to job site to hangers, supports, stands and equipment fabricated from ferrous metals.
 - .3 Touch-up damaged finish surfaces to satisfaction of Engineer. Use primer or enamel to match original. Do not paint over nameplates.
 - .4 Painting of all above grade propane piping.

1.21 BASES AND SUPPORTS

- .1 Unless otherwise noted, concrete bases are required under all floor mounted equipment including equipment with attached skid and bases. All such bases shall be 100mm deep and shall be 100mm larger in all directions than the equipment being supported.

- .2 Where equipment is raised above the floor it shall be supported by means of angle iron, I beams or pipe. All such supports shall be anchored to the floor and shall have a metal base to spread the load. These supports shall be cross- braced with diagonal members.
- .3 Where equipment is suspended from the structure provide appropriately sized hanger rods, channel iron or angle iron hangers. Distribute the weight of the units uniformly across the structure, consistent with the design loading for the structure and as approved by the Consultant.
- .4 Where structure has not been designed to support equipment, this contractor shall provide pipe stands or angle iron supports to support the equipment from the floor.
- .5 Concrete bases shall be the responsibility of General Contractor. This Contractor to supervise and coordinate final layout and sizes of all concrete bases.
- .6 Unless specifically noted otherwise, provide spring isolators under all floor mounted vibrating, rotating or oscillating equipment designed to eliminate 90% of the vibration from being transmitted to the structure. For similar suspended equipment, provide spring hangers.

1.22 DI-ELECTRIC UNIONS

- .1 All connections between steel and copper for pipe 50mm and smaller shall be made with di-electric unions. On pipe 63mm and larger use flanged connections with non-metallic gasket and plastic sleeves for bolts.

1.23 INSPECTION, TESTING, AND CERTIFICATES

- .1 Periodic inspections of the work in progress will be made to check general conformity of the work to the Contract Documents. Observed deficiencies will be reported. Correct deficiencies immediately.
- .2 Meet the requirements of all laws, bylaws, codes, regulations and authorities having jurisdiction.
- .3 Where the Contract Documents, instructions or the governing authorities require Division 15 work to be tested, inspected or approved, give sufficient notice of its readiness for inspection and schedule the date and time for such inspection.
- .4 Uncover Division 15 work that is covered up without consent, upon Consultant request, for examination and restore at no extra cost to the Owner.
- .5 Furnish certificates and evidence that Division 15 work meets the requirements of authorities having jurisdiction.
- .6 Correct deficiencies immediately upon notification.

1.24 TESTS

- .1 Notice of Tests: Give written notice in ample time of date when tests will be made.

- .2 Prior Tests: Concealed or insulated work shall remain uncovered until completely tested and approved but if construction schedule requires arrange for prior tests on parts of system as approved.
- .3 Acceptance Tests: Conduct in presence of the Consultant or representative of Agencies having jurisdiction.
- .4 Costs: Bear all costs in connection with all tests.
- .5 Certificates: Obtain acceptance certificates from Agencies having jurisdiction. Work is not considered complete until certificates have been delivered to Consultant.
- .6 Water Systems: Fill with water and hydraulically test at 1½ times system operating pressure or at 100 psig whichever is greatest. Unless otherwise noted maintain pressures without loss for a four (4) hour period.
- .7 Test plumbing sanitary sewer, storm sewer and vent piping as required by National Building Code and Provincial Regulations.
- .8 Sanitary, storm and vent piping shall be tested by sealing outlets and filling the system to the highest point with water. The water level shall remain constant for a minimum of two (2) hours.
- .9 All ductwork to be leak tested in accordance with SMACNA "Air Duct Leakage Test Manual". Leakage not to exceed values specified in 15800-3.03.
 - (i) Contractor shall submit air duct leakage reports to Engineer for review. Report format to be in accordance with SMACNA manual.
 - (ii) Portion of ductwork to be tested to be as follows:
General Ductwork: 25%
- .10 For testing of air systems see individual items.

1.25 FLUSHING AND CLEANING

- .1 After pressure tests are completed and approved, prior to start-up and placing into operation, flush and clean out all piping systems.
- .2 Water Circulating Systems:
 - .1 A solution of Tri Sodium Phosphate T.S.P. shall be inserted into the system. This shall be allowed to remain in the system under heat conditions for at least twelve (12) hours. Then drain out, refill, flush again then refill.
 - .2 Drain Systems: Fill with solution of water and approved non-foaming, phosphate free detergent. Circulate solution throughout piping system.

- .3 Flush and drain systems until free of dirt, sludge, oil, grease and other foreign material. Clean strainers.
- .4 Refill water systems with clean water.

1.26 BALANCING

- .1 Scope of work
 - .1 The contractor will contract with an independent testing, adjusting, and balancing (TAB) agency to test, adjust, and balance the systems.
 - .2 The work included in this section consists of furnishing labor, instruments, and tools required in testing, adjusting and balancing the systems, as described in these specifications or shown on accompanying drawings. Services shall include checking equipment performance, taking the specified measurements, and recording and reporting the results.
 - .3 The items requiring testing, adjusting, and balancing include the following:
 - .1 Air Distribution Systems
 - .2 Hydronic Systems
- .2 Definitions, References, Standards
 - (i) All work shall be in accordance with the latest edition of the AABC National Standards. If these contract documents set forth more stringent requirements than the AABC National Standards, these contract documents shall prevail.
- .3 Submittals
 - (i) Qualifications: The TAB agency shall submit a company resume listing personnel and project experience in air and hydronic system balancing and a copy of the agency's test and balance engineer (TBE) certificate.
- .4 TAB preparation and coordination
 - .1 Shop drawings, submittal data, up-to-date revisions, change orders, and other data required for planning, preparation, and execution of the TAB work shall be provided to the TAB agency no later than 30 days prior to the start of TAB work.
 - .2 System installation and equipment startup shall be complete prior to the TAB agency's being notified to begin.
 - .3 The building control system shall be complete and operational. The Building Control System contractor shall install all necessary computers and computer programs, and make these operational. Assistance shall be provided as required for reprogramming, coordination, and problem resolution.
 - .4 All test points, balancing devices, identification tags, etc. shall be accessible and clear of insulation and other obstructions that would impede TAB procedures.
 - .5 Qualified installation or startup personnel shall be readily available for the operation and adjustment of the systems. Assistance shall be provided as required for coordination and problem resolution.
- .5 Reports
 - (i) Final TAB Report - The TAB agency shall submit the final TAB report for review

by the engineer. All outlets, devices, HVAC equipment, etc., shall be identified, along with a numbering system corresponding to report unit identification. The TAB agency shall submit an a certificate assuring that the project systems were tested, adjusted and balanced in accordance with the project specifications and AABC National Standards.

Submit three (3) copies of the Final TAB Report.

.6 Deficiencies

- .1 Any deficiencies in the installation or performance of a system or component observed by the TAB agency shall be brought to the attention of the Consultant.
- .2 The work necessary to correct items on the deficiency listing shall be performed and verified by the affected contractor before the TAB agency returns to retest. Unresolved deficiencies shall be noted in the final report.

.7 Instrumentation

- .1 All instruments used for measurements shall be accurate and calibrated. Calibration and maintenance of all instruments shall be in accordance with the requirements of AABC National Standards.
- .2 CAUTION - Contractor shall provide instrumentation devices as required to complete the balancing. Utilize external flow meters on hydronic systems where circuit setters or triple duty valves are not indicated.

