1 General

1.1 SUBMITTAL

.1 Each bidder for the work of Division 15: Mechanical shall submit this Supplementary Bid Form to the consultant at time of tender closing to the Consultant.

.2 This document, on acceptance by the Consultant, will be included in the Contract Documents and shall govern the work of Division 15: Mechanical.

1.2 DIVISION 15 SUBCONTRACTORS

.1 List the trade Subcontractors that have been included in the bid proposal;

TRADE		SUBCONTRACTOR
Plumbing	❑ **Own Forces**	_____
Gas Fitting	❑ **Own Forces**	_____
Hydronic Piping	❑ **Own Forces**	_____
Welding	❑ **Own Forces**	_____
Automatic Sprinklers	❑ **Own Forces**	_____
Sheet Metal	❑ **Own Forces**	_____
Refrigeration	❑ **Own Forces**	_____
Insulation	❑ **Own Forces**	_____
Controls		_____
Testing Adjusting Balancing		_____
Commissioning Agent		_____

1.3 LABOUR RATES

.1 Indicate the unit labour rate required for additional work and/or work to be deleted in changes to the Contract under Part 6 of the General Conditions of the Stipulated Price Contract. Rates indicated shall include all allowances for foremen, supervision and office support but shall not include the Division 15 Contractor's overhead and profit margins and shall be based on regular working hours.

.2 The Owner reserves the right to negotiate labour rates prior to award of contract.

TRADE	HOURLY RATE
Plumbing	_____
Gas Fitting	_____
Hydronic Piping	_____
Welding	_____
Automatic Sprinklers	_____
Sheet Metal	_____
Refrigeration	_____
Insulation	_____
Controls	_____
Testing Adjusting Balancing	_____
Commissioning Agent	_____

1.4 PRODUCTS

.1 Indicate the name of the manufacturer of equipment items included in the Bid Price. Failure to indicate a specific manufacturer will be taken to mean that products of the first manufacturer named in the specifications are included in the Bid Price. This list is intended to cover only major equipment items and shall in no way limit the extent of the Contract.

.2 The Division 15 Bidder may propose the name of an alternative manufacturer for any equipment item in accordance with Section 15010, Part 2, Article 2.03.

.3 Verify that electric power is available and of the correct characteristics.

PRODUCT	MANUFACTURER	ALTERNATIVE
15110: Gauges and Meters		
Gauges	_____	_____
15115: Access Doors		
Access Doors	_____	_____
15125: Variable Frequency Drives		
VFD's	_____	_____
15160: Piping Expansion Compensation		
Expansion Compensation	_____	_____
15305: Portable Fire Extinguishers		
Fire Extinguishers	_____	_____
Cabinets	_____	_____
15410: Plumbing Pumps		
Domestic Hot Water Recirc Pump	_____	_____
15415: Plumbing Piping		
Valves	_____	_____
15420: Plumbing Specialties		
Cleanouts	_____	_____
Roof Drains	_____	_____
Floor Drains	_____	_____
Wall Hydrants	_____	_____
Backflow preventers	_____	_____
Water hammer arrestors	_____	

Thermostatic mixing valves	_____	_____
Trap Seal Primers	_____	_____
Trench Drain	_____	_____
Oil Interceptor	_____	_____
Grease Interceptor	_____	_____
Pressure Tank	_____	_____
Washing Machine Valve	_____	_____
15430: Water Closet		
Water Closet	_____	_____
Seats and Lids	_____	_____
Flush valves	_____	_____
Carriers	_____	_____
15432: Urinals		
Urinals	_____	_____
Flush valves	_____	_____
Carriers	_____	_____
15433: Lavatories		
Lavatories	_____	_____
Faucets	_____	_____
Carriers	_____	_____
15434: Stainless Steel Sinks		
Stainless Steel Sinks	_____	_____
Faucets	_____	_____
15435: Utility Sinks		
Utility Sinks	_____	_____
Facuets	_____	_____
Hose Wash	_____	_____
15436: Showers		

Showers	_____	_____
15439 Safety Fixtures		
Eye/Face wash	_____	_____
Combination Drench Shower / Eye/Face wash	_____	_____
15441: Drinking Fountains		
Hydration Station	_____	_____
15450: Plumbing Equipment		
Hot Water Heaters	_____	_____
15470: Compressed Air System		
Valves	_____	_____
Air Compressor	_____	_____
Hose Reels	_____	_____
15500: Hydronic Piping		
Valves	_____	_____
Circuit Balancing Valves	_____	_____
15501: Radiant Floor Heating System		
Fittings	_____	_____
Manifolds	_____	_____
Controls	_____	_____
15505: Chemical Treatment for HVAC Piping		
Chemical Treatment	_____	_____
15510: HVAC Pumps		
Pumps	_____	_____
15515: Hydronic Equipment and Specialties		
Expansion Tanks	_____	_____
15530 Fuel Gas Piping		
Valves	_____	_____
15544: Boilers, Condensing Type		

Boilers	_____	_____
15570: Heat Exchangers		
Heat Exchangers	_____	_____
15655: Ductless Split Air Conditioning System		
PQRY-P-THMU Modular Water-Cooled Condensing Unit	_____	_____
Branch Circuit BC Controllers for WR2-Series Systems	_____	_____
Citymulti Variable Refrigerant Flow Indoor Units	_____	_____
PLFY-P**NBMU-E (4-Way Ceiling-Recessed Cassette With Grille) Indoor Unit	_____	_____
PEFY (Ceiling-Concealed Ducted) Indoor Unit	_____	_____
15730: Make-Up Air Units		
Make-Up Air Units	_____	_____
15732: Infrared Heaters, Fuel-Fired		
Infrared Heaters, Fuel-Fired	_____	_____
15820: Sount Attenuators		
Sount Attenuators	_____	_____
15825: Fans, Commercial/Institutional		
Fans	_____	_____
Energy Recovery Ventilator	_____	_____
15845: Air Outlets and Inlets		
Air Outlets and Inlets	_____	_____
15855: Engine Exhaust Gas Collection		
Engine Exhaust Gas Collection	_____	_____
15900: Building Management System		
Building Management System	_____	_____

Affix Corporate Seal

Name and Address of Division 16
Electrical Sub-Contractor:

_____

_____

_____

_____

_____

End of Section

1 General

1.1 GENERAL

.1 Read and conform to:
- .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
- .2 Division 1 requirements and documents refered to therein.
- .3 Refer to Instructions to Bidders and/or Supplementary Conditions for instructions regarding taxes, including the Manitoba Provincial Retail Sales Tax (RST) and the Federal Goods and Services Tax (GST).

.2 The technical Sections of this Division are generally divided into units of work for the purpose of ready reference. The division of the work among subcontractors is not the Consultant's responsibility and the Consultant assumes no responsibility to act as an arbiter and/or to establish subcontract limits between any Sections of the work.

.3 The specifications are integral with the drawings which accompany them. Neither is to be used alone. Any item or subject omitted from one but implied in the other is fully and properly required.

.4 Wherever differences occur in the tender documents, the most onerous condition governs. Base the bid on the most costly arrangement.

1.2 GENERAL REQUIREMENTS

.1 Section 15010 applies to and governs the work of all Sections of Division 15.

1.3 COMMON WORK ELEMENTS

.1 Provide labour, materials, plant equipment, and incidentals necessary to completely supply, install, test and put into operation all mechanical work indicated under this Division. Provide all tools, equipment and services required to do the work.

.2 Cutting and patching of new or existing work

.3 Excavating and backfilling

.4 Identification of equipment, piping, ductwork, and valves and controllers

.5 Concrete equipment bases, housekeeping pads, sump pits and trenches.

.6 Motors required for equipment supplied under this Division.

.7 Internal wiring, relays, contactors, switches, transformers, motor starters, and all controls necessary for the intended operation, furnished with terminals and external controls suitable for connection to power source at a single easily accessed location for equipment items that are supplied with motors and/or electrical or electronic components under this Division.

.8 Disconnect switches for exhaust fans located on the roof complete with;
- .1 EEMAC 1 enclosure if housed within a weatherproof cabinet,
- .2 EEMAC 3 enclosure if exposed to weather

.9 Take such measures and include in Bid Price for the proper protection of the existing building and its finishes at all times during alterations and constructionof the new addition. Coordinate this protective work with all trades.

.10 Refer to Mechanical/Electrical Schedule for extent of wiring and electrical characteristics.

.11 Verify the correct operation of each equipment item provided and/or altered and each system in total and obtain the Owner's approval prior to starting and/or returning to operation.

1.4 RELATED WORK

.1 Power wiring, conduit and connections for motors under this Division will be by Division 16.

.2 Flashings for mechanical equipment and services located on or passing through roofs will be provided under Division 7. Supply counter flashings, and integral flashing collars on equipment and piping under this Division.

.3 Painting of exposed piping and ductwork other than for identification will be supplied under Division 9.

1.5 SUBMITTALS

.1 Approval Drawings: Prepare and submit drawings necessary for approval to any authority having jurisdiction, and obtain two (2) copies of approved drawings for retention by Consultant prior to commencement of work under this Division.

.2 Shop Drawings:Prepare and submit two (2) copies of shop drawings of major equipment items (including those items specifically indicated under Part 1: General of each Section), to the Consultant for review. The Consultant will return one copy, marked with comments and his review stamp as he deems appropriate. Prepare the necessary number of copies of the returned set and distribute to the Owner, the Prime Consultant, the General Contractor, the site, and to subcontractors and suppliers.

.1 Clearly indicate manufacturer's and supplier's names, catalogue model numbers, details of construction, accurate dimensions, capacities and performance. Prior to submission check and certify as correct, shop drawings and data sheets. Do not order equipment until a copy of the shop drawings, reviewed by Consultant, has been returned to Contractor.

.2 Clearly indicate the weight, location, method of support and anchor point forces and locations for each piece of equipment on shop drawings.

.3 The Consultant will not review shop drawings that fail to bear the Contractor's stamp of approval or certification.

.4 Read the following in conjunction with the wording on the shop drawing review stamp applied to each and every drawing submitted:
"This review by the Consultant is for the sole purpose of ascertaining conformance with general design concept. This review shall not mean that the Consultant approves the detail design inherent in the shop drawings, responsibility for which shall remain with the Contractor submitting same, and such review shall not relieve the Contractor of his responsibility for errors or omissions in the shop drawings or of his responsibility for meeting all requirements of the Contract Documents. The Contractor is responsible for dimensions to be confirmed and correlated at the job site, for information that pertains solely to fabrication processes or to techniques of construction and installation and for coordination of the work of all sub trades."

.3 Sleeving Drawings: Prepare and submit 4 copies of sleeving drawings to clearly and accurately indicate the exact location, elevation and size of any and all formed holes, recesses and sleeving required in the work of Division 15. Obtain Consultant's approval in writing prior to sleeving, forming or cutting any such opening. Provide a copy of approved sleeving drawings to the reinforcement detailer well in advance of planned pours.

.4 Composite Wiring Diagrams: Prepare and submit three (3) copies of complete composite wiring diagrams of each specific mechanical system. Indicate all electrical equipment and wiring, both internal and external, for review and coordination of trades.

.5 Contractor's Material and Test Certificates: Prepare and submit certificates for each system installed. Where certificates are prescribed by regulations, codes or standards ensure they conform to the requirements of those documents (eg. NFPA-standards). Include a copy of each certificate in the Operation and Maintenance manual. Certificates shall include the following:

.1 description of the system (description and type),

.2 description of the tests conducted and results observed, including re-testing, where necessary,

.3 description of any corrective measures undertaken,

.4 description of materials used (pipe and fittings),

.5 list of witnesses for each test conducted,

.6 date system left ready for service,

.7 signature of installing Contractor.

.6 Directories & Schematics

.1 Submit five (5) copies of a neat typewritten directory indicating the valve number, related service,and location of each valve under this Division.

.2 Submit five (5) copies of system control schematics for each mechanical system indicating relative locations of equipment and control devices.

.3 Enclose one (1) copy of each directory/schematic under glass in a neat polished 18" x24" (460 mm x 610 mm) metal frame, complete with mounting clips.

.7 Maintenance Data and Operating Instructions

.1 Submit three (3) copies of Operation and Maintenance Manual individually bound in hard backed three-ring binders.

.2 Ensure the binder spines have typewritten lettering as follows:
OPERATION & MAINTENANCE MANUAL
FOR
[Insert name of project]
[Insert date of submission]
[Insert Division Title]

.3 Provide a list of names, addresses and telephone numbers of equipment suppliers, installing contractors, general contractors, architect and Consultant. Include special telephone numbers for service departments on normal and emergency call basis.

.4 Provide descriptive literature (shop drawings) of each manufactured item. Include a bill of material with purchase order numbers and vendor's identification of equipment orders for each item.

.5 Include copies of start-up reports and checklists and all certificates issued with respect to this contract.

.6 Ensure operating instructions include the following:
.1 General description of each mechanical system.
.2 Step by step procedure to follow in putting each piece of equipment into service.
.3 Schematic control diagrams for each separate mechanical system, control thermometers, freezestats, firestats, pressure gauges, automatic valves, and refrigeration accessories. Mark correct operating settings for each control device on these diagrams.
.4 Diagram of the electrical control system indicating the wiring of all related electrical components such as PE and EP switches, firestats, freezestats, fuses, interlocks, electrical switches and relays.
.5 Drawings of each control panel including temperature control and electrical panels, completely identifying all components on the panels and their function.

.7 Ensure maintenance instructions include the following:
.1 Manufacturer's maintenance instructions for each item of mechanical equipment installed under this Division. Instructions shall include installation instructions, parts numbers and lists, name of supplier and maintenance and lubrication instructions.
.2 Summary list of each item of mechanical equipment requiring lubrication, indicating the name of the equipment item, location of all points of lubrication, type of lubricant recommended, and frequency of lubrication.
.3 Equipment directory indicating name, model, serial number and nameplate data of each item of equipment supplied, and system with which it is associated.
.4 Balancing and testing reports.
.5 Copy of valve directory.

.8 As-Built Records: Prepare and submit complete as-built records prior to Substantial Performance of the Contract. Refer to paragraph 3.6 and to Division 1 for requirements.

.9 Requests for Shut-Down: Obtain permission for systems shut-down and/or service interruption from the Owner prior to disruption of any system or service in use by the Owner. Employ the Owner's standard form of request where available. Refer to Division 1 for additional requirements.

.10 Requests for Start-up: Obtain permission from the Owner to start-up or to return to service any item of equipment, system or service installed new or previously shut-down. Refer to Division 1 for additional requirements.

1.6 QUALITY ASSURANCE

.1 Conform to minimum requirements or better of provincial and local codes, where existing, and to requirements of local inspection authorities for execution of work under this Division.

.2 Ensure materials supplied under this Division conform to minimum requirements and recommendations or better of applicable standards of the following:
.1 AABC Associated Air Balance Council
.2 AMCA Air Moving and Conditioning Association
.3 ANSI American National Standards Institute
.4 ASA American Standards Association

.5	ASHRAE	American Society of Heating, Refrigerating, and Air Conditioning Engineers
.6	ASME	American Society of Mechanical Engineers
.7	ASSE	American Society of Sanitary Engineers
.8	ASPE	American Society of Plumbing Engineers
.9	ASTM	American Society of Testing and Materials
.10	AWWA	American Water Works Association
.11	CAN2	National Standard of Canada (Published by CGSB)
.12	CAN3	National Standard of Canada (Published by CSA)
.13	CGSB	Canadian General Standards Board
.14	CSA	Canadian Standards Association
.15	EEMAC	Electrical & Electronic Manufacturer's Association of Canada
.16	NBC	National Building Code of Canada
.17	NEBB	National Environmental Balancing Bureau
.18	NFPA	National Fire Protection Association
.19	NEMA	National Electrical Manufacturers Association
.20	SMACNA	Sheet Metal & Air Conditioning Contractors National Association
.21	TIAC	Thermal Insulation Asociation of Canada
.22	ULC	Underwriter's Laboratories of Canada Ltd
.23	UL	Underwriter's Laboratories (including cUL)

.3 Use latest editions and amendments in effect on date of Bid call subject to requirements of the code.

.4 Arrange and pay for permits and inspections by authorities having jurisdiction, required in the undertaking of this Division. Make modifications required by authorities.

.5 All tradesmen employed on the project shall hold valid trade certificates/licenses and shall make a copy available for review by the Consultant and/or Owner when requested.

.6 All welding shall be executed by certified welders in accordance with registered procedures.

.7 All refrigeration work shall be executed only by qualified mechanics.

1.7 PRODUCT DELIVERY, HANDLING AND STORAGE

.1 Immediately after letting of contract, review material and equipment requirements for this work, determine supply and delivery dates for all items, and notify Consultant of any potential delays in completion of this project in order that remedial action may be taken.

.2 Store neatly out of the way and protected from damage and theft, materials and equipment supplied under this Division that are received at the site by this Division.

1.8 JOB CONDITIONS

.1 Visit site and examine existing conditions which may affect work of this Division.

.2 Examine all Contract Documents to ensure that work of this Division may be satisfactorily completed.

.3 Notify Consultant upon discovery of conditions which adversely affect work of this division. No allowance will be made after letting of contract for any expenses incurred through failure to do so.

.4 Submission of a bid confirms that the Contract Documents and site conditions are accepted without qualifications, unless exceptions are specifically noted in the Bid.

1.9 WARRANTY

.1 Refer to General Conditions. Arrange with each manufacturer/supplier to extend warranties as necessary to coincide with warranty period or those periods specified.

.2 Make submissions necessary to register product warranties to the benefit of the Owner.

.3 Submit to Consultant, prior to Substantial Performance of the Contract, manufacturer's written warranties covering periods longer than one year or offering greater benefits than required in specifications and in the Owner's name.

1.10 DEFINITIONS

.1 The following are definitions of words found in this specification and on associated drawings under this Division:

.1	"Concealed"	-	hidden from normal sight in furred spaces, shafts, ceiling spaces, walls, and partitions.
.2	"Exposed"	-	mechanical work normally visible to building occupants.
.3	"Provide"	-	(and all tenses of "provide") - supply, install and connect complete.
.4	"Install"	-	(and all tenses of 'install") - install and connect complete, products and services specified.
.5	"Supply"	-	supply to site in location determined by Owner.
.6	"Wet"	-	wet areas requiring special materials.

2 Products

2.1 MATERIALS AND EQUIPMENT

.1 Ensure materials and equipment provided under this Division are new and free from defects and bear labels of approval as required by codes referred to in this Division and/or by inspection authorities.

.2 Ensure apparatus and equipment provided under this Division bears manufacturer's nameplate indicating name of manufacturer, model number or type, size, capacity, CRN, and other pertinent information. Ensure nameplates are easily read and clearly visible, with openings provided where equipment is insulated.

.3 Ensure manufacturers and suppliers of equipment or materials under this Division determine if their products are composed of any hazardous materials. If they are, the products are suitably labeled and supplied with Material Safety Data sheets. Obtain the Owner's approval in writing to bring hazardous materials onto the site prior to doing so.

.4 When utilizing any products that are hazardous, keep Material Safety Data sheets on file at the job site and present them to anyone requesting this information. When transferring hazardous materials from original container into other containers, provide Workplace Labels on such containers.

2.2 ACCEPTABLE PRODUCTS

.1 First item named or specified by catalogue number meets specifications regarding performance, quality of material and workmanship, and is acceptable to the Consultant.

.2 Items, other than first named, meeting specifications regarding quality of materials and workmanship are acceptable to the Consultant, only, if they also meet performance and/or capacities specified and can be accommodated within the space allotted.

.3 General approval indicated by inclusion of other manufacturers named is subject to final review of shop drawings, performance data and test reports.

2.3 EQUIVALENTS AND ALTERNATIVES

.1 Suppliers wishing approval for additional equipment items as equivalent to those specified must submit complete description, technical and performance data to Consultant at least ten (10) working days prior to Bid closing date. Such equivalent equipment, if accepted, to conform to specifications with regard to all details, accessories, modifications, features and performance. Deviations from specifications must be stated in writing at time of submission for approval.

.2 Bid Prices shall include only products specified or approved equivalents. Contractors may propose unsolicited alternatives to the products specified. Alternative proposals shall be submitted in sealed envelope at time of general contract Bid submission and shall include full description and technical data, and a statement of the related increase or decrease in Bid Price should alternatives be accepted. All additional costs associated with unsolicited alternative proposals such as larger motor starters, larger power feeders, space revisions to associated equipment, controls, etc. shall be included in alternative price. Prior approval by Consultant is not required for unsolicited alternative proposals.

.3 Where the Contractor uses equipment other than that first named, on which the design is based, he shall be responsible for all details of installation including equipment size, arrangement, fit, and maintenance of all required clearances. Contractor shall prepare and submit revised layouts to iindicate arrangement of all affected piping, ductwork, conduit, lighting, equipment, etc. Failure by Contractor to provide such drawings will be considered indication that original arrangements and space allocations are adequate. All additional costs associated with equivalent equipment such as larger motor starters, larger power feeders, space revisions to associated equipment, controls, etc. shall be included in Bid Price.

2.4 SUBSTITUTIONS DURING PROGRESS OF WORK

.1 If during the progress of work, specified products are not obtainable, equivalent or similar products by other manufacturers may be permitted by Consultant.
.2 Apply, in writing, to Consultant for substitution of any products, indicating the following:
  .1 Manufacturer's name, model number, details of construction, accurate dimensions, capacities and performance of proposed products.
  .2 Reason for substitution.
  .3 Any revisions to the contract price made necessary by substitution.
  .4 Any revisions to the contract time made necessary by substitution.
  .5 Any revisions to layout, arrangement or services made necessary by substitution.
.3 No substitutions will be permitted without written authorization from the Consultant.

2.5 CONSULTANT'S REVIEW

.1 The consultants will review and evaluate unsolicited alternatives and substitutions proposed by the Contractor. Such review and evaluation work will be undertaken by the Consultant on an additional fee basis. The Contractor shall reimburse the Owner for all costs associated with such reviews and evaluations.
.2 The Contractor shall also reimburse the Owner for any and all costs incurred in updating Contract Documents to reflect such changes.

3 Execution

3.1 INSPECTION

.1 Inspect installed work of other trades and verify that such work is complete to point where work under this Division may properly commence.
.2 Verify that work of this Division may be executed in accordance with pertinent codes and regulations, specifications, drawings, and referenced standards.
.3 Review drawings and verify dimensions at the site. Report discrepancies immediately to Consultant before proceeding with any construction work or shop drawings.

3.2 RELATIONSHIP WITH OTHER TRADES

.1 Cooperate with other trades whose work affects or is affected by work of this Division to ensure satisfactory installation and to avoid delays.
.2 Provide materials to be built-in, such as sleeves, anchors, and inserts, together with templates and/or measurements, promptly when required by other trades.
.3 Provide structural supports for equipment to be mounted on or in walls, supported above floors and/or suspended from the structure.

3.3 INSTALLATION REQUIREMENTS

.1 The Consultant's drawings and instructions govern the location of all items. Prepare fully coordinated installation drawings prior to installation.
.2 Install equipment neatly to the satisfaction of the Consultant. Unless noted otherwise install products and services to follow building planes. Ensure installation permits free use of space and maximum headroom.
.3 Confirm the exact location of outlets, fixtures and connections. Confirm location of outlets for equipment supplied under other Divisions.

.4 Install equipment and apparatus to allow free access for maintenance, adjustment and eventual replacement.
.5 Install metering and/or sensing devices to provide proper and reliable sampling of quantities being measured. Install instruments to permit easy observation.
.6 Provide suitable shielding and physical protection for devices.
.7 Install products and services in accordance with the manufacturer's requirements and/or recommendations.
.8 Provide bases, supports, hangers and fasteners. Secure products and services so as not to impose undue stresses on the structure and systems.
.9 Do not use power activated tools without written permission of the Consultant. Use them in accordance with the Owner's health and safety policies.
.10 Ensure that the load onto structures does not exceed the maximum loading per square metre indicated on the structural drawings or as directed by the Consultant.

3.4 CONTRACT DRAWINGS

.1 The drawings of this Division are performance drawings and indicate general arrangement of the work. They are diagrammatic except where specific details are given.
.2 Obtain accurate dimensions from the architectural and structural drawings, or by measurement. Location and elevation of services are approximate. Verify them before construction is undertaken.
.3 Make changes where required to accommodate structural conditions, (beams, columns, etc.). Obtain Consultant's approval before proceeding.
.4 Adjust the location of materials and/or equipment as directed without adjustment to contract price, provided that the changes are requested before installation and do not affect material quantity. Note that outlets and/or equipment may be relocated up to 10 feet (3 m) in any direction without a change to the contract price.
.5 Note that the layout and orientation of the ceiling outlets on the architectural reflected ceiling drawings may differ from that shown on the mechanical drawings. Make the installation in accordance with the latest architectural ceiling drawings. Provide the equipment as specified and/or shown on the documents of this Division.
.6 The drawings of this Division are intended for tender pricing. The quantities and quality to be included in the bid price shall be based on the layout and specifications as shown on the mechanical documents. If there is a difference in quantity between the architectural and drawings of this Division, base the contract price on the greater quantity.
.7 Prepare installation (construction) drawing to reflect the latest architectural ceiling layout.

3.5 CONSTRUCTION DRAWINGS

.1 Prepare fully dimensioned drawings showing devices, fixtures, equipment, outlets, sleeves and openings through structure. Indicate locations and weights on load points.
.2 Prepare fully dimensioned construction drawings of products and services suitably interfaced with work of the sub-trades, in mechanical rooms, service and ceiling spaces, and other critical locations. Coordinate the work with other divisions. Base drawings on reviewed shop drawings and latest architectural drawings. Indicate details pertaining to the following: access, clearances, cleanouts, sleeves, electrical connections, drain locations and elevation of pipes, ducts, conduits.
.3 Prepare drawings of pits, curbs, sills, equipment bases, anchors, inertia slabs, etc.
.4 Submit construction drawings to other Divisions. Provide one (1) transparency and four (4) print copies of construction drawings to the Consultant for record purposes.
.5 Submit construction drawings prior to commencement of work.

3.6 RECORD DRAWINGS

.1 Maintain project "as-built" record drawings. Obtain white prints from the Consultant for this purpose and pay printing costs. Identify each set as "Project Record Copy".
.2 Record deviations from contract documents caused by site conditions or by changes ordered by the Consultant. Record deviations in red ink clearly and accurately, using industry standard drafting procedures consistent with quality and standards of Consultants documents.
.3 Record deviations as work progresses throughout the execution of this contract. Maintain record drawings on site in clean, dry, legible condition, making them available for periodic review by the Consultant.

.4 Record location of concealed services, particularly underground services. Before commencing any backfilling, obtain accurate measurements and information concerning correct location and depth of services.
.5 Transfer records from the "Project Record Copy" to a DVD in Autocad format matching the Consultant's documents. Arrange computer file in layers to exactly match the layering system of the Consultant.
.6 Submit the "Project Record Copy" on one or more DVD with white prints of each drawing to the Consultant at the time of Substantial Performance.

3.7 CUTTING AND PATCHING

.1 Include cutting and patching as required in execution of work under respective Sections of this Division.
.2 Holes through the structure will not be permitted without written approval of the Consultant. Any and all openings required through the completed structure must be clearly and accurately shown on a copy of the relevant structural drawing(s). Exact locations, elevations and size of the proposed opening must be identified well in advance of the need for the work.
.3 All sleeved or formed openings through the structure must be shown on sleeving drawings and must be approved by the Structural Consultant prior to construction.
.4 The Contractor shall conduct exploratory work including x-ray of the existing structure, shall mark the location of embedded reinforcements, anchors, conduits and piping on exposed surfaces of adjacent floors and/or walls and shall pay all associated costs.
.5 Reinforcing shall not be cut or modified without prior approval of the Structural Consultant. Should reenforcement be cut without such prior approval, the cost of any additional reenforcement deemed necessary by the Structural Consultant shall be the responsibility of this Contractor.
.6 Alternative imaging techniques are subject to the approval of the Structural Consultant.
.7 Ensure that cutting and patching of roofs and reinforced concrete structures is executed by specialists familiar with the materials affected, and is performed in a manner to neither damage nor endanger the work. Coordinate and supervise such cutting and patching.
.8 Maintain the integrity of fire rated assemblies where they are pierced by ducts and pipes.
.9 Make good surfaces affected by this work and repair finish to satisfaction of Consultant. Finish painting, where required, will be provided under Division 9.
.10 Stop work immediately upon discovery of any hazardous material and report discovery to the Owner and Consultant. Obtain instruction prior to proceeding with the work.

3.8 EXCAVATING AND BACKFILLING

.1 Be responsible for excavation and backfilling necessary for installation of underground work under this Division.
.2 Excavate with suitable machinery or by hand as may be necessary and as follows:
  .1 Excavate to the depth and dimensions shown on drawings.
  .2 Keep excavation free of water by bailing, pumping or a system of drainage as required.
  .3 Cut and trim banks of excavation evenly, as nearly vertical as possible, and shore if required to prevent caving-in.
  .4 Keep bottom of excavation clean and clear of loose material. Slope or grade as required.
  .5 Provide shoring in accordance with The Occupational Health and Safety Act, and Regulations for Construction Projects.
  .6 Notify Consultant immediately in case of encountering any unstable ground, unsuitable for bearing of pipes. Consultant will decide the method of installation of pipes in unstable ground.
  .7 Inform Consultant immediately if the excavation reveals seepage zones, springs or other unexpected sub-surface conditions which may necessitate revisions to drainage or water supply systems.
.3 Obtain Consultant's approval prior to commencement of backfilling of trenches. Backfill the trenches carefully to prevent injury to the work and subsequent settlement and execute backfilling generally as follows:
  .1 provide minimum 6" (150 mm) fine gravel or coarse sand bedding (Class B) or as indicated for the bottom of trenches.
  .2 backfill above pipe bedding with granular material specified, hand tamp in layers of 6" (150

mm) thickness. Extend backfill 12" (300 mm) above pipe.

.3 backfill and consolidate remainder of trench depth below paved or graveled areas with granular Class "B" aggregate in 6" (150 mm) layers to an elevation to allow for thickness of Class "A" aggregate and asphalt pavement.

.4 backfill and consolidate reminder of trench depth below sodded or seeded areas with specified granular material or material obtained from site excavation where approved by Consultant, in 9" (225 mm) layers to an elevation 6" (150 mm) below of proposed grades in sodded/seeded areas.

.5 compact each layer thoroughly at optimum moisture content with approved hand or mechanical tampers to a density equal to;
95% of Maximum Standard Proctor Density
- Behind foundation and retaining walls on grades
- Below sodded or seeded areas

100% of Maximum Standard Proctor Density
- Below slabs on grade within building areas up to the underside of the crushed stone underlay
- Below paved or graveled areas

.6 Do not puddle or flood with water for consolidating backfill. Add Water during the compaction to optimum moisture content of backfilling material.

3.9 PAINTING

.1 Repair minor damage to finish of equipment with standard factory applied baked enamel finish under the appropriate Sections of this division. Replace entirely, items suffering major damage to finish if too extensive to be repaired in the opinion of the Consultant.

.2 Apply at least one coat of corrosion resistant primer paint to supports, and equipment fabricated from ferrous metals.

3.10 PROTECTION

.1 Protect finished and unfinished work by tarpaulins, or other covering, from damage due to execution of work under this Division.

.2 Repair to satisfaction of Consultant, damage to building resulting from failure to provide such protection.

3.11 SUPPORT AND ATTACHEMENT

.1 Support and attach piping, ductwork fixtures and equipment from load bearing structures such as beams, joists, reinforced concrete slabs and concrete block walls, and do not support from or attach to steel roof deck and/or wall or ceiling finishes. Roof mounted mechanical equipment and services shall be anchored to the roof structure to resist both lateral and uplift wind forces in accordance with requirements of the Manitoba Building Code.

3.12 EQUIPMENT BASES AND CURBS

.1 Supply and erect structural work required for installation of mechanical equipment.