.8 Air Distribution Systems:

- .1 The balancing sub-contractor will completely familiarize himself with the air distribution systems at the time of tender and will report to the Sheet Metal Contractor any and all areas where he feels additional dampers or other control devices are necessary for him to do a complete and thorough job.
- .2 Test and balance all air supply, return, and exhaust systems. Balancing must be performed by trained personnel who shall keep records on each trial balance.
- .3 Balancing shall be accomplished by means of Pitot tube traverse on all main and branch ducts. Fan speeds and dampers shall be adjusted until proper air quantities are obtained. Individual dampers behind registers and diffusers shall only be used for fine tuning.
- .4 Each outlet shall be adjusted by a "flow hood", anemometer or velometer readings to provide air quantities specified. Each supply outlet shall be adjusted to provide proper throw and distribution in accordance with requirements.
- .5 All necessary equipment including gauges, pitot tubes, anemometers velometers, etc., required for the testing and air balance shall be furnished and shall be of quality and capacity to ensure proper accuracy.
- .6 Upon completion of the balancing, supply the Architect with four (4) complete records which shall include air quantities at each outlet, provide if requested, a spot check on the system with the Owner's representative and Architect. If actual quantities do not agree with the balance report, this sub-contractor may be called upon to completely rebalance the systems until satisfactory to the Architect.
- .7 Adjust air flow at registers and grilles to equalize volume supplied and withdrawn from each room as indicated.

- .8 Provide the following information as part of the balancing report:

System No. System
Location Area System
Serves

Specified L/S
Actual L/S

Specified Suction SP
Actual Suction SP

Specified Discharge SP
Actual Discharge SP
Specified Total SP Actual
Total SP

Type of Sheave and Location (Motor or Fan)
Position of Sheave (i.e.) Maximum or Minimum RPM
Motor KW
Fan Rated KW

Amp Draw on Each Phase
Measured Voltage
Motor RPM

Fan RPM Specified
Fan RPM Actual

Fan curves for each fan showing plotted design and field conditions, static pressure readings across filter banks, coils banks of each air handling system, showing design and actual readings. Detailed summary of velocity traverses and calculated air quantities for each fan and branch ductwork. Schematic diagrams for all systems with all outlet numbered. Individual Diffuser Reports shall include:

Diffuser Type
Velocity M/S
Diffuser Multiplier
Specified L/S Actual
L/S

- .9 All openings shall be closed using removable gasketed plugs.

.10 Hydronic Systems

.1 The balancing sub-contractor will completely familiarize himself with the distribution systems at the time of tender and will report to the Contractor any and all areas where he feels additional valves, gauges or control devices are necessary for him to do a complete and thorough job.

.2 The TAB agency shall, as applicable, confirm that all hydronic equipment, piping, and coils have been filled and purged; that strainers have been cleaned; and that all balancing valves (except bypass valves) are set full open. The TAB agency shall perform the following testing and balancing functions in accordance with the AABC National Standards:

- .1 Pumps
 - .1 Test and adjust pumps to achieve maximum or design GPM. Check pumps for proper operation. Pumps shall be free of vibration and cavitation. Record appropriate gauge readings for final TDH and Block-Off/Dead head calculations.
 - .2 Current and Voltage - Test and record motor voltage and amperage, and compare data with the nameplate limits to ensure pump motor is not in or above the service factor.
 - .3 Mains & Branches
 - .1 Adjust water flow in pipes to achieve maximum or design GPM.
- .2 Heat Exchangers
 - .1 Verify that heat exchangers have been filled and started by others, and are in operation.
 - .2 Test and adjust water flow through heat exchangers.
 - .3 Test and record temperature and pressure profiles of water or steam heat exchangers.
- .3 Coils
 - .1 Tolerances - Test, adjust, and balance all cooling-water and hot-water coils within 10% of design requirements.
 - .2 Verification - Verify the type, location, final pressure drop and GPM of each coil. This information shall be recorded on coil data sheets.
- .11 Report Verification
 - .1 At the time of final inspection, the TAB agency may be required to recheck, in the presence of the owner's representative, specific or random selections of data recorded in the certified report. Points and areas for recheck shall be selected by the owner's representative. Measurements and test procedures shall be the same as approved for the initial work for the certified report. Selections for recheck, specific plus random, will not exceed 10% of the total number tabulated in the report.

1.27 IDENTIFICATION

- .1 Manufacturers Nameplates:
 - .1 Provide on each piece of equipment a metal nameplate, mechanically fastened with raised or recessed letters.
 - .2 Include registration plates (e.g. Pressure vessel, Underwriters' Laboratories and CSA approval) as required by respective agency and as specified. Indicate size, equipment model, manufacturer's name, serial number, voltage cycle, phase and power of motors, all factory supplied.
 - .3 Locate nameplates so that they are easily read. Do not insulate or paint over plates.

- .2 System Nameplates:
 - .1 Provide laminated plastic plates with black face and white centre of minimum size 15mm x 75mm x 3 mm nominal thickness, engraved with 6mm high lettering. Use 25mm lettering for major equipment.
 - .2 Fasten nameplates securely in conspicuous place. Where nameplates can not be mounted on cool surface, provide standoffs.
 - .3 Identify equipment type and number and service or areas or zone of building served.
- .3 Pipe Identification:
 - .1 Identify medium in piping with markers or stencils showing name and service including temperature and pressure and directional flow arrows where relevant.
 - .2 Contractor to provide identification schedule indicating legend and colours for approval prior to proceeding with identification.
- .4 Stencilled Identification:
 - .1 As an alternate to manufactured pipe markers identification may be stencilled on pipe using a first quality oil base paint and colour bands. Letters shall be a minimum of 19mm high.
- .5 Location of Identification:
 - .1 Locate markers and classifying colours on piping systems so they can be seen from floor or platform.
 - .2 Identify piping runs at least once in each room.
 - .3 Do not exceed 6 metres between identifications in open areas.
 - .4 Identify both sides where piping passes through walls, partitions and floors.
 - .5 Where piping is concealed in pipe chase or other confined space, identify at points of entry and leaving, and at each access opening.
 - .6 Identify piping at starting and ending points of runs and at each piece of equipment.
 - .7 Identify piping at major manual and automatic valves immediately upstream of valves. Where this is not possible, place identification as close to valve as possible.
 - .8 Identify branch, equipment or building served after such valve.
- .6 Duct Identification
 - .1 Use 50mm high black stencilled letters, i.e. "Cold", "Hot", "Return", "Sanitary Exhaust", "Kitchen Exhaust", with directional flow arrow.
 - .2 Maintain 6 metres maximum distance between markings.
 - .3 Identify ducts each side of dividing walls or partitions and beside each access door.
 - .4 Stencil over final finish only.
- .7 Valves:
 - .1 Provide brass or lamicoid tags with 12mm stamped code lettering and numbers filled with black paint. Secure with non-ferrous chains or "S" hooks. Use for all valves and operating controllers.

- .2 Provide Architect with six (6) identification flow diagrams of approved size for each system. Include tag schedule, designating number, service, function, and location of each tagged item and normal operating position of valves.
- .3 Mount where directed one copy of flow diagram and schedule each mounted in a glazed frame. Provide one copy in each maintenance instruction manual.
- .4 Consecutively number valves in system.

1.28 OPERATING INSTRUCTION & MAINTENANCE MANUAL

- .1 Refer to Section 017300.
- .2 Provide factory trained personnel to instruct operating staff on maintenance, adjustment and operation of mechanical equipment. Instruct staff on changes or modification in equipment made under terms of guarantee.
- .3 Provide instruction during regular work hours prior to acceptance and turn-over to operating staff for regular operation.
- .4 Prepare a maintenance schedule which will advise the Owner's staff what maintenance must be done and the suggested intervals at which it should be done.
- .5 Submit one copy for review at least two weeks before instruction to Owner are commenced.
- .6 Submit three (3) copies of final manuals to the Architect.
- .7 Ensure that the terminology used in various sections of the manual is consistent.
- .8 Each manual shall contain the following information:
 - .1 Description of each system with description of each major component of system.
 - .2 Complete sets of page size equipment Shop Drawings
 - .3 Equipment manufacturer's installation, startup and operation manuals.
 - .4 Equipment manufacturer's recommended spare parts lists
 - .5 Equipment wiring diagrams
 - .6 Lubrication schedule for all equipment
 - .7 Equipment identification list with serial numbers
 - .8 Page size valve tag schedule and flow diagrams
 - .9 Final balancing reports
 - .10 Water treatment procedure and tests
 - .11 Control drawings, sequences of operation
 - .12 Extended warranty documentation if applicable.
- .9 Manuals are to be completed and approved in time to be used during instruction of operating staff.