.2 Build concrete bases 6" (150 mm) high, providing all necessary inserts, anchor bolts and other fasteners required, for floor mounted tanks, heaters, pumps, air handlers, boilers, etc. Make concrete bases 2" (50 mm) larger all around than the base of the supported equipment and trowel finish to a neat smooth finish. Anchor equipment to pads using 8" (200 mm) cast-in-place anchor bolts. Ensure concrete supplied under this Division is 2500 psi (17 MPa) compressive strength after 28 days.

.3 Build 4" (100 mm) high concrete curbs around all openings through floors for ductwork. Make allowances for installation of ductwork and fire dampers where required. Ensure joint between curb and floor is watertight and maintains integrity of floor membrane where applicable.

3.13 SERVICE CONNECTIONS

.1 Include in Bid Price all amounts required by municipality and/or utilities for service connections and /or modifications to service connections for water services. Ensure amounts include fees, assessments, charges, etc., required in relation to service connection. Do not include acreage or frontage charges.

3.14 BELT DRIVES AND SHEAVES

.1 Provide belt driven equipment with V-belt drive, designed for at least 130 percent of motor nameplate horsepower rating and in accordance with manufacturer's recommendations for type of service intended. Ensure belt drives are at least 95 percent efficient. Balance and properly align drives. Provide matched sets of belts for multiple belt assemblies. Select belts to suit starting torque of driver. Do not use single belt drives only for motors larger than two horsepower.

.2 Provide motor sheaves for one and two belt drives of variable pitch type, with Dodge key adjustments. Supply two sets of fixed drive sheaves for drives with three or more belts. Install first set of fixed motor sheaves to obtain the originally specified rpm. After initial test and preliminary adjustment, supply and install the second set of fixed sheaves if necessary, to provide the design flow quantities as established on the job. Obtain correct total flow rate for fans through speed changes and not by throttling.

.3 Provide adjustable sheaves on motor sizes up to 2 HP (1492 w) and fixed sheaves on larger motors.

3.15 GUARDS

.1 Provide OSHA compliant guards for exposed drives as follows;
- .1 expanded metal screen (both sides) welded to 1" (25 mm) steel angle frame.
- .2 18 ga. 1" (25 mm) thick galvanized sheet metal tops and bottoms.
- .3 removable sides for servicing.
- .4 1-1/2" (40 mm) dia. holes on both shaft centres for insertion of tachometer.

.2 Provide means to permit lubrication and use of test instruments with guards in place.

.3 Install belt guards to permit movement of motors for adjusting belt tension.

.4 For flexible couplings, provide removable, "U" shaped, 12 ga. 1/10" (2.7 mm) thick galvanized frame and 18 ga. 1/25" (1.2 mm) thick expanded mesh face.

.5 Provide 3/4" (20 mm) galvanized mesh wire screen on inlet or outlet of exposed fan blades such that net free area to openings is not less than 1.25 of original openings.

3.16 ELECTRICAL COMPONENTS AND WIRING

.1 Ensure Electrical components and wiring provided as part of the work of this Division shall conform to requirements and standards of the various Sections of Division 16.

3.17 RENOVATIONS

.1 Isolate and drain systems as required to effect renovations, modifications and/or repairs. On completion of renovations, modifications and/or repairs, test entire system as if new. Report repairs or replacements required of existing equipment, piping, fittings or devices that are not included in contract to Consultant and Owner for instruction. Flush, clean and refill renovated systems as specified for new.

.2 Relocate or remove existing items so designated unless specifically indicated to be relocated or removed under other sections.

.3 Existing items to be relocated shall be cleaned and repaired or altered as required to suit new location. All damaged or ineffective parts shall be replaced and the item made "as new".

.4 Existing items to be removed remain the property of the owner and shall be delivered to a location on site designated by the owner. If the owner declares no interest in the removed items, assume ownership and remove the items from the site.

.5 Make good all surfaces and finishes in areas from which items have been removed and in which items are relocated. Cap all existing services required to be severed to effect alterations and do all other work necessary to make good such areas to satisfaction of consultant.

.6 Openings in existing floor assemblies and vertical fire separations necessitated by installation of equipment and systems or construction in general must be temporarily sealed with fire barrier

materials such as mineral wool or other noncombustible insulation.

.7 If during alteration work existing asbestos material, other than known asbestos, is discovered (e.g. fireproofing, acoustic or thermal insulation, tank covering), stop work in the affected area and immediately notify consultant.

.8 Existing refrigerant indicated to be removed shall not be discharged to the atmosphere, but shall be salvaged and reclaimed or disposed of following the guidelines of the authority having jurisdiction.

3.18 PREPARATION

.1 Existing services and equipment shall be relocated or removed to suit new construction and renovation work.

.2 Services that are no longer required shall be removed or cut back and capped to the satisfaction of Consultant.

.3 Obtain written authorization from Consultant for renovation work that is not specifically indicated.

.4 Where modifications or connections to existing systems require shutdown of the system the Contractor shall submit a request for system shutdown describing the system or part to be shutdown, the duration of the shutdown, the work planned and steps to be taken to reinstate the system to full operation. The request shall be submitted in the format stipulated by the Owner.

.5 All work required to prepare systems for shutdown and/or re-instatement, such as draining, chemical treatments, and re-filling shall be included in this Bid Price.

3.19 SPECIAL TOOLS AND SPARE PARTS

.1 Within 30 days of award of contract, prepare a complete itemized list of special tools and spare parts and submit to Consultant for review. List will be used as a checklist and should include provision for sign off by the Owner on receipt.

.2 On completion of the project furnish spare parts to the Owner as follows:

- .1 One set of mechanical seals for each pump.
- .2 One casing joint gasket for each pump.
- .3 One head gasket for each heat exchanger.
- .4 One glass for each gauge glass installed.
- .5 One set of v-belts for each piece of machinery.
- .6 One set of new filters for each filter bank installed.

.3 Identify spare parts containers as to contents and replacement parts number.

.4 Provide one set of special tools required to service equipment as recommended by manufacturers.

.5 Furnish one grease gun and adaptors to suit different types of grease and fittings.

3.20 FIELD QUALITY CONTROL

.1 Temporary and Trial Usage

- .1 Allow the Owner the privilege of temporary and trial usage of installed equipment, as soon as work is complete, for a period of time required to conduct a thorough test.
- .2 Do not construe such usage as evidence of acceptance of work by Owner.
- .3 Repair damage to work tested, resulting from such trial usage, by this Contractor at no cost to Owner.

.2 Systems Verification:

- .1 Verify the correct installation and proper operation of equipment and systems installed. Adjust and balance each system as necessary to achieve optimum operation of each system.
- .2 Co-operate with the Systems Verification agency as follows:
  - .1 provide assistance when and as requested,
  - .2 co-ordinate completion of work systematically to permit orderly verification and adherence to schedules,
  - .3 provide additional necessary flow balancing devices as directed by agency,
  - .4 notify Systems Verification Agency of tests being conducted.

3.21 ADJUST AND CLEAN

.1 Clean equipment and fixtures, lubricate mechanical equipment installed under this Division and leave items in perfect order ready for operation.
.2 Test and adjust control devices, instrumentation, relief valves, dampers, etc., installed in this Division after cleaning of systems and leave in perfect order ready for operation.
.3 Remove from the premises upon completion of work of this division, debris, surplus, and waste materials resulting from operations.

3.22 COMMISSIONING

.1 The Contractor shall start-up and completely commission all equipment and systems installed and/or modified under this contract. Commissioning work shall be completed to the satisfaction of the Consultant prior to acceptance of the Work or any part thereof.
.2 The Commissioning Team shall be comprised of;
  .1 Representatives of the Contractor and his sub-contractors as required,
  .2 The individual, company or agency undertaking the work of each Section,
  .3 Representatives of equipment manufacturers,
  .4 Representatives of the Consultants,
  .5 Representatives of the Owner.
.3 The Contractor and his sub-contractors shall each assign an individual representing each of the relevant trades to the commissioning team and shall ensure that representatives of the equipment manufacturers are present during the relevant commissioning tasks.
.4 The Contractor shall provide all necessary labour, materials, equipment, testing apparatus and incidentals necessary to completely start-up, verify, test and commission each system provided as part of the Work.
.5 Each Section shall prepare Check Sheets in accordance with the ASHRAE and SMACNA Guidelines and shall issue them to the commissioning team for use during the commissioning process.
.6 Three (3) copies of commissioning manuals shall be provided, bound in hard cover D-ring binders with transparent cover on front and spine personalized to indicate;
  .1 name and logo of Facility,
  .2 name of the project,
  .3 the Owner's project number,
  .4 identification of the system commissioned,
  .5 the date that the system was commissioned.
.7 Commissioning manuals shall include machine printable index dividers to organize each manual by system and by commissioning stage.

3.23 EXTRAS AND CREDITS

.1 Accompany all price submissions requested by Consultant for extra work, or work to be deleted, with a complete cost breakdown as follows:
  .1 Materials, quantities and unit costs including any applicable contractors trade discount clearly identified.
  .2 Labour hours and unit costs.
  .3 Total materials and labour costs.
  .4 Overhead and profit mark-ups in accordance with the General Conditions of the Contract.

3.24 INSTRUCTION

.1 Instruct and familiarize Owner's operating personnel with the various mechanical systems. Arrange instruction for each system separately.
.2 Provide instruction for each system on two separate occasions, coordinated with the Owner's staff operating schedule, in order that interested personnel may arrange to attend.
.3 Ensure each instruction period includes, but is not limited to the following;
  .1 a classroom seminar with operating manuals, product and system drawings and such other audio/visual aids as may be appropriate,
  .2 instruction during the classroom seminar by the manufacturer's representative regarding the proper operating and maintenance procedures for each item of equipment,

.3 demonstration of the proper operating procedures for each item of equipment,
.4 explanation of the purpose and function of all safety devices provided,
.5 demonstration of all measures required for safe and proper access for operation and maintenance.

.4 Provide a period of follow-up instruction (on two occasions) approximately one month after completing Owner's instruction to clarify and reinforce earlier instructions.

.5 Submit a letter from the Owner's management staff indicating the instruction has been given satisfactorily to the Consultant prior to substantial completion of the project.

3.25 UNIT PRICES

.1 Unit prices shall be included on the Supplementary Bid Form and may be used in determining the value of changes to the Contract

3.26 STANDARD DRAWINGS

.1 The following standard drawings shall be considered an integral part of the contract documents for the work of this Division;

MSD-637	Detail of Piping to Plate Type Heat Exchanger
MSD-701	Piping Schematic of Inline Circulating Pump with Standby Pump
MSD-702	Detail of Vertical Centrifugal Pump
MSD-801	Detail of Roof Mounted Exhaust Fan
MSD-810	Detail of Roof Mounted Exhaust Fan
MSD-850	Detail of Round Duct Take-Off
MSD-852	Detail of Full Radius Elbow Branch Take-Off
MSD-853	Detail of Supply Tap-In Connection
MSD-854	Detail of Return Tap-In Connection
MSD-900	Detail of Fire Damper Installation - Vertical
MSD-901	Detail of Fire Damper Installation - Vertical Alternate
MSD-902	Detail of Fire Damper Installation - Horizontal
MSD-903	Detail of Fire Damper Installation - Horizontal Alternate
MSD-905	Detail of Side Wall Fire Damper Installation
MSD-958	Detail of Vertical Discharge Above Roof

End of Section

1 General

1.1 GENERAL

.1 Read and conform to:
- .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
- .2 Division 1 requirements and documents refered to therein.

1.2 MECHANICAL GENERAL REQUIREMENTS

.1 Comply with Mechanical General Requirements of Section 15010.

1.3 SECTION INCLUDES

.1 Testing, adjustment, and balancing of air systems.
.2 Testing, adjustment, and balancing of hydronic and steam systems.
.3 Measurement of final operating condition of HVAC systems.
.4 Verification of;
- .1 piping systems,
- .2 air systems,
- .3 operation of equipment,

1.4 REFERENCES

.1 AABC - National Standards for Total System Balance.
.2 ACG - AABC Commissioning Guideline.
.3 ADC - Test Code for Grilles, Registers, and Diffusers.
.4 ASHRAE 111 - Practices for Measurement, Testing, Adjusting, and Balancing of Building Heating, Ventilation, Air-conditioning, and Refrigeration Systems.
.5 ASHRAE Guideline 0 The Commissioning Process,
.6 ASHRAE Guideline 1 The HVAC Commissioning Process,
.7 ASHRAE Guideline 1.1 HVAC&R Technical Requirements for the Commissioning Process,
.8 ASTM E779 Determining Air Leakage Rate by Fan Pressurization.
.9 NEBB - Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.
.10 SMACNA - HVAC Systems Testing, Adjusting, and Balancing.
.11 SMACNA HVAC Systems Commissioning Manual,

1.5 SUBMITTALS

.1 Submit name of adjusting and balancing agency for approval within 30 days after award of Contract.
.2 Field Reports: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
.3 Prior to commencing work, submit report forms or outlines indicating adjusting, balancing, and equipment data required.
.4 Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Consultant and for inclusion in operating and maintenance manuals.
.5 Provide reports in soft cover, letter size, 3-ring binder manuals, complete with index page and indexing tabs, with cover identification at front and side.
.6 Include detailed procedures, agenda, sample report forms and copy of AABC National Project Performance Guaranty prior to commencing system balance.
.7 Test Reports: Indicate data on AABC National Standards for Total System Balance forms. Submit data in S.I. Metric units.
.7 All reports shall be prepared in electronic (computer) format using MS Word software and all tabulations shall be prepared in electronic (computer) format using MS Excel spreadsheet software. Submittals shall include three (3) copies each of hard copy printout and electronic copy (CD/DVD/USB Drive).

1.6 PROJECT RECORD DOCUMENTS

.1 Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.
.2 Record actual locations of flow measuring stations.

1.7 QUALITY ASSURANCE

.1 Perform total system balance to AABC National Standards for Field Measurement and Instrumentation, Total System Balance.
.2 Maintain one copy of each document on site.

1.8 INDEPENDENT AGENCY

.1 All work of Mechanical Testing, Adjusting and Balancing shall be undertaken by a single agency, employed under Division 15.
.2 Agency: Company specializing in the testing, adjusting, and balancing of systems under this Section with minimum five years documented experience certified by AABC.
.3 Work shall be performed under the supervision of an AABC certified Test and Balance Engineer, an NEBB Certified Testing, Adjusting and Balancing Supervisor or a registered Professional Engineer experienced in the performance of this work and licenced in the province where the Project is located.
.4 The work of the agency consists of the furnishing of all labour, materials, equipment and accessories necessary in the testing, verification and documentation of the operational performance of all equipment and systems installed under the Sections of Division 15: Mechanical.

1.9 PRE-BALANCING CONFERENCE

.1 Convene one week prior to commencing work of this Section.

1.10 SEQUENCING

.1 Sequence work to commence after completion of systems and schedule completion of work before Substantial Completion of Project.

1.11 SCHEDULING

.1 Schedule and provide assistance in final adjustment and test of life safety system with Fire Authority.

1.12 CO-OPERATION

.1 Co-operate with installing Contractor(s) in advising them of specific scheduling requirements for systems verification.
.2 Provide advice to installing Contractors regarding the location and installation of devices required to permit system balancing and measurements, prior to start of the installation work.
.3 Coordinate verification of smoke control and automatic sprinkler systems with verification of fire alarm system under Division 16.

2 Products

2.1 REFERENCE STANDARDS

.1 All equipment required for the verification of equipment and systems shall be furnished by the agency employed to conduct the Mechanical Systems Verification.
.2 Testing and measuring equipment used in the verification of the mechanical systems shall be calibrated to give true readings within the accuracy specifications of the equipment used. A certificate of calibration from an independent testing laboratory may be required by the Consultant if there is any reason to suspect that the equipment used is giving erroneous readings. In such an event the verification agency shall reconduct its verifications.
.3 All equipment used by the agency in its verification of mechanical systems remains the property/responsibility of the agency and is not included in the supply to the project.

3 Execution

3.1 EXAMINATION

.1 Verify that systems are complete and operable before commencing work. Ensure the following conditions:
- .1 Systems are started and operating in a safe and normal condition.
- .2 Temperature control systems are installed complete and operable.
- .3 Proper thermal overload protection is in place for electrical equipment.
- .4 Final filters are clean and in place. If required, install temporary media in addition to final filters.
- .5 Duct systems are clean of debris.
- .6 Fans are rotating correctly.
- .7 Fire and volume dampers are in place and open.
- .8 Air coil fins are cleaned and combed.
- .9 Access doors are closed and duct end caps are in place.
- .10 Air outlets are installed and connected.
- .11 Duct system leakage is minimized.
- .12 Hydronic systems are flushed, filled, and vented.
- .13 Pumps are rotating correctly.
- .14 Proper strainer baskets are clean and in place.
- .15 Service and balance valves are open.

.2 Submit field reports. Report defects and deficiencies noted during performance of services which prevent system balance.

.3 Beginning of work means acceptance of existing conditions.

3.2 PREPARATION

.1 Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Consultant to facilitate spot checks during testing.

.2 Provide additional balancing devices as required.

3.3 INSTALLATION TOLERANCES

.1 Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply, return and exhaust systems.

.2 Air Outlets and Inlets: Adjust total to within plus and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 5 percent of design.

.3 Hydronic Systems: Adjust to within plus or minus 5 percent of design.

3.4 ADJUSTING

.1 Ensure recorded data represents actual measured or observed conditions.

.2 Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.

.3 After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.

.4 Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

.5 At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Owner.

.6 Check and adjust systems approximately six months after final acceptance and submit report.

3.5 AIR SYSTEM PROCEDURE

.1 Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude.

.2 Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.

.3 Measure air quantities at air inlets and outlets.
.4 Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.
.5 Use volume control devices to regulate air quantities only to extend that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.
.6 Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.
.7 Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
.8 Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.
.9 Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
.10 Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.
.11 Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate, full heating.
.12 Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately 12.5 Pa positive static pressure near the building entries.
.13 For variable air volume system powered units set volume controller to air flow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable air volume temperature control.
.14 On fan powered VAV boxes, adjust air flow switches for proper operation.

3.6 WATER SYSTEM PROCEDURE

.1 Adjust water systems to provide required or design quantities.
.2 Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.
.3 Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.
.4 Effect system balance with automatic control valves fully open to heat transfer elements.
.5 Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.
.6 Where available pump capacity is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.

3.7 SCHEDULES

.1 Equipment requiring testing, adjusting and balancing:
  .1 Plumbing Pumps
  .2 HVAC Pumps
  .3 Energy Recovery Ventilators
  .4 Fans
  .5 Air Filters
  .6 Air Inlets and Outlets
.2 Report Forms
  .1 Title Page:
    .1 Name of Testing, Adjusting, and Balancing Agency
    .2 Address of Testing, Adjusting, and Balancing Agency
    .3 Telephone number of Testing, Adjusting, and Balancing Agency
    .4 Project name
    .5 Project location
    .6 Project Architect
    .7 Project Engineer

.8 Project Contractor
.9 Project altitude
.10 Report date

.2 Summary Comments:
.1 Design versus final performance
.2 Notable characteristics of system
.3 Description of systems operation sequence
.4 Summary of outdoor and exhaust flows to indicate amount of building pressurization
.5 Nomenclature used throughout report
.6 Test conditions

.3 Instrument List:
.1 Instrument
.2 Manufacturer
.3 Model number
.4 Serial number
.5 Range
.6 Calibration date

.4 Electric Motors:
.1 Manufacturer
.2 Model/Frame
.3 HP/BHP
.4 Phase, voltage, amperage; nameplate, actual, no load
.5 RPM
.6 Service factor
.7 Starter size, rating, heater elements
.8 Sheave Make/Size/Bore

.5 V-Belt Drive:
.1 Identification/location
.2 Required driven RPM
.3 Driven sheave, diameter and RPM
.4 Belt, size and quantity
.5 Motor sheave diameter and RPM
.6 Centre to centre distance, maximum, minimum, and actual

.6 Pump Data:
.1 Identification/number
.2 Manufacturer
.3 Size/model
.4 Impeller
.5 Service
.6 Design flow rate, pressure drop, BHP
.7 Actual flow rate, pressure drop, BHP
.8 Discharge pressure
.9 Suction pressure
.10 Total operating head pressure
.11 Shut off, discharge and suction pressures
.12 Shut off, total head pressure

.7 Heat Pump:
.1 Identification/number
.2 Location
.3 Manufacturer
.4 Model number
.5 Serial number
.6 Entering and leaving water air temperature, design and actual
.7 Entering and leaving refrigerant air temperature, design and actual
.8 Number of compressors
.9 Power draw
.10 Elect volts, amps, phase

.8 Heat Exchanger:
- .1 Identification/number
- .2 Location
- .3 Service
- .4 Manufacturer
- .5 Model number
- .6 Serial number
- .7 Primary water entering temperature, design and actual
- .8 Primary water leaving temperature, design and actual
- .9 Primary water flow, design and actual
- .10 Primary water pressure drop, design and actual
- .11 Secondary water leaving temperature, design and actual
- .12 Secondary water leaving temperature, design and actual
- .13 Secondary water flow, design and actual
- .14 Secondary water pressure drop, design and actual

.9 Fan Coil Data:
- .1 Identification/number
- .2 Location
- .3 Service
- .4 Manufacturer
- .5 Air flow, design and actual
- .6 Entering air DB temperature, design and actual
- .7 Entering air WB temperature, design and actual
- .8 Leaving air DB temperature, design and actual
- .9 Leaving air WB temperature, design and actual
- .10 Water pressure drop, design and actual
- .11 Entering refrigerant temperature, design and actual
- .12 Leaving refrigerant temperature, design and actual
- .13 Saturated suction temperature, design and actual
- .14 Air pressure drop, design and actual
- .15 Motor size, power draw, volts, phase, amps sepc'd

.10 Air Moving Equipment
- .1 Location
- .2 Manufacturer
- .3 Model number
- .4 Serial number
- .5 Arrangement/Class/Discharge
- .6 Air flow, specified and actual
- .7 Return air flow, specified and actual
- .8 Outside air flow, specified and actual
- .9 Total static pressure (total external), specified and actual
- .10 Inlet pressure
- .11 Discharge pressure
- .12 Sheave Make/Size/Bore
- .13 Number of Belts/Make/Size
- .14 Fan RPM

.11 Return Air/Outside Air Data:
- .1 Identification/location
- .2 Design air flow
- .3 Actual air flow
- .4 Design return air flow
- .5 Actual return air flow
- .6 Design outside air flow
- .7 Actual outside air flow
- .8 Return air temperature
- .9 Outside air temperature
- .10 Required mixed air temperature
- .11 Actual mixed air temperature

.12 Design outside/return air ratio
.13 Actual outside/return air ratio

.12 Exhaust Fan Data:
.1 Location
.2 Manufacturer
.3 Model number
.4 Serial number
.5 Air flow, specified and actual
.6 Total static pressure (total external), specified and actual
.7 Inlet pressure
.8 Discharge pressure
.9 Sheave Make/Size/Bore
.10 Number of Belts/Make/Size
.11 Fan RPM

.13 Duct Traverse:
.1 System zone/branch
.2 Duct size
.3 Area
.4 Design velocity
.5 Design air flow
.6 Test velocity
.7 Test air flow
.8 Duct static pressure
.9 Air temperature
.10 Air correction factor

.14 Duct Leak Test:
.1 Description of ductwork under test
.2 Duct design operating pressure
.3 Duct design test static pressure
.4 Duct capacity, air flow
.5 Maximum allowable leakage duct capacity times leak factor
.6 Test apparatus
.1 Blower
.2 Orifice, tube size
.3 Orifice size
.4 Calibrated
.7 Test static pressure
.8 Test orifice differential pressure
.9 Leakage

.15 Air Distribution Test Sheet:
.1 Air terminal number
.2 Room number/location
.3 Terminal type
.4 Terminal size
.5 Area factor
.6 Design velocity
.7 Design air flow
.8 Test (final) velocity
.9 Test (final) air flow
.10 Percent of design air flow

3.8 VERIFICATION CHECKLIST

.1 Prepare a series of checklists to record the verification of each item of equipment and each system. Submit a draft of each checklist to the Consultant and the Owner for review and approval. Discuss comments offered the Consultant and Owner and include improvements as directed.

.2 Checklists shall include the following as a minimum;

.1 date(s) of observations and/or tests,
.2 a record of the nameplate data for each equipment item and each associated motor,
.3 a list of observations appropriate to the equipment item or system with space adjacent to indicate whether the item was satisfactory or unsatisfactory,
.4 appropriate space for recording comments and/or instructions given during observations.

3.9 EQUIPMENT VERIFICATION

.1 Test the operation of all equipment installed under Division 15 according to instructions in appropriate articles of this Division. Advise installing contractor of any required adjustments or replacements to ensure that equipment is operating as intended. Retest equipment after adjustment or replacement.
.2 Ensure that the Contractor has given proper advance notification to all persons required to be present as tests are conducted. Refer to 15100.
.3 Instrumentation: verify installation of air filter gauges, pumps, thermometers, thermometer wells, pitot traverse stations, and flow-measuring devices ensuring that:
  .1 Location of points for readings is appropriate to measure what it is intended to measure;
  .2 The scale range is appropriate to place the normal reading near mid-range of the scale;
  .3 Proper positioning of instrumentation to allow reading from a convenient location, and for easy access.
.4 Filters Inspection: visually inspect each filter installation. Verify adjustment of latching devices, installation of end spacers in filter boxes, and proper latching and sealing of access doors. Verify the installation of new (clean) filter media after Contractor's start-up procedures.
.5 Pre-start-up Inspection:
  .1 Verify proper equipment mounting and setting.
  .2 Verify that control, interlock, and power wiring are complete.
  .3 Verify proper alignment of motors and drives.
  .4 Verify proper piping connections and accessories.
  .5 Verify that lubrication is complete.
.6 First Run Observation:
  .1 Verify direction of rotation.
  .2 Verify setting of safety controls.
  .3 Monitor heat build-up in bearings.
  .4 Check motor loads against nameplate ratings.
.7 Equipment Checkout:
  .1 Verify the proper overload heater sizes.
  .2 Verify function of safety and operating controls.
  .3 Verify proper operation of equipment.
  .4 Report on inspection, observation, and checkout procedures.
.8 Stuffing Boxes and Packing Glands: verify adjustment of boxes on pump shafts and packing glands on valve stems.
.9 Motor Rotation: visually inspect and verify the direction of motor rotation. It is possible for motor rotation to have been checked by the electrician when power connections were made on temporary electric power, then when final connections were made to the permanent transformer bank, crossed phasing may reverse the rotation of all three-phase motors on the system.
.10 Overload Heaters: verify supply voltage to each equipment. If the applied voltage is different from the motor nameplate, determine whether the applied voltage is within the range allowed under the motor guarantee. If not, take the necessary action to have the Contractor change the motor or the applied voltage. When the voltage is off the nameplate value, but within the allowable range, compute the equivalent amperage at nameplate voltage and compare to the overload heater amperage rating range. Then, consider whether the ambient temperature of the starter is above, below, or the same as the ambient temperature are not the same. Advise the Contractor to use overload heaters of higher range for "hot area" starters or ones of lower range for "cold area" starters to compensate the heater trip point for heat gains or losses with the environment.
.11 Alignment of Drives: verify the alignment of drives, belt and direct coupled, and the adjustment of belt tension.
.12 Control Diagrams and Sequences: provide for coordination with work under the automatic control systems to have the control diagrams and sequences of operation corrected to "as installed",

reflecting changes brought about in response to contract modifications and to the more pragmatic changes in diagrams and sequences to make the installed system control the building systems as intended by the designer.

.13 Safety and Operating Control Setpoints: systematically verify the safety and operating controls of equipment, including an operational check of associated control sequences.

.14 Fin Straightening: inspect finned surface heat transfer coils for damages fins and advise Contractor of repairs required.

.15 Verify that manufacturer's start-up procedures have been performed and that equipment is installed in accordance with the manufacturer's written installation recommendations.

.16 Where work is noted to be done in stages a complete air balance and verification report will be required at the end of each stage.

3.10 PIPING SYSTEMS VERIFICATION

.1 Review the drawings, specifications, and installed work to ensure that systems may be properly balanced in accordance with drawings. Advise the installing Contractor of any additional requirements for effective balancing.

.2 Complete air balance must have been accomplished before water balance is verified.

.3 Open all valves to full position, including coil stop valves, close bypass valves, and return line balancing cocks.

.4 Verify that all strainers are clean.

.5 Examine water in system to determine if it has been treated and is clean.

.6 Check and record type and concentration of glycol in systems which require freeze protection.

.7 Check pump rotation.

.8 Check diaphragm expansion tanks to ensure that fill pressure is adequate (re. static head of systems plus 5 psig or 12 psig minimum (35 kPa or 83 kPa minimum).

.9 Check open expansion tanks to make sure they are not air bound and that the system is full of water.

.10 Check all air vents at high points of water systems to make sure they are installed properly and are operating freely. Verify that all air is removed from circulating system.

.11 Set all temperature controls so that all coils are calling for full cooling. This should close all automatic bypass valves at coil and chillers. To balance hot water coils, set systems to call for full heating.

.12 Verify operation of automatic bypass valve.

.13 Verify operating temperature of heat exchangers, to design requirements.

.14 Check and record the following items at each cooling and heating element:

- .1 Inlet water and air temperatures. Note rise or drop in temperature train source.
- .2 Leaving water and air temperatures.
- .3 Pressure drop and flow through each coil.
- .4 Pump operating suction and discharge pressure and final t.d.h. and flow delivered.
- .5 Pressure drop across bypass valve.
- .6 All mechanical specifications of pumps.
- .7 Rated and actual running amperage of pump motor.

.15 Witness all piping tests.

3.11 AIR SYSTEM VERIFICATION

.1 Review drawings, specifications and installed work to ensure that systems may be properly balanced in accordance with drawings. Advise installing Contractor of any additional requirements for effective balancing.

.2 In air handling systems which include supply fans with variable speed drives, airflows shall be verified to design with all filters clean and with all filters loaded to filter manufacturer's recommended final (change-out) resistance. Motor and drive capacity to accommodate full range of filter loadings shall be verified.

.3 In air handling systems which include supply fans without variable speed drives, air filters shall be verified to design airflows with air filters loaded so that the air pressure drop through each filter is equal to the average of the manufacturers listed initial resistance and recommended final (change-out) resistance.

.4 Test and record blower rpm for each fan and air handling unit.

.5 Test and record motor full load amperes.
.6 Make Pitot tube traverse of main supply and obtain operating air quantities at fans.
.7 Test and record system static pressures, suction and discharge.
.8 Test and record system operating recirculated air quantities.
.9 Test and record system operating outside air quantities.
.10 Test and record entering drybulb air temperatures (heating and cooling coils).
.11 Test and record entering wet bulb air temperatures (heating and cooling coils).
.12 Test and record leaving dry bulb air temperatures (heating and cooling coils).
.13 Test and record leaving wet bulb air temperatures (cooling coils only).
.14 Measure airflow in all main and zone branch supply and return air ducts.
.15 Test and record airflow at each diffuser, grille, and register.
.16 Witness and verify results of duct leakage tests conducted under section 15810.
.17 Tabulate and certify test results on suitable forms and submit Consultant for approval and record. Identity each diffuser, grille, and register as to location and area. Identify and list size, type, and manufacturer of diffusers, grilles, registers, and all testing equipment. Use manufacturer's rating on all equipment to make required calculations.

3.12 ROOM RELATIVE PRESSURES

.1 Supply, return and exhaust airflows shall be arranged to move air from clean to less clean areas.
.2 The relative pressure in contaminated or malodourous areas shall be negative in relation to adjacent areas.
.3 The following areas shall be negative relative to surrounding areas;
  .1 Turnover room
  .2 Janitor room
  .3 Apparatus bay
  .4 Washrooms

End of Section

1 General

1.1 GENERAL

.1 Read and conform to:
- .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
- .2 Division 1 requirements and documents refered to therein.