1.29 COMPLETION

- .1 Nothing herein contained can be construed to relieve the trade from making good and perfect work in all usual details of construction and in accordance with best standard practice and in strict compliance with the provisions of any and all laws and ordinances, and the rules and regulations of any duly constituted public body having jurisdiction over this work.
- .2 This trade shall be held responsible to provide and furnish all necessary labour and to bear all expenses incidental to the satisfactory completion of the work.
- .3 Remove all debris from inside Division 15 systems and equipment.
- .4 Rectify deficiencies and complete work before submitting request for Substantial Performance inspection.
- .5 Follow manufacturer's written instructions regarding bearing lubrication. Remove grease from pillowblock type bearings and install new grease before equipment is put into operation.
- .6 Check and align all drives to manufacturer's acceptable tolerances.
- .7 Adjust belts for proper tension.
- .8 Check and align all pumps to manufacturer's acceptable tolerances.
- .9 Remove all temporary protection and covers.
- .10 Remove oil and grease from equipment and bases.
- .11 Clean all fixtures and equipment. Polish all plated surfaces.
- .12 Vacuum clean the inside of all air handling systems, including fans, ducts, coils and terminal units to ensure that they are free from debris and dust.
- .13 Change air and water filters.
- .14 Remove, clean and reinstall pipeline strainer screens.
- .15 Leave Division 15 work in as new working order.
- .16 Contractor to commission system in accordance with AAFC Greenhouse Commissioning Plan.

1.30 PROJECT RECORD DRAWINGS

- .1 Nothing herein contained can be construed to relieve the trade from making good and perfect work in all usual details of construction and in accordance with best standard practice and in strict compliance with the provisions of any and all laws and ordinances, and the rules and regulations of any duly constituted public body having jurisdiction over this work.

- .2 One (1) set of white prints, and an electronic disk will be provided for record drawing purposes. Maintain project "as-built" record drawings and accurately record significant deviations from the Contract Documents, caused by site condition or Contract change. Mark changes on white prints in "Red". At the completion of the project, and prior to final inspection, transfer "as- built" information and notations to reproducible transparencies and submit both sets to the Architect for review.

1.31 INSTALLATION AND COMMISSIONING OF EQUIPMENT

- .1 Manufacturer's instructions shall be made available to both the installing tradesmen and the on-site inspector prior to installation of equipment. These instructions are to be read, understood and closely followed. Failure to abide by this requirement will provide justification for the engineer to require removal and re-installation.
- .2 Ensure that all safety devices and other significant accessories are in place and operable before starting major pieces of equipment. As part of the commissioning process accessories are to be checked, calibrated and adjusted as necessary to ensure safe operation.
- .3 Follow manufacturer's instructions in detail in establishing commissioning procedure and complete commissioning in accordance with the AAFC Greenhouse Commissioning Plan.
- .4 Provide start-up reports on all equipment installed under this Contract.

1.32 DEMONSTRATION OF COMPLETE SYSTEMS

- .1 At the conclusion of the job, the contractor shall review and demonstrate to the owner all equipment and their respective functions and operation. Such demonstration shall be provided for such reasonable periods of time as the complexity of the job warrants, and as approved by the Consultant. Such review and demonstration shall be made by an authorized representative of the contractor, fully knowledgeable of the project, its installation and operation.
- .2 The length of time required for training for each specific piece of equipment and each specific system will be approved by the Consultant prior to the training period.
- .3 Provide the Consultant with a schedule of system demonstration at least two (2) weeks prior to demonstration.
- .4 Refer to the AAFC Greenhouse Commissioning Plan for further requirements.

1.33 MECHANICAL SUBSTANTIAL COMPLETION

- .1 Prior to substantial completion of the mechanical work, the Contractor will inspect the project, provide a mechanical deficiency list, provide confirmation that all items on the list have been corrected and complete the following:
 - .1 All systems have been tested and certificates provided as required - Section 150100-1.24.
 - .2 All systems have been flushed and cleaned - Section 150100-1.25.
 - .3 All the Balancing is completed and the Report submitted - Section 150100-1.26.
 - .4 All Identification of systems is completed - Section 15010-1.27.

- .5 All Operating Instruction & Maintenance Manuals have been submitted - Section 15010-1.28.
 - .6 Complete all items listed in Section 150100-1.29 - Completion.
 - .7 Provide Record Drawings - Section 150100-1.30.
 - .8 Complete the Demonstration of the completed systems - Section 150100-1.32.
 - .9 Confirmation that all equipment has been properly commissioned. Refer to the AAFC Greenhouse Commissioning Plan.
- 2 Automatic Controls
- .1 All automatic control systems have been completed, commissioned, tested and debugged. Commissioning report has been submitted.
 - .2 The training of the automatic control systems has been completed with the Owner's representatives.
 - .3 All controls must be permanent controls. No temporary automatic controls will be permitted.

END OF SECTION

Part One - General

1.01 GENERAL

- .1 All conditions included in Section 15010 form part of this specification and shall apply as if repeated here. This contractor is to become familiar with those requirements and to conform to all provisions affecting his work.

1.02 SCOPE OF WORK

- .1 The work included in this Contract shall include the furnishing of all labour, materials, equipment, plant, tools and services necessary for, and incidental to the supply, installation and completion of insulation to the full intent of the Drawings and as hereinafter specified.
- .2 Work shall include, but is not necessarily limited to insulation of the following:
 - .1 Hot water heating piping.
 - .2 Domestic water piping.
 - .3 Tempered water piping.

1.03 REFERENCE STANDARDS

- .1 Conform to CHVAC-1975, CSA B54.1-1972 and ASTM 4-11-1967.

1.04 SUBMITTALS

- .1 Submit for approval if requested, manufacturer's catalogue literature related to installation, fabrication for pipe, fittings, valves and jointing recommendations.

1.05 DEFINITIONS

- .1 Unless otherwise specified, terms "exposed pipe" or "exposed ductwork" as used in this section shall refer to pipe or ductwork in finished spaces and shall include all areas except; furred spaces, pipe and duct shafts, spaces above furred ceilings, spaces over excavated areas, and crawl spaces. These latter areas will be referred to as "concealed spaces". Working chases or cores shall be considered as finished spaces.

Part Two - Products

2.01 PIPE INSULATION

- .1 Pipe insulation shall be preformed glass fibre having a nominal density of 88 kg/m³.
- .2 Jacketing on pipe insulation shall be as follows:
 - .1 Glass fibre reinforced kraft foil laminate.
 - .2 Maximum vapour transmission rate of 0.02 perms.
 - .3 50mm longitudinal overlap joints.

- .4 Fire retardant having a maximum flame spread rating of 25 and a maximum smoke developed rating of 25.
- .5 50mm overlap butt joints.
- .6 Insulation covers for fittings shall be premolded P.V.C. on exposed pipes.
- .7 Pipe jacketing in exposed areas shall be 8 oz. canvas with three coats of lagging adhesive to provide smooth finish, or premolded PVC jacketing system.

2.02 ACCESSORIES

- .1 Stainless steel wire, 18 gauge, Type 304, dead soft annealed.
- .2 Galvanized wire, 15 gauge, annealed.
- .3 Stainless steel mesh, hexagonal mesh, 20 gauge, Type 204.
- .4 Galvanized Mesh, hexagonal mesh, 15 gauge, galvanized annealed.
- .5 Aluminum straps, shall be 13mm x 26 gauge.
- .6 Stainless steel straps, shall be 13mm x 26 gauge. Type 304, dead soft.
- .7 Lagging adhesive, shall be Childers Chil-Lag CP-52 or Sealfast 30.36.
- .8 Vapour barrier mastic, shall be Childers Chil-Perm CP-10 weather barrier coating.
- .9 Weatherproof coating shall be Childers Chil-Perm CP-32 or Flintkote 230-04.
- .10 Reinforcing membrane under weatherproof coating shall be Childers Chil- Glas #5.