1.2 REFERENCES

.1 ASME A13.1 - Scheme for the Identification of Piping Systems.

1.3 SUBMITTALS

.1 Section 15010: Procedures for submittals**.**
.2 Submit list of wording, symbols, letter size, and colour coding for mechanical identification.
.3 Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
.4 Product Data: Provide manufacturers catalogue literature for each product required.
.5 Manufacturer's Installation Instructions: Indicate special procedures, and installation.

2 Products

2.1 NAMEPLATES

.1 Provide laminated plastic plates with black face and white centre of minimum size 3-1/2" x 1-1/2" x 3/32" (90 x 40 x 2 mm) nominal thickness, engraved with 1/4" (6 mm) high lettering. Use 1" (25 mm) lettering for major equipment.
.2 Fasten nameplates securely in conspicuous place. Where nameplates cannot be mounted on cool surface, provide standoffs.
.3 Identify equipment type and number and service of areas or zone of building served.
.4 For each item of equipment which may be started automatically or remotely, add a red lamacoid plate, 2-1/2" x 9" (60 x 230 mm), reading:

"WARNING. THIS EQUIPMENT IS AUTOMATICALLY
CONTROLLED AND MAY START AT ANY TIME."

2.2 TAGS

.1 Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background colour. Tag size minimum 1-1/2" (40 mm) diameter. **OR**
.2 Metal Tags: Brass with stamped letters; tag size minimum 1-1/2" (40 mm) diameter with smooth edges.
.3 Chart: Typewritten letter size list in anodized aluminum frame.

2.3 STENCILS

.1 Stencils: With clean cut symbols and letters of following size:
- .1 3/4"-1-1/4" (20-30 mm) Outside Diameter of Insulation or Pipe: 8" (200 mm) long colour field, 1/2" (15 mm) high letters.
- .2 1-1/2"-2" (40-50 mm) Outside Diameter of Insulation or Pipe: 8" (200 mm) long colour field, 3/4" (20 mm) high letters.
- .3 2-1/2"-6" (65-150 mm) Outside Diameter of Insulation or Pipe: 12" (300 mm) long colour field, 1-1/4" (30 mm) high letters.
- .4 8" - 10" (200-250 mm) Outside Diameter of Insulation or Pipe: 24" (600 mm) long colour

field, 2-1/2" (65 mm) high letters.
.5 Over 10" (250 mm) Outside Diameter of Insulation or Pipe: 32" (800 mm) long colour field, 3-1/2" (90 mm) high letters.
.6 Ductwork and Equipment: 2-1/2" (65 mm) high letters.

3 Execution

3.1 PREPARATION

.1 Degrease and clean surfaces to receive adhesive for identification materials.
.2 Prepare surfaces for stencil painting.

3.2 INSTALLATION

.1 Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
.2 Install tags with corrosion resistant chain.
.3 Comply with standard detail drawing plate, "Detail of Piping Identification".
.4 Apply stencil markings on all covered piping.
.5 Install plastic tape pipe markers complete around bare pipe to manufacturer's instructions.
.8 Identify natural gas piping in accordance with CAN1-B149.1
.10 Label piping that is heat traced or equipped with heating cable "HEAT TRACED" in addition to other identification. Locate such labels adjacent to other identifications.
.12 Mark drain from hot lab sink with radiation warning symbols at 10 ft. (3 m) intervals.
.13 Install underground plastic pipe markers 6"-8" (150-200 mm) below finished grade, directly above buried pipe.
.14 Identify air handling units, fans, pumps, heat transfer equipment, tanks, and water treatment devices with plastic nameplates. Small devices, such as in-line pumps, may be identified with tags.
.15 Identify control panels and major control components outside panels with plastic nameplates.
.16 Identify thermostats relating to terminal boxes or valves with nameplates.
.17 Identify valves in main and branch piping with tags. Consecutively number valves in each system.
.18 Identify fan coil units and radiator valves with numbered tags.
.19 Tag automatic controls, instruments, and relays. Key to control schematic.
.20 Identify piping, concealed or exposed, with stencilled painting and plastic tape pipe markers . Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 6 m on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction.
.21 Identify covered ductwork with stencilled painting and bare ductwork with plastic tape duct markers. Identify ductwork with air handling unit identification number and area served. Locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction.
.22 For each item of equipment which may be started automatically or remotely, add a red lamacoid plate, 2-3/8" x 9" (60 x 230 mm), reading:

"WARNING. THIS EQUIPMENT IS AUTOMATICALLY CONTROLLED. IT MAY START AT ANY TIME."

.23 Provide colour coded self-adhesive dots to locate valves or dampers above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

3.3 SCHEDULES

.1 Consult the Owner and identify piping, ductwork and equipment as directed;
.1 conforming to the Owner's existing identification practices, or
.2 conforming to the following Pipe and Valve Identification Table:

Pipe Marker Legend	Valve Tag Legend	Primary Colour	Secondary Colour
Cold Water	CW	Green	None
Compressed Air	CA [psi]	Green	None
Dom. Hot Water Supply	DHWS	Green	None
Dom. Hot Water Recirc.	DHWR	Green	None

Engine Exhaust	EXHST	Yellow	Black
Fire Protection Water	FPW	Red	White
Natural Gas	GAS	Yellow	Black
Sanitary Sewer	SAN	Green	None
Sprinkler Water	SPR	Red	White
Storm Sewer		Green	None
Vent		Green	None

.2 Where coloured PVC jacketing is specified, conform to the following schedule;

Service	**Legend**	**Colour**
Cold Water	CW	Dark Green
Dom. Hot Water Supply	DHWS	Yellow
Dom. Hot Water Recirc.	DHWR	Yellow
Engine Exhaust	EXHST	Orange
Sanitary Sewer	SAN	Dark Grey
Storm Sewer	STRM	Light Grey

3.4 MANUFACTURER'S NAMEPLATES

.1 Provide metal nameplates on each piece of equipment, mechanically fastened with raised or recessed letters.

.2 Include registration plates, 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.

3.5 FLOW DIAGRAMS AND DIRECTORIES

.1 Provide Consultant with six 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.

.2 Install where agreed with the Owner one copy of each flow diagram and valve schedule mounted in glazed frame. Provide one copy of each in Operation and Maintenance Manual.

End of Section

1 General

1.1 SECTION INCLUDES

.1 Positive displacement meters.
.2 Vortex flow metres.
.3 Pressure gauges and Pressure gauge taps.
.4 Thermometers and thermometer wells.
.5 Static pressure gauges.
.6 Filter gauges.

1.2 REFERENCES

.1 ASME B40.100 - Pressure Gauges and Gauge Attachments.
.2 ASME MFC-3M - Measurement of Fluid Flow in Pipes Using Orifice, Nozzle and Venturi.
.3 ASTM E1 - Specification for ASTM Thermometers.
.4 ASTM E77 - Inspection and Verification of Thermometers.
.5 AWWA C700 - Cold Water Meters - Displacement Type, Bronze Main Case.
.6 AWWA C701 - Cold Water Meters - Turbine Type, for Customer Service.
.7 AWWA C702 - Cold Water Meters - Compound Type.
.8 AWWA C706 - Direct-Reading, Remote Registration System for Cold-Water Meters.
.9 AWWA M6 - Water Meters - Selection, Installation, Testing, and Maintenance.
.10 ISA RP 3.2 - Flange Mounted Sharp Edged Orifice Plates for Flow Measurement.
.11 UL 393 - Indicating Pressure Gauges for Fire-Protection Services.
.12 UL 404 - Gauges, Indicating Pressure, for Compressed Gas Service.

1.3 SUBMITTALS FOR REVIEW

.1 Section 15010: Procedures for submittals.
.2 Product Data: manufacturers catalogue brochure identifying product features and available ranges
.3 Provide a complete Installation Schedule which indicates use, operating range, total range and location for gauges and meters.

1.4 SUBMITTALS AT PROJECT CLOSEOUT

.1 Section 15010: Submittals for project closeout.
.2 Project Record Documents: Record actual locations of components and instrumentation.
.3 Operation and Maintenance Data:

1.5 ENVIRONMENTAL REQUIREMENTS

.1 Section 15010: Environmental conditions affecting products on site.
.2 Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports and test plugs.

1.6 EXTRA MATERIALS

.1 Section 15010: Submittals for project closeout.
.2 Provide two bottles of red gauge oil for static pressure gauges.
.3 Provide pressure gauges with pulsation damper.

2 Products

2.1 PRESSURE GAUGES

.1 Manufacturer: Trerrice
.2 Other acceptable manufacturers offering equivalent products.
  .1 Weiss
  .2 Winter
  .3 Morrisson

.4 Taylor Model

.3 Gauge: ASME B40.1, UL 393 drawn steel case, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background.
- .1 Case: Steel with brass bourdon tube.
- .2 Size: 50 mm (2") diameter.
- .3 Mid-Scale Accuracy: One percent.
- .4 Scale: kPa.

2.2 PRESSURE GAUGE TAPPINGS

.1 Gauge Cock: Tee or lever handle, brass for maximum 1034 kPa.
.2 Needle Valve: Brass, 6 mm (1/4") NPT for minimum 1034 kPa.
.3 Pulsation Damper: Pressure snubber, brass with 6 mm connections.
.4 Syphon: Steel, Schedule 40, 1/4 inch (6 mm) angle or straight pattern.

2.3 STEM TYPE THERMOMETERS

.1 Manufacturer: Trerrice
.2 Other acceptable manufacturers offering equivalent products.
- .1 Weiss
- .2 Winter
- .3 Morrisson
- .4 Taylor

.3 Thermometer: ASTM E1, red appearing mercury, lens front tube, cast aluminum case with enamel finish.
- .1 Size: 175 mm (7") scale.
- .2 Window: Clear glass.
- .3 Stem: 20 mm brass.
- .4 Accuracy: ASTM E77 2 percent. Calibration: Degrees C Both degrees F and degrees C.

.4 OR

.5 Thermometer: ASTM E1, adjustable angle, red appearing mercury, lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device.
- .1 Size: 175 mm (7") scale.
- .2 Window: Clear glass.
- .3 Stem: 20 mm (3/4") NPT brass.
- .4 Accuracy: ASTM E77 2 percent.
- .5 Calibration: Degrees C Both degrees F and degrees C.

2.4 DIAL THERMOMETERS

.1 Manufacturer: Trerrice Model.
.2 Other acceptable manufacturers offering equivalent products.
- .1 Weiss Model
- .2 Winter Model
- .3 Morrisson Model
- .4 Taylor Model

.3 Thermometer: ASTM E1, stainless steel case, bimetallic helix actuated with silicone fluid damping, white with black markings and black pointer hermetically sealed lens, stainless steel stem.
- .1 Size: 50 mm diameter dial.
- .2 Lens: Clear glass.
- .3 Accuracy: 1 percent.
- .4 Calibration:Degrees C Both degrees F and degrees C.

.4 OR

.5 Thermometer: ASTM E1, stainless steel case, adjustable angle with front recalibration, bimetallic helix actuated with silicone fluid damping, white with black markings and black pointer hermetically sealed lens, stainless steel stem.
- .1 Size: 75 mm (3") diameter dial.
- .2 Lens: Clear glass.
- .3 Accuracy: 1 percent.
- .4 Calibration: Degrees F.

.6 OR

.7 Thermometer: ASTM E1, stainless steel case, vapour or liquid actuated with brass or copper bulb, copper or bronze braided capillary, white with black markings and black pointer glass lens.
- .1 Size: 60 mm (2-3/8") diameter dial.
- .2 Lens: Clear glass.
- .3 Length of Capillary: Minimum 1500 mm (60")
- .4 Accuracy: 2 percent.
- .5 Calibration:Degrees C Both degrees F and degrees C.

2.5 THERMOMETER SUPPORTS

.1 Socket: Brass separable sockets for thermometer stems with or without extensions as required, and with cap and chain.

.2 Flange: 75 mm (3") outside diameter reversible flange, designed to fasten to sheet metal air ducts, with brass perforated stem.

2.6 TEST PLUGS

.1 Manufacturer:

.2 Test Plug: 6 mm or 13 mm (1/4" or 1/2") brass fitting and cap for receiving 3 mm (1/8") outside diameter pressure or temperature probe with neoprene core for temperatures up to 93°C (200°).

.3 Test Kit: Carrying case, internally padded and fitted containing one diameter pressure gauges, one gauge adapters with 3 mm (1/8") probes, two 25 mm (1") dial thermometers.

2.7 STATIC PRESSURE GAUGES

.1 Manufacturer:

.2 90 mm diameter dial in metal case, diaphragm actuated, black figures on white background, front recalibration adjustment, 2 percent of full scale accuracy.

.3 Inclined manometer, red liquid on white background with black figures, front recalibration adjustment, 3 percent of full scale accuracy.

.4 Accessories: Static pressure tips with compression fittings for bulkhead mounting, 6 mm (1/4") diameter tubing.

3 Execution

3.1 INSTALLATION

.1 Install to manufacturer's instructions.

.2 Install positive displacement meters with isolating valves on inlet and outlet to AWWA M6. Provide full line size valved bypass with globe valve for liquid service meters.

.3 Provide one pressure gauge per pump, installing taps before strainers and on suction and discharge of pump. Pipe to gauge.

.4 Install pressure gauges with pulsation dampers. Provide gauge cock to isolate each gauge. Provide syphon on gauges in steam systems. Extend nipples and syphons to allow clearance from insulation.

.5 Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 60 mm (2-3/8") for installation of thermometer sockets. Ensure sockets allow clearance from insulation.

.6 Install thermometers in air duct systems on flanges.

.7 Install thermometer sockets adjacent to controls systems thermostat, transmitter, or sensor sockets. Where thermometers are provided on local panels, duct or pipe mounted thermometers are provided on local panels, duct or pipe mounted thermometers are not required.

.8 Locate duct mounted thermometers minimum 10 feet (3 m) downstream of mixing dampers, coils, or other devices causing air turbulence.

.9 Coil and conceal excess capillary on remote element instruments.

.10 Provide instruments with scale ranges selected according to service with largest appropriate scale.

.11 Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.
.12 Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.
.13 Locate test plugs adjacent thermometers and thermometer sockets.
.14 Provide a pressure tap for each steam flow meter (one only in main steam header).

3.2 SCHEDULES

.1 Flow Meter Schedule
LOCATION
.1 Heating water system

.2 Pressure Gauge Schedule
LOCATION
.1 Pumps
.2 Expansion tanks
.3 Pressure reducing valves
.4 Backflow preventers

.3 Pressure Gauge Tapping Schedule
LOCATION
.1 Heat exchangers - inlets and outlets
.2 Boiler - inlets and outlets

.4 Stem Type Thermometer Schedule
LOCATION
.1 Domestic hot water supply and recirculation

End of Section

1 General

1.1 GENERAL

.1 Read and conform to:
  .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
  .2 Division 1 requirements and documents refered to therein.

1.2 SECTION INCLUDES

.1 Standard access doors
.2 Concealed access doors
.3 Fire rated access doors

1.3 SUBMITTALS FOR REVIEW

.1 Section 15010: Procedures for submittals.
.2 Product Data: manufacturers catalogue brochure identifying product features
.3 Shop drawings indicating materials, finishes, dimensions and methods of attachment

1.4 SUBMITTALS AT PROJECT CLOSEOUT

.1 Section 15010: Submittals for project closeout.
.2 Project Record Documents: Record actual locations of components.

2 Products

2.1 MANUFACTURERS

.1 Manufacturer: Acudoor.
.2 Other acceptable manufacturers offering equivalent products.
  .1 LeHage.
  .2 CEB.
  .3 Contour Model.

2.2 STANDARD

.1 Minimum 16ga.
.2 Steel, prime coat painted
.3 Heavy duty fully concealed hinges
.4 Positive locking device.
.5 Access doors as recommended by manufacturer for particular installation.

2.3 CONCEALED

.1 Minimum 16ga.
.2 Steel, prime coat painted
.3 Heavy duty fully concealed frame and hinges
.4 Positive locking device.
.5 Access doors as recommended by manufacturer for particular installation.

2.4 FIRE RATED

.1 Access doors in fire separations or fire rated assemblies: ULC labelled.
.2 Refer to architectural drawings for ratings of fire separations and assemblies.
.3 Minimum 12ga.

.4 Steel, prime coat painted
.5 Heavy duty fully concealed frame and hinges
.6 Positive locking device.
.7 Access doors as recommended by manufacturer for particular installation.

3 Execution

3.1 INSTALLATION

.1 Supply access doors for access to equipment requiring service, lubrication or adjustment and all concealed valves, cleanouts, trap primers, control and volume dampers, and other such equipment.
.2 Turn over access doors to the appropriate general trade for installation under other sections.

End of Section

1 General

1.1 GENERAL

.1 Read and conform to:
- .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
- .2 Division 1 requirements and documents refered to therein.

1.2 SECTION INCLUDES

.1 Single phase electric motors.
.2 Three phase electric motors.

1.3 REFERENCES

.1 AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
.2 AFBMA 11 - Load Ratings and Fatigue Life for Roller Bearings.
.3 IEEE 112 - Test Procedure for Polyphase Induction Motors and Generators.
.4 NEMA MG 1 - Motors and Generators.

1.4 SUBMITTALS

.1 Section 15010: Procedures for submittals.
.2 Product Data: Provide wiring diagrams with electrical characteristics and connection requirements.
.3 Test Reports: Indicate test results verifying nominal efficiency and power factor for three phase motors larger than 3.7 kW.
.4 Manufacturer's Installation Instructions: Indicate setting, mechanical connections, lubrication, and wiring instructions.

1.5 OPERATION AND MAINTENANCE DATA

.1 Section 15010: Submittals for project closeout.
.2 Operation Data: Include instructions for safe operating procedures.
.3 Maintenance Data: Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.6 QUALIFICATIONS

.1 Manufacturer: Company specializing in manufacture of electric motors for HVAC use, and their accessories, with minimum three years documented product development, testing, and manufacturing experience.

1.7 REGULATORY REQUIREMENTS

.1 Conform to Manitoba Electrical Safety Code.
.2 Provide certificate of compliance from authority having jurisdiction indicating approval of high efficiency motors.
.3 Products Requiring Electrical Connection: Listed and classified by CSA or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.8 DELIVERY, STORAGE, AND HANDLING

.1 Section 15010: Transport, handle, store, and protect products.
.2 Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

1.9 WARRANTY

.1 Section 15010: Submittals for project closeout.
.2 Provide extended coverage five year warranty for motors larger than 20 horsepower.

2 Products

2.1 GENERAL CONSTRUCTION AND REQUIREMENTS

.1 Motors less than 0.33 HP (250 W), for intermittent service may be equipment manufacturer's standard and need not conform to these specifications.

.2 Electrical Service:
- .1 Motors 0.35 HP (0.38 kW) and Smaller: 115 volts, single phase, 60 Hz.
- .2 Motors Larger than 0.35 HP (0.38 kW): 575 volts, three phase, 60 Hz.

.3 Type:
- .1 Open drip-proof except where noted otherwise.
- .2 Design for continuous operation in 104°F (40°C) environment.
- .3 Design for temperature rise to NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
- .4 Motors with frame sizes 254T and larger: Energy Efficient Type.

.4 Motors smaller than 0.5 HP (372 W): Provide continuously rated squirrel cage induction type with capacitor start, EEMAC `N' starting characteristics and a minimum of Class `A' insulation.

.5 Motors 0.5 HP (372 W) and over: Provide continuously rated squirrel cage induction type with EMAC `B' starting characteristics and a minimum of Class `B' insulation.

.6 Provide drip-proof type motors with a 1.15 service factor, unless specified or required otherwise by the motor location.

.7 Provide fan cooled totally enclosed motors having a 1.0 service factor.

.8 Explosion-Proof Motors: UL approved and labelled for hazard classification, with over temperature protection.

.9 Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.

.10 Wiring Terminations:
- .1 Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to code, threaded for conduit.
- .2 For fractional horsepower motors where connection is made directly, provide conduit connection in end frame.

.11 Provide motors within the 1-500 horsepower range of the "high efficiency" or "premium efficiency" as required under provincial regulations. Ensure this is indicated on the motor nameplate. Provide "T" frame (NEMA Specifications) motors approved under the Manitoba Electrical Safety Code. If delivery of specified motor will delay delivery of any equipment, install an acceptable motor for temporary use. Final acceptance of equipment will not occur until the specified motor is installed.

.12 Coordinate with Division 16 the sizing of electrical protective devices supplying new and relocated echanical equipment that contain integral motor starters and contactors.

.13 Motor ratings rated in watts refer to output watts.

.14 Provide constant speed motors with reduced voltage starters where specified.

.15 Motors for use with variable frequency drives shall be rated for invertor duty. Motors for pumps and fans shall be rated for inverter duty whether or not VFD are included at this time.

2.2 SINGLE PHASE POWER - SPLIT PHASE MOTORS

.1 Starting Torque: Less than 150 percent of full load torque.

.2 Starting Current: Up to seven times full load current.

.3 Breakdown Torque: Approximately 200 percent of full load torque.

.4 Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve or ball bearings.

.5 Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

2.3 SINGLE PHASE POWER - PERMANENT-SPLIT CAPACITOR MOTORS

.1 Starting Torque: Exceeding one fourth of full load torque.
.2 Starting Current: Up to six times full load current.
.3 Multiple Speed: Through tapped windings.
.4 Open Drip-proof or Enclosed Air Over Enclosure: Class A (50 degrees C temperature rise) insulation, minimum 1.0 Service Factor, prelubricated sleeve or ball bearings, automatic reset overload protector.

2.4 SINGLE PHASE POWER - CAPACITOR START MOTORS

.1 Starting Torque: Three times full load torque.
.2 Starting Current: Less than five times full load current.
.3 Pull-up Torque: Up to 350 percent of full load torque.
.4 Breakdown Torque: Approximately 250 percent of full load torque.
.5 Motors: Capacitor in series with starting winding; provide capacitor-start/capacitor-run motors with two capacitors in parallel with run capacitor remaining in circuit at operating speeds.
.6 Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve bearings.
.7 Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, pre-lubricated ball bearings.

2.5 THREE PHASE POWER - SQUIRREL CAGE MOTORS

.1 Starting Torque: Between 1 and 1-1/2 times full load torque.
.2 Starting Current: Six times full load current.
.3 Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics.
.4 Design, Construction, Testing, and Performance: Conform to NEMA MG 1 for Design B motors.
.5 Insulation System: NEMA Class B or better.
.6 Testing Procedure: To IEEE 112. Load test motors to determine free from electrical or mechanical defects in compliance with performance data.
.7 Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.
.8 Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors imbedded in motor windings and epoxy encapsulated solid state control relay for wiring into motor starter; refer to Section 26 29 23 - Variable Frequency Controllers.
.9 Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum AFBMA 9, L-10 life of 20,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt centre line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.
.10 Sound Power Levels: To NEMA MG 1.
.11 Part Winding Start Where Indicated: Use part of winding to reduce locked rotor starting current to approximately 60 percent of full winding locked rotor current while providing approximately 50 percent of full winding locked rotor torque.
.12 Weatherproof Epoxy Sealed Motors: Epoxy seal windings using vacuum and pressure with rotor and starter surfaces protected with epoxy enamel; bearings double shielded with waterproof non-washing grease.
.13 Nominal Efficiency: As scheduled at full load and rated voltage when tested to IEEE 112.
.14 Nominal Power Factor: As scheduled at full load and rated voltage when tested to IEEE 112.

3 Execution

3.1 APPLICATION

.1 Single phase motors for shaft mounted fans: Split phase type.
.2 Single phase motors for shaft mounted fans or blowers: Permanent split capacitor type.

.3 Single phase motors for fans: Capacitor start type.
.4 Single phase motors for fans: Capacitor start, capacitor run type.
.5 Motors located in exterior locations: Totally enclosed type.
.6 Motors located in outdoors: Totally enclosed weatherproof epoxy-treated type.
.7 Motors located in outdoors: Totally enclosed weatherproof epoxy-sealed type.

3.2 INSTALLATION

.1 Install motors to manufacturer's instructions.
.2 Install securely on firm foundation. Mount ball bearing motors with shaft in any position.
.3 Check line voltage and phase and ensure agreement with nameplate.

3.3 NEMA OPEN MOTOR SERVICE FACTOR SCHEDULE

	kW	3600 RPM	1800 RPM	1200RPM	900RPM
.1	.12-0.25	1.35	1.35	1.35	1.35
.2	.38	1.25	1.25	1.25	1.15
.3	.5	1.25	1.25	1.15	1.15
.4	.75	1.25	1.15	1.15	1.15
.5	.1-111	1.15	1.15	1.15	1.15

3.4 PERFORMANCE SCHEDULE: THREE PHASE - ENERGY EFFICIENT, OPEN DRIP-PROOF

	kW	RPM(Syn)	NEMA Frame	Minimum Percent Efficiency	Minimum Percent Power Factor
.1	0.75	1200	145T	81	72
.2	1.1	1200	182T	83	73
.3	1.5	1200	184T	85	75
.5	2.25	1200	213T	86	60
.6	3.7	1200	215T	87	65
.7	5.6	1200	254T	89	73
.9	7.5	1200	256T	89	74
.10	11	1200	284T	90	77
.11	15	1200	286T	90	78
.13	18	1200	324T	91	74
.14	22.5	1200	326T	91	78
.15	30	1200	364T	93	77
.16	37	1200	365T	93	79
.18	45	1200	404T	93	82
.19	56	1200	405T	93	80
.20	75	1200	444T	93	80
.21	93	1200	444T	93	84
.23	0.75	1800	143T	82	84
.24	1.1	1800	145T	84	85
.25	1.5	1800	145T	84	85
.27	2.25	1800	182T	86	86
.28	3.7	1800	184T	87	87
.29	5.6	1800	213T	88	86
.31	7.5	1800	215T	89	85
.32	11	1800	256T	91	85
.33	15	1800	256T	91	86
.35	18	1800	284T	91	85
.36	22.5	1800	286T	92	88
.37	30	1800	324T	92	83
.39	37	1800	326T	93	85
.40	45	1800	364T	93	88
.41	56	1800	365T	93	88

.43	75	1800	404T	93	83
.44	93	1800	405T	93	86
.45	112	1800	444T	93	85
.46	150	1800	445T	94	85
48	1.1	3600	143T	82	85
.49	1.5	3600	145T	82	87
.50	2.25	3600	145T	84	85
.52	3.7	3600	182T	85	86
.53	5.6	3600	184T	86	88
.54	7.5	3600	213T	87	86
.56	11	3600	215T	89	89
.57	15	3600	254T	90	89
.58	18	3600	256T	90	92
.60	22.5	3600	284T	91	91
.61	30	3600	286T	92	92
.62	37	3600	324T	93	89
.64	45	3600	326T	93	91
.65	56	3600	364T	93	88
.66	75	3600	365T	92	88

3.5 PERFORMANCE SCHEDULE: THREE PHASE-ENERGY EFFICIENT, TOTALLY ENCLOSED, FAN COOLED

	kW	RPM(Syn)	NEMA Frame	Minimum Percent Efficiency	Minimum Percent Power Factor
.1	0.75	1200	145T	81	72
.2	1.1	1200	182T	83	65
.3	1.5	1200	184T	85	68
.4	2.25	1200	213T	85	63
.5	3.7	1200	215T	86	66
.6	5.6	1200	254T	89	68
.7	7.5	1200	256T	89	75
.8	11	1200	284T	90	72
.9	15	1200	286T	90	76
.10	18	1200	324T	90	71
.11	22.5	1200	326T	91	79
.12	30	1200	364T	92	78
.13	37	1200	365T	92	81
.14	45	1200	404T	92	83
.15	56	1200	405T	92	80
.16	75	1200	444T	93	83
.17	93	1200	445T	93	85
.18	0.75	1800	143T	82	84
.19	1.1	1800	145T	84	85
.20	1.5	1800	145T	84	85
.21	2.25	1800	182T	87	83
.22	3.7	1800	184T	88	83
.23	5.6	1800	213T	89	85
.24	7.5	1800	215T	90	84
.25	11	1800	254T	91	86
.26	15	1800	256T	91	85
.27	18	1800	284T	92	84
.28	22.5	1800	286T	93	86
.29	30	1800	324T	93	83
.30	37	1800	326T	93	85
.31	45	1800	364T	93	87
.32	56	1800	365T	93	87

.33	75	1800	405T	94	86
.34	93	1800	444T	94	87
.35	112	1800	445T	94	88
.36	150	1800	447T	95	87
.37	1.1	3600	143T	82	85
.38	1.5	3600	145T	82	87
.39	2.25	3600	182T	82	87
.40	3.7	3600	184T	85	88
.41	5.6	3600	213T	86	86
.42	7.5	3600	215T	86	86
.43	11	3600	254T	88	91
.44	15	3600	256T	89	89
.45	18	3600	284T	90	92
.46	22.5	3600	286T	91	92
.47	30	3600	324T	91	91
.48	37	3600	326T	90	92
.49	45	3600	364T	91	93
.50	56	3600	365T	91	91
.51	75	3600	405T	92	92

End of Section

1 General

1.1 GENERAL

.1 Read and conform to:
- .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
- .2 Division 1 requirements and documents refered to therein.

1.2 SECTION INCLUDES

.1 Variable Frequency Drives.

1.3 SUBMITTALS

.1 Section 15010: Procedures for submittals.
.2 Product Data: Provide wiring diagrams with electrical characteristics and connection requirements.
.3 Manufacturer's Installation Instructions: indicate setting, mechanical connections, lubrication, and wiring instructions.
.4 Submit manufacturer's performance data including dimensional drawings, power circuit diagrams, installation and maintenance manuals, warranty description, VFD's FLA rating, certification agency file numbers and catalog information.
.5 The specification lists the minimum VFD performance requirements for this project. Each supplier shall list any exceptions to the specification. If no departures from the specification are identified, the supplier shall be bound by the specification.
.6 Harmonic filtering. The seller shall, with the aid of the buyer's electrical power single line diagram, providing the data required by IEEE-519, perform an analysis to initially demonstrate the supplied equipment will met the IEEE standards after installation. If, as a result of the analysis, it is determined that additional filter equipment is required to meet the IEEE recommendations, then the cost of such equipment shall be included in the bid. A harmonic analysis shall be submitted with the approval drawings to verify compliance with the latest version of IEEE-519 voltage and current distortion limits as shown in table 10.2 and 10.3 at the point of common coupling (PCC). The PCC shall be defined as the consumer-utility interface or primary side of the main distribution transformer.

1.4 OPERATION AND MAINTENANCE DATA

.1 Section 15010: Submittals for project closeout.
.2 Operation Data: Include instructions for safe operating procedures.
.3 Maintenance Data: Include assembly drawings.

1.5 QUALITY ASSURANCE

.1 Manufacturer: Company specializing in manufacture of variable frequency drives for HVAC use, and their accessories, with minimum three years documented product development, testing, and manufacturing experience.
.2 To ensure quality and minimize infantile failures at the jobsite, the complete VFD shall be tested by the manufacturer. The VFD shall operate a dynamometer at full load and speed and shall be cycled during the test.
.3 All optional features shall be functionally tested at the factory for proper operation.

1.6 REGULATORY REQUIREMENTS

.1 Conform to Manitoba Electrical Safety Code.
.2 Provide certificate of compliance from authority having jurisdiction indicating approval of variable frequency drives.
.3 Products Requiring Electrical Connection: Listed and classified by CSA or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

.1 Section 15010: Transport, handle, store, and protect products.
.2 Protect variable frequency drives stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering.

1.8 WARRANTY

.1 Section 15010: Submittals for project closeout.
.2 Provide extended coverage five year warranty for variable frequency drives.

1.9 Copy of OPERATION AND MAINTENANCE DATA

.1 Section 15010: Submittals for project closeout.
.2 Operation Data: Include instructions for safe operating procedures.
.3 Maintenance Data: Include assembly drawings.

2 Products

2.1 MANUFACTURERS

.1 Provide Danfoss Graham VLT6000 Variable Frequency Drives as per the specifications below and the schedules shown.
.2 Acceptable alternates ABB, Allan Bradley.

2.2 VARIABLE FREQUENCY DRIVES

.1 Furnish complete variable frequency VFDs as specified herein for the fans and pumps designated on the drawing schedules to be variable speed. All standard and optional features shall be included within the VFD enclosure, unless otherwise specified. VFD shall be housed in a metal NEMA 1 enclosure, The VFD's UL listing shall allow mounting in plenum or other air handling compartments.
.2 The VFD shall convert incoming fixed frequency three-phase AC power into a variable frequency and voltage for controlling the speed of three-phase AC motors. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for centrifugal pump and fan control and to eliminate the need for motor derating.
.3 With the motor's rated voltage applied to the VFD input, the VFD shall allow the motor to produce full rated power at rated amps, RMS fundamental volts, and speed without using the motor's service factor. VFDs utilizing sine weighted/coded modulation (with or without 3rd harmonic injection) must provide data verifying that the motors will not draw more than full load current during full load and full speed operation.
.4 The VFD shall include an input full-wave bridge rectifier and maintain a fundamental power factor near unity regardless of speed or load.
.5 The VFD and options shall be tested to ANSI/UL Standard 508. The complete VFD, including all specified options, shall be assembled by the manufacturer, which shall be UL-508 certified for the building and assembly of option panels. Assembly of the option panels by a third-party panel shop is not acceptable. The appropriate CSA or C-UL stickers shall be applied to both the VFD and option panel, in the case where these are not contained in one panel. Both VFD and option panel shall be manufactured in ISO 9001 certified facilities.
.6 The VFD shall have DC link reactors on both the positive and negative rails of the DC bus to minimize power line harmonics. VFDs without DC link reactors shall provide a minimum 3% impedance line reactor.
.7 The VFD's full load amp rating shall meet or exceed NEC Table 430-150. The VFD shall be able to provide full rated output current continuously, 110% of rated current for 60 seconds and 160% of rated current for up to 0.5 second while starting.
.8 The VFD shall be able to provide full torque at any selected frequency from 28 Hz to base speed to allow driving direct drive fans without derating.
.9 An automatic energy optimization selection feature shall be provided standard in the VFD. This feature shall automatically and continually monitor the motor's speed and load and adjust the applied voltage to maximize energy savings and provide up to an additional 3% to 10% energy

savings.

.10 Input and output power circuit switching shall be able to be accomplished without interlocks or damage to the VFD. Switching rate may be up to 1 time per minute on the input and unlimited on the output.

.11 An automatic motor adaptation test algorithm shall measure motor stator resistance and reactance to optimize performance and efficiency. It shall not be necessary to run the motor or de-couple the motor from the load to run the test.

.12 Galvanic and/or optical isolation shall be provided between the VFD's power circuitry and control circuitry to ensure operator safety and to protect connected electronic control equipment from damage caused by voltage spikes, current surges, and ground loop currents. VFDs not including either galvanic or optical isolation on both analog I/O and discrete I/O shall include additional isolation modules.

.13 VFD power components to be designed for 575VAC.

.14 VFD shall minimize the audible motor noise through the use of an adjustable carrier frequency. The carrier frequency shall be automatically adjusted to optimize motor and VFD efficiencies while reducing motor noise.

.15 VFD's operating motors not designed to meet Nema MG1 Part 31 should include Output Load reactors.

2.3 PROTECTIVE FEATURES

.1 A minimum of Class 20 I^2t electronic motor overload protection for single motor applications and thermal-mechanical overloads for multiple motor applications shall be provided.

.2 Protection against input transients, loss of AC line phase, output short circuit, output ground fault, over-voltage, under-voltage, VFD over-temperature and motor over-temperature. The VFD shall display all faults in plain English. Codes are not acceptable.

.3 Protect VFD from sustained power or phase loss. The VFD shall provide full rated output with an input voltage as low as 90% of the nominal.

.4 The VFD shall incorporate a motor preheat circuit to keep the motor warm and prevent condensation build up in the stator.

.5 To prevent breakdown of the motor winding insulation, the VFD shall be designed to comply with IEC Part 34-17. Motors shall have inverter rated insulation (1600V).

.6 VFD shall include a "signal loss detection" circuit to sense the loss of an analog input signal such as 4 to 20 mA or 2 to 10 V DC, and shall be programmable to react as desired in such an instance.

.7 VFD shall function normally when the keypad is removed while the VFD is running and continue to follow remote commands. No warnings or alarms shall be issued as a result of removing the keypad.

.8 VFD shall catch a rotating motor operating forward or reverse up to full speed.

.9 VFD shall be rated for 100,000 amp interrupting capacity (AIC).

.10 VFD shall include current sensors on all three output phases to detect and report phase loss to the motor. The VFD will identify which of the output phases is low or lost.

.11 VFD shall continue to operate without faulting until input voltage reaches 300 V AC on 208/230 volt.

2.4 INTERFACE FEATURES

.1 Hand/Start, Off/Stop and Auto/Start selector switches shall be provided to start and stop the VFD and determine the speed reference.

.2 The VFD shall be able to be programmed to provide a 24 V DC output signal to indicate that the VFD is in Auto/Remote mode.

.3 The VFD shall provide digital manual speed control. Potentiometers are not acceptable.

.4 Lockable, alphanumeric backlit display keypad can be remotely mounted up to 10 feet (3 m) away using standard 9-pin cable.

.5 The keypads for all sizes of VFDs shall be identical and interchangeable.

.6 To set up multiple VFDs, it shall be possible to upload all setup parameters to the VFD's keypad, place that keypad on all other VFDs in turn and download the setup parameters to each VFD. To facilitate setting up VFDs of various sizes, it shall be possible to download from the keypad only size independent parameters.

.7 Display shall be programmable to display in 3 languages including English, Spanish and French.

.8 The display shall have four lines, with 20 characters on three lines and eight large characters on one line.

.9 A red FAULT light, a yellow WARNING light and a green POWER-ON light shall be provided. These indications shall be visible both on the keypad and on the VFD when the keypad is removed.

.10 A quick setup menu with factory preset typical HVAC parameters shall be provided on the VFD eliminating the need for macros.

.11 The VFD shall include a standard RS-485 communications port and capabilities to be connected at a future date to a Johnson Controls N2, Siemens FLN, or Lonworks. The connection shall be software selectable by the user.

.12 As a minimum, the following points shall be controlled and/or accessible:

.1 VFD Start/Stop, Speed reference, Fault diagnostics, and Meter points as follows;

.2 Motor power in HP, Motor power in kW, Motor kW-hr, Motor current, Motor voltage, Hours run, Feedback signal #1, Feedback signal #2, DC link voltage, Thermal load on motor, and Thermal load on VFD, Heatsink temperature.

.13 Four additional Form C 230 volt programmable relays shall be available for factory or field installation within the VFD.

.14 Two set-point control interface (PID control) shall be standard in the unit. VFD shall be able to look at two feedback signals, compare with two set-points and make various process control decisions.

.15 Floating point control interface shall be provided to increase/decrease speed in response to contact closures.

.16 Four simultaneous displays shall be available. They shall include frequency or speed, run time, output amps and output power. VFDs unable to show these four displays simultaneously shall provide panel meters.

.17 Sleep mode shall be provided to automatically stop the VFD when its speed drops below set "sleep" level for a specified time. The VFD shall automatically restart when the speed command exceeds the set "wake" level.

.18 The sleep mode shall be functional in both follower mode and PID mode.

.19 Run permissive circuit shall be provided to accept a "system ready" signal to ensure that the VFD does not start until dampers or other auxiliary equipment are in the proper state for VFD operation. The run permissive circuit shall also be capable of sending an output signal as a start command to actuate external equipment before allowing the VFD to start.

.20 The following displays shall be accessible from the control panel in actual units: Reference Signal Value in actual units, Output Frequency in Hz or percent, Output Amps, Motor HP, Motor kW, kWhr, Output Voltage, DC Bus Voltage, VFD Temperature in degrees, and Motor Speed in engineering units per application (in GPM, CFM, etc.). VFD will read out the selected engineering unit either in a linear, square or cubed relationship to output frequency as appropriate to the unit chosen.

.21 The display shall be programmed to read in inches of water column (in-wg) for an air handler application, pressure per square inch (psi) for a pump application, and temperature (°F) for a cooling tower application.

.22 VFD shall be able to be programmed to sense the loss of load and signal a no load/broken belt warning or fault.

.23 If the temperature of the VFD's heat sink rises to 176 °F (80 °C), the VFD shall automatically reduce its carrier frequency to reduce the heat sink temperature. If the temperature of the heat sink continues to rise the VFD shall automatically reduce its output frequency to the motor. As the VFD's heat sink temperature returns to normal, the VFD shall automatically increase the output frequency to the motor and return the carrier frequency to it's normal switching speed.

.24 The VFD shall have temperature controlled cooling fans for quiet operation and minimized losses.

.25 The VFD shall store in memory the last 10 faults and related operational data.

.26 Eight programmable digital inputs shall be provided for interfacing with the systems control and safety interlock circuitry.

.27 Two programmable relay outputs, one Form C 240 V AC, one Form A 30 V AC, shall be provided for remote indication of VFD status.

.28 Three programmable analog inputs shall be provided and shall accept a direct-or-reverse acting signal. Analog reference inputs accepted shall include two voltage (0 to 10 V DC, 2 to 10 V DC) and one current (0 to 20 mA, 4 to 20 mA) input.

.29 Two programmable 0 to 20 mA analog outputs shall be provided for indication of VFD status. These outputs shall be programmable for output speed, frequency, current and power. They shall also be programmable to provide a selected 24 V DC status indication.

.30 Under fire mode conditions, the VFD shall be able to be programmed to automatically default to a preset speed.

2.5 ADJUSTMENTS

.1 VFD shall have an adjustable carrier frequency in steps of not less than 0.1 kHz to allow tuning the VFD to the motor.
.2 Sixteen preset speeds shall be provided.
.3 Four acceleration and four deceleration ramps shall be provided. Accel and decel time shall be adjustable over the range from 0 to 3,600 seconds to base speed. The shape of these curves shall be automatically contoured to ensure no-trip acceleration and deceleration.
.4 Four current limit settings shall be provided.
.5 If the VFD trips on one of the following conditions, the VFD shall be programmable for automatic or manual reset: undervoltage, overvoltage, current limit and inverter overload.
.6 The number of restart attempts shall be selectable from 0 through 20 or infinitely and the time between attempts shall be adjustable from 0 through 600 seconds.
.7 An automatic "on delay" may be selected from 0 to 120 seconds.

2.6 BY-PASS

.1 Provide a manual 3-contactor bypass, were indicated in schedules, consisting of a door interlocked main fused disconnect padlockable in the off position, a built-in motor starter and a four position DRIVE/OFF/BYPASS/TEST switch controlling three contactors. In the DRIVE position, the motor is operated at an adjustable speed from the VFD. In the OFF position, the motor and VFD are disconnected. In the BYPASS position, the motor is operated at full speed from the AC power line and power is disconnected from the VFD so that service can be performed. In the TEST position, the motor is operated at full speed from the AC line power while power is applied to the input of the VFD. This allows the VFD to be given an operational test while continuing to run the motor at full speed in bypass. In case of an external safety fault, a customer supplied normally closed dry contact shall be able to stop the motor whether in DRIVE or BYPASS mode.
.2 Service personnel shall be able to defeat the main power disconnect and open the bypass enclosure without disconnecting power. This shall be accomplished through the use of a specially designed tool and mechanism while meeting all local and national code requirements for safety.

2.7 SERVICE CONDITIONS

.1 Ambient temperature, 14° to 104°F (-10° to 40°C).
.2 0 to 95% relative humidity, non-condensing.
.3 Elevation to 3,300 feet (1006 m) without derating.
.4 AC line voltage variation, -10 to +10% of nominal with full output.
.5 No side clearance shall be required for cooling of any units. All power and control wiring shall be done from the bottom.

3 Execution

3.1 START- UP SERVICE

.1 The manufacturer shall provide start-up commissioning of the VFD and its optional circuits by a factory certified service technician who is experienced in start-up and repair services. Sales personnel and other agents who are not factory certified shall not be acceptable as commissioning agents. Start-up services shall include checking for verification of proper operation and installation for the VFD, its options and its interface wiring to the building automation system.

3.2 WARRANTY

.1 The VFD shall be warranted by the manufacturer for a period of 5 years from date of Substantial Performance.
.2 The warranty shall include parts, labour, travel costs and living expenses incurred by the manufacturer to provide factory authorized on-site service.

3.3 EXAMINATION

.1 Contractor to verify that job site conditions for installation meet factory recommended and code-required conditions for VFD installation prior to start-up, including clearance spacing, temperature, contamination, dust, and moisture of the environment. Separate conduit installation of the motor wiring, power wiring, and control wiring, and installation per the manufacturer's recommendations shall be verified.

.2 The VFD is to be covered and protected from installation dust and contamination until the environment is cleaned and ready for operation. The VFD shall not be operated while the unit is covered.

End of Section

1 General

1.1 GENERAL

.1 Read and conform to:
- .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
- .2 Division 1 requirements and documents refered to therein.

1.2 SECTION INCLUDES

.1 Sealants
.2 Firestopping sealants
.3 Sleeves
.4 Flashings and counter-flashings
.5 Seals
.4 Escutcheons and plates.

1.3 SUBMITTALS

1. Section15010: Procedures for submittals.
2. Product Data: physical properties, application limits.
3. Manufacturer's Installation Instructions
4. Submit manufacturer's performance data, certification agency file numbers and catalog information.
5. Environmental requirements.
6. Prepare and submit a schedule of service penetration systems to be employed indicating the ULC listing designation, services involved, location of opening through fire separation and the components of the fire separation and/or assembly.

1.4 QUALITY ASSURANCE

.1 Manufacturer: Company specializing in manufacture of sealants with minimum three years documented product development, testing, and manufacturing experience.

1.5 REGULATORY REQUIREMENTS

.1 Conform to Manitoba Building Code.
.2 Conform to Manitoba Fire Code.

1.6 REFERENCES

1. CSA

2 Products

2.1 SEALANTS & CAULKING

.1 Refer to Division 7

2.2 FIRESTOPPING COMPOUNDS

.1 Manufacturer: 3M products indicated.
.2 Other acceptable manufacturers offering equivalent products.
- .1 Dow Corning Fire Stop Foam RTV
- .2 John Manville Firetemp caulk and spray
- .3 Hilti Firestop Systems

.3 Fire Rated Sealants: intumescent material, synthetic elasomers, capable of expanding up to 8 to 10 times when exposed to temperatures of 250°F (121°C) or higher. ULC listed and labelled.
.4 Caulk: type CP-25.
.5 Putty: type 303.

2.3 SLEEVES

.1 Materials: minimum schedule 20 galvanized steel or cast iron.

2.4 SERVICE CONES

2.5 FLASHINGS AND COUNTERFLASHINGS

.1 Material: 20-ga G90 galvanized steel.

2.6 PENETRATION SEALS

.1 Manufacturer: Link-Seal

2.7 ESCUTCHEONS

.1 Material: Brass or Bronze.
.2 Finish: Polished chrome

3 Execution

3.1 SEALANTS & CAULKING

.1 Fill voids around pipes:
  .1 Seal between sleeve and pipe in foundation walls and below grade floors with penetration seals (link-seal)). Install as per manufacturer's installation instructions.
  .2 Where sleeves pass through non-fire rated walls or floors, caulk space between pipe and sleeve with fibreglass. Seal space at each end with waterproof, fire retardant, non-hardening mastic.
  .3 Ensure no contact between copper tube or pipe and ferrous sleeve.
  .4 Fill future-use sleeves with easily removable filler.
  .5 Coat exposed exterior surfaces or ferrous sleeves with heavy application of zinc rich paint.
.2 Temporarily plug all openings during construction.

3.2 FIRESTOPPING

.1 In fire separations and fire rated assemblies:
  .1 All openings in fire separations and fire rated assemblies for service penetrations shall be protected with ULC listed service penetration firestop systems (SP).
  .2 The service penetration firestop system shall have F and FT ratings equal to or greater than ratings specified by the Architect for the fire separation (F) and firewall (FT) joint firestop systems (JF).

3.3 SLEEVES AND CURBS

.1 Provide pipe sleeves at points where pipes pass through masonry or concrete.
.2 Provide sleeves of minimum schedule 20 galvanized steel or cast iron.
.3 Use cast iron or steel pipe sleeves with annular fin continuously welded at midpoint:
  .1 through foundation walls.
  .2 through floors of mechanical rooms and equipment rooms.
.4 Provide 1/4" (6 mm) clearance all around, between sleeve and pipes or between sleeve and insulation.
.5 Where piping passes below footings, provide minimum clearance of 2" (50 mm) between sleeve and pipe. Backfill up to underside of footing with concrete of same strength as footing with concrete of same strength as footing.
.6 Terminate sleeves flush with surface of concrete and masonry and 2" (50 mm) above floors. Not

applicable to concrete floors on grade.

.7 Provide watertight concrete curb 4" (100 mm) high around mechanical services (pipes, ducts, conduits) which rise through mechanical (service) room floors. Provide minimum 4" (100 mm) clearance between openings for services within curbs.

.8 For pipes passing through roofs, use 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 water-tight durable joint. Co-ordinate with roofing Section.

3.4 FLASHINGS

.1 Provide all flashing at each point where piping passes through the roof.

.2 Coordinate this work with the roofing Trades to ensure a satisfactory installation and to avoid delays.

3.5 ESCUTCHEONS AND PLATES

.1 Provide on pipes passing through finished walls, partitions, floors and ceilings.

.2 Use chrome or nickel plated brass, solid type with set screws for ceiling or wall mounting.

.3 Inside diameter shall fit around finished pipe. Outside diameter shall cover opening or sleeve.

.4 Where sleeve extends above finished floor, escutcheon or plates shall clear sleeve extension.

.5 Secure to pipe or finished surface, but not insulation.

End of Section

1 General

1.1 GENERAL

.1 Read and conform to:
- .1 The General Conditions of the Contract
- .2 Comply with Division 1 requirements and documents referred to herein.

1.2 SECTION INCLUDES

.1 Flexible pipe connectors.
.2 Expansion joints and compensators.
.3 Pipe loops, offsets, and swing joints.
.4 Anchors and guides

1.3 REFERENCES

.1 MIL-E-17814E - Expansion Joints, Pipe, Slip-Type, Packed.

1.4 PERFORMANCE REQUIREMENTS

.1 Provide structural work and equipment required to control expansion and contraction of piping. Verify that anchors, guides, and expansion joints provided, adequately protect system.
.2 Arrange all piping so that expansion and contraction of any piping may take place without placing undue strain on the piping or connections to the equipment. Use swing joints and suitable expansion joints wherever necessary due to field conditions and where indicated on the drawings.
.3 This Section shall analyze each section of pipe installed between constraints and shall determine the potential for expansion of the pipe based on pipe temperature at installation and pipe temperatures throughout the pipe's operating range. Where potential expansion exceeds 25 mm (1") over the length of the pipe section, expansion compensators shall be installed. Pipe sections are constrained where they penetrate walls, partitions, floors, ceilings, roofs and movement of the pipe is restricted and where the pipe is anchored to the building structure. In addition, expansion compensators shall be installed where specifically indicated (no attempt has been made to indicate all locations where compensators are required.)
.4 Expansion Calculations:
- .1 Installation Temperature: 10 degrees C.
- .2 Hot Water Heating: 99 degrees C.
- .3 Domestic Hot Water: 60 degrees C.
- .4 Safety Factory: 30 percent.

1.5 SUBMITTALS

.1 Section 15010: Procedures for submittals.
.2 Product Data:
- .1 Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per metre and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.
- .2 Expansion Joints: Indicate maximum temperature and pressure rating, and maximum expansion compensation.

.3 Design Data: Indicate selection calculations.
.4 Manufacturer's Installation Instructions: Indicate special procedures, and external controls.

1.6 PROJECT RECORD DOCUMENTS

.1 Section 15010: Submittals for project closeout.
.2 Record actual locations of flexible pipe connectors, expansion joints, anchors, and guides.

1.7 OPERATION AND MAINTENANCE DATA

.1 Section 15010: Submittals for project closeout.
.2 Maintenance Data: Include adjustment instructions.

1.8 QUALIFICATIONS

.1 Manufacturer: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
.2 Design expansion compensating system under direct supervision of a Professional Engineer experienced in design of this work and licensed in the Province of Manitoba.

1.9 DELIVERY, STORAGE, AND HANDLING

.1 Section 15010: Transport, handle, store, and protect products.
.2 Accept expansion joints on site in factory packing with shipping bars and positioning devices intact. Inspect for damage.
.3 Protect equipment from exposure by leaving factory coverings, pipe end protection, and packaging in place until installation.

1.10 WARRANTY

.1 Warranty: Include coverage for leak free performance of packed expansion joints.

1.11 EXTRA MATERIALS

.1 Section 15010: Submittals for project closeout.
.2 Provide two 340 gm containers of packing lubricant and cartridge style grease gun.

2 Products

2.1 FLEXIBLE PIPE CONNECTORS

.1 Manufacturers:
  .1 Sr. Flexonics
  .2 United Flexible of Canada.
  .3 Hydro-Flex.
  .4 Vibra-Flo
  .5 Manitoba Hose Piping Accessories
  .6 Colton
.2 Copper Piping:
  .1 Inner Hose: Bronze
  .2 Exterior Sleeve: Braided bronze.
  .3 Pressure Rating: 862 kPa WSP and 232 degrees C.
  .4 Joint: As specified for pipe joints.
  .5 Size: Use pipe sized units
  .6 Maximum offset: 20 mm on each side of installed centre line.
.3 Steel Piping, 50mm diameter and smaller:
  .1 Inner Hose: braided bronze.
  .2 Exterior Sleeve: None.
  .3 Pressure Rating: 862 kPa WSP and 232 degrees C.
  .4 Joint: Threaded.
  .5 Size: Use pipe sized units.
  .6 Maximum offset: 20 mm (3/4") on each side of installed centre line.
.4 Steel Piping, 65mm to 90mm (2-1/2" to 3-1/2") diameter :
  .1 Inner Hose: braided bronze.
  .2 Exterior Sleeve: None.
  .3 Pressure Rating: 862 kPa WSP and 232 degrees C.
  .4 Joint: Flanged.
  .5 Size: Use pipe sized units.
  .6 Maximum offset: 20 mm (3/4") on each side of installed centre line.

.5 Steel Piping, 100mm (4") diameter and larger:
.1 Inner Hose: braided 321 stainless steel.
.2 Exterior Sleeve: None.
.3 Pressure Rating: 862 kPa WSP and 232 degrees C.
.4 Joint: Flanged.
.5 Size: Use pipe sized units.
.6 Maximum offset: 20 mm (3/4") on each side of installed centre line.

2.2 EXPANSION JOINTS

.1 Manufacturers:
.1 Sr. Flexonics
.2 United Flexible of Canada.
.3 Hydro-Flex.
.4 Vibra-Flo
.5 Manitoba Hose Piping Accessories
.6 Colton

.2 Stainless Steel Bellows Type:
.1 Construction 2-ply stainless steel bellows, carbon steel shrouds, internal positive anti-torque device and internal guides
.2 Pressure Rating: 862 kPa WSP and 204 degrees C.
.3 Maximum Compression: 45 mm.
.4 Maximum Extension: 6 mm (1/4").
.5 Joint: Flanged.
.6 Size: Use pipe sized units
.7 Application: Steel piping 65 mm (2-1/2")and smaller.

.3 Stainless Steel Bellows Type:
.1 Construction: Self-equalizing type with two-ply stainless steel bellows, carbon steel shrouds, internal positive anti-torque device and internal guides.
.2 Pressure Rating: 1380 kPa WOG and 121 degrees C.
.3 Maximum Compression: 45 mm.
.4 Maximum Extension: 6 mm (1/4").
.5 Joint: Flanged.
.6 Size: Use pipe sized units
.7 Application: Steel piping 75 mm (3") and larger.

.4 Bronze Bellows Type:
.1 Construction: 2-ply bronze with anti-torque device, limit stops, internal guides.
.3 Pressure Rating: 862 kPa WSP and 204 degrees C.
.4 Maximum Compression: 45 mm.
.5 Maximum Extension: 6 mm (1/4").
.6 Joint: Soldered.
.7 Size: Use pipe sized units
.8 Application: Copper piping.

2.3 ACCESSORIES

.1 Manufacturers:
.1 Sr. Flexonics
.2 United Flexible of Canada.
.3 Hydro-Flex.
.4 Vibra-Flo
.5 Manitoba Hose Piping Accessories
.6 Colton

.2 Pipe Alignment Guides: Two piece welded steel with enamel paint, bolted, with spider to fit standard pipe, frame with four mounting holes, clearance for minimum 25 mm (1") thick insulation, minimum 75 mm (3") travel.

.3 Swivel Joints: Fabricated steel body, double ball bearing race, field lubricated, with rubber (Buna-N) o-ring seals.

2.4 FLEX HOSE EXPANSION LOOP

.1 Designed to provide a flexible pipe loop to absorb and compensate for multi-plane pipe movements simultaneously. Construction: 3 equal length sections of annular corrugated stainless steel (or bronze) close-pitch hose with stainless steel (or bronze) overbraid that will absorb or compensate for pipe movements in all 6 degrees of freedom simultaneously. The corrugated metal hose, braid (s), and a stainless steel ring-ferrule/band integrally seal-welded. End fittings shall be selected per application. Fittings must be attached using a 100% circumferential TIG weld. Suitable for operating temperatures up to 850 degrees F (455 degrees C) stainless steel and 400 degrees F (204 degrees C) bronze. Designed for pressure testing to 1.5 times their maximum rated working pressure and a minimum 4:1 (burst to working) safety factor. Each unit shall be individually leak tested.
.2 Materials: Stainless Steel or Bronze as applicable.
.3 Sizes: 1/2" to 14" I.D.
.4 Hanger assembly kit : UL Listed Seismic Wire/Cable assemblies conforming to the requirements of the ASCE (American Society of Civil Engineers) guidelines for structural applications of wire rope.
.5 Installation: Install and guide following the manufacturer's printed installation instructions.
.6 Warranty: 3-years.
.7 Acceptable Material: Flex-Hose Co. Tri-Flex Loop TFL2, TFL4, or approved equal.

3 Execution

3.1 INSTALLATION

.1 Install to manufacturer's instructions.
.2 Construct spool pieces to exact size of flexible connection for future insertion.
.3 Install flexible pipe connectors on pipes connected to equipment supported by vibration isolation. Provide line size flexible connectors.
.4 Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end. Install in horizontal plane unless indicated otherwise.
.5 Pipe anchors shall be installed securing the piping system to the building structure in order to control the direction and the amount of pipe movement. In addition, pipe anchors shall be installed to prevent separation of pipe due to hydraulic pressures. Pipe anchors shall be designed by the Contractor to accommodate all forces experienced. Prepare calculations for each anchor and submit to Consultant for review and approval. Provide pipe guides so movement is directed along axis of pipe only. Not less than two guides shall be provided on each side of an expansion joint. Erect piping such that strain and weight is not on cast connections or apparatus.
.6 Provide support and equipment required to control expansion and contraction of piping. Provide pipe offsets, and swing joints, or expansion joints where required. The Contractor may elect to install expansion loops in place of expansion compensators where there is adequate space to do so; subject to the approval of the Consultant. The Contractor shall prepare and submit detailed design calculations for each expansion loop proposed to the Consultant for review and approval prior to installation.
.7 Provide victaulic piping with minimum one joint per 25 mm (1") pipe diameter instead of flexible connector supported by vibration isolation. Victaulic piping need not be anchored.

3.2 MANUFACTURER'S FIELD SERVICES

.1 Prepare and start systems to Section 15010.
.2 Provide inspection services by flexible pipe manufacturer's representative for final installing and certify installation is to manufacturer's recommendations and connectors are performing satisfactorily.
.3 Inspection reports shall be submitted to the Consultant and CA for review and approval.

End of Section

1 General

1.1 GENERAL

.1 Read and conform to:
- .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
- .2 Division 1 requirements and documents refered to therein.

1.2 SECTION INCLUDES

.1 Pipe and equipment hangers and supports.
.2 Equipment bases and supports.
.3 Sleeves and seals.
.4 Flashing and sealing equipment and pipe stacks.

1.3 REFERENCES

.1 ASME B31.1 - Power Piping.
.2 ASME B31.2 - Fuel Gas Piping.
.3 ASME B31.5 - Refrigeration Piping and Heat Transfer Components.
.4 ASME B31.9 - Building Services Piping.
.5 ASTM F708 - Design and Installation of Rigid Pipe Hangers.
.6 MSS SP58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
.7 MSS SP69 - Pipe Hangers and Supports - Selection and Application.
.8 MSS SP89 - Pipe Hangers and Supports - Fabrication and Installation Practices.
.9 NFPA 13 - Installation of Sprinkler Systems.
.10 UL 203 - Pipe Hanger Equipment for Fire protection Service.

1.4 SUBMITTALS

.1 Section 15010: Procedures for submittals.
.2 Shop Drawings: Indicate system layout with location and detail of trapeze hangers.
.3 Product Data: Provide manufacturers catalogue data including load capacity.
.4 Design Data: Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.
.5 Manufacturer's Installation Instructions: Indicate special procedures and assembly of components.

1.5 REGULATORY REQUIREMENTS

.1 Conform to CSA B-51 for support of piping.

2 Products

2.1 PIPE HANGERS AND SUPPORTS

.1 Manufacturers:
- .1 Anvil
- .2 Myat
- .3 Hunt

.2 Hydronic Piping:
- .1 Conform to CSA B-51 and ASME B31.9.
- .2 Hangers for Pipe Sizes 1/2" to 1-1/2" (13 to 38 mm): Carbon steel, adjustable swivel, split ring.
- .3 Hangers for Cold Pipe Sizes 2" (50 mm) and Over: Carbon steel, adjustable, clevis.
- .4 Hangers for Hot Pipe Sizes 2" to 4" (50 to 100 mm): Carbon steel, adjustable, clevis.
- .5 Hangers for Hot Pipe Sizes 6" (150 mm) and Over: Adjustable steel yoke, cast iron roll, double hanger.
- .6 Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
- .7 Multiple or Trapeze Hangers for Hot Pipe Sizes 6" (150 mm) and Over: Steel channels with

welded spacers and hanger rods, cast iron roll.
.8 Wall Support for Pipe Sizes to 3" (76 mm): Cast iron hook.
.9 Wall Support for Pipe Sizes 4" (100 mm) and Over: Welded steel bracket and wrought steel clamp.
.10 Wall Support for Hot Pipe Sizes 6" (150 mm) and Over: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.
.11 Vertical Support: Steel riser clamp.
.12 Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
.13 Floor Support for Hot Pipe Sizes to 4" (100 mm): Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
.14 Floor Support for Hot Pipe Sizes 6" (150 mm) and Over: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
.15 Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

.3 Refrigerant Piping:
.1 Conform to ASME B31.5.
.2 Hangers for Pipe Sizes 1/2" to 1-1/2" (13 to 38 mm): Carbon steel, adjustable swivel, split ring.
.3 Hangers for Pipe Sizes 2" (50 mm) and Over: Carbon steel, adjustable, clevis.
.4 Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
.5 Wall Support for Pipe Sizes to 3" (75 mm): Cast iron hook.
.6 Wall Support for Pipe Sizes 4" (100 mm) and Over: Welded steel bracket and wrought steel clamp.
.7 Vertical Support: Steel riser clamp.
.8 Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
.9 Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

2.2 ACCESSORIES

.1 Hanger Rods: galvanized, mild carbon steel continuous threaded.

2.3 INSERTS

.1 Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.4 EQUIPMENT ROOF CURBS

.1 Fabrication: Welded 0.05" (1.2 mm) galvanized steel shell and base, mitred 3" (75 mm) cant, variable step to match roof insulation, factory installed wood nailer.