2.03 ACCEPTABLE PRODUCTS

- .1 Products of the following manufacturers are acceptable.
 - Fibreglass Canada
 - Canadian Johns Manville
 - Knauf Fibre Glass
 - Bakor
 - Dow

Part Three - Execution

3.01 PIPE INSULATION

- .1 25mm thick insulation is required on:
 - .1 Hot water heating piping.

- .2 Domestic water piping above 32mm.
- .2 12mm thick pipe insulation is required on:
 - .1 Domestic water piping up to 32mm.
 - .2 Tempered water piping.
- .3 Insulation shall not be applied until all the required tests have been completed.
- .4 Pipe surfaces must be clean and dry prior to application of insulation.
- .5 Pipe insulation must be kept clean and dry.
- .6 Pipe insulation shall be continuous at all hangers. The hangers shall be sized for the insulation thickness and be complete with insulation shields.
- .7 Unless specifically noted otherwise on the drawings, insulation shall be carried through walls and floors in 18 gauge galvanized iron pipe sleeves. Pipe sleeves shall be 25mm larger in diameter than the insulated pipe and the resulting void is to be packed with firestop material.
- .8 Both longitudinal and butt joints may be made with factory applied pressure sensitive vapour proof adhesive or by using a vapour proof mastic extending at least 25mm on either side of the joint.
- .9 Valve bodies shall have removable insulation.
- .10 Gouge out insulation for proper fit where there is interface between weld bead and insulation. Insulation shall be bevelled away from studs and nuts to permit their removal without damage to insulation, and shall be closely and neatly trimmed around extending parts of pipe saddles, supports, hangers, and clamp guides and sealed with insulating cement.
- .11 In exposed areas apply 8 oz. canvas jacketing c/w three coats of lagging adhesive to provide a smooth surface or premolded PVC jacketing system.

3.02

WORKMANSHIP

- .1 Install insulation in first class manner with smooth and even surfaces. Outline of pipe and round duct insulation shall be true circular and concentric shape. Outline of fitting insulation shall be shaped to blend with adjacent covering. Do not use scrap pieces of insulation where full length section will fit.

END OF SECTION

Part One - General

1.01 GENERAL CONDITIONS

- .1 All conditions included in Section 15010 form part of this specification and shall apply as if repeated here. This contractor is to become familiar with those requirements and to conform to all provisions affecting his work.
- .2 The plumbing systems are designed and installed in accordance with the National Building Code.

1.02 SCOPE

- .1 The intent of this Section of the specifications is to complement the drawings in describing all of the plumbing work required for the completion of this project.
- .2 This shall include but is not necessarily confined to the following:
 - .1 A complete sanitary drainage and vent system and all drains as shown on the drawings or specified herein.
 - .2 A complete hot and cold water distribution system as shown on drawings or specified herein.
 - .3 Provision of plumbing fixtures.
 - .4 Provision of plumbing equipment such as pumps, etc.
 - .5 Provision of domestic hot and cold water piping for connection by greenhouse contractor.

1.03 SHOP DRAWINGS

- .1 This contractor shall submit for approval a minimum of twelve (12) copies of the drawings for the following equipment:
 - .1 Plumbing fixtures and trim
 - .2 Plumbing specialties
 - .3 Valves
 - .5 Thermometers
 - .6 Pressure gauges

Part Two - Products

2.01 PIPING AND FITTINGS

- .1 Below Ground Sanitary Drainage & Vent Piping
 - .1 Pipe: - ABS conforming to CAN 3-B181.1-M
 - .2 Fittings - Same as pipe.
 - .3 Joints - solvent weld.
- .2 Above Ground Sanitary Drainage & Vent Piping 63mm and Larger
 - .1 Pipe: - Cast iron conforming to CSA-B70-M
 - .2 Fittings: - Same as pipe.
 - .3 Joints: - Mechanical joint.
 - .4 All urinal waste piping shall be cast iron.

- .3 Above Ground Sanitary Drainage & Vent Piping 50mm and Smaller
 - .1 Pipe: - DWV copper conforming to ASTM B306
 - .2 Fittings: - Wrought copper or cast brass.
 - .3 Joints: - 50/50 soldered, screwed at fixtures.

- .4 Water Piping - Below Ground
 - .1 Pipe: - Type "K" copper conforming to ASTM B88 or Aquapex.
 - .2 Fittings: - Wrought copper or cast brass.
 - .3 Joints: - Silver solder.

- .5 Water Piping - Above Ground
 - .1 Pipe: - Type "L" copper conforming to ASTM B88
 - .2 Fittings: - Wrought copper or cast brass.
 - .3 Joints: - 95/5 lead-free solder. Unions at fixtures.
 - .4 All exposed water, waste or vent piping, traps, etc. shall be heavy triple chrome plated.

- .6 Trap Prime Water Piping - Below Ground and Embedded in Concrete
 - .1 Pipe: - Aquapex or equal.
 - .2 Fittings: - Cast Brass.
 - .3 Joints: - Compression.

- .7 Trap Prime Water Piping - Above Ground
 - .1 Pipe: - Type "L" copper conforming to ASTM B88
 - .2 Fittings: - Wrought copper or cast brass.
 - .3 Joints: - 95/5 lead-free solder. Unions at fixtures.

2.02 HANGERS

- .1 Myatt, Grinnell or approved equal and equal to the following Myatt Cat. No.'s:
 - .1 Cast iron soil pipe:
Myatt Fig. 124 standard clevis hanger.
 - .2 Copper pipe:
Myatt Fig. 151CT Copper plated clevis hanger.
 - .3 Hangers on insulated piping are to be sized to accommodate the insulation thickness. Provide Myatt Fig. 251S insulation shields for all hangers on insulated piping.

2.03 PLUMBING SPECIALTIES

- .1 General:
 - .1 Plumbing specialties shall be Zurn, Smith, or Enpoco unless otherwise noted.
 - .2 All parts of specialties (other than gaskets) shall be metallic.

- .2 Standard of Acceptance:
 - .1 Floor Drains (F.D.)
Zurn Model ZN-415-B floor drain with 150mm diameter nickel bronze strainer, trap primer connection.
 - .2 Funnel Floor Drain (FFD)
Zurn Model Z-415-E funnel floor drain c/w trap primer connection and polished nickel bronze top.
 - .3 Trench Drain (TD-1)
Provide trench drains as indicated on the mechanical plans. Trench drains to be equal to ACO Drain Model K100S trench drain system. System to be complete with end caps and in-line catch basins with removable basket strainers as required. Trench drain to be installed in strict accordance with manufacturer's instructions.
 - .4 Cleanouts
 - .1 Finish Floor
Zurn Model ZN-1602 finished floor cleanout with 130mm diameter nickel bronze scoriated cover, and seal plug.
 - .2 Wall
Zurn Model ZN-1446-BP wall cleanout with access cover.
 - .5 Water Hammer Arresters
 - .1 Provide water hammer arresters on both hot and cold water piping.
 - .2 Arresters shall be sized in accordance with P.D.I. Standard WH201 where not indicated on the drawings.
 - .3 Arresters shall be Zurn Shoktrol Z-1700 series.
 - .6 Wall Hydrants
Ground Level - Zurn Model Z-1310 non-freeze wall hydrant with anti-siphon and automatic draining.
 - .7 Vacuum Breakers
Breakers: to CSA-B64 Series, vacuum breaker hose connection.
 - .8 Hose Bibbs and Sediment Faucets
Bronze construction complete with integral back flow preventer, hose thread spout, replaceable composition disc, and chrome plated in finished areas.

2.04

VALVES

- .1 All valves of a similar type shall be by one manufacturer and shall have the manufacturer's name and pressure rating clearly marked on the outside of the body.
- .2 The metal bodies, bonnets, yokes and discs of all bronze valves shall conform to ASTM-B-62. In iron body valves the cast iron shall conform to ASTM-A126, Class B.