2.5 ROOFTOP PIPE/DUCT SUPPORTS

.1 Acceptable manufacturers;
.1 Portable Pipe Hangers, Inc.
.2 Unistrut

.2 Pre-enginnered pipe/duct support system including;
1. Bases: weather resistant and UV radiation resistant with seismic attachments
2. Framing: 1-5/8" (41.3mm) strut or 1-7/8" (47.6mm) strut, fabricated of steel to ASTM A570, Grade 33., roll formed of 12-gauge (2.7mm thick) steel into 3-sided or tubular shape.
3. Pipe Supports and Hangers: Conform to MSS SP-58 and MSS SP-69, fabricated of carbon steel. Single roller supports for piping subject to expansion and contraction.
4. Finishes:
.1 Plastics as moulded with UV radiation protection.
.2 Metal surfaces hot dip galvanized free of roughness, whiskers, unsightly spangles, icicles, runs, barbs, sags, droplets and other surface blemishes. Galvanizing shall conform to ASTM A123 for tubing and to ASTM A153 for hardware and accessories.

.5 Shop Drawings: Manufacturer to provide detailed shop drawings to indicate layout and supporting capacities of system components with installation and assembly instructions for each application. Shop drawings shall bear the signature and seal of a professional engineer licenced in Manitoba.

3 Execution

3.1 INSTALLATION

.1 Install to manufacturer's instructions and best trade practises.

3.2 INSERTS

.1 Provide inserts for placement in concrete formwork.
.2 Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
.3 Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4" (100 mm).
.4 Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
.5 Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.

3.3 PIPE HANGERS AND SUPPORTS

.1 Support horizontal piping as scheduled.
.2 Install hangers to provide minimum 1/2" (13 mm) space between finished covering and adjacent work.
.3 Place hangers within 12" (300 mm) of each horizontal elbow.
.4 Use hangers with 1-1/2" (38 mm) minimum vertical adjustment.
.5 Support horizontal cast iron pipe adjacent to each hub, with 5 feet (1.5 m) maximum spacing between hangers.
.6 Support vertical cast iron pipe at each floor at hub.
.7 Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
.8 Support riser piping independently of connected horizontal piping.
.9 Provide copper plated hangers and supports for copper piping.
.10 Design hangers for pipe movement without disengagement of supported pipe.
.11 Prime coat exposed steel hangers and supports. Refer to Section 15010. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

3.4 EQUIPMENT BASES AND SUPPORTS

.1 Provide housekeeping pads of concrete, minimum 4" (100 mm) thick and extending 6" (150 mm) beyond supported equipment. Refer to Section 15010.
.2 Provide templates, anchor bolts, and accessories for mounting and anchoring equipment.
.3 Construct supports of steel members. Steel pipe and fittings. Brace and fasten with flanges bolted to structure.
.4 Provide rigid anchors for pipes after vibration isolation components are installed.

3.5 ROOFTOP PIPE/DUCT SUPPORT

.1 Coordinate installation of supports and bases with roofing work. Ensure that roofing surfaces are smooth and flat and are ready to receive work.
.2 Use care in installation of support systems not to damage roofing, flashing, equipment or related materials.
.3 Install and secure support systems in strict accordance with manufacturer's written instruction.
.4 Consult manufacturers of roofing system to determine if walk pads are required. Provide and fully adhere walk pads to roof system where required.
.5 Bases and support framing shall be located as indicated on shop drawings provided by support system manufacturer and as specified herein. The support of all piping shall be complete and adequate, whether or not all required devices are shown.

.6 The use of wood or wire for supporting piping will not be permitted.
.7 Deflection of pipes shall not exceed 1/240th of the span.
.8 Accurately locate and align bases. Where applicable, replace gravel around bases. Set framing posts into bases and assemble framing structure as indicated.
.9 Use galvanized fasteners for galvanized framing, and use stainless steel fasteners for stainless steel framing.

3.6 FLASHING

.1 Provide flexible flashing and metal counterflashing where piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.
.2 Flash vent and soil pipes projecting 3" (75 mm) minimum above finished roof surface with lead worked 1" (25 mm) minimum into hub, 8" (200 mm) minimum clear on sides with 24" x 24" (600 x 600 mm) sheet size. For pipes through outside walls, turn flanges back into wall and caulk, metal counterflash, and seal.
.3 Flash floor drains in floors with topping over finished areas with lead, 10" (250 mm) clear on sides with minimum 36" x 36" (910 x 910 mm) sheet size. Fasten flashing to drain clamp device.
.4 Seal roof, floor, shower and mop sink drains watertight to adjacent materials.
.5 Provide acoustical lead flashing around ducts and pipes penetrating equipment rooms, installed to manufacturer's instructions for sound control.
.6 Provide curbs for mechanical roof installations 14" (350 mm) minimum high above roofing surface. Flash and counterflash with sheet metal; seal watertight. Attach counterflashing mechanical equipment and lap base flashing on roof curbs. Flatten and solder joints.
.7 Adjust storm collars tight to pipe with bolts; caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

3.7 SLEEVES

.1 Set sleeves in position in formwork. Provide reinforcing around sleeves.
.2 Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
.3 Extend sleeves through floors 1" (25 mm) above finished floor level. Caulk sleeves.
.4 Where piping or ductwork penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent work with stuffing insulation and caulk. air tight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.
.5 Install chrome plated steel escutcheons at finished surfaces.

3.8 SCHEDULES

.1 Imperial Measure (IP)

Pipe Size(in)	Rod Diameter (in)	Support Spacing (Ft)	
		Steel Pipe	Copper Tube
1/2	3/8	7	6
3/4	3/8	7	6
1	3/8	7	6
1-1/4	3/8	7	6
1-1/2	3/8	9	8
2	3/8	10	9
2-1/2	3/8	12	10
3	3/8	12	10
4	5/8	14	12
6	7/8	17	
8	7/8	19	
10	7/8	21	
12	7/8	23	

.2 Metric Measure (SI)

Pipe Size(mm)	Rod Diameter (mm)	Support Spacing (m)	
		Steel Pipe	Copper Tube
13	10	2.1	1.8
20	10	2.1	1.8
25	10	2.1	1.8
32	10	2.1	1.8
38	10	2.7	2.4
50	10	3	2.7
65	10	3.6	3
75	10	3.6	3
100	16	4.2	3.6
150	22	17	
200	22	5.7	
250	22	6.4	
300	22	7	

End of Section

1 General

1.1 GENERAL

.1 Read and conform to:
- .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
- .2 Division 1 requirements and documents refered to therein.

1.2 SECTION INCLUDES

.1 Inertia bases.
.2 Vibration isolation.
.3 Coordination with Section 15165 Supports and Anchors
.3 Coordination with Section 15191 Seismic Restraints

1.3 PERFORMANCE REQUIREMENTS

.1 Provide vibration isolation on motor driven equipment over 0.35 kW, plus connected piping and ductwork.
.2 Provide minimum static deflection of isolators for equipment as indicated.
- .1 Ground Floor, Under 15 kW
  - .1 Under 400 rpm: RIS
  - .2 400 - 600 rpm: 1" (25 mm)
  - .3 600 - 800 rpm: 1/2" (12 mm)
  - .4 800 - 900 rpm: 1/4" (5 mm)
  - .5 1100 - 1500 rpm: 1/8" (4 mm)
  - .6 Over 1500 rpm: 1/8" (3 mm)
- .2 Ground Floor, Over 15 kW
  - .1 Under 400 rpm: RIS
  - .2 400 - 600 rpm: 2" (50 mm)
  - .3 600 - 800 rpm: 1" (25 mm)
  - .4 800 - 900 rpm: 1/2" (12 mm)
  - .5 1100 - 1500 rpm: 1/4" (5 mm)
  - .6 Over 1500 rpm: 1/8" (4 mm)

1.4 SUBMITTALS

.1 Section 15010: Procedures for submittals.
.2 Shop Drawings: Indicate inertia bases and locate vibration isolators, with static and dynamic load on each.
.3 Product Data: Provide schedule of vibration isolator type with location and load on each.
.4 Manufacturer's Installation Instructions: Indicate special procedures and setting dimensions.
.5 Manufacturer's Certificate: Certify that isolators are properly installed and adjusted to meet or exceed specified requirements.

1.5 PROJECT RECORD DOCUMENTS

.1 Section 15010: Submittals for project closeout.
.2 Record actual locations of hangers including attachment points.

2 Products

2.1 MANUFACTURERS

.1 Manufacturer shall be a member of VISCMA.
.2 Coordinate selection of Manufacturer with Section 15191.

.3 Acceptable manufacturers;
.1 Vibron/Kinetics.
.2 VAW Systems.
.3 Korfund
.4 Masdom

2.2 VIBRATION ISOLATORS

.1 Open Spring Isolators:
.1 Spring Isolators:
.1 For Exterior and Humid Areas: Provide hot dipped galvanized housings and neoprene coated springs.
.2 Code: Colour code springs for load carrying capacity.
.2 Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
.3 Spring Mounts: Provide with levelling devices, minimum 1/4" (6 mm) thick neoprene sound pads, and zinc chromate plated hardware.
.4 Sound Pads: Size for minimum deflection of 0.05" (1.2 mm); meet requirements for neoprene pad isolators.
.2 Restrained Spring Isolators:
.1 Spring Isolators:
.1 For Exterior and Humid Areas: Provide hot dipped galvanized housings and neoprene coated springs.
.2 Code: Colour code springs for load carrying capacity.
.2 Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
.3 Spring Mounts: Provide with levelling devices, minimum 1/4" (6 mm) thick neoprene sound pads, and zinc chromate plated hardware.
.4 Sound Pads: Size for minimum deflection of 0.05" (1.2 mm); meet requirements for neoprene pad isolators.
.5 Restraint: Provide heavy mounting frame and limit stops.
.3 Closed Spring Isolators:
.1 Spring Isolators:
.1 For Exterior and Humid Areas: Provide hot dipped galvanized housings and neoprene coated springs.
.2 Code: Colour code springs for load carrying capacity.
.2 Type : Closed spring mount with top and bottom housing separated with neoprene rubber stabilizers.
.3 Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
.4 Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators, and neoprene side stabilizers with minimum 1/4" (7 mm) clearance.
.4 Restrained Closed Spring Isolators:
.1 Spring Isolators:
.1 For Exterior and Humid Areas: Provide hot dipped galvanized housings and neoprene coated springs.
.2 Code: Colour code springs for load carrying capacity.
.2 Type : Closed spring mount with top and bottom housing separated with neoprene rubber stabilizers.
.3 Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
.4 Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators, and neoprene side stabilizers with minimum 1/4" (7 mm) clearance and limit stops.
.5 Spring Hanger:
.1 Spring Isolators:
.1 For Exterior and Humid Areas: Provide hot dipped galvanized housings and neoprene coated springs.

.2 Code: Colour code springs for load carrying capacity.

.2 Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.

.3 Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators.

.4 Misalignment: Capable of 20 degree hanger rod misalignment.

.6 Neoprene Pad Isolators:

.1 Rubber or neoprene waffle pads.

.1 30 durometer.

.2 Minimum 1/2" (13 mm) thick.

.3 Maximum loading 275 kPa.

.4 Height of ribs: maximum 0.7 times width.

.2 Configuration: Single layer.

.7 Rubber Mount or Hanger: Moulded rubber designed for 1/2" (13 mm) deflection with threaded insert.

.8 Glass Fibre Pads: Neoprene jacketed pre-compressed moulded glass fibre.

3 Execution

3.1 INSTALLATION

.1 Install to manufacturer's instructions.

.2 Install isolation for motor driven equipment.

.3 Install spring hangers without binding.

.4 On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions.

.5 Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim removal.

.6 Provide pairs of horizontal limit springs on fans with more than 1.5 kPa static pressure, and on hanger supported, horizontally mounted axial fans.

.7 Support piping connections to isolated equipment resiliently as follows:

.1 Up to 4" (100 mm) Diameter: First three points of support.

.2 5" to 8" (125 to 200 mm) Diameter: First four points of support.

.3 10" (250 mm) Diameter and Over: First six points of support.

.4 Select three hangers closest to vibration source for minimum 1" (25 mm) static deflection or static deflection of isolated equipment. Select remaining isolators for minimum 1" (25 mm) static deflection or 1/2 static deflection of isolated equipment.

.8 Connect wiring to isolated equipment with flexible hanging loop.

3.2 MANUFACTURER'S FIELD SERVICES

.1 Inspect isolated equipment after installation and submit report. Include static deflections.

3.3 EQUIPMENT ISOLATION SCHEDULE

End of Section

1 General

1.1 GENERAL

.1 Read and conform to:
- .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
- .2 Division 1 requirements and documents refered to therein.

1.2 SECTION INCLUDES

.1 Engineering, design and calculations for seismic restraint
.2 Seismic restraints for equipment, piping and ductwork
.3 Coordination with Section 15165 Supports and Anchors
.4 Coordination with Section 15190 Vibration Isolation

1.3 REFERENCES

.1 Manitoba Building Code
.2 National Building Code
.3 ASHRAE Standard "A Practical Guide to Seismic Restraint",
.4 NFPA 13,
.5 SMACNA "HVAC Duct Construction Standards"
.6 Good engineering practice.

1.4 SUBMITTALS

.1 All vibration isolation and seismic restraint systems shall be by one manufacturer. Preferred manufacturer is Vibro-Acoustics.
.2 Submit shop drawings for all devices specified herein and as indicated on the drawings. Submittals shall include dimensions, materials, attachment and anchorage requirements. Indicate compliance with each specification item herein.
.3 Provide calculations for selection of seismic restraints, certified by a qualified professional engineer licensed in the province where the project is located. Design calculations shall use the following parameters:
- .1 Building site classification for seismic site response is D.
- .2 Earthquake importance factor for the building, IE, is 1.5.
- .3 Spectral response acceleration for short periods, $S_a(0.2)$, is: 0.18.
- .4 Spectral response acceleration for 1-second periods, $S_a(1.0)$, is: 0.04.
- .5 Importance factor for wind load, IW, is 1.25.
- .6 The reference hourly wind velocity pressure, q, in kPa, is 0.47.

.4 Shop Drawings:
- .1 Provide detailed drawings of all seismic control measures for equipment, duct, and piping.
- .2 Provide separate shop drawings for each isolated system complete with performance and product data, indicating all calculations for loads and deflections.
- .3 Indicate inertia bases and locate vibration isolators, with static and dynamic loads on each.
- .4 Shop drawings shall include engineering calculations for all seismic restraints and attachment. A Professional Engineer registered in the province of the project shall sign, seal and date the calculations.

.5 Product Data: Provide schedule of vibration isolator type with location and load on each.
.6 Manufacturer's Installation Instructions: Indicate special procedures and setting dimensions.
.7 Manufacturer's Certificate: Certify that isolators are properly installed and adjusted to meet or exceed design requirements.

1.5 PROJECT RECORD DOCUMENTS

.1 Record actual locations of seismic restraints including attachment points.

1.6 SEISMIC ENGINEER

.1 Professional Engineer holding a Certificate of Authorization in the Province of Manitoba with a minimum of 5 years experience in seismic design, and a minimum of $1 million Professional Liability Insurance including Errors and Omissions Insurance.
.2 At the completion of the project, the Seismic Engineer shall review the installations on site, and shall prepare a written report, with a letter signed, sealed and dated by the Seismic Engineer, certifying that the installations have been completed in accordance with their design and shop drawings.

1.7 SEISMIC CONTROL MEASURES

.1 A single Supplier shall provide seismic design, vibration isolation, and seismic restraint. Coordinate with Section 15190.
.2 Seismic restraints are to be provided for all operational and functional components of building services in accordance with current requirements of the Manitoba Building Code.
.3 Cable restraint systems, rod stiffener clamps and seismic isolator capacities shall be verified by an independent test laboratory.
.4 Connection materials shall be selected by and site specific designs to be prepared by the Seismic Engineer. The Seismic Engineer may select and specify materials and anchors to be provided by the contractor where this is appropriate.
.5 Contractor shall ensure that the Seismic Engineers' requirements and specification are met.
.6 Seismic Force: the Importance Factor for this project is 1.5.

2 Products

2.1 MANUFACTURERS

.1 Manufacturer shall be a member of VISCMA.
.2 Coordinate selection of Manufacturer with Section 15190.
.3 Acceptable manufacturers;
  .1 Vibron/Kinetics.
  .2 VAW Systems
  .3 Korfund
  .4 Masdom

2.2 GENERAL

.1 All isolation and seismic restraint products supplied by common manufacturer / supplier.
.2 All isolators are to be seismic rated or to be used with a bracing or snubber system.
.3 Colour code springs for load carrying capacity.
.4 Outdoor springs and housings to be corrosion resistant.
.5 Units containing water that can be drained are to use a vertical limiting spring as F-2.

3 Excecution

3.1 SEISMIC RESTRAINT

.1 Pipes and Ducts: the following pipe and duct sizes, and larger, must be restrained:
  .1 2.5" (64 mm) diameter pipe in general areas
  .2 1.25" (32 mm) diameter pipe in mechanical rooms
  .3 1" (25 mm) diameter pipe containing hazardous materials and medical piping (ie natural gas, oil, medical vacuum, etc)
  .4 6 square feet face area for duct
  .5 any trapeze with a component combined weight that exceeds the above items
.2 Pipes and ducts hung with hanger rods less than 12" (300 mm) in length do not require seismic restraint provided the following conditions are all satisfied:
  .1 All hanger rods in the "run" are attached to the structure with non-moment generating connections; and

.2 At least 12" (300 mm) clearance on each side of the pipe or duct is provided for the entire "run" so that the pipe or duct can swing freely and will not contact anything; and
.3 All hanger rods in a "run" of pipe or duct must be less than 12" (300 mm) in length. If one hanger rod exceeds 12" (300 mm) in a "run", this exception cannot be applied.
.4 The 12" (300 mm) rule does not apply to suspended equipment.

.3 Base Mounted Equipment: all base mounted equipment requires attachments and seismic restraint as specified by the Seismic Engineer.
.4 Suspended Equipment: all suspended equipment requires seismic restraint.
.5 Roof mounted equipment shall be installed on a structural frame, seismic rated roof curb, or structural curb or frame mechanically connected to the structure. Items shall not be mounted on sleepers or pads that are not mechanically attached to the structure.
.6 Roof mounted piping and ductwork is to be installed on curbs or frames mechanically connected to the building structure. Roof anchors and seismic cables or frames shall be used to resist seismic and wind loading. Wind loading forces shall be determined by the Seismic Engineer.

3.2 INSTALLATION - GENERAL

.1 Install to manufacturer's instructions and adjust mountings to level equipment.
.2 Ensure pipe, duct and electrical connections to isolated equipment do not reduce system flexibility. Ensure that pipe, conduit and duct passing through walls and floors do not transmit vibrations.
.3 Install isolation for motor driven equipment.
.4 Bases:
.1 Set steel bases for 1" (25 mm) clearance between housekeeping pad and base.
.2 Set concrete inertia bases for 2" (50 mm) clearance between housekeeping pad and base.
.3 Adjust equipment level.
.5 Install spring hangers without binding.
.6 On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions.
.7 Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim removal.
.8 Provide pairs of horizontal limit springs on fans with more than 1.5 kPa static pressure, and on hanger supported, horizontally mounted axial fans.
.9 Provide resiliently mounted equipment, piping, and ductwork with seismic snubbers. Provide each inertia base with minimum of four seismic snubbers located close to isolators. Snub equipment designated for post disaster use to 0.06" (1.5 mm) maximum clearance. Provide other snubbers with clearance between 1/8" and 1/4" (4 mm and 7 mm).
.10 Block and shim level bases so that ductwork and piping connections can be made to a rigid system at the operating level, before isolator adjustment is made. Ensure that there is no physical contact between isolated equipment and building structure.
.11 Connect wiring to isolated equipment with flexible hanging loop.

3.3 INSTALLATION - EQUIPMENT

.1 Rigid Mounted Equipment:
.1 Anchor floor and wall mounted equipment to structure as per the seismic shop drawings.
.2 Suspended equipment shall be restrained using sway bracing, or struts, and hanger rods as per the seismic shop drawings.
.2 Vibration isolated equipment:
.1 Seismic control measures shall not compromise the performance of noise control, vibration isolation or fire stopping systems.
.2 Equipment supported by vibration-isolation hangers shall be detailed and installed with isolation hangers tight to the structure and upward limit stops located directly below the hangers.

3.4 INSTALLATION - PIPING AND DUCT SYSTEMS

.1 Provide seismic control measures with spacing and anchorage engineered for the specific project. Provide rod stiffeners where required.
.2 Maximum Restraint Spacing
.1 Piping: transverse spacing 40 ft (12 m), longitudinal spacing 80 ft (24 m).

.2 Duct: transverse spacing 40 ft (12 m), longitudinal spacing 80 ft (24 m).
.3 Hazardous Material and Medical Piping: transverse spacing 20 ft (6 m), longitudinal spacing 40 ft (12 m).

.3 Support piping connections to isolated equipment resiliently as follows:
.1 Up to 4" (100 mm) Diameter: First three points of support.
.2 5" - 8" (125 to 200 mm) Diameter: First four points of support.
.3 10" (250 mm) Diameter and Over: First six points of support.
.4 Select three hangers closest to vibration source for minimum 1" (25 mm) static deflection or static deflection of isolated equipment. Select remaining isolators for minimum 1" (25 mm) static deflection or 1/2 static deflection of isolated equipment.
.5 First point of support shall have a static deflection of twice deflection of isolated equipment, but not more than 2" (50 mm).
.6 Deflection shall be not less than that for the equipment to which the piping is connected.

.4 Seismic systems are to be compatible with requirements for anchoring and guiding of piping systems.
.5 Drilled or power driven anchors or fasteners not permitted for use with seismic control measures.
.6 Outdoor and roof mounted systems must be mechanically attached to structure. This attachment must account for seismic and wind loading.
.7 Friction due to gravity does not constitute a seismic attachment.
.8 Where equipment is mounted on concrete housekeeping pads the design of reinforcement and anchorage of the pad to the structure shall be performed by the Seismic Engineer. Alternatively, the equipment must be attached through the pad to the base structure, at the Seismic Engineer's discretion.
.9 Do not brace equipment to separate portions of the structure that may act differently in response to an earthquake. For example, do not connect a transverse brace to a wall and a longitudinal brace to a floor or roof at the same brace location.
.10 All duct over 6 square feet is to be hung with a double trapeze at restraint locations, one angle on the top and one angle on the bottom of the duct.
.11 Unless noted otherwise on seismic shop drawings, all duct is to be screwed to the trapeze (top and bottom) with #10 screws at 12" (300 mm) spacing for every trapeze.
.12 All pipes must be attached to trapeze with pipe clamps.
.13 Where pipe or duct size reduces below required dimensions noted in Section 2.3.1, the final restraint shall be installed at the transition location.
.14 Items mounted into T-bar suspended ceiling grids require 4 wires to attach the unit to the structure. The wires and their attachment do not form part of the seismic restraint system. If the ceiling grid is seismically restrained, then the item does not require independent seismic restraint. This design in not in this scope of work, as the ceiling grid is an architectural component.
.15 Sleepers for roof mounted pipes, duct, and equipment require mechanical connection to the building. The forces imposed on this attachment are to be provided by the seismic engineer.
.16 Seismic restraint connections are not to be connected to the bottom chord of steel joists or the bottom flange of steel beams.
.17 Rod stiffeners are required where the hanger rod exceeds the maximum length as shown in the seismic calculation sheets. They are only required at restraint locations.
.18 Standard beam clamps can only be used on seismically restrained components; they cannot be used to connect the seismic restraint to the structure - only for the hanger rods.
.19 Horizontal penetrations through walls should be through a pre-fabricated metal sleeve with a compressible material between the pipe and the sleeve. Vertical penetrations through floors/roofs should use an oversize hole in the structure with compressible material between the hole and the pipe and the pipe should be supported by a clamp resting on two steel load-distributing plates.
.20 Block walls can be used for transverse restraints if the item penetrates the wall at 90 degrees and is a snug fit. If angles are attached to the item around its perimeter and attached to the wall, then the wall can act as a transverse and longitudinal restraint. Metal stud walls cannot be used for restraint unless specifically designed.

3.5 MANUFACTURER'S FIELD SERVICES

.1 Examine systems to Section 15010.
.2 Inspect isolated equipment after installation and submit report. Include static deflections.

3.6 PIPE ISOLATION SCHEDULE

	Pipe Size mm	Isolated Distance from Equipment
.1	25	120 diameters (3.0 m)
.2	50	90 diameters (4.5 m)
.3	80	80 diameters (6.0 m)
.4	100	75 diameters (7.5 m)
.5	150	60 diameters (9.0 m)
.6	200	60 diameters (12.0 m)
.7	250	54 diameters (13.5 m)
.8	300	50 diameters (15.0 m)
.9	400	45 diameters (18.0 m)
.10	600	38 diameters (23.0 m)
.11	Over 600	to be determined by Seismic Engineer

3.7 EQUIPMENT ISOLATION SCHEDULE

EQUIPMENT ITEM	BASEMENT & SLAB ON GRADE			UPPER FLOORS		
	BASE TYPE	ISOLATOR SERIES	STATIC DEFLECTION	BASE TYPE	ISOLATOR SERIES	STATIC DEFLECTION
CENTRIFUGAL FANS						
To 40 HP (30 kW), to 275 rpm	IS	VO	3.0`` (76mm)	IS	VO	3.0`` (76mm)
To 40 HP (30 kW), 276 to 600 rpm	IS	VO	1.5`` (38mm)	IS	VO	2.0`` (50mm)
To 40 HP (30 kW), over 600 rpm	IS	VO	1.0`` (25mm)	IS	VO	1.0`` (25mm)
Over 40 HP (30 kW), to 275 rpm	CI	VO	3.0`` (76mm)	CI	VO	3.0`` (76mm)
Over 40 HP (30 kW), 276 to 600 rpm	CI	VO	1.5`` (38mm)	CI	VO	2.0`` (50mm)
Over 40 HP (30 kW), over 600 rpm	CI	VO	1.0`` (25mm)	CI	VO	1.0`` (25mm)
AXIAL & TUBULAR CENTRIFUGAL FANS						
Suspended, all sizes to 750 rpm	–	VH	1.0`` (25mm)	–	VH	1.5`` (38mm)
Suspended, all sizes over 750 rpm	–	VH	0.7`` (18mm)	–	VH	1.1`` (28mm)
Floor mounted, all sizes to 750 rpm	IS	VO	0.7`` (18mm)	IS	VO	1.5`` (38mm)
Floor mounted, all sizes over 750 rpm	IS	VO	0.7`` (18mm)	IS	VO	1.1`` (28mm)
SUSPENDED PACKAGED AIR HANDLERS TO 5``SP						
To 7.5HP (5.6kW), all rpm	–	V	0.7`` (18mm)	–	VH	0.7`` (18mm)
Over 7.5HP (5.6kW), to 600rpm	–	V	0.7`` (18mm)	–	VH	1.0`` (25mm)
Over 7.5HP (5.6kW), 601 to 1000rpm	–	V	0.7`` (18mm)	–	VH	1.0`` (25mm)
Over 7.5HP (5.6kW), over 1000rpm	–	V	0.7`` (18mm)	–	VH	0.7`` (18mm)
FLOOR MNTD PACKAGED AIR HANDLERS TO 5``SP						
To 7.5HP (5.6kW), all rpm	–	MD	0.25`` (6.4mm)	–	V	0.75`` (19mm)
Over 7.5HP (5.6kW), to 600rpm	–	V	0.7`` (18mm)	–	V	1.0`` (25mm)
Over 7.5HP (5.6kW), 601 to 1000rpm	–	V	0.7`` (18mm)	–	V	1.0`` (25mm)
Over 7.5HP (5.6kW), over 1000rpm	–	V	0.7`` (18mm)	–	V	0.7`` (18mm)
UTILITY SETS						
Suspended to 500rpm	–	VH	0.35`` (8.9mm)	–	VH	1.0`` (25mm)
Suspended over 500rpm	–	VH	0.35`` (8.9mm)	–	VH	0.7` (18mm)
Floor mounted to 500rpm	RM	MD	0.35`` (8.9mm)	IS	VO	1.5`` (38mm)
Floor mounted over 500rpm	RM	MD	0.35`` (8.9mm)	IS	VO	1.1`` (28mm)
CENTRIFUGAL PUMPS						
Close coupled to 5HP (3.75kW)	CI	VO	1.0`` (25mm)	CI	VO	1.0`` (25mm)
Close coupled over 5HP (3.75 kW)	CI	VO	1.0`` (25mm)	CI	VO	1.0`` (25mm)
Base mounted to 5HP (3.756 kW)	CI	VO	1.0`` (25mm)	CI	VO	1.0`` (25mm)
Base mounted 7.5 - 75HP (5.6-56 kW)	CI	VO	1.0`` (25mm)	CI	VO	1.0`` (25mm)
Base mounted to 5HP (3.75 kW)	CI	VO	1.0`` (25mm)	CI	VO	1.5`` (38mm)
IN LINE PUMPS						
To 40HP (30kW)	–	VSV	0.15`` (3.8mm)	–	V	1.0`` (25mm)
Over 40HP (30kW)	–	VSV	0.15`` (3.8mm)	CI	V	1.0`` (25mm)
PACKAGED STEAM GENERATORS						
All sizes	–	VOR	1.0`` (25mm)	–	VOR	1.75`` (44mm)
CENTRIFUGAL CHILLERS						
All sizes	IS	VOR	1.0`` (25mm)	IS	VOR	2.0`` (50mm)
ABSORPTION CHILLERS						
All sizes	IS	VOR	1.0`` (25mm)	IS	VOR	1.5`` (38mm)
ELECTRICAL DISTRIBUTION TRANSFORMERS						
To 50kva	–	VP	0.06`` (1.5mm)	–	VSV	0.12`` (3.0mm)
51 to 250kva	–	MD	0.25`` (6.4mm)	–	MD	0.3`` (7.6mm)
Over 250kva	–	MD	0.35`` (8.9 mm)	–	V	0.7`` (18 mm)

NOTES: * Concrete inertia base to be at least 3 times the weight of the unit.
SPEC NOTE: Check with Vibron

End of Section

1 General

1.1 GENERAL

.1 Read and conform to:
- .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
- .2 Division 1 requirements and documents refered to therein.

1.2 SECTION INCLUDES

.1 Piping insulation.
.2 Jackets and accessories.

1.3 REFERENCES

.1 ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate.
.2 ASTM C177 - Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
.3 ASTM C195 - Mineral Fibre Thermal Insulating Cement.
.4 ASTM C335 - Steady-State Heat Transfer Properties of Horizontal Pipe Insulation.
.5 ASTM C449/C449M - Mineral Fibre Hydraulic-setting Thermal Insulating and Finishing Cement.
.6 ASTM C518 - Steady-State Thermal Transmission Properties by Means of the Heat Flow Metre Apparatus.
.7 ASTM C533 - Calcium Silicate Block and Pipe Thermal Insulation.
.8 ASTM C534 - Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
.9 ASTM C547 - Mineral Fibre Pipe Insulation.
.10 ASTM C578 - Rigid, Cellular Polystyrene Thermal Insulation.
.11 ASTM C585 - Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System).
.12 ASTM C591 - Unfaced Preformed Cellular Polyisocyanurate Thermal Insulation.
.13 ASTM C610 - Moulded Expanded Perlite Block and Pipe Thermal Insulation.
.14 ASTM C921 - Properties of Jacketing Materials for Thermal Insulation.
.15 ASTM D1056 - Flexible Cellular Materials - Sponge or Expanded Rubber.
.16 ASTM D1667 - Flexible Cellular Materials - Vinyl Chloride Polymers and Copolymers (Closed Cell Foam).
.17 ASTM D2842 - Water Absorption of Rigid Cellular Plastics.
.18 ASTM E84 - Surface Burning Characteristics of Building Materials.
.19 ASTM E96 - Water Vapour Transmission of Materials.
.20 NFPA 255 - Surface Burning Characteristics of Building Materials.
.21 UL 723 - Surface Burning Characteristics of Building Materials.