- .3 Valves shall be Jenkins, Crane, Red & White/Toyo, Milwaukee or Kitz and equal to the following Jenkins Fig No.'s:

Up to 75mm

- Ball Valve - Jenkins Fig 201J or Fig 202J
Check Valve - Jenkins Fig 4092J or 9093
Globe Valve - Jenkins Fig 106BPJ or 106BP

100mm and Larger

- Butterfly Valve - Jenkins Series 100
Globe Valve - Jenkins Fig 2342J
Check Valve - Jenkins Fig 588J

2.05 DI-ELECTRIC UNIONS

- .1 Provide di-electric unions equal to Watts 3001A Series.

2.06 TRAP PRIMING

- .1 Provide Precision Plumbing Products P-1 trap primer valve and distribution units as required for trap priming of floor drains.

2.07 PLUMBING FIXTURES AND TRIM

- .1 Plumbing fixtures shall be as shown on Schedule A - Plumbing Fixtures and Trim.

- .1 Acceptable Manufacturers:

China: American Standard, Kohler
Stainless: Kindred, AMI
Service Sinks: Fiat, Florestone
Water Cooler: Elkay
Toilet Seats: Olsonite, Bemiss
Emergency Fixtures: Haws, Bradley

- .2 Fixture Trim shall be as shown on Schedule A - Plumbing Fixtures and Trim.

- .1 Acceptable Manufacturers:

General: Delta, Chicago, Zurn, T & S Brass
Showers: Symmons.

- .3 Materials

- .1 Vitreous China to CSA B45.
.2 Stainless steel fixtures to CSA B45.4 Class II. Type 302 in accordance with CSA G110.6 unless otherwise stated.
.3 Plumbing fittings to CSA B125
.4 Exposed plumbing brass and metal work shall be heavy triple chromium plated.
.5 Plumbing fixtures and trim shall be as shown in Schedule "A" at the end of this Section.

.4 CAUTION

Contractors to install supplies, drains, etc. for all fixtures in strict accordance with manufacturers roughing-in instructions. Carefully check exact location of all fixtures on the Architectural Drawings. Variances in roughing-in of plumbing fixtures will not be acceptable.

2.08 THERMOMETERS

- .1 Adjustable type, 225mm case, calibrated in Degrees F and Degrees C with range to suit the normal operating temperature of the fluid.
- .2 Acceptable Products: Winters Vari-Angle, Terrice BX, or Taylor-Weiss.

2.09 PRESSURE GAUGES

- .1 110mm diameter, equal to Ashcroft No. 1010.
- .2 All gauges to be complete with a gauge cock.
- .3 Provide a syphon on all steam services, snubber for pulsating operation, diaphragm for corrosive service.
- .4 Acceptable Products: Ashcroft, Morrison, Taylor.

2.10 BACKFLOW PREVENTERS

- .1 Provide where indicated or required where risk of cross contamination exists.
- .2 High hazards, including water entrance, to be protected by reduced pressure principle type backflow preventer, Watts Series 009.
- .3 Low risk hazard to be protected by double check valve type backflow preventer, Watts Series 007.
- .4 Provide dual check valve type backflow preventers on all kitchen equipment where indicated or required equal to Watts Series SD-2.
- .5 Acceptable Products: Febco.

2.11 DUPLEX SUMP PUMP

- .1 Provide Liberty 1100 Series duplex sump pump. Sump pump to be Liberty Model LE50 sewage pump, ½ HP, 230/1/60.
- .2 Sump pump system to be complete with the following hardware:
 - Integral float controls
 - AE21L=3 duplex pump controller
 - Red alarm beacon
 - Audible alarm
 - Auxiliary contacts for interface to EMCS
- .3 Acceptable Products: Hydromatic

2.12 DRAIN TILE PUMPING SYSTEM

- .1 Provide Liberty 1100 Series duplex sump pump. Sump pump to be Liberty Model FL62A sump pump, 6/10 HP, 230/1/60.
- .2 Sump pump system to be complete with the following hardware:
 - Integral float controls
 - AE21L=3 duplex pump controller
 - Red alarm beacon
 - Audible alarm
 - Auxiliary contacts for interface to EMCS
- .3 Acceptable Products: Hydromatic

Part Three - Execution

3.01 PIPING INSTALLATION

- .1 Install in accordance with Canadian Plumbing Code (CPC) and authorities having jurisdiction.
- .2 Conform to requirements of ANSI B31 Code for Pressure Piping.
- .3 Install propane piping in accordance with propane installation code (CSA B149.1) and authorities having jurisdiction.
- .4 Install straight, parallel and close to walls and ceilings, with specified pitch. Use standard fittings for direction changes.
- .5 Install groups of piping parallel to each other, spaced to permit application of insulation, identification, and service access or trapeze hangers.
- .6 Install eccentric reducers in horizontal piping to permit drainage and eliminate air pockets.
- .7 Where pipe sizes differ from connection sizes of equipment, install reducing fittings close to equipment. Reducing bushings are not permitted.
- .8 Brass and copper pipe and tubing shall be free from surface damage. Replace damaged pipe or tubing.
- .9 Ream ends of pipes and tubes before being made up.
- .10 Lay copper tubing so that it is not in contact with dissimilar metal and will not be kinked or collapsed.
- .11 Use non-corrosive lubricant or teflon tape applied to male thread.
- .12 Grooved pipe ends: cut square, seating surface clean and free from indent and score marks.
- .13 Install di-electric couplings wherever piping of dissimilar metals are joined.

- .14 Install swing or swivel joints to connect risers to mains.
- .15 All piping shall be run concealed in pipe spaces, chases and ceiling spaces where possible. Piping that is run exposed in finished areas shall be located in corners and boxed in. Where exposed piping is not boxed in, it is to be chrome plated.
- .16 Right angle connections in drain pipes shall be made with Y branches and 1/8 bends, the use of 90 Degree tees and elbows being avoided.
- .17 Each fixture shall be provided with back vent connections and individual trap.
- .18 All pipes passing under or through walls or underground shall be protected from breakage. All pipes below grade shall be carefully supported and every precaution taken against injury to pipe and joints.
- .19 An easily accessible cleanout shall be provided at each alternate change in direction in main soil or waste pipe and at the base of each stack. All cleanouts shall be of the same nominal size as the pipes up to 100mm and not less than 100mm for larger pipes. The distance between cleanouts in horizontal soil and waste lines shall not exceed 15m in pipe 100mm and smaller and 25m in pipe 150mm and larger.
- .20 Each main, all branch mains and runouts to a fixture group shall be valved.
- .21 Stacks less than 75mm where carried through the roof, shall be increased to at least 75mm before passing through the roof. Stacks 75mm and larger shall be carried through the roof full size.
- .22 It shall be the responsibility of this contractor to space all pipes so that they may be completely and separately insulated. Where possible, hot water pipes shall not run below parallel cold water pipes.
- .23 Pipe all relief valves to the floor. In other than Mechanical Rooms, pipe relief valves to floor drains or service sink.

3.02

HANGERS

- .1 All piping shall be securely hung from the building structure using approved hangers.
- .2 Maximum spacing shall be as follows:

Pipe Size	Maximum Spacing
Up to 38mm	2m
38mm to 75mm incl.	3m
100mm to 200mm incl.	4m
- .3 Horizontal storm, sanitary and special sewer pipes shall be supported at intervals of not more than 1.5m. Vertical pipes shall be supported at each floor by means of iron hooks or straps placed directly below hub or fittings. Vertical drops to fixture shall be supported at top of riser to prevent strain on fixture connection.

3.03 STOP VALVES AND DRAINS

- .1 Where runouts serve down-feed risers, a drain cock shall be placed at the low point in the supply pipe in an easily accessible location. Drain cocks may be omitted where pipe will drain completely through faucets.
- .2 Where indicated, and whenever any fixtures or floor drains are located below the street level, the contractor shall supply and install approved type backwater valves.

3.04 WATER CONNECTION

- .1 The Plumbing Contractor shall connect to the water service at the location as indicated on the drawings.

3.05 CLEANOUTS

- .1 Every cleanout shall be easily accessible and it shall be the responsibility of the Mechanical Contractor to see that access panels are provided for this purpose.