1.4 SUBMITTALS

.1 Product Data: Provide product description, list of materials and thickness for each service, and locations.
.2 Manufacturer's Installation Instructions: Indicate procedures which ensure acceptable workmanship and installation standards will be achieved.

1.5 QUALITY ASSURANCE

.1 Materials: Flame spread/smoke developed rating of 25/50 or less to ASTM E84.

1.6 QUALIFICATIONS

.1 Applicator: Company specializing in performing the work of this section with minimum three years experience.

1.7 DELIVERY, STORAGE, AND HANDLING

.1 Transport, handle, store, and protect products.
.2 Deliver materials to site in original factory packaging, labelled with manufacturer's identification, including product density and thickness.
.3 Store insulation in original wrapping and protect from weather and construction traffic.
.4 Protect insulation against dirt, water, chemical, and mechanical damage.

1.8 ENVIRONMENTAL REQUIREMENTS

.1 Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
.2 Maintain temperature during and after installation for minimum period of 24 hours.

2 Products

2.1 GLASS FIBRE

.1 Manufacturers:
  .1 Manufacturer: Owens Corning Fiberglas
.2 Other acceptable manufacturers offering equivalent products:
  .1 Manson
  .2 Knauf Fiber Glass
  .3 Schuller
.2 Insulation: ASTM C547; rigid moulded, noncombustible.
  .1 'ksi' value : ASTM C335, 0.035 at 75°F (24°C).
  .2 Minimum Service Temperature: -20°F (-28.9°C).
  .3 Maximum Service Temperature: 302°F (150°C).
  .4 Maximum Moisture Absorption: 0.2 percent by volume.
.3 Vapour Barrier Jacket
  .1 ASTM C921, White kraft paper reinforced with glass fibre yarn and bonded to aluminized film.
  .2 Moisture Vapour Transmission: ASTM E96; 0.02 perm.
  .3 Secure with self sealing longitudinal laps and butt strips.
  .4 Secure with outward clinch expanding staples and vapour barrier mastic.
.4 Tie Wire: 1.3 mm stainless steel with twisted ends on maximum 12" (300 mm) centres.
.5 Vapour Barrier Lap Adhesive
  .1 Compatible with insulation.
.6 Insulating Cement/Mastic
  .1 ASTM C195; hydraulic setting on mineral wool.
.7 Fibrous Glass Fabric
  .1 Cloth: Untreated; 9 oz/sq yd (305 g/sq m) weight.
  .3 Blanket: 1.0 lb/cu ft (16 kg/cu m) density.
.8 Indoor Vapour Barrier Finish
  .1 Vinyl emulsion type acrylic, compatible with insulation, white colour.
.9 Outdoor Vapour Barrier Mastic
  .1 Vinyl emulsion type acrylic, compatible with insulation, white colour.
.10 Insulating Cement
  .1 ASTM C449.

2.2 UNDERGROUND PIPE INSULATION

.1 Manufacturer: Pittsburgh Corning Corporation
.2 Other acceptable manufacturers when offering equivalent products:
.3 Insulation: FOAMGLAS® insulation, ASTM C 552, "Specification for Cellular Glass Thermal Insulation".
.4 Jacketing: PITTWRAP® jacketing (FI-209)
.5 Jacketing: PITTWRAP® SS jacketing (FI-179A)
.6 Jacketing: PITTWRAP® CW Plus jacketing (FI-234)

.7 Asphalt Coating: PITTCOTE®300 Finish (FI-120)
.8 Reinforcing Fabric: PC® Fabric 79 (FI-159)
.9 Strapping Tape: glass fiber reinforced, 1" (25mm) Scotch brand #880 by 3M
.10 Bore Coating: Hydrocal® B-11 by US Gypsum
.11 High Temperature Sealant: PC® HI-TEMP/RTV Silicone Adhesive (FI-232) max. temperature limit of 500°F (260°C) continuous service
.12 High Temperature Sealant: PC® HI-TEMP/RTV 450 Silicone Adhesive (FI-244) max. temperature limit of 400°F (204°C) continuous service

2.3 JACKETS

.1 PVC Plastic
  .1 Jacket: ASTM C921, One piece moulded type fitting covers and sheet material.
    .1 Minimum Service Temperature: -31°F (-35°C).
    .2 Maximum Service Temperature: 151°F (66°C).
    .3 Moisture Vapour Transmission: ASTM E96; 0.03 perm inches.
    .4 Maximum Flame Spread: ASTM E84; 25 or less.
    .5 Maximum Smoke Developed: ASTM E84; 50 or less.
    .6 Thickness: 20 mil (0.4 mm) minimum.
  .2 Colour: standard off-white.
  .3 Covering Adhesive Mastic
    .1 Compatible with insulation, low VOC.
  .4 Manufacturer;
    .1 Ceel-Co 300 series
    .2 Speedline *Smoke Safe*
.2 Aluminum Jacket: ASTM B209.
  .1 Thickness: 0.02" (0.40 mm) sheet.
  .2 Finish: Smooth.
  .3 Joining: Longitudinal slip joints and 2" (50 mm) laps.
  .4 Fittings: 0.02" (0.40 mm) thick die shaped fitting covers with factory attached protective liner.
  .5 Metal Jacket Bands: 3/8" (10 mm) wide; 0.01" (0.38 mm) thick aluminum.

3 Execution

3.1 EXAMINATION

.1 Verify that piping has been tested before applying insulation materials.
.2 Verify that surfaces are clean, foreign material removed, and dry.

3.2 INSTALLATION

.1 Install piping insulations to TIAC National Installation Standards.
.2 Apply insulation materials, accessories, jackets and finishes in accordance with manufacturer' written instructions and as specified.
.3 On exposed piping, locate insulation and cover seams in least visible locations.
.4 Insulated dual temperature pipes or cold pipes conveying fluids below ambient temperature:
  .1 Provide vapour barrier jackets, factory applied or field applied.
  .2 Insulate fittings, joints, and valves with moulded insulation of like material and thickness as adjacent pipe.
  .3 Finish with glass cloth and vapour barrier adhesive.
  .4 PVC fitting covers may be used.
  .5 Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations.
  .6 Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
.5 For insulated pipes conveying fluids above ambient temperature:
  .1 Provide standard jackets, with or without vapour barrier, factory applied or field applied.
  .2 Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining

pipe.
.3 Finish with glass cloth and adhesive.
.4 PVC fitting covers may be used.
.5 For hot piping conveying fluids 140°F (60°C) or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
.6 For hot piping conveying fluids over 140°F (60°C), insulate flanges and unions at equipment.

.6 Inserts and Shields:
.1 Application: Piping 1-1/2" (40 mm) diameter or larger.
.2 Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
.3 Insert Location: Between support shield and piping and under the finish jacket.
.4 Insert Configuration: Minimum 6" (150 mm) long, of same thickness and contour as adjoining insulation; may be factory fabricated.
.5 Insert Material: hydrous calcium silicate insulation.

.7 Finish insulation at supports, protrusions, and interruptions.

.8 For pipe exposed in mechanical equipment rooms or in finished spaces below 10 ft (3 m) above finished floor, finish with canvas jacket sized for finish painting.

.9 For exterior applications, provide vapour barrier jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapour barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal piping.

.10 For buried piping, provide factory fabricated assembly with inner all-purpose service jacket with self sealing lap, and asphalt impregnated open mesh glass fabric, with one mil (0.025 mm) thick aluminum foil sandwiched between three layers of bituminous compound; outer surface faced with a polyester film.

.11 For heat traced piping, insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer. Cover with aluminum jacket with seams located on bottom side of horizontal piping.

3.3 TOLERANCE

.1 Substituted insulation materials: Thermal resistance within 10 percent at normal conditions, as materials indicated.

3.4 PIPE INSULATION

.1 Insulate piping with rigid pipe insulation as follows:

Service	Operating Temperature Range °F (°C)	Pipe Diameter in. (mm)	Insulation Thickness in. (mm)
Geothermal	40 to 55 (4 to 13)	All sizes	1-1/2 (40)
	< 40 (4.4)	1(25) and smaller	1-1/2 (40)
	< 40 (4.4)	1-1/4 (38) and larger	1-1/2 (40)
Condensate (cold)	0 to 850 (-18 to 454)	All sizes	1/2 (13)
Domestic cold water	0 to 850 (-18 to 454)	All sizes	1 (25)
Domestic hot water & hot water recirculation	105 (41) and higher	2 (50) and smaller	1 (25)
		2-1/2 (65) and larger	1-1/2 (40)
Hydronic heating (hot water and glycol/water	105 to 140 (41 to 60)	4 (100) and smaller	1 (25)
	105 to 140 (41 to 60)	5 (125) and larger	1-1/2 (40)
	141 to 200 (61 to 93)	All sizes	1-1/2 (40)
Sanitary drainage	40 to 55 (4 to 13)	All sizes	1 (25)
Steam humidifer	201 to 250 (94 to 121)	2 (50) and smaller	1-1/2 (40)

		2-1/2 (65) to 6 (150)	2 (50)
		8	3
Storm drainage	40 to 55 (4 to 13)	All sizes	1 (25)

.2 Insulate with flexible insulation as follows:

Service	Thickness
Horizontal storm and sanitary drainage	1" (25 mm)

.3 Insulate fittings and flanges and pipe connections with insulated fitting covers.

.4 Wrap butt joints with a 4" (100 mm) strip of fire resistant vapour barrier jacket cemented with lagging adhesive.

.5 Where the pipe hanger is around the insulation, provide an insulation protection shield within the pipe saddle. Coordinate with installation of hangers.

.6 Insulate all fittings, flanges and valves on pipes to provide equivalent insulation to that on adjoining pipe.

.7 Continue insulation through sleeves including specified finish.

.8 Cut back covering on strainers and finish off to expose removable head insulation.

.9 Cover expansion joints first with 24 gauge (0.7 mm) galvanized metal sleeve and then insulate to provide equivalent thickness to that on adjoining pipe.

.10 Protect insulation with protection saddles where insulated pipe is supported by rollers.

.11 Insulate pipe hangers supporting new piping carrying water at 70°F (21°C) or less to prevent condensation. Extend insulating material along hanger rod to height 4 times thickness of insulation. Seal insulation with vapourproof sealant.

.12 Extend pipe insulation and covering through walls, floors, ceilings, and concrete beams, unless indicated otherwise on drawings. protect exposed insulation extending through floors with 4" (100 mm) wide strip of 18 gauge (1.3 mm) galvanized iron.

.13 Pack annular space between pipe sleeves and piping or pipe covering with glass fibre insulation or rockwool insulation. In fire rated assemblies use Dow Silicon RTV or other ULC listed materials. Seal exposed insulation with mastic.

.14 Recover exposed surfaces of insulated piping installed in exposed areas, mechanical rooms, and equipment rooms with PVC jacketing and PVC fitting covers installed in accordance with manufacturers instructions.

.15 Insulate and cover exposed surfaces of waste connections, traps, hot and cold supply risers and valves at each lavatory and sink designated for "handicapped" or "barrier free" use with: PVC insulated fitting covers specifically designed for this application. Vinyl material is not to exceed flame spread rating of 150, and if intended to be used in high buildings, its smoke developed classification does not exceed 300. Zeston or other equivalant material. or foamed plastic type insulation finished with two coats of Armstrong Armflex or other equivalent material.

.16 Provide aluminum metal cladding over the insulation on the following services. All exposed pipign located outdoors.

.17 Insulate sprinkler and standpipe main from take-off from domestic water to a point approximately 6 feet (1800 mm) after electrically supervised valve.

.18 Oversize insulation of Domestic hot water piping complete with heating cable for pipe sizes 1-1/4" (35 mm) dia. and smaller by 1/4" (6 mm) in inside diameter to allow for installation over heating cable.

3.5 HIGH TEMPERATURE PIPE INSULATION

.1 Applications: cut or mitre insulation where necessary to fit the shape and contour of the vessel. Impale insulation over welded pins on 12" (300 mm) centres. (When 2 layers are used the joints shall be stagger.) Apply Expanded Metal Lath using speed washers to hold insulation and mesh in place. Lace Metal Edges that butt together with 16 ga. (1.7 mm) galvanized annealed wire.

.2 Emergency Generator Exhaust

- .1 Insulate the exhaust stack system including silencer (muffler) with 3" (75 mm) of high temperature pipe insulation.
- .2 Tightly butt and stagger all joints. Secure blocks with galvanized steel bands. Provide welded studs, clips or angles as required to anchor wire and bands. Secure a 1" (25 mm) hexagonal wire mesh over the insulation.
- .3 In exposed areas, cover insulation with 2 coats of Manson No. 375 finishing cement applied

in 1/4" (7 mm) layers and trowel to a smooth hard finish.

.4 Cover with:
- .1 6 oz./sq.yd. (200 g/m2) canvas neatly pasted in place.
- .2 Aluminum jacketing installed to manufacturers instructions.

.5 Insulation shall be extended up through roof sleeve.

3.6 REFRIGERATION PIPE INSULATION

.1 Insulate all refrigerant suction and hot gas piping and fittings with flexible foamed plastic pipe insulation. Insulation shall fit pipe. Thickness shall be as follows: 1/2" (13 mm) thick for pipe 1" (25 mm) O.D. and smaller; 3/4" (20 mm) thick for pipe 1-1/8" (28 mm) to 2" (50 mm) O.D.; 1" (25 mm) thick for pipes 2-1/8" (54 mm) O.D. and larger.

.2 Slip insulation on to tubing before tubing sections and fittings are assembled. Keep slitting of insulation to a very minimum. Seal all joints in the insulation with Armaflex 520 or BFG Construction Adhesive #105. Insulate flexible pipe connectors.

.3 On insulation exposed outside the building, place "slit" joint seams on bottom of pipe and provide two coats of grey Armaflex finish. Extend insulation through pipe support clamps. Provide a 6" (150 mm) long, 20 gauge (1.1 mm) galvanized steel sleeve around pipe insulation at each support.

3.7 UNDERGROUND INSULATION

.1 Install insulation underground where and as indicated and in accordance with manufacturer's recommended installation instructions.

.2 All piping shall be cleaned of foreign substances and free of surface moisture prior to and during application of insulation and coverings.

.3 Ensure that all weld beads are ground smooth with the surface of the pipe prior to application of the insulation.

.4 Insulation thickness:

Service	Thickness
pumped condensate	1.5 in. (38mm)
low temp heat recovery	1.0 in. (25mm)
geothermal water	1.0 in. (25mm)

.5 Preparation:
- .1 After the nominal system diameter is determined (pipe diameter plus insulation thickness), the trench shall be excavated to allow 6" (15 cm) minimum clearance in all directions around the final OD of the system.
- .2 The bottom of the trench shall be graded to the design slope of the piping and to provide uniform bearing along its entire length. Where wet or unstable soils are encountered, such soil shall be removed to a sufficient depth and the trench backfilled with coarse sand or loose granular earth.
- .3 This backfill shall be compacted to a density equal to that of the acceptable portions of the trench. where excavation of rock is required, the rock shall be excavated to an overdepth of 6" (15 cm) minimum below te specified trench depth. Overdepths in rock shall be backfilled with loose granular earth or coarse sand adn thoroughly tamped.
- .4 In areas of high water table, adequate drainage shall be provided by a gravel bed and a perforated drain pipe covered with synthetic dainage fabric to prevent clogging. The pipe shall lead to a sump provided with means to remove water from the trench area.
- .5 All insulated piping shall rest in a 6" (15 cm) layer of compacted sand. Excavation shall be kept free of standing water during insulation and jacketing application.
- .6 Where excessive or cyclical movement is anticipated, the bore of FOAMGLAS® insulation shall be coated with a thin application of bore coating and allowed to dry before insulation is applied to the pipe.

.6 Insulation Application:
- .1 FOAMGLAS® insulation and PITTWRAP® jacketing shall be applied to piping in 10' (3 m) segments (maximum length). After completion, the segments are rotated 180° and the bottom of the jacketing and butt strips are inspected for proper application an sealing. If any defects are visible, they must be corrected. Major defects may require removal of jacketing. Assuming proper jacketing and sealing, the segments are rotated back into position and the connecting butt strips are applied.

1. Field jacketed insulation --staggered joints: the last section of FOAMGLAS® pipe covering the 10' (3 m) segment is cut even to form a through joint between completed segments.
2. Large diameter piping: shorter segments can be insulated and jacketed if more practical.
3. Abrasion: Insulation sections for large diameter piping will have to be bore coated.
4. Special considerations - anchors, guides, expansion loops, elbows, etc.: the completed insulated segment is rotated and inspected before installing the connecting section of insulation at the anchors, guides, expansion loops, elbows, etc. These procedures are not to be used on oversied insulation.

.2 Field-Jacketed: Field-jacketed FOAMGLAS® insulation shall be applied to the piping with butt joints staggered and tightly butted. Longitudinal and butt joints shall be left dry. All joints shall be tightly fitted to eliminate voids by refitting or replacing sections of insulation. Each section of insulation shall be held in palce by two wraps of strapping tape with a 50% overlap per wrap. For double-layer applications, the second layer of FOAMGLAS® insulation shall be applied in a manner similar to the first, with all joints staggered between layers.

.3 Factory-Jacketed: FOAMGLAS® insulation which has been prejacketed with PITTWRAP® jacketing shall be applied joint-to-joint with all joints tightly butted. Strapping taple may be used over the jacketing to temporarily secure the insulation until longitudinal laps are sealed and butt strips applied. See Section 3.3 and appropriate data sheet for details for sealing PITTWRAP® jacketing laps and butt strip application.

.4 Pre-Insulation of Pipe: Where conditions permit, FOAMGLAS® insulation and jacketing may be applied outside of the trench to sections of piping. Pipe lengths should be insulated in segments. Length of insulation segment should not exceed 10' (3 m). Leave uninsulated spaces between segments to allow for placement of sliings by which the pipe can be lowered into the trench. The use of a spreader bar with two slings or more is recommended. The quantity and location of sling palcement shall be determined by the design professional to avoid excessive deflection, and facilitate proper control of the pipe length during transfer. After the sections of pipe are in place in the trench, and ends of the sections secured, insulation and jacketing shall be aplied to the joint areas and uninsulated spaces that were not complted above ground. Adequate working space should be maintained for installation personnel.

.7 Jacketing Application:

.1 Apply the specified jacketing in strict accordance with the appropriate product data sheet. Request Technical Data Letter #244 for quality control installatin methods. Seal all overlaps and butt strips as noted in the product data sheet to ensure that groudn water cannot penetrate the jacket system.

.2 In tunnels, manholes and pre-cast trenches where high ambient temperatures may exist, metal bands should be installed 12" (300 mm) on centre of the jacketing exterior to control slippage of the overlap seal.

.3 Irregular Surfaces:

.1 At all irregular surfaces such as elbows, tees, fitting covers, etc., the PITTWRAP® jacketing shall be precut to fit the contour of the surface to which it is to be applied. Precut sections shall allow for 2" (50 mm) overlap. All laps shall be sealed. In addition to sealing the PITTWRAP® jacketing on these irregular surfaces, a glove coat of the PITTCOTE® 300 coating shall be applied over the jacketing. First, carefully burn away the exterior plastic film on the PITTWRAP® jacketing. Then apply a glove coat of PITTCOTE® 300 coating. While still tacky, embed a layer of reinforcingfabric in the coating. After one hour, apply a second coat of PITTCOTE® 300 coating over the first coat. Total wet film thickness of the two coats should be 1/8" (3 mm) minimum.

.2 As an alternative to the cutting and fitting of PITTWRAP® jacketing on fittings, a five-layer applicatin of PITTCOTE® 300 coating may be used. The coating shall be applied in accordance with the procedures found in product data sheet FI-120, in alternating layers of mastic, reinforcing fabric, mastic, mastic fabric and mastic, totaling five layers. Total wet film thickness shall be 1/4" (6 mm) minimum.

.3 If backfilling takes place less than 24 hours after PITTCOTE® 300 coating is

applied, roofing felt shall be placed over the coating before backfilling.

.4 Ends and bore of insulation left exposed at day's end shall be sealed between the insulation and the pipe with PITTCOTE® 300 coating to prevent bulk water entry.

.5 All completed work shall be backfilled as soon as possible to prevent damage to the insulation system.

.8 Special Considerations:

.1 Anchors and Guides: Size of concrete anchors and guide blocks and location so feach shall be determined by the engineer or design professional. Anchors shall be continuously welded to the carrier pipe. When sizing anchors, coefficient of friction for FOAMGLAS® insulation is an average of 0.6.

It is common engineering practice to locate line guides on both sides of an expansion loop, zee or expansion joint. The line guide ensures that the thermal expansion is properly directed into the expansion mechanism.

Butt ends of insulation in contact with anchor and/or guide plates shall be sealed continuously to plates with high-temperature sealant.

Diameter of pipe sleeve guides shall be a maximum of 1/4" (6 mm) greater in diameter than the diameter of the pipe.

.2 Wall Penetrations: The piping system should be designed so that no movement occurs at the penetrations except for manholes containing expansion loops or at changes of direction.

Prime all concrete surfaces at penetrations before applying asphalt coating.

.3 Expansion Provisions: Expansion loops, ells, zees and lead-off lines shall be insulated with oversize insulation. Inside diameter of the oversie insulation shall be the same as the exterior diameter of the straight run piping insulation. If the calculated pipe movement is greater than this allowance, contact Pittsburgh Corning Coporatoin. Oversize insulation shall be the same thickness as the straight run piping insulation, but not less than 2" (50 mm) thick. Oversize insulation shall overlap straight run insulation at least 9" (225 mm). All oversie insulation which provides for expansion shall be encased in concrete, a minimum of 3" (75 mm) thick around the insulation.

Concrete pad supports molded to fit inside the oversize insulation to center the pipe and to allow free movement shall be provided. Concrete support pads may be fabricated in the field or prefabricated. These supports should be cured a minimum of seven days prior to use in steam piping applications.

Altenratively, expansion joints may be used to accommodate expansion and are to be insulated. Expansion joints are common on pipes larger than 12" (300 mm) NPS. A sheet metal insulation support shall be provided to support the oversize insulation. If pipe insulation is not of sufficient thickness to allow sheet metal support to clear expansion joints, provide insulation collars of sufficient thickness and minimum 9" (225 mm) width to provide clearance.

.9 Field Quality Control: After application of the jacketing system to all straight and irregular sections of insulatoin, visually inspect all laps, seams, butt strips and glove-coated areas to ensure that these areas are sealed from water entry in accordance with the specifications and appropriate product data sheets.

.10 Backfilling: The trench shall be carefully backfilled using the excavated earth approved for backfilling, consisting of sand, clay, earth, loam or other approved materials. Sand backfill shall be placed within 6" (150 mm) of the insulated pipe and shall be free of rocks, debris or stons greater than 1/4" (6 mm) diameter. Care shall be taken not to damage the PITTWRAP® jacketing during backfilling. Backfill shall be applied in 6" (150 mm) lifts, tamping each lift until a depth of 1' (30 cm) over the insulated pipe is reached. The remainder of the trench shall be backfilled in 1' (30 cm) lifts, with eachlift tamped to the desired compaction.

End of Section

1 General

1.1 GENERAL

.1 Read and conform to:
- .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
- .2 Division 1 requirements and documents refered to therein.

1.2 SECTION INCLUDES

.1 Duct work insulation.
.2 Duct Liner.
.3 Insulation jackets.

1.3 REFERENCES

.1 Section 15010: Requirements for references and standards.
.3 ASTM C518 - Steady-State Thermal Transmission Properties by Means of the Heat Flow Metre Apparatus.
.4 ASTM C553 - Standard Specification for Mineral Fibre Blanket Thermal Insulation for Commercial and Industrial Applications.
.5 ASTM C612 - Standard Specification for Mineral Fibre Block and Board Thermal Insulation.
.6 ASTM C921 - Properties of Jacketing Materials for Thermal Insulation.
.7 ASTM C1071 - Fibrous Glass Duct Lining Insulation(Thermal Sound Absorbing Material).
.8 ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
.9 ASTM E96 - Water Vapour Transmission of Materials.
.10 ASTM E162 - Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source.
.11 ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
.12 NAIMA National Insulation Standards.
.13 NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials.
.14 SMACNA - HVAC Duct Construction Standards - Metal and Flexible.
.15 UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.
.16 CGSB-Canadian General Standards Board.
.17 CAN/CGSB-51.9 Mineral Fiber Thermal Insulation for Piping and Round Ducting.
.18 CAN/CGSB-51.10 Mineral Fiber Board Thermal Insulation
.19 CAN/CGSB-51.11 Mineral Fiber Thermal Insultation Blanket.
.20 CAN/CGSB-5140 Mineral Insulation, Fexible, Elastomeric, Unicellular, Sheet & Pipe Coverup.
.21 CAN/CGSB-51-GP-52 Ma Vapor Barrier, Jacket and Facing Material for Pipe, Duct & Equipment Thermal Insulation.

1.4 SUBMITTALS FOR REVIEW

.1 Section 15010: Procedures for submittals.
.2 Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

1.5 SUBMITTALS FOR INFORMATION

.1 Section 15010: Procedures for submittals.
.2 Manufacturer's Instructions: Indicate installation procedures which ensure acceptable workmanship and installation standards will be achieved.

1.6 QUALITY ASSURANCE

.1 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
.2 Applicator Qualifications: Company specializing in performing the work of this section with minimum 6 years documented experience.

1.7 REGULATORY REQUIREMENTS

.1 Materials: Flame spread/smoke developed rating of 25/50 to ASTM E84.

1.8 DELIVERY, STORAGE, AND PROTECTION

.1 Section 15010: Transport, handle, store, and protect products.
.2 Accept materials on site in original factory packaging, labelled with manufacturer's identification, including product density and thickness.
.3 Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.9 ENVIRONMENTAL REQUIREMENTS

.1 Section 15010: Environmental conditions affecting products on site.
.2 Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
.3 Maintain temperature during and after installation for minimum period of 24 hours.

2 Products

2.1 GLASS FIBRE, FLEXIBLE

.1 Manufacturer: Owens Corning Fiberglas
.2 Other acceptable manufacturers offering equivalent products:
  .1 Manson
  .2 Knauf Fiber Glass
  .3 Schuller
3 Insulation: ASTM C553; flexible, noncombustible blanket.
  .1 'ksi' value : ASTM C518,0.045 at 75.2 °F (24 °C).
  .2 Maximum service temperature: 250 °F (121 °C).
  .3 Maximum moisture absorption: 0.20 percent by volume.
.4 Vapour Barrier Jacket:
  .1 Kraft paper with glass fibre yarn and bonded to aluminized film.
  .2 Moisture vapour transmission: ASTM E96; 0.02 perm.
  .3 Secure with pressure sensitive tape.
.5 Vapour Barrier Tape:
  .1 Kraft paper reinforced with glass fibre yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.
.6 Outdoor Vapour Barrier Mastic:
  .1 Vinyl emulsion type acrylic or mastic, compatible with insulation, black colour.
.7 Tie Wire: Annealed steel, 1/16" (1.5 mm).

2.2 GLASS FIBRE, RIGID

.1 Manufacturer: Owens Corning Fiberglas Model Vapour-Seal.
.2 Other acceptable manufacturers offering equivalent products:
  .1 Manson
  .2 Knauf Fiber Glass
  .3 Schuller
  .4 Substitutions: Refer to Section 01 62 00.
.3 Insulation: ASTM C612; rigid, noncombustible blanket.
  .1 'ksi' value : ASTM C518,0.036 at 75.2 °F (24 °C).
  .2 Maximum service temperature: 250 °F (121 °C).

.3 Maximum moisture absorption: 0.20 percent by volume.
.4 Density: 48 kg/cu m.

.4 Vapour Barrier Jacket:
.1 Kraft paper with glass fibre yarn and bonded to aluminized film.
.2 Moisture vapour transmission: ASTM E96; 0.04 perm.
.3 Secure with pressure sensitive tape.

2.3 JACKETS

.1 Mineral Fibre (Outdoor) Jacket: Asphalt impregnated and coated sheet, 2.45 kg/sq m.
.2 PVC Jacket (Indoor):
.1 Jacket: ASTM C921, One piece sheet material.
.1 Minimum Service Temperature: -31 °F (-35 °C).
.2 Maximum Service Temperature: 150 °F (66 °C).
.3 Moisture Vapour Transmission: ASTM E96; 0.03 perm inches.
.4 Maximum Flame Spread: ASTM E84; 25 or less.
.5 Maximum Smoke Developed: ASTM E84; 50 or less.
.6 Thickness: 20 mil (0.4 mm) minimum.
.2 Colour: standard off-white
.3 Covering Adhesive Mastic
.1 Compatible with insulation, low VOC.
.4 Manufacturer;
.1 Ceel-Co 300 series
.2 Speedline *Smoke Safe*

2.4 ACCESSORIES

.1 Vapor retarder lap adhesive shall be water based, fire retardant
.2 Tapes shall be of cloth reinforced aluminum, soft adhesive with minimum 2" (50 mm) width.
.3 Tie wire shall be of 1/16" (1.5 mm) ø stainless steel.
.4 Fasteners shall be of 1/8" (4 mm) Ø pins, with 35 mm square clips. Clip length to suit insulation thickness.
.5 Bands shall be 1/2" (12 mm) wide 1/4" (6mm) thick galvanized steel.
.6 Facing shall be of 1" (25 mm) galvanized steel hexagonal wire mesh attached on both faces of insulation.

3 Execution

3.1 EXAMINATION

.1 Verify that duct work has been tested before applying insulation materials.
.2 Verify that surfaces are clean, foreign material removed, and dry.

3.2 INSTALLATION

.1 Install duct insulations to TIAC National Installation Standards.
.2 Apply insulation materials, accessories, jackets and finishes in accordance with manufacturer' written instructions and as specified.
.3 Insulated duct work conveying air below ambient temperature:
.1 Provide insulation with vapour barrier jackets.
.2 Finish with tape and vapour barrier jacket.
.3 Continue insulation through walls, sleeves, hangers, and other duct penetrations.
.4 Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.
.4 Insulated duct work conveying air above ambient temperature:
.1 Provide with or without standard vapour barrier jacket.
.2 Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.

.5 Duct Work Exposed in Mechanical Equipment Rooms or Finished Spaces below 3 metres above finished floor: Finish with PVC jacket.

.6 Duct and Plenum Liner Application:

.1 Adhere insulation with adhesive for 90 percent coverage.

.2 Secure insulation with mechanical liner fasteners. Refer to SMACNA Standards for spacing.

.3 Seal and smooth joints. Seal and coat transverse joints.

.4 Seal liner surface penetrations with adhesive.

.5 Duct dimensions indicated are net inside dimensions required for air flow. Increase duct size to allow for insulation thickness.

3.3 SCHEDULES

.1

Service	Type	Thickness	
Air supply rectangular	rigid	1-1/2"	(45 mm)
Air supply round	flexible	1-1/2"	(45 mm)
Exhaust 6' (2 m) from outside) rectangular	rigid	3"	(75 mm)
Exhaust 6' (2 m) from outside) round	flexible	3"	(75 mm)
Fresh air intake rectangular	rigid	3"	(75 mm)
Exhaust air plenums	rigid	3"	(75 mm)
Ductwork outdoors	rigid	3"	(75 mm)
Rectangular air supply runouts to terminal units less than 10' (3 m) in length	rigid	1-1/2"	(45 mm)
Round air supply runouts to terminal units less than 10'(3 m) in length	flexible	1-1/2"	(25 mm)

.2 Inline supply duct silencers to be insulated to match supply duct insulation.

End of Section

1 General

1.1 GENERAL

.1 Read and conform to:
- .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
- .2 Division 1 requirements and documents refered to therein.

1.2 SECTION INCLUDES

.1 Equipment insulation.
.2 Covering.

1.3 REFERENCES

.1 Section 15010: Requirements for references and standards.
.2 ASTM A167 - Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
.3 ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate.
.4 ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
.5 ASTM C195 - Mineral Fibre Thermal Insulating Cement.
.6 ASTM C240 - Testing Cellular Glass Insulation Block.
.7 ASTM C449/C449M - Mineral Fibre Hydraulic-Setting Thermal Insulating and Finishing Cement.
.8 ASTM C518 - Steady-State Thermal Transmission Properties by Means of the Heat Flow Metre Apparatus.
.9 ASTM C533 - Calcium Silicate Block and Pipe Thermal Insulation.
.11 ASTM C552 - Cellular Glass Thermal Insulation.
.12 ASTM C553 - Mineral Fibre Blanket Thermal Insulation for Commercial and Industrial Applications.
.13 ASTM C592 - Mineral Fibre Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type).
.14 ASTM C612 - Mineral Fibre Block and Board Thermal Insulation.
.15 ASTM C921 - Properties of Jacketing Materials for Thermal Insulation.
.16 ASTM D1056 - Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber.
.17 ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
.18 ASTM E96 - Water Vapour Transmission of Materials.
.19 NAIMA National Insulation Standards.
.20 NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials.
.21 UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.
.22 CAN/CG5B-51.11 Mineral Fiber Thermal Insulation Blanket.
.23 CAN/CG5B-51-GP-52 Ma Vapor Barrier, Jacket & Facing Material For Pipe Duct & Equipment Thermal Insulation.
.24 CAN/CG5B-51-GP-53 M Jacketing, Polyvinyl Chloride Sheet for Insulating Pipes, Vessels of Round Ducts.

1.4 SUBMITTALS FOR REVIEW

.1 Section 15010: Procedures for submittals.
.2 Product Data: Provide product description, thermal characteristics, list of materials and thickness for equipment scheduled.
.3 Samples: Submit two samples of any representative size illustrating each insulation type.

1.5 SUBMITTALS FOR INFORMATION

.1 Section 15010: Procedures for submittals.
.2 Manufacturer's Instructions: Indicate installation procedures which ensure acceptable workmanship and installation standards will be achieved.

1.6 QUALITY ASSURANCE

.1 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
.2 Applicator Qualifications: Company specializing in performing the work of this section with minimum 5 years documented experience.

1.7 REGULATORY REQUIREMENTS

.1 Materials: Flame spread/smoke developed rating of 25/50 to ASTM E84.

1.8 DELIVERY, STORAGE, AND PROTECTION

.1 Section 15010: Transport, handle, store, and protect products.
.2 Accept materials on site in original factory packaging, labelled with manufacturer's identification, including product density and thickness.
.3 Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.9 ENVIRONMENTAL REQUIREMENTS

.1 Section 15010: Environmental conditions affecting products on site.
.2 Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
.3 Maintain temperature during and after installation for minimum period of 24 hours.

2 Products

2.1 GLASS FIBRE, FLEXIBLE

.1 Manufacturer: Owens Corning Fiberglas
.2 Other acceptable manufacturers offering equivalent products:
  .1 Manson
  .2 Knauf Fiber Glass
  .3 Schuller
  .4 Substitutions: Refer to Section 15010
.3 Insulation: ASTM C553; flexible, noncombustible.
  .1 'ksi' Value: ASTM C177 or ASTM C518, 0.035 at 75.2 °F (24 °C).
  .2 Maximum Service Temperature: 250 °F (121 °C).
  .3 Maximum Moisture Absorption: 0.2 percent by volume.
  .4 Density: 16 kg/cu m.
.4 Vapour Barrier Jacket:
  .1 ASTM C921,.
  .2 Moisture vapour transmission: ASTM E96; 0.02 perm.
  .3 Secure with self-sealing longitudinal laps and butt strips.
  .4 Secure with outward clinch expanding staples and vapour barrier mastic.
.5 Tie Wire: 3/64" (1.22 mm) stainless steel with twisted ends on maximum 12" (300 mm) centres.
.6 Vapour Barrier Lap Adhesive:
  .1 Compatible with insulation.
.7 Insulating Cement/Mastic:
  .1 ASTM C195; hydraulic setting on mineral wool.
.8 Taps shall be of aluminum, self adhesive with minimum 2" (50 mm) width.

2.2 GLASS FIBRE, RIGID

.1 Manufacturer: Owens Corning Fiberglas AF545
.2 Other acceptable manufacturers offering equivalent products:
  .1 Manson
  .2 Knauf Fiber Glass
  .3 Schuller
  .4 Substitutions: Refer to Section 15010.

.3 Insulation: ASTM C612 or ASTM C592; rigid, noncombustible.
.1 'ksi' Value: ASTM C177 or ASTM C518,0.035 at 75.2 °F (24 °C).
.2 Maximum Service Temperature: 450 °F (232 °C).
.3 Maximum Moisture Absorption: 0.1 percent by volume.
.4 Density: 16 kg/cu m.
.4 Vapour Barrier Jacket:
.1 Kraft paper reinforced with glass fibre yarn and bonded to aluminized film.
.2 Moisture vapour transmission: ASTM E96; 0.02 perm.
.3 Secure with self-sealing longitudinal laps and butt strips.
.4 Secure with outward clinch expanding staples and vapour barrier mastic.
.5 Facing: 1" (25 mm) galvanized steel hexagonal wire mesh stitched on one face of insulation.
.6 Vapour Barrier Lap Adhesive:
.1 Compatible with insulation.
.7 Insulating Cement/Mastic:
.1 ASTM C195; hydraulic setting on mineral wool.

2.3 JACKETS

.2 PVC Jacket (Indoor):
.1 Jacket: ASTM C921, One piece sheet material.
.1 Minimum Service Temperature: -31 °F (-35 °C).
.2 Maximum Service Temperature: 150 °F (66 °C).
.3 Moisture Vapour Transmission: ASTM E96; 0.03 perm inches.
.4 Maximum Flame Spread: ASTM E84; 25 or less.
.5 Maximum Smoke Developed: ASTM E84; 50 or less.
.6 Thickness: 20 mil (0.4 mm) minimum.
.2 Colour: standard off-white
.3 Covering Adhesive Mastic
.1 Compatible with insulation, low VOC.
.4 Manufacturer;
.1 Ceel-Co 300 series
.2 Speedline *Smoke Safe*

3 Execution

3.1 EXAMINATION

.1 Verify that equipment has been tested before applying insulation materials.
.2 Verify that surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION

.1 Install equipment insulations to TIAC National Installation Standards.
.2 Apply insulation materials, accessories, jackets and finishes in accordance with manufacturer' written instructions and as specified.
.3 Do not insulate factory insulated equipment .
.4 Exposed Equipment: Locate insulation and cover seams in least visible locations.
.5 Apply insulation close to equipment by grooving, scoring, and bevelling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
.6 Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapour barrier cement.
.7 Insulated equipment containing fluids below ambient temperature: Insulate entire system.
.8 Fibre glass insulated equipment containing fluids below ambient temperature: Provide vapour barrier jackets, factory-applied or field-applied. Finish with glass cloth and vapour barrier adhesive.
.9 For hot equipment containing fluids 140°F (60°C) or less, do not insulate flanges and unions, but bevel and seal ends of insulation.
.10 For hot equipment containing fluids over 140°F (60°C), insulate flanges and unions with removable sections and jackets.
.11 Fibre glass insulated equipment containing fluids above ambient temperature: Provide standard

jackets, with or without vapour barrier, factory-applied or field-applied. Finish with glass cloth and adhesive.

.12 Inserts and Shields:
- .1 Application: Equipment 1-1/2 " (40 mm) diameter or larger.
- .2 Shields: Galvanized steel between hangers and inserts.
- .3 Insert location: Between support shield and equipment and under the finish jacket.
- .4 Insert configuration: Minimum 6" (150 mm) long, of same thickness and contour as adjoining insulation; may be factory fabricated.
- .5 Insert material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.

.13 Finish insulation at supports, protrusions, and interruptions.

.14 Equipment in Mechanical Equipment Rooms or Finished Spaces: Finish with PVC jacket.

.15 Exterior Applications: Provide vapour barrier jacket or finish with glass mesh reinforced vapour barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal equipment.

.16 Cover glass fibre insulation with metal mesh and finish with heavy coat of insulating cement.

.17 Nameplates and ASME Stamps: Bevel and seal insulation around; do not insulate over.

.18 Equipment Requiring Access for Maintenance, Repair, or Cleaning: Install insulation so it can be easily removed and replaced without damage.

3.3 SCHEDULES

.1 Mineral Fiber Blanket - Hot Surfaces 20ºC - 400ºC:

Item	Thickness
Heating Glycol Pumps along with Fittings & Accessories	2" (50 mm)
Expansion Tanks, Air Separators	2" (50 mm)
Heat Exchangers	2" (50 mm)
Any Other Equipment Operating at High Temp.	2" (50 mm)

.2 Flexible Elastomeric Unicellular Sheet - Cold Surfaces

Item	Thickness
GeoThermal Water Pumps, Fittings and Accessories	1-1/2 (38 mm)
Evaporators, Coolers, Compressors	1-1/2 (38 mm)
Expansion Tanks and Air Separators	1-1/2 (38 mm)
Roof Drain Sumps	1-1/2" (38 mm)
Water Meter	1" (25 mm)
Strainer Heads In Cold Piping	2" (50 mm)
Any Other Equipment Operating at Low Temp	1-1/2 (38 mm)

End of Section

1 General

1.1 GENERAL

.1 Read and conform to:
- .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
- .2 Division 1 requirements and documents refered to therein.

1.2 SECTION INCLUDES

.1 Portable Fire Extinguishers
.2 Fire Extinguisher Cabinets
.3 Fire Extinguisher Brackets

1.3 REFERENCES

.1 FM - Factory Mutual System - Approval Guide.
.2 NFPA 10 - Portable Fire Extinguishers.
.3 ULC - Fire Protection Equipment Directory.

1.4 SUBMITTALS FOR REVIEW

.1 Section 15010: Procedures for submittals.
.2 Product Data: Provide manufacturers literature including general assembly, type and rating of extinguishant.

1.5 SUBMITTALS AT PROJECT CLOSEOUT

.1 Section 15010: Procedures for submittals.
.2 Project Record Documents: Record actual locations of components and accessories.
.3 Maintenance Data: Include manufacturers literature, cleaning procedures, replacement parts lists, and repair data for pumps, drivers and controllers.

1.6 QUALITY ASSURANCE

.1 Perform Work to NFPA 10
.3 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1.7 REGULATORY REQUIREMENTS

.1 ULC listed and labelled
.2 Rated and identified in conformance with CAN/ULC S508, "Rating and Fire Testing of Fire Extinguishers".

2 Products

2.1 GENERAL

.1 Manufacturers
- .1 National Fire Equipment
- .2 Flag
- .3 Kent
- .4 Pyrene Canada
- .5 CFH
- .6 Safety Supply Chubb

2.2 MULTI-PUPURPOSE DRY CHEMICAL

.1 Type: multi-purpose (ABC) type, dry chemical
.2 Size: 5 lb. (2.27 kg)
.3 Rating: minimum 3A:10Bc.
AND
.1 Type: multi-purpose (ABC) type, dry chemical
.2 Size: 10 lb. (4.54 kg)
.3 Rating: minimum 4A:60Bc

2.3 CARBON DIOXIDE

.1 Type: carbon dioxide type
.2 Size: 10 lb. (4.54 kg)
.3 Rating: minimum 5BC.

2.4 CABINETS

.1 Fully Recesssed
- .1 Tub: 18 ga. (1.3 mm) steel tub with white prime painted finish
- .2 Door & Trim: 14 gauge (2.1 mm) stainless steel, brushed finish OR steel with prime painted finish
- .3 Panel: "Lexan" glass
- .4 Size: to accommodate specified extinguisher

2.5 BRACKETS

.1 Total fire extinguisher shall be provided with wall mounting bracket where not installed in cabinets.

3 Execution

3.1 INSTALLATION

.1 Install to manufacturer's instructions.
.2 Conform to NFPA 10.
.3 Locate and secure cabinets plumb and level. Establish top of cabinet (inside horizontal surface) 65" (1675 mm) above finished floor.
.4 Locate fire extinguisher in cabinet as indicated.
.5 Install with wall mounting bracket where not installed in cabinets.

3.2 APPLICATIONS

.1 Provide fire extinguishers where indicated and in conformance with the Manitoba Fire Code and NFPA 10.
.2 Provide 10 lb. (4.54 kg) multi-purpose extinguishers in each fire hose cabinet and in mechanical rooms.
.3 Provide 10 lb. (4.54 kg) carbon dioxide extinguishers in electrical rooms, communications rooms and Data centres
.4 Provide a minimum 40:BC rate extinguisher in all commercial kitchens.
.5 Provide 5 lb. (2.27 kg) multi-purpose extinguishers in each fire hose cabinet and in each kitchen/kitchenette.

End of Section

1 General

1.1 GENERAL

.1 Read and conform to:
- .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
- .2 Division 1 requirements and documents refered to therein.

1.2 SECTION INCLUDES

.1 Disinfection of potable water distribution system.
.2 Testing and reporting results.

1.3 REFERENCES

.1 AWWA B300 - Standard for Hypochlorites.
.2 AWWA C651 - Standards for Disinfecting Water Mains.

1.4 SUBMITTALS FOR INFORMATION

.1 Test Reports: Indicate results comparative to specified requirements.
.2 Certificate: Certify that cleanliness of water distribution system meets or exceeds District Public Health Unit requirements.

1.5 PROJECT RECORD DOCUMENTS

.1 Section 15010: Submission procedures.
.2 Disinfection report:
- .1 Type and form of disinfectant used.
- .2 Date and time of disinfectant injection start and time of completion.
- .3 Test locations.
- .4 Initial and 24 hour disinfectant residuals (quantity in treated water) in ppm for each outlet tested.
- .5 Date and time of flushing start and completion.
- .6 Disinfectant residual after flushing in ppm for each outlet tested.

.3 Bacteriological report:
- .1 Date issued, project name, and testing laboratory name, address, and telephone number.
- .2 Time and date of water sample collection.
- .3 Name of person collecting samples.
- .4 Test locations.
- .5 Initial and 24 hour disinfectant residuals in ppm for each outlet tested.
- .6 Coliform bacteria test results for each outlet tested.
- .7 Certification that water conforms, or fails to conform, to bacterial standards of District Public Health unit.

1.6 QUALITY ASSURANCE

.1 Perform Work in accordance with AWWA C651.
.2 Water Treatment Firm: Company specializing in disinfecting potable water systems specified in this Section with minimum three years documented experience.
.3 Testing Firm: Company specializing in testing potable water systems, certified by the Province of Manitoba.
.4 Submit bacteriologist's signature and authority associated with testing.

1.7 REGULATORY REQUIREMENTS

.1 Conform to applicable code or regulation for performing the work of this Section.
.2 Provide certificate of compliance from authority having jurisdiction indicating approval of water system.

2 Products

2.1 DISINFECTION CHEMICALS

.1 Chemicals: AWWA B300, Hypochlorite.

3 Execution

3.1 EXAMINATION

.1 Verify that piping system has been cleaned, inspected, and pressure tested.
.2 Perform scheduling and disinfecting activity with start-up, testing, adjusting and balancing, demonstration procedures, including coordination with related systems.

3.2 EXECUTION

.1 Provide and attach required equipment to perform the work of this Section.
.2 Inject treatment disinfectant into piping system.
.3 Maintain disinfectant in system for 24 hours.
.4 Flush, circulate, and clean until required cleanliness is achieved; use municipal domestic water.
.5 Replace permanent system devices removed for disinfection.
.6 Pressure test system to requirements of Manitoba Building Code. Repair leaks and re-test.

3.3 FIELD QUALITY CONTROL

.1 Section 15010: Field inspection and testing.
.2 Test samples in accordance with AWWA C651.

End of Section

1 General

1.1 GENERAL

.1 Read and conform to:
- .1 The General Conditions of the Contract
- .2 Comply with Division 1 requirements and documents referred to herein.

1.2 SECTION INCLUDES

.1 Circulators.

1.3 REFERENCES

.1 ASHRAE 90A - Energy Conservation in New Building Design.

1.4 SUBMITTALS FOR REVIEW

.1 Section 15010: Procedures for submittals.

.2 Product Data:
- .1 Indicate pump type, capacity, power requirements.
- .2 Controls.
- .3 Provide certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable.
- .4 Provide electrical characteristics and connection requirements.

.3 Shop Drawings:
- .1 Indicate pump dimensions, sump or tank dimensions, size of tappings.
- .2 Wiring diagrams.

1.5 SUBMITTALS AT PROJECT CLOSEOUT

.1 Section 15010: Procedures for submittals.

.2 Project Record Documents: Record actual locations of components.

.3 Operation and Maintenance Data: Include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.

.4 Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.6 QUALITY ASSURANCE

.1 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum five years documented experience.

.2 Provide pumps with manufacturer's name, model number, and rating/capacity identified.

.3 Ensure products and installation of specified products are to recommendations and requirements of the following organizations:
- .1 National Sanitation Foundation (NSF).
- .3 American Society of Mechanical Engineers (ASME).
- .4 Canadian Standards Association (CSA)
- .5 National Electrical Manufacturers' Association (NEMA).
- .6 Underwriters Laboratories of Canada (ULC).

.4 Ensure pumps operate at specified system fluid temperatures without vapour binding and cavitation, are non-overloading in parallel or individual operation, operate within 25 percent of midpoint of published maximum efficiency curve.

1.7 REGULATORY REQUIREMENTS

.1 Products Requiring Electrical Connection: CSA Listed and classified as suitable for the purpose specified and indicated.

1.8 DELIVERY, STORAGE, AND PROTECTION

.1 Section 15010: Transport, handle, store, and protect products.
.2 Provide temporary inlet and outlet caps. Maintain caps in place until installation.

1.9 WARRANTY

.1 Section 15010.
.2 Provide five year manufacturer warranty for pumps.

1.10 EXTRA MATERIALS

.1 Section 15010.
.2 Provide two of pump seals.

2 Products

2.1 MANUFACTURERS

.1 ITT Bell & Gosset
.2 Other acceptable manufacturers offering equivalent products.
  .1 S. A. Armstrong
  .2 Darling-Duro
  .3 Grundfos
  .4 Substitutions: Refer to Section 15010.

2.2 VERTICAL IN-LINE PUMPS (RE-CIRC PUMP)

.1 Type: Vertical, single stage, close coupled, radially or horizontally split casing, for in-line mounting, for 1200 kPa working pressure.
.2 Casing: Cast iron, with suction and discharge gauge port, casing wear ring, seal flush connection, drain plug, flanged suction and discharge.
.3 Impeller: Bronze, fully enclosed, keyed directly to motor shaft or extension.
.4 Shaft: Carbon steel with stainless steel impeller cap screw or nut and bronze sleeve.
.5 Seal: Carbon rotating against a stationary ceramic seat, viton fitted, 107°C maximum continuous operating temperature.
.6 Performance: 3 GPM @ 1 FT.HD.
.7 Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to code.
.8 Acceptable Products: ITT Bell & Gossett series NBF 8 S/LW.

3 Execution

3.1 PREPARATION

.1 Verify that electric power is available and of the correct characteristics.

3.2 INSTALLATION

.1 Install to manufacturer's instructions.
.2 Provide access space around pumps for service. Provide no less than minimum as recommended by manufacturer.
.3 Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings. For close coupled or base mounted pumps, provide supports under elbows on pump suction and discharge line sizes 4" (102 mm) and over.
.4 Provide line sized shut-off valve and strainer on pump suction, and line sized soft seat check valve and balancing valve on pump discharge.
.5 Provide air cock and drain connection on horizontal pump casings.

.6 Provide drains for bases and seals, piped to and discharging into floor drains.
.7 Check, align, and certify alignment of base mounted pumps prior to start-up.
.8 Lubricate pumps before start-up.

End of Section

1 General

1.1 GENERAL

.1 Read and conform to:
- .1 The General Conditions of the Contract
- .2 Comply with Division 1 requirements and documents referred to herein.

1.2 SECTION INCLUDES

.1 Pipe, pipe fittings, valves, and connections for piping systems.
- .1 Storm Sewer.
- .2 Sanitary Sewer
- .3 Sanitary Vent
- .4 Domestic Water
- .5 Condensate Drain

1.3 REFERENCES

.1 ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
.2 ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
.3 ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings - DWV.
.4 ASME B16.26 - Copper Alloy Bronze Fittings for Flared Copper Tubes.
.5 ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV.
.6 ASME B16.32 - Cast Copper Alloy Solder Joint Fittings for Sovent Drainage Systems.
.7 ASTM A74 - Cast Iron Soil Pipe and Fittings.
.8 ASTM B32 - Solder Metal.
.9 ASTM B42 - Seamless Copper Pipe, Standard Sizes.
.10 ASTM B68 - Seamless Copper Tube, Bright Annealed.
.11 ASTM B75 - Seamless Copper Tube.
.12 ASTM B88 - Seamless Copper Water Tube.
.13 ASTM B251 - General Requirements for Wrought Seamless Copper and Copper-Alloy Tube.
.14 ASTM B302 - Threadless Copper Pipe, Standard Sizes.
.15 ASTM B306 - Copper Drainage Tube (DWV).
.16 ASTM C1053 - Borosilicate Glass Pipe and Fittings for Drain, Waste, and Vent (DWV) Applications.
.17 ASTM D2235 - Solvent Cement for Acrylonitrile - Butadiene - Styrene (ABS) Plastic Pipe and Fittings.
.18 ASTM D2239 - Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter.
.19 ASTM D2241 - Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
.20 ASTM D2447 - Polyethylene (PE) Plastic Pipe, Schedules 40 and 80, Based on Outside Diameter.
.21 ASTM D2466 - Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
.22 ASTM D2564 - Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
.23 ASTM D2661 - Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings.
.24 ASTM D2665 - Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.
.25 ASTM D2729 - Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
.26 ASTM D2751 - Acrylonitrile-Butadiene-Styrene (ABS) Sewer, Pipe, and Fittings.
.27 ASTM D2846 - Chlorinated Polyvinyl Chloride (CPVC) Pipe, Fittings, Solvent Cements and Adhesives for Potable Hot Water Systems.
.28 ASTM D2855 - Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings.
.29 ASTM D3034 - Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
.30 ASTM E814 - Fire Tests of Through-Penetration Fire Stops.
.31 ASTM F679 - Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.
.32 ASTM F708 - Design and Installation of Rigid Pipe Hangers.
.33 AWWA C110 - Ductile - Iron and Gray - Iron Fittings, 3 In. - 48 In. (76 mm - 1219 mm), for Water.
.34 AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
.35 AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast, for Water.
.36 AWWA C651 - Disinfecting Water Mains.
.37 AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe (and Fabricated Fittings), 4 inch - 12 inch

(100 mm - 300 mm), for Water Distribution.
.38 AWWA C901 - Polyethylene (PE) Pressure Pipe and Tubing, 1/2 inch - 3 inch (13 mm - 76 mm) for Water Service.
.39 AWWA C902 - Polybutylene (PB) Pressure Pipe and Tubing, 1/2 inch - 3 inch (13 mm - 76 mm) for Water.
.40 AWWA C905 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 inch - 48 inch (350 mm - 1200mm).
.41 CISPI 301 - Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste and Vent Piping Applications.
.42 CISPI 310 - Joints with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applictions.
.43 MSS SP58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
.44 MSS SP69 - Pipe Hangers and Supports - Selection and Application.
.45 MSS SP89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

1.4 SUBMITTALS FOR REVIEW

.1 Section 15010: Procedures for submittals.
.2 Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalogue information. Indicate valve data and ratings.

1.5 SUBMITTALS AT PROJECT CLOSEOUT

.1 Section 15010: Procedures for submittals.
.2 Project Record Documents: Record actual locations of valves.

1.6 QUALITY ASSURANCE

.1 Perform Work to Province of Manitoba standards. Maintain one copy on site.
.2 Identify pipe with marking including size, ASTM material classification, ASTM specification, potable water certification, water pressure rating.

1.7 REGULATORY REQUIREMENTS

.1 Perform Work to Province of Manitoba plumbing code.
.2 Conform to applicable code for installation of backflow prevention devices.
.3 Provide certificate of compliance from authority having jurisdiction indicating approval of installation of backflow prevention devices.

1.8 DELIVERY, STORAGE, AND PROTECTION

.1 Section 15010: Transport, handle, store, and protect products.
.2 Accept valves on site in shipping containers with labelling in place. Inspect for damage.
.3 Provide temporary protective coating on cast iron and steel valves.
.4 Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
.5 Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.9 ENVIRONMENTAL REQUIREMENTS

.1 Section 15010: Environmental conditions affecting products on site.
.2 Do not install underground piping when bedding is wet or frozen.

1.10 EXTRA MATERIALS

.1 Section 15010: Operation and maintenance data.
.2 Provide two repacking kits for each size valve.

2 Products

2.1 SANITARY SEWER PIPING, BURIED WITHIN 5' (1500 MM) OF BUILDING

.1 Cast Iron Pipe: ASTM A74 extra heavy weight.
- .1 Fittings: Cast iron.
- .2 Joints: Hub-and-spigot, CISPI HSN compression type with ASTM C564 neoprene gaskets or lead and oakum.

.2 Cast Iron Pipe: CISPI 301, hubless.
- .1 Fittings: Cast iron.
- .2 Joints: CISPI 310, neoprene gasket and stainless steel clamp and shield assemblies.

.3 Copper Tube: ASTM B306, DWV.
- .1 Fittings: ASME B16.23, cast bronze, or ASME B16.29, wrought copper.
- .2 Joints: ASTM B32, solder, Grade 50B.

.4 ABS Pipe: ASTM D2751 or ASTM F628.
- .1 Fittings: ABS.
- .2 Joints: ASTM D2235, solvent weld.

.5 ABS Pipe: ASTM D2661 or ASTM D2751.
- .1 Fittings: ABS.
- .2 Joints: ASTM D2235, solvent weld.

.6 PVC Pipe: ASTM D2665 or ASTM D3034.
- .1 Fittings: PVC.
- .2 Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.

.7 PVC Pipe: ASTM D2665, ASTM D3034, or ASTM F679.
- .1 Fittings: PVC.
- .2 Joints: ASTM F477, elastomeric gaskets.

2.2 SANITARY SEWER PIPING, ABOVE GRADE

.1 Cast Iron Pipe: ASTM A74, service weight.
- .1 Fittings: Cast iron.
- .2 Joints: ASTM C564, neoprene gasket system

.2 Cast Iron Pipe: CISPI 301, hubless, service weight.
- .1 Fittings: Cast iron.
- .2 Joints: CISPI 310, neoprene gaskets and stainless steel clamp-and-shield assemblies.

.3 Copper Tube: ASTM B306, DWV.
- .1 Fittings: ASME B16.23, cast bronze, or ASME B16.29, wrought copper, or ASME B16.32, sovent.
- .2 Joints: ASTM B32, solder, Grade 50B.

2.3 WATER PIPING, BURIED WITHIN 5' (1500 MM) OF BUILDING

.1 Copper Tubing: ASTM B42, hard drawn.
- .1 Fittings: ASME B16.18, cast copper alloy or ASME B16.22 wrought copper and bronze.
- .2 Joints: AWS A5.8, BCuP silver braze.

.2 Copper Tubing: ASTM B42, annealed.
- .1 Fittings: ASME B16.26, cast bronze.
- .2 Joints: Flared.

.3 Ductile Iron Pipe: AWWA C151.
- .1 Fittings: Ductile iron, standard thickness.
- .2 Lining: cement
- .3 Joints: AWWA C111, rubber gasket with 19 mm diameter rods.

2.4 WATER PIPING, ABOVE GRADE

.1 Copper Tubing: ASTM B88M, Type L, hard drawn.
- .1 Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.

.2 Joints: ASTM B32, solder, Grade 95TA.
.2 Copper Tubing: ASTM B88M, Type L, hard drawn.
.1 Fittings: Cast iron, coated.
.2 Joints: Grooved mechanical couplings.

2.5 STORM WATER PIPING, BURIED WITHIN 5' (1500 MM) OF BUILDING

.1 Cast Iron Pipe: ASTM A74 extra heavy weight.
.1 Fittings: Cast iron.
.2 Joints: ASTM C564, neoprene gasket system or lead and oakum.
.2 Cast Iron Pipe: CISPI 301, hubless, service weight.
.1 Fittings: Cast iron.
.2 Joints: Neoprene gaskets and stainless steel clamp-and-shield assemblies.
.3 ABS Pipe: ASTM D2680 or ASTM D2751.
.1 Fittings: ABS.
.2 Joints: ASTM D2235, solvent weld.
.4 PVC Pipe: ASTM D2665 or ASTM D3034.
.1 Fittings: PVC.
.2 Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.
.5 PVC Pipe: ASTM D2665, ASTM D3034, or ASTM F679.
.1 Fittings: PVC.
.2 Joints: ASTM F477, elastomeric gaskets.

2.6 STORM WATER PIPING, ABOVE GRADE

.1 Cast Iron Pipe: ASTM A74 extra heavy weight.
.1 Fittings: Cast iron.
.2 Joints: ASTM C564, neoprene gasket system or lead and oakum.
.2 Cast Iron Pipe: CISPI 301, hubless, service weight.
.1 Fittings: Cast iron.
.2 Joints: Neoprene gaskets and stainless steel clamp-and-shield assemblies.

2.7 CONDENSATE DRAIN LINES

.1 3/4" (20 mm) and 1" (25 mm) type M copper, 1-1/4" (32 mm) and larger annealed coppertubing, type DWV, to ASTM B306-86, soldered, with wrought copper or copper alloy drainage fittings to ANSI B16.29-1980 or cast brass drainage fittings to B158.1-1976.