3.06 WATER HAMMER ARRESTERS

- .1 Water hammer arresters shall be located as shown on drawings and specified herein. Where not indicated they shall be located according to manufacturer's recommendations.
- .2 Install air chambers for each fixture and where indicated. These chambers shall consist of extending the water piping 450mm long by 19mm diameter.

3.07 CONNECTIONS TO FIXTURES

- .1 All plumbing fixtures shall be connected by means of unions, flanges, etc., so they may be easily removed without breaking in case of defect or repair.

3.08 VALVES

- .1 Globe valves used on hot water service shall be fitted with No. 110 discs suitable for hot water service.
- .2 A ball valve and check valve shall be installed in each recirculation branch or riser before joining the main.

3.09 DI-ELECTRIC UNIONS AND FLANGES

- .1 Install between any iron or steel and copper piping or equipment up to and including 50mm. Flanged connections with rubber gaskets and plastic bolt sleeves are to be used above 50mm.

3.10 SPECIAL EQUIPMENT

- .1 The contractor shall provide all necessary piping and make all connections to all special equipment such as heating equipment, ventilation equipment etc. All air handling units shall be provided with drains and piped indirectly to the sewer. A drain shall be provided at all fresh air intake and exhaust openings and shall be piped indirectly to the sewer. Traps or drains shall have unequal legs to compensate for the fan static pressure.

3.11 FIXTURE INSTALLATION

- .1 Connect fixtures complete with supplies and drains, separately trapped, supporting level and square. Each fixture must have valve and air chambers on supplies. Hot water faucets must be on left. Mixing faucets: mixing faucets and thermostatic controlled mixing valves to have check valves on supplies. Fixtures on outside walls to have supplies from floor; other fixtures to be served from wall.
- .2 Exposed piping, valves and metal to fixtures: Chrome plated IPS and with plated escutcheons.
- .3 Provide supports required to set fixtures level and square. Mount fixtures so that 100 kg. weight will not loosen or distort mounting. Fasten fixtures on walls or partitions with 12mm nominal carriage bolts passing through wall to 3mm thick steel plates, recessed where required, on other side of wall, unless chair carriers are specified.
- .4 Fixtures mounted on glazed tile surfaces shall have ground faces to finished surfaces.
- .5 Fixtures shall be serviced as follows:

Fixture	Waste (in)	Vent (in)	Cold Water (in)	Hot Water (in)
Floor Drain	75mm	32mm	----	----
Floor Drain (Slab on Grade)	75mm	32mm	----	----
Shower Drain	75mm	32mm	----	----
Emergency Eyewash/Shower	38mm	32mm	----	25mm

- .6 Floor drains shall be individually vented and individually trap primed.

.7 CAUTION

Contractor to install supplies, drains, etc. for all fixtures in strict accordance with manufacturers roughing-in instructions. Variance from this information will not be accepted.

**SCHEDULE A
PLUMBING FIXTURES**

P-1 Emergency Eyewash/Shower

Fixture: Haws Model 8300 combination emergency shower and eyewash.

END OF SECTION

Part One - General

1.01 GENERAL CONDITIONS

- .1 All conditions included in Section 15010 form part of this specification and shall apply as if repeated here. This contractor is to become familiar with those requirements and to conform to all provisions affecting his work.

1.02 SCOPE OF WORK

- .1 The work included in this Contract shall include the furnishing of all labour, materials, equipment, plant tools, and services, necessary for or incidental to the supply, installation and completion of a heating system to the full intent of the drawings and as hereinafter specified.
- .2 Any piping, fixtures, work or equipment herein specified but not shown on the plans, or vice versa, or any work, material or equipment necessary for the proper completion of the job, shall be furnished and installed as though both shown on the plans and specifications.
- .3 The work shall include, but is not necessarily limited to the following:
 - .1 Provision of hot water supply and return mains to serve the greenhouse.

1.03 SHOP DRAWINGS

- .1 This contractor shall submit for approval a minimum of ten (10) copies of shop drawings for the following equipment:
 - .1 Valves

Part Two - Products

2.01 PIPE AND FITTINGS

- .1 Above ground hot water piping shall be as follows: PIPE
 - 50mm & smaller - Blk steel T&G, ASTM-A-53 Sched. 40 continuous weld.
 - 65mm & larger - Blk steel P.E., ASTM-A-53 Sched. 40.
- JOINTS
 - 50mm & smaller - Screwed
 - 65mm & larger - Victaulic grooved or welded, flanged for valves at equipment.
- FITTINGS
 - 50mm & smaller - Standard malleable iron, screwed.
 - 65mm & larger - Sch. 40 steel butt welding ASTM-A-234 Grade A, Weld-O-Lets or equal.
- FLANGES
 - All - Class 150 steel slip-on or weld neck type, raised face, ASTM-A-181.
- BOLTS
 - Stud bolts, carbon steel, heavy hex nuts.

UNIONS
65mm & smaller - Class 150 malleable iron, brass to iron seats.

GASKETS
All - 2.3mm thick Cranite or approved equal.

- .2 Below grade hot water piping shall be Wirsbo Hepex cross-linked polyethylene in accordance with ASTM F876-877 c/w oxygen diffusion barrier. Below grade piping to be insulated with one inch thick armaflex foam pipe insulation.

2.02 HANGERS AND INSERTS

- .1 Pipe hangers to be Myatt or Grinnell and equal to the following Myatt Cat. No.'s.

Hot Water Piping - 124L

2.03 VALVES

- .1 All valves shall be by one manufacturer and shall have the manufacturer's name and pressure rating clearly marked on the outside of the body.

- .2 The metal bodies, bonnets, yokes and discs of all bronze valves shall conform to ASTM-B-62. In iron body valves the cast iron shall conform to ASTM-A-126, Class B.

- .3 All valves shall be complete with 50mm diameter metal tag attached with a chain identifying its function.

- .4 Valves shall be Jenkins, Milwaukee, Red & White/Toyo, Newman Hattersley, Kitz or Crane and equal to the following Fig. No.'s.

Up to 75mm

Ball Valve - Jenkins Fig 201J or 202J
Check Valve - Jenkins Fig 4092J or 9093
Globe Valve - Jenkins Fig 106BP or 106BPJ

100mm and Larger

Gate Valve - Jenkins Fig 454J
Globe Valve - Jenkins Fig 2342J
Check Valve - Jenkins Fig 588J
Butterfly Valve - Jenkins Series 100 with EPDM seat

2.04 AIR VENTS

- .1 Float type automatic air eliminators are required at all high points in the piping system. Provide a pet-cock or ball valve between the main and the air vent for servicing of vent.

- .2 Acceptable Products: Armstrong AV-11, Watts, Flair, Taco.

2.05 IN LINE CIRCULATING PUMPS

- .1 Existing pumps to be re-balanced to the flows indicated.
- .2 C-1a and C-1b - B & G Series 1531 model 2 ½ AB
(Greenhouse - Existing) 150 usgpm @ 40 ft head
1750 rpm 3 Hp 575V 3 Ph

Part Three - Execution

3.01 PIPING AND INSTALLATION

- .1 Arrange and install piping approximately as indicated, straight, plumb, and as direct as possible. Pipe shall be at right angles to parallel lines and building walls.
- .2 Locate groups of pipe parallel to each other, spaced at a distance to permit applying full insulation and access for servicing valves.
- .3 Grade forced water piping 1.5mm per meter so that when the system is filled, the air in the mains and risers shall be carried to vents at high point. Install sediment faucets to drain low points.
- .4 Where horizontal water piping is reduced in size, provide eccentric reducing coupling with top of pipe level.
- .5 All downfed heating units to have sediment faucets on return piping for proper drainage of heating systems.
- .6 Forced water return and supply piping shall be taken off main at 45 Degree angle from each main or branch main. All runouts to be made with four (4) joints to permit expansion and avoid strain on equipment.
- .7 Unions shall be provided where indicated and at the following locations; in by-passes around equipment, at heaters, tanks, pumps or other equipment requiring disconnection for repairs or replacement. Locate between shut-off and equipment. Do not conceal unions in walls, partitions, or ceilings.
- .8 Provide shut-off valves where indicated or specified and in the following locations: in risers and main branches at point of take-off from the supply or return main, at individual equipment unit inlets and outlets to permit unit removal for repairs without interfering with remainder of system.
- .9 Keep piping free from scale and dirt. Protect open end of pipe wherever work is suspended during construction. To prevent foreign bodies entering or lodging use temporary plugs, burlap or other approved materials for protection.

3.02 EXPANSION JOINTS ANCHORS AND GUIDES

- .1 Provide for expansion of mains and risers by use of loops, bends, offsets and expansion joints. Provide guides and anchors where indicated or as required to allow expansion of pipe without binding.
- .2 Install expansion joints in strict conformity with manufacturer's instructions.
- .3 All main expansion loops or bends shall be half cold sprung. Branch connections shall have strain on when cold, off when hot.
- .4 Where not otherwise indicated provide two (2) sets of alignment guides on each side of expansion joint spaced to manufacturer's requirement.
- .5 All wall fin radiation with 12m or more of finned radiation to have expansion compensators installed in such a manner to prevent stress on joints and connections.

3.03 HANGERS AND SUPPORTS

- .1 Provide all hangers required for the proper support of piping in this division.
- .2 In concrete construction, each Sub-Contractor shall set inserts at proper centers, securely attached to forms before concrete is poured. Inserts shall be Grinnell No. 281. Where concrete has been poured, a suitable fastening device shall be used.
- .3 Beam clamps shall be used when hanging from any structural steel members. No drilling or welding of these members shall be permitted unless approved by the Architect.
- .4 Hang all piping to and from any circulating pumps 2 h.p. and larger within mechanical room with spring hangers.
- .5 Supporting bolts shall be maximum size usable with the specified hanger, with adjustable and locking stop units.
- .6 Space hangers for horizontal piping as follows:
 - .1 Steel Piping
 - Up to & including 25mm - 2m intervals.
 - 32mm and over - 3m intervals.
 - .2 Copper Piping
 - Up to & including 25mm - 2m intervals.
 - 32mm and over - 3m intervals.
- .7 On uninsulated copper piping, use plastic coated hangers, or other approved separation between copper and ferrous hanger.

- .8 Pipe hanger and structural attachments shall be installed in such a manner that the rod is vertical when the piping is hot.

3.04 AIR VENTS

- .1 At every high point in piping mains, the contractor shall supply and install automatic air eliminators in order to avoid air pockets in the system. Air vents are to be installed at an accessible place with the aid of necessary piping in order to facilitate maintenance.
- .2 Supply and install a pet-cock on pipe between main and air vent for shut-off and servicing of vent.
- .3 Provide manual type air vents on all upfed radiation. Extension shall be provided to enable operation of the vent without removing the enclosure.

3.05 DRAINS

- .1 Provide drain valves with hose ends at the low points of all piping, and at the bottom of each downfeed heating riser.
- .2 All small drains from each piece of equipment shall be brought over to a hopper drain and shall terminate 50mm above the funnel. These shall include small surface drains from pumps, strainers, boilers, heating system main drain outlets, etc., and shall run in galvanized steel piping to nearest floor drain or hopper. No drip drain or over-flow line shall be left so that liquid or vapour will spill on equipment or floors.
- .3 On all mains and risers provide a ball valve between mains and sediment faucets.

END OF SECTION

Part One - General

1.01 GENERAL CONDITIONS

- .1 All conditions included in Section 15010, Division 1 and General Conditions form part of this specification and the contractor shall comply with all clauses included in these sections.

1.02 SCOPE OF WORK

- .1 The work included in this Contract shall include the furnishing of all labour, materials, etc. necessary for the completion of the Automatic Control Systems required for the addition to alarm inputs from greenhouse expansion automatic controls system.
- .2 The building automation and control network shall use BACnet communication protocol.

1.03 ELECTRICAL WORK

- .1 Line voltage power wiring will be done by the Electrical Contractor. Source of 120V power for low voltage transformers will be provided in the Mechanical Room. Actuators etc. shall be fed from that point by this Contractor.
- .2 All control wiring (regardless of voltage) shall be the responsibility of this Contractor, unless otherwise indicated. Wiring to be installed in accordance with this Section and Div. 16 Sections.
- .3 Generally, all controls shall be low voltage unless otherwise indicated.
- .4 All Electrical wiring to be done in accordance with the P.E.I. Electrical Code.

1.04 SHOP DRAWINGS

- .1 This contractor shall submit for approval ten (10) copies of shop drawings for all Automatic Control Systems.
- .2 Provide technical literature on system components.
- .3 Submit for review detailed drawing of control panel layout, of control graphic illustration and construction proposed.

1.05 MAINTENANCE AND SERVICE

- .1 Provide maintenance data for incorporation into maintenance manual specified in Section 15010. Data shall refer only to specific models and types of equipment installed.
- .2 Check and adjust control systems every three (3) months during first year from date of acceptance. Report in writing, results of resettings made. (Include as part tendered price total cost of standard equipment supplier/installer service

contract for a further period of twelve months, allowing for not less than six (6) visits for service adjustment in the second twelve month period).

- .3 Provide as-built information in accordance with Section 15010.

1.06 GUARANTEE

- .1 Provide a written guarantee stating that the controls are guaranteed against faulty material and workmanship for a period of two years from the latest of:
1. Date of substantial completion;
 2. The date on which all systems are demonstrated to be operating correctly. For the purpose of establishing the latter date, the contractor shall arrange to demonstrate full and complete operation to the Owner and Engineer. This demonstration to take place after all controlled items are in place and operating.
- .2 At the end of the warranty period the DDC operating system shall be the latest version from the manufacturer.

Part Two - Products

2.01 GENERAL

- .1 Control Systems provided by Controls & Equipment and Memco Controls are considered acceptable for this project.

2.02 EQUIPMENT

- .1 Stand Alone Controller (SAC)
- .1 Stand Alone controller (SAC) panels shall be stand alone, independent devices, each capable of carrying out its control functions completely independently of all other control panels. Each control panel shall be able to communicate and share information with other control panels in LAN arrangement.
 - .2 Control panel software shall be protected from loss due to power failure for a minimum period of 72 hours.
 - .3 The control panel shall contain a real time hardware clock and watchdog timer.
 - .4 Control panel diagnostics shall consist of built in continuous operational and board level tests. Light emitting diodes shall annunciate hardware failures, and control program errors.
 - .5 Panel input/output points shall be universal allowing each point to be defined as an analog or digital.

- .6 Each control panel shall have separate RS-232 ports for communicating with a personal computer, printer and a modem.
- .7 I/O configuration:
 - .1 SAC to provide connection for 16 inputs and 16 outputs in any combination of digital and analog. Outputs shall have on-board HAND-OFF-AUTO switch for override control in the field. A maximum of 24 expansion boards can be added for inputs/outputs in any combination.
 - .2 Each MiniSAC to have 8 universal inputs and 12 outputs. A maximum of 24 Input/Output boards can be added for I/O expansion in any combination.
 - .3 Each MicroSAC to have 4 universal inputs and 4 digital or universal outputs. A maximum of 24 Input/Output boards can be added for I/O expansion in any combination.
- .8 Memory Capacity: Each controller to have sufficient capacity of RAM, ROM and FlashRAM to handle the points and programmed database required.
- .9 Power Switch: Each controller to have an on-board power switch to turn the controller's power on and off. Each controller to have on board fuses.
- .10 Powerline Filters: Controllers to be provided with on-board powerline filter circuitry to minimize the effects of powerline noise, surges, and spikes.
- .11 Dip Switches: On-board dip switches are provided to permit simple assignment of panel number. The dip switches shall uniquely describe each panel's trunk and panel number as PA101, PA102, PA103, and so on. MicroSAC panels shall be addressable in flashRAM so that loss of power will retain panel address.
- .12 Compatible Baud Rate: Terminal and modem baud rates US Robotics compatible for 9,600, 19,200, 33,600, 55,600 baud.
- .13 Multiple Controllers: While fully capable of operating as an independent device, a controller may be connected via an RS-485 communication bus to other controllers.
- .14 Peer-to-Peer Communication: Information, either gathered via controller inputs or calculated to be available for use by any other connected controller. Both control algorithms and displays in one controller may automatically use information from any or all connected controllers.

- .2 Stand-Alone Operation: Each SAC Controller to contain in memory all required schedules and control algorithms for monitoring and controlling all connected equipment. If its communication bus were removed, it would continue to operate normally under its own direction and clock schedule. Once programmed, a system of controllers will operate independently. Peer-to-Peer communications and data sharing is still provided. Each controller may request and receive information from any connected controller.
 - .1 The RS-485 data communication bus at 38,400 baud provides a maximum distance between end controllers of 100m (3280 ft.). This distance can be extended using RS485 repeater boards or fibre optics converters.
 - .2 Communication Bus: To be a twisted, 18 AWG (0.823 mm) two wire, in conduit or equivalent FT4 shielded cable.
 - .3 Environmental Operating Limits: Temperature: 0°C to 50°C (32F to 122F). Humidity 0-95% RH, non-condensing.

2.03

DEVICES

- .1 I/O devices connected to the controller shall use snap on/off connector blocks. Their configuration to be programmer selectable from the SAC panel.
- .2 Analog Inputs: Analog inputs are programmer assigned as automatic or manual. In the manual mode, the assignable input values range from -3200.0 to 3200.0. Analog inputs may be assigned a zero adjustment value between -100.0 to 100.0.
 - .1 Thermistor sensors to provide temperature readings selectable in either 0°C or F. A 1000 ohm thermistor is used for outdoor air temperature with a range of -40°C to 40°C (-40F to 110F). 3000 ohm thermistors used elsewhere covering a range of -10°C to 120°C (15F to 250F).
 - .2 Platinum: 100 ohm or 1000 ohm at 0°C, platinum, two-wire sensors with external 4 to 20 ma transmitter.
 - .3 Voltage: The following voltage ranges shall provide a reading of 0 to 100% and are programmer selectable: 0 to 1Vdc, 0 to 5Vdc, 0-10Vdc and 2 to 10Vdc.
 - .4 Current: The following programmer selectable current inputs are provided, based on a 500 ohm load: 0 to 20 mA dn 4 to 20 mA.
 - .5 Pulses: The Totalizer shall accept a rate of 600 pulses per minute or less.
- .3 Digital Inputs: Digital inputs (DI's) to be programmer assigned as automatic or manual. In the automatic mode, the controller shall read the actual status of its input. In the manual mode, the reported status of the input can be overridden by the operator. Direct or reverse action is also selectable. The input contacts may be normally open or normally closed.

- .4 Analog Outputs: Analog outputs (AO's) are programmer assigned as automatic or manual. In the automatic mode, the analog output is determined by the controller programmed algorithm. In the manual mode, the operator can override the output state. Direct or reverse action is also selectable.
- .5 Digital Outputs: Digital Outputs (DO's) are programmer assigned as automatic or manual. In the automatic mode, the digital output is determined by the controller programmed algorithm. In the manual mode, the operator can override the output state. Direct or reverse action is also selectable. Each controller shall support direct ribbon cable connection to standard external relay boards.

2.04 SOFTWARE

- .1 Operating software shall be provided at no additional charge.
- .2 At least four levels of access shall be provided. Specifics of access to be determined in consultation with Engineer and owner.
- .3 Diskette to be provided at no additional cost to allow owner to "dump" program.
- .4 At least the first two levels of access shall be "menu driven".

2.05 GRAPHIC PACKAGE

- .1 Provide upgraded controls graphic package for controls system. Contractor to develop graphics for each new system being controlled and/or monitored.
- .2 Provide the capability to control all points from the dynamic graphic display.

2.06 ELECTRIC RELAYS

- .1 Provide DPDT relays for control and status indication of alarms and/or electrical starters and equipment where shown on point schedule.
- .2 Relay coils shall be 24 Vac to suit application.
- .3 Contacts rated at 5 amps at 120 VAC.
- .4 Relays to be plug in type with termination base.
- .5 Acceptable Material: Omron LY series with PTF08 base or approved equal.

2.07 CURRENT TRANSDUCER

- .1 Provide current transducers pump and boiler status with range to suit application.

- .2 Current transducers shall measure line current and product a signal in one of the following ranges:
 - .1 On-Off
 - .2 4-20mA.
 - .3 0-5 Vdc.
 - .4 Acceptable Material: Greystone CS305/350, Veris 705/905

Part Three - Execution

3.01 GENERAL

- .1 Install all automatic control components in accordance with the manufacturer's recommendations.
- .2 Provide operational instructions on all control systems.
- .3 Perform all low voltage wiring in strict accordance with the P.E.I. Electrical Code.

3.02 SEQUENCE OF OPERATION

- .1 General
 - .1 In addition to the items shown or specified elsewhere in the specification the EMS system is required to provide the following information:
 - .1 On/off status of the following:
 - Alarms from Greenhouse
 - Alarm from sewage lift station
 - Alarm from drainage tile pump station

3.03 INSTALLATION

- .1 Electrical:
 - .1 Furnish all electrical control wiring in conduit unless indicated otherwise on plans.
 - .2 All work shall be installed to the applicable codes and regulations. Fire rated plenum cable may be used for all low voltage control wiring in accessible ceiling cavity where the installation of such meets the Canadian Electrical Code. Exposed or concealed wiring must be in conduit. All wiring and conduit to be run parallel to building lines. Contractor to run plenum cable in a neat manner and group wiring in J-hooks where practical.
 - .3 Obtain and pay for all required electrical permits and inspections at no additional charge to the Owner.

- .4 All electrical work shall be in full compliance with the requirements of Section 16000.
- .2 Check and verify location of temperature sensors and other exposed control sensors with plans and room details before installation.
- .3 All equipment installed shall be mechanically stable and, as necessary, fixed to wall or floor. Anti-vibration mounts to be provided, if required, for proper isolation of the equipment.
- .4 Equipment shall be installed so as to allow for easy maintenance access. Equipment shall be installed such that it does not interfere in any way with access to adjacent equipment and personnel traffic.
- .5 Permanently identify each wire, cable, and conduit at each termination.
- .6 Wiring shall be identified at each DDC panel by termination number. Wiring shall be identified at terminal device by termination and DDC panel numbers.

3.04 START-UP AND ADJUSTMENT

- .1 Upon completion of installation, test, adjust and regulate controls or safety equipment provided under this section.
- .2 Adjust and place in operating condition.
- .3 Plasticized control schematics shall be provided for each fan system mounted inside cabinet enclosures.
- .4 Provide lamicoid label at each sensor identifying its function. Use same terminology as on shop drawings and software. Install labels before system demonstration. Identify location of each sensor during demonstration.
- .5 Fully test and debug all sequences prior to demonstration to the Engineer and prior to the demonstration of the Owner.
- .6 Provide a calibrated digital test thermometer for the commissioning period. Provide 2-way radios capable of transmitting from one end of the building to the other for the commissioning period.

3.05 INSTRUCTION AND TRAINING

- .1 Training in the operation of the system shall be provided at two levels as follows:
 - .1 Maintenance personnel shall be instructed in the operation and maintenance of all mechanical components and shall be provided with "hands-on" instructions of the energy management system. To facilitate this, simplified written instructions shall be provided giving key strokes etc. necessary for operation.
 - .2 Detailed instructions and training shall be provided to designated technical personnel to enable them to become fully conversant with diagnostic procedures as well as modifications possible at all levels of access.

- .3 Allow for a minimum of two (2) days training.
- .4 At the time of the Owner's demonstration and instruction period:
 - .1 Demonstrate confirm that all systems are programmable and operating correctly.
 - .2 Submit (3) printed copies of final programs that include all point definitions, weekly and annual schedule settings, controller setpoints and tuning parameters, and documented general control language (GCL) programs.

END OF SECTION