2.8 FLANGES, UNIONS, AND COUPLINGS

.1 Pipe Size 3" (80 mm) and Under:
.1 Ferrous pipe: Class 150 malleable iron threaded unions.
.2 Copper tube and pipe: Class 150 bronze unions with soldered joints.
.2 Pipe Size Over 1" (25 mm):
.1 Ferrous pipe: Class 150 malleable iron threaded or forged steel slip-on flanges; preformed neoprene gaskets.
.2 Copper tube and pipe: Class 150 slip-on bronze flanges; preformed neoprene gaskets.
.3 Grooved and Shouldered Pipe End Couplings:
.1 Housing: Malleable iron clamps to engage and lock, designed to permit some angular deflection, contraction, and expansion; steel bolts, nuts, and washers; galvanized for galvanized pipe.
.2 Sealing gasket: "C" shape composition sealing gasket.
.4 Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

2.9 PIPE HANGERS AND SUPPORTS

.1 Plumbing Piping - Drain, Waste, and Vent:
- .1 Conform to ASME B31.9.
- .2 Hangers for Pipe Sizes 1/2" to 1-1/2" (15 to 40 mm): Malleable iron, adjustable swivel, split ring.
- .3 Hangers for Pipe Sizes 2" (50 mm) and Over: Carbon steel, adjustable, clevis.
- .4 Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
- .5 Wall Support for Pipe Sizes to 3" (80 mm): Cast iron hook.
- .6 Wall Support for Pipe Sizes 4" (100 mm) and Over: Welded steel bracket and wrought steel clamp.
- .7 Vertical Support: Steel riser clamp.
- .8 Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
- .9 Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

.2 Plumbing Piping - Water:
- .1 Conform to ASME B31.9.
- .2 Hangers for Pipe Sizes 1/2" to 1-1/2" (15 to 40 mm): Malleable iron, adjustable swivel, split ring.
- .3 Hangers for Cold Pipe Sizes 2" (50 mm) and Over: Carbon steel, adjustable, clevis.
- .4 Hangers for Hot Pipe Sizes 2" to 4" (50 to 100 mm): Carbon steel, adjustable, clevis.
- .5 Hangers for Hot Pipe Sizes 6" (150 mm) and Over: Adjustable steel yoke, cast iron pipe roll, double hanger.
- .6 Multiple or Trapeze Hangers: Steel channels with welded supports or spacers and hanger rods.
- .7 Multiple or Trapeze Hangers for Hot Pipe Sizes 6" (150 mm) and Over: Steel channels with welded supports or spacers and hanger rods, cast iron roll.
- .8 Wall Support for Pipe Sizes to 3" (80 mm): Cast iron hook.
- .9 Wall Support for Pipe Sizes 4" (100 mm) and Over: Welded steel bracket and wrought steel clamp.
- .10 Wall Support for Hot Pipe Sizes 6" (150 mm) and Over: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron pipe roll.
- .11 Vertical Support: Steel riser clamp.
- .12 Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
- .13 Floor Support for Hot Pipe Sizes to 14" (100 mm): Cast iron adjustable pipe saddle, locknut, nipple, floor flange, and concrete pier or steel support.
- .14 Floor Support for Hot Pipe Sizes 6" (150 mm) and Over: Adjustable cast iron pipe roll and stand, steel screws, and concrete pier or steel support.
- .15 Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

2.10 VALVES - GENERAL

.1 Conform to requirements of ANSI, ASTM, ASME, and applicable MSS standards.
.2 Provide valves of the same manufacturer where possible.
.3 Manufacturer's name and pressure rating clearly marked on body to MSS-SP-25.
.4 Valid CRN (Canadian Registration Number) issued by Provine of Manitoba required for each valve.
.5 Materials:

.1	Bronze:	ASTM B62 or B61 as applicable
.2	Brass:	ASTM B283 C3770
.3	Cast Iron:	ASTM A126 Class B

.6 End Connections:

.1	Flanged ends:	ANSI B16.1 (Class 125), ANSI B16.5
.2	Face-to-face dimensions:	ANSI B16.10

.7 Design and Testing:

.1	Bronze Gate & Check valves:	MSS-SP-80
.2	Ball Valves:	MSS-SP-110
.3	Cast Iron Gate Valces:	MSS-SP-70
.4	Cast Iron Globe Valves:	MSS-SP-85

.5 Cast Iron Check: MSS-SP-71
.6 Butterfly Valves: MSS-SP-67

.8 First named product as indicated in paragraphs below; other acceptable manufacturers, subject to equivalent products listed on spread sheet attached. Substitutions: Refer to Section 15010.

2.11 ISOLATING VALVES

Up To and Including 3" (75mm):
.1 Manufacturer: Crane Model CSC-9222.
.2 Construction: MSS SP-110, Class 150, 600psi (4140 kPa) CWP, forged brass, two piece body, stainless steel ball and stem, full port, virgin PTFE seats and stem packing, blow-out proof stem, lever handle with balancing stops, stem extensions for insulated piping, solder ends.

4" (100mm) and Larger:
.1 Manufacturer: Crane Center Line Series 200.
.2 Construction: MSS SP-67, 200 psi (1380 kPa) CWP, cast or ductile iron body, nickel-plated ductile iron disc, resilient replaceable EPDM seat, wafer ends, extended neck, 10 position lever handle. Provide gear operators for valves 6" (150 mm) and larger, and chain-wheel operators for valves mounted over 96" (2400 mm) above floor.

2.12 THROTTLING VALVES

Up To and Including 2" 50mm:
.1 Manufacturer: Crane Figure 1703S .
.2 Construction: MSS SP-80, Class 125, 200psi (1380 kPa) CWP, rising stem, bronze body globe style, bronze seat, handwheel, PTFE disc, solder ends.

2-1/2" 65mm and Larger
.1 Manufacturer: Crane Center Line Series 200.
.2 Construction: MSS SP-67, 200 psi (1380 kPa) CWP, cast or ductile iron body, nickel-plated ductile iron disc, resilient replaceable EPDM seat, wafer ends, extended neck, 10 position lever handle. Provide gear operators for valves 6" (150 mm) and larger, and chain-wheel operators for valves mounted over 96" (2400 mm) above floor.

2.13 CHECK VALVES

.1 Up To and Including 3" (75 mm):
  .1 Manufacturers: Crane Figure 1342
  .2 Construction: MSS SP-80, Class 150, 300 psi (2070 kPa) CWP, bronze body and cap, bronze swing disc with rubber seat, solder ends
.2 4" (100mm) and Larger:
  .1 Manufacturers: Crane Figure 375
  .2 Construction: MSS SP-71, Class 125, 200psi (1380 kPa) CWP, iron body and bolted cap, bronze trim, bronze swing disc with replaceable bronze seat rings, flanged ends.

2.14 DRAIN VALVES

.1 Manufacturers:Crane
.2 Brass ball valve with cap and chain, 1/2" (20 mm) hose thread.

2.15 STRAINERS

.1 Size 2" (50 mm) and Under:
  .1 Manufacturers:
    .1 Armsrong Model F4SC.
    .2 Spirax Model BT.
    .3 Watts Model 777 series.
    .4 Substitutions: Refer to Section 15010.
  .2 Threaded brass body for 1200 kPa CWP, Y pattern with 0.8 mm1/32 inch stainless steel perforated screen.
.2 Size 1-1/2" to 4" (40 mm to 100 mm):
  .1 Manufacturers:
    .1 Armstrong Model F4FL.

.2 Spirax Model FIG 3.
.3 Watts Model 77F series.
.4 Substitutions: Refer to Section 15010.

.2 Class 125, flanged iron body, Y pattern with 1.6 mm stainless steel perforated screen.

3 Execution

3.1 EXAMINATION

.1 Verification of existing conditions before starting work.
.2 Verify that excavations are to required grade, dry, and not over-excavated.

3.2 PREPARATION

.1 Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
.2 Remove scale and dirt, on inside and outside, before assembly.
.3 Prepare piping connections to equipment with flanges or unions.

3.3 INSTALLATION

.1 Install to manufacturer's instructions.
.2 Provide non-conducting dielectric connections wherever jointing dissimilar metals.
.3 Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
.4 Install piping to maintain headroom, conserve space, and not interfere with use of space.
.5 Group piping whenever practical at common elevations.
.6 Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
.7 Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
.8 Provide access where valves and fittings are not exposed. Coordinate size and location of access doors.
.9 Establish elevations of buried piping outside the building to ensure not less than 4'-0" (1.2 m) of cover.
.10 Install vent piping penetrating roofed areas to maintain integrity of roof assembly; refer to Division 07.
.11 Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
.12 Provide support for utility meters to requirements of utility companies.
.13 Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting.
.14 Excavate: Refer to Division 1.
.15 Backfill: Refer to Division 1.
.16 Install bell and spigot pipe with bell end upstream.
.17 Install valves with stems upright or horizontal, not inverted.
.18 Install water piping to ASME B31.9.
.19 Sleeve pipes passing through partitions, walls and floors.
.20 Inserts:
.1 Provide inserts for placement in concrete formwork.
.2 Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
.3 Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 100 mm.
.4 Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
.5 Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.
.21 Pipe Hangers and Supports:
.1 Install to ASTM B31.9.
.2 Support horizontal piping as scheduled.
.3 Install hangers to provide minimum 1/2" (15 mm) space between finished covering and adjacent work.

.4 Place hangers within 12" (300 mm) of each horizontal elbow.
.5 Use hangers with 1-1/2" (40 mm) minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
.6 Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
.7 Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
.8 Provide copper plated hangers and supports for copper piping.
.9 Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
.10 Provide hangers adjacent to motor driven equipment with vibration isolation.
.11 Support cast iron drainage piping at every joint.

3.4 APPLICATION

.1 Use grooved mechanical couplings and fasteners only in accessible locations.
.2 Install unions downstream of valves and at equipment or apparatus connections.
.3 Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.
.4 Install gate valves for shut-off and to isolate equipment, part of systems, or vertical risers.
.5 Install globe valves for throttling, bypass, or manual flow control services.
.6 Provide lug end butterfly valves adjacent to equipment when provided to isolate equipment.
.7 Provide spring loaded check valves on discharge of water pumps.
.8 Provide plug valves in natural gas systems for shut-off service.
.9 Provide flow controls in water recirculating systems where indicated.

3.5 ERECTION TOLERANCES

.1 Section 15010: Tolerances.
.2 Establish invert elevations, slopes for drainage as per drawing. Maintain gradients.
.3 Slope water piping minimum 0.25 percent and arrange to drain at low points.

3.6 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

.1 Disinfect water distribution system to Section 15401.
.2 Prior to starting work, verify system is complete, flushed and clean.
.3 Ensure Ph of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).
.4 Inject disinfectant, free chlorine in liquid, powder, tablet or gas form, throughout system to obtain 50 to 80 mg/L residual.
.5 Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15 percent of outlets.
.6 Maintain disinfectant in system for 24 hours.
.7 If final disinfectant residual tests less than 25 mg/L, repeat treatment.
.8 Flush disinfectant from system until residual equal to that of incoming water or 1.0 mg/L.
.9 Take samples no sooner than 24 hours after flushing, from 10 percent of outlets and from water entry, and analyze to AWWA C651.

3.7 SERVICE CONNECTIONS

.1 Provide new sanitary sewer services. Before commencing work check invert elevations required for sewer connections, confirm inverts and ensure that these can be properly connected with slope for draiage and cover to avoid freezing.
.2 Provide new water service complete with approved reduced pressure backflow preventer and water meter with by-pass valves pressure reducing valve,.
    .1 Provide sleeve in wall for service main and support at wall with reinforced concrete bridge. Caulk enlarged sleeve and make watertight with pliable material. Anchor service main inside to concrete wall.
.3 OR

.1 Provide 1.20 mm galvanized sheet metal sleeve around service main to 150 mm above floor and 1800 mm minimum below grade. Size for minimum of 50 mm of loose batt insulation stuffing.

3.8 SCHEDULES

.1 Pipe Hanger Schedule:
- .1 Metal Piping:
  - .1 Pipe size: 1/2" to 1-1/4" (15 to 32 mm):
    - .1 Maximum hanger spacing: 6'-6" (2 m).
    - .2 Hanger rod diameter: 3/8" (9 mm).
  - .2 Pipe size: 1-1/2" to 2" (40 to 50 mm):
    - .1 Maximum hanger spacing: 9'-10" (3 m).
    - .2 Hanger rod diameter: 3/8" (9 mm).
  - .3 Pipe size: 2-1/2" to 3" (65 to 75 mm):
    - .1 Maximum hanger spacing: 9'-10" (3 m).
    - .2 Hanger rod diameter: 1/2" (15 mm).
  - .4 Pipe size: 4" to 6" (100 to 150 mm):
    - .1 Maximum hanger spacing: 9'-10" (3 m).
    - .2 Hanger rod diameter: 1/2" (15 mm).
  - .5 Pipe size: 8" to 12" (200 to 300 mm):
    - .1 Maximum hanger spacing: 14' (4.25 m).
    - .2 Hanger rod diameter: 22 mm.
  - .6 Pipe size: 14" (350 mm) and Over:
    - .1 Maximum hanger spacing: 19'-8"6 (6 m)
    - .2 Hanger rod diameter: 1" (25 mm).

End of Section

1 General

1.1 GENERAL

.1 Read and conform to:
  .1 The General Conditions of the Contract
  .2 Comply with Division 1 requirements and documents referred to herein.

1.2 SECTION INCLUDES

.1 Roof and floor drains.
.2 Cleanouts.
.3 Hose bibs.
.4 Hydrants.
.5 Backflow preventers.
.6 Water hammer arrestors.
.7 Thermostatic mixing valves.
.8 Trap Seal Primers.
.9 Trench Drain
.10 Oil Interceptor
.11 Grease Interceptor
.12 Pressure Tank
.13 Washing Machine Valve

1.3 REFERENCES

.1 ASME A112.21.1 - Floor Drains.
.2 ASME A112.21.2 - Roof Drains.
.3 ASME A112.26.1 - Water Hammer Arrestors.
.4 ASSE 1011 - Hose Connection Vacuum Breakers.
.5 ASSE 1013 - Backflow Preventers, Reduced Pressure Principle.
.6 ASSE 1019 - Wall Hydrants, Frost Proof Automatic Draining Anti-Backflow Types.
.7 AWWA C506 - Backflow Prevention Devices - Reduced Pressure Principle and Double Check Valve Types.
.8 PDI WH-201 - Water Hammer Arrestors.

1.4 SUBMITTALS FOR REVIEW

.1 Section 15010: Procedures for submittals.
.2 Product Data: Provide component sizes, rough-in requirements, service sizes, and finishes.
.3 Shop Drawings: Indicate dimensions, weights, and placement of openings and holes.

1.5 SUBMITTALS FOR INFORMATION

.1 Section15010: Procedures for submittals.
.2 Manufacturer's Instructions: Indicate Manufacturer's Installation Instructions: Indicate assembly and support requirements.

1.6 SUBMITTALS AT PROJECT CLOSEOUT

.1 Section 15010: Procedures for submittals.
.2 Project Record Documents: Record actual locations of equipment, cleanouts, backflow preventers, water hammer arrestors
.3 Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.7 QUALITY ASSURANCE

.1 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1.8 DELIVERY, STORAGE, AND PROTECTION

.1 Section 15010: Transport, handle, store, and protect products.
.2 Accept specialties on site in original factory packaging. Inspect for damage.

2 Products

2.1 GENERAL

1. Manufacturer: Watts Drainage model indicated or equivalent by;
   .1 Zurn
   .2 Jay R. Smith
   .3 MIFAB
   .4 Substitutions: Refer to Section 15010.
   .5 Precision Plumbing Products.

2.2 ROOF DRAINS

.1 **Built - Up Roofs**
   .1 Manufacturer: Watts Drainage Model RD100-BED-W-1.
   .2 Assembly: ANSI A112.21.2.
   .3 Body: Lacquered cast iron with sump.
   .4 Strainer: Removable polyethylene dome with vandal proof screws.
   .5 Accessories: Coordinate with roofing type, refer to Division 7:
      .1 Membrane flange and membrane clamp with integral gravel stop.
      .2 Adjustable under deck clamp.
      .3 Roof sump receiver.
      .4 Adjustable extension sleeve for roof insulation

2.3 FLOOR DRAINS

.1 Floor Drain (FD):
   .1 Watts Drainage model FD-100-C-5
   .2 ANSI A112.21.1; lacquered cast iron two piece body with double drainage flange, weep holes, reversible clamping collar, and round, adjustable round nickel-bronze strainer.
.2 Floor Drain (FFD):
   .1 Watts Drainage Model FD-100-C-EG
   .2 ANSI A112.21.1; lacquered cast iron two piece body with double drainage flange, weep holes, reversible clamping collar, and round, adjustable nickel-bronze strainer with polished bronze eleongated funnel.
.3 Hub Drain (HD):
   .1 Watts Drainage Model FD-100-C-DD
   .2 ANSI A112.21.1; lacquered cast iron two piece body with double drainage flange, weep holes, reversible clamping collar, round, adjustable Hub funnel, trap primer tapping.

2.4 TRAP SEAL PRIMERS

1. Individual Traps:
   1. Watts Drainage model MS-810
   2. Automatic cast brass body, renewable disc and seat rings, vacuum breaker and removable cover.
2. Groups of Traps:
   1. PPP Inc. Oregon #1 complete with suply tube and/or distribution units. Primer suitable up to 8 drains.

2.5 CLEANOUTS

.1 Exterior Surfaced Areas:
- .1 Watts Drainage model CO-200-RFC
- .2 Round cast nickel bronze access frame and non-skid cover.

.2 Exterior Unsurfaced Areas:
- .1 Watts Drainage model CO-300-MF
- .2 Extra Heavy Duty type with epoxy coated cast iron body with two fixed anchor flanges and round heavy duty ductile iron gasketed cover.

.3 Interior Finished Floor Areas:
- .1 Watts Drainage model CO-200-R, CO-200-U
- .2 Lacquered cast iron body with anchor flange, reversible clamping collar, threaded top assembly, and round gasketed scored cover in service areas and round gasketed depressed cover to accept floor finish in finished floor areas.

.4 Interior Finished Wall Areas:
- .1 Watts Drainage model WUCO
- .2 Line type with lacquered cast iron body and round epoxy coated gasketed cover, and round stainless steel access cover secured with machine screw.

.5 Interior Unfinished Accessible Areas: Caulked or threaded type. Provide bolted stack cleanouts on vertical rainwater leaders.

.6 Line Cleanouts: lacquered cast iron Malcom type with cleanout ferrule, 1/2" (13mm) thick epoxy coated gasketted cover.

2.6 HYDRANTS

.1 Exterior Wall Hydrant:
- .1 Watts Drainage model HY-725-SS
- .2 ANSI/ASSE 1019; non-freeze, self-draining type with stainless steel box and cover for recssed mounting, all bronze head, seat casting and internal working parts, 3/4" (20mm) hose thread spout, key operated, integral vacuum breaker, galvanized wall casing and hydrant key.

.2 Interior Wall Hydrant:
- .1 Watts Drainage model HY-330-SS
- .2 ANSI/ASSE 1019; self-draining type with stainless steel box and cover for recssed mounting, all bronze head, seat casting and internal working parts, 3/4" (20mm) hose thread spout, key operated, integral vacuum breaker, galvanized wall casing and hydrant key.

2.7 BACKFLOW PREVENTERS

.1 Reduced Pressure Backflow Preventers:
- .1 Manufacturers:
  - .1 Watts Model 909.
  - .2 ITT lawler Model RZ.
  - .3 Baukman Model BF-299.
  - .4 Febco Model 825Y
  - .4 Substitutions: Refer to Section 15010.
- .2 ANSI/ASSE 1013; bronze body with bronze internal parts and stainless steel springs; two independently operating, spring loaded check valves; diaphragm type differential pressure relief valve located between check valves; third check valve that opens under back pressure in case of diaphragm failure; non-threaded vent outlet; assembled with two gate valves, strainer, and four test cocks.

.2 Double Check Valve Assembly
- .1 Manufactruers
  - .1 Watts 709 (65 mm - 250 mm) & Watts 007 (15 mm - 50 mm)
  - .2 ITT
  - .3 Baukman
  - .4 FEBCO
  - .5 Conbraco
  - .6 Zurn/Wilkins

.7 Substitutions: Refer to 15010.

.2 CSA B64.5 ASSE 1015, AWWA C510-92, Construction: Epoxy coated bronze body (15 to 50 mm), epoxy coated cast iron body with bronze seat (65 to 250 mm), integral strainer, bronze ball valve test cocks, cupply pressure up to 175 PSI (1.2 MPa), water temperature: (15 to 30 mm) 180°F (82°C), (65 to 250 mm) 140°F (60°C).

2.8 WATER HAMMER ARRESTORS

.1 Watts Drainage Series 05

.2 ANSI A112.26.1; copper construction, piston type sized to PDI WH-201, precharged suitable for operation in temperature range-73 to 149 degrees C and maximum 1000 kPa150 psi working pressure.

2.9 TRENCH DRAINS

.1 Trench drain system consists of 39" (1000 mm) long, 6" (150 mm) wide, 4" (100 mm) radused bottom with 0.6% built-in slope suitable for external & internal applications, with an integral cast-in metal rail edge, with preformed dillouts fur outlets connectins, full length anchoring ribs, grate locing slots, interlocking ends.
ACO K100S Kassikdrain
Polydrain

.2 Heavy duty slotted ductile iron, ADA iron, Class E
ACO Type 478Q
Polydrain

.3 In-line Catch Basin, multi part polymer concrete catch basin, class E ADA iron grate, c/w trash bucket & integral cast-in ductile iron frame grate.
ACO 614 with Series 600 "short" trash bucket
Polydrain

2.10 OIL INTERCEPTOR

.1 General: white epoxy coated inside and outside fabricated steel interceptor with multi-weir bucket assembly, code approved deep seal trap, adjustable draw-off assembly, double vent connections, stainless steel calibrated orifice plate and removable epoxy coated non-skid heavy duty cover, and same size storage tank.

.2 Capacity and Model:

Flow Rate	Model
50 GPM	Watts OI-555-X-HDC

.3 Acceptable Manufacturer: Watts model indicated. Zurn, J.R. Smith, MIFAB.

2.11 GREASE INTERCEPTOR

.1 Epoxy coated inside and outside fabricated steel grease interceptor, one piece removable baffle assembly, code approved deep seal trap, secured and gasketed non slip cover.

.2 Capacity: 70 lbs. grease storage, 35 gpm flow.
Model: Watts WD-135-X

.3 Acceptable Manufacturer: Watts model indicated. Zurn, J.R. Smith, MIFAB.

2.12 THERMOSTATIC MIXING VALVE (MASTER MIXING)

.1 Large type TM thermostatic water mixing valve, small type TM valve, dura-trol solid bi-metal thermostat with 7 year limited warranty, colour coded dials, locking temperature regulator handles, adjustable limit stops set to 120°F, integral hot and cold supply checkstops. Outlet ball valve shutoffs and inlet piping manifold. Factory pre-assembled and tested, rough bronze finish. Shall provide full time standby service should one mixing valve require maintenance. Piped according to manufacturers requirements.

.2 Provide line size solenoid valve and shock absorber.

.3 Manufacturer: Leonard TM-520, Symmons, Powers, Substitutions: Refer to Section 15010.

2.13 THERMOSTATIC MIXING VALVES FOR EMERGENCY FIXTURES

.1 Drench and/or Combination Emergency Showers
- .1 General: Emergency thermostatic mixing valve that mixes hot and cold water to supply tempered water to one or more emergency drench showers and eyewash fixtures. Unit employs two separate thermostatic mixing elements and includes three outlet temperature gauges. Unit is constructed of bronze, brass, copper and stainless steel. The outlet temperature factory setting is 80°F (26°C). Will safely temper water to flows as little as 2 gpm. System shuts off all incoming hot water should cold water supply fail. Should the hot water supply become interrupted or the thermostatic element fails, the valve will go into cold-water bypass mode. Inlet and Outlet: 1-1/4" IPS. Isolation check valves are supply for installation at inlet and outlet. Semi-Recessed 18ga. (1.2mm) Type 304 With #4 Finish Stainless Steel Cabinet, Viewport and Dial Thermometer, 23" high x 19" wide x 6-3/4" deep.
- .2 Capacity: 3 to 64 USGPM.
- .3 Manufacturer: Leonard model TM-800, Haws, Bradley, Powers, Substitutions: Refer to Section 15010..

.2 Eye Wash/With Face Wash
- .1 General: Emergency thermostatic mixing valve that mixes hot and cold water to supply tempered water to fixtures requiring flow up to 7 GPM @ 30 psi, sufficient for a single eye-eye/face wash. The unit employs a thermostatic mixing element and includes an outlet temperature gauge. The outlet temperature factory setting is 80°F (26°C). Will safely temper water to flows as little as 2 gpm. System shuts off all incoming hot water should cold water supply fail. Should the hot water supply become interrupted or the thermostatic element fails, the valve will go into cold-water bypass mode. Inlet and Outlet: ½" NPT inlet and 3/4" NPT outlet; Supplied with check valves.
- .2 Capacity: up to 8.0 USGPM
- .3 Manufacturer: Leonard TA-300, Haws, Powers, Substitutions: Refer to Section 15010.

2.14 PRESSURE TANK (HOT WATER SYSTEM)

.1 Manufacturer
- .1 Amtrol
- .2 Myers
- .3 Taco
- .4 Bell & Gossett
- .5 Substitutions: Section 15010.

.2 125 psi maximum working pressure, heavy gauge metal construction, polyester paint finish, elongated seamless water cell, stainless steel service connections, nitrogen-rich precharge, high-impact composite abs base, nickel-plated brass threaded air valve.

.3 Capacitites: 8 US Ga., manufacturer: Amtrol ST-20V-C.

2.15 WASHING MACHINE VALVE (WS)

.1 Supply and drain fixture with 1/2" swear union connections and 2" drain connection, flush with wall c/w service stops.

.2 Manufacturer: Symmons W-602-X, Substitutions: Refer to Section 15010.

3 Execution

3.1 INSTALLATION

.1 Install to manufacturer's instructions.

.2 Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for rodding of drainage system.

.3 Encase exterior cleanouts in concrete flush with grade.

.4 Install floor cleanouts at elevation to accommodate finished floor.

.5 Install approved potable water protection devices on plumbing lines where contamination of

domestic water may occur; on boiler feed water lines, janitor rooms, fire sprinkler systems, premise isolation, irrigation systems, flush valves, interior and exterior hose bibs.

.6 Pipe relief from backflow preventer to nearest drain.

.7 Install water hammer arrestors complete with accessible isolation valve on hot and cold water supply piping to lavatories.

.8 Install air chambers on hot and cold water supply piping to each fixture or group of fixtures (each washroom). Fabricate same size as supply pipe or20 mm minimum, and minimum450 mm long.

3.2 CLEANOUTS

.1 Cleanouts shall be the same size as pipe up to 4" (100 mm) and not less than 4" (100 mm) for larger pipes.

.2 Provide cleanouts at the end of mains and branches, at changes in direction, in long straight runs, at the base of all soil stacks and rainwater leaders and where required by code.

.3 Use extended cleanouts for piping installed below grade and in furred ceiling spaces.

.4 On floors with surface waterproofing membranes use only cleanouts with surface membrane clamp and anchoring flange. It is not acceptable to cut out around the cleanout and glue the membrane to the floor.

.5 Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for rodding of drainage system.

.6 Encase exterior cleanouts in concrete flush with grade.

.7 Install floor cleanouts at elevation to accommodate finished floor.

3.3 FLOOR DRAINS

.1 Provide drains, complete with traps, where shown on drawings.

.2 Embed traps and floor drains protruding below concrete slabs on grade entirely in concrete. Piping passing through such floors shall be surrounded with sufficient concrete to make the installation watertight, and prevent ground water from seeping between the metal and concrete into the rooms.

.3 Provide trap seal primers and supply lines to each drains trap.

.4 On floors with surface waterproofing membranes use only floor drains with surface membrane clamps and anchoring flange. It is not acceptable to cut out around the drain and glue the membrane to the floor.

3.4 WALL HYDRANT

.1 Locate wall hydrants as indicated.

3.5 ROOF DRAINS

.1 Provide roof drains where shown on drawings. Co-ordinate this work with the roofing contractor.

3.6 WATER HAMMER ARRESTORS

.1 Provide water hammer arrestors ahead of each plumbing fixture or fixture group utilizing solenoid valves, flush valves, or other quick closing valves and wherever else necessary to prevent water hammer.

.2 Pipe relief from backflow preventer to nearest drain.

.3 Install water hammer arrestors complete with accessible isolation valve on hot and cold water supply piping to lavatories.

3.7 INTERCEPTORS

.1 Install interceptors so as to be accessible for cleaning and all other maintenance which may be required. Make all piping connections. Provide venting as per Manitoba Building Code Part 7.

3.8 GREASE INTERCEPTOR

.1 Provide grease interceptor so as to be accessible for cleaning and all other maintenance which may be required. Make all piping connections.

3.9 TRAP SEAL PRIMER

.1 Preferred method to prime traps is by connecting to the flush tube of flush valve or from the waste of a drinking fountains.
.2 Condensate drains from cooling units are not a reliable method to prime traps.
.3 No more than 3 traps may be primed by one drinking fountain or flush valve.
.4 Where a drinking fountain or flush valve is not available, or where no other means is shown to prime traps, provide a trap seal primer ensuring manufacturers installation instructions are followed.

3.10 HIGH TEMP SHUT-OFF AUTOMATIC MIXING VALVE AND ALARM

.1 Provide thermostat, bulb, and well ahead of solenoid valve and in accordance with manufacturer's instructions. Set thermostat for 110°F.
.2 Provide shock absorber in front of solenoid valve in accordance with manufacturer's instructions.
.3 All wiring under Division 16.

3.11 THERMOSTATIC MIXING VALVE

.1 Provide thermostatic mixing valves as indicated and following manufacturer's installation instructions.
.2 Make all necessary piping connections.

End of Section

1 General

1.1 GENERAL

.1 Read and conform to:
- .1 The General Conditions of the Contract
- .2 Comply with Division 1 requirements and documents referred to herein.

1.2 SECTION INCLUDES

.1 Water closets.
.2 Supplies
.3 Seats and Lids
.4 Flush valves
.5 Carriers

1.3 REFERENCES

.1 CAN/CSA-B125: Plumbing Fittings
.2 CAN/CSA-B45.0: General Requirements
.3 CAN/CSA-B45.1: Vitreous China
.4 CAN/CSA-B45.2: Enamelled Cast Iron
.5 CAN/CSA-B45.3: Porcelain Enamelled Steel
.6 AN/CSA-B45.4: Stainless Steel
.7 CAN/CSA-B45.5: Plastic
.8 ASME A112.6.1 - (Floor Affixed) Supports for Off-the-Floor Plumbing Fixtures for Public Use.
.9 ASME A112.19.5 - Trim for Water-Closet Bowls, Tanks, and Urinals.
.10 Manitoba Electrical Safety Code

1.4 SUBMITTALS FOR REVIEW

.1 Section 15010: Procedures for submittals.
.2 Product Data: Provide catalogue illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.

1.5 SUBMITTALS FOR INFORMATION

.1 Section 15010: Procedures for submittals.
.2 Manufacturer's Instructions: Indicate installation methods and procedures.

1.6 SUBMITTALS AT PROJECT CLOSEOUT

.1 Section 15010: Procedures for submittals.
.2 Maintenance Data: Include fixture trim exploded view and replacement parts lists.
.3 Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.7 QUALITY ASSURANCE

.1 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1.8 WATER EFFICIENCY

.1 The flush cycle for each fixture that is a water closet or urinal, shall not exceed the maximum flush cycle listed in the table as follows:

FIXTURES	MAXIMUM FLUSH	
	I.Gal.	(L)
Water Closet	1.32	(6.0)

1.9 DELIVERY, STORAGE, AND PROTECTION

.1 Section 15010: Transport, handle, store, and protect products.
.2 Accept fixtures on site in factory packaging. Inspect for damage.
.3 Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

1.10 WARRANTY

.1 Section 15010.

2 Products

2.1 MANUFACTURERS

.1 All plumbing fixtures, fixture trim and accessories shall be products of one manufacturer to the extent that this is possible.
.2 Vitreous China fixtures:
  .1 Manufacturer: American Standard.
  .2 Other acceptable manufacturers offering equivalent products.
    .1 Crane
    .2 Kohler
    .3 Toto
    .4 Eljer
    .5 Substitutions: Section 15010.
.3 Seats
  .1 Manufacturer: Centoco
  .2 Other acceptable manufacturers offering equivalent products.
    .1 Benecke
    .2 Olsonite
    .3 Kohler
    .4 Bemis
    .5 Substitutions: and Section 15010.
.4 Electronic Flush Valves
  .1 Manufacturer: Sloan Regal
  .2 Other acceptable manufacturers offering equivalent products.
    .1 Delta Commercial
    .2 Zurn
    .3 Powers
    .4 Nepitek
    .5 DMP Electronics
    .6 Substitutions: and Section 15010
.5 Carriers
  .1 Manufacturer: Watts Ancon
  .2 Other acceptable manufacturers offering equivalent products.
    .1 Zurn
    .2 J. R. Smith
    .3 MIFAB
    .4 Substitutions: Section 15010

2.2 WALL HUNG, FLUSH VALVE, 6-L (W1)

.1 Bowl: ASME A112.19.2; wall hung, siphon jet vitreous china closet bowl, with elongated rim, 38 mm top spud, white.
American Standard "AFWALL" 3351.160
.2 Flush Valve: Manual, exposed chrome plated 1-1/2" top spud, vacuum breaker, 6 LPF, Vandal Resistant stop cap, Adjustable tailpiece.
Sloan Regal 111-1.6
.3 Seat: Solid white plastic, open front, extended back, brass bolts, without cover for standard

fixtures.

.4 Wall Mounted Carrier:Extra heavy duty 500-Lb (227-kg) adjustable cast iron frame, integral drain hub and vent, adjustable spud, lugs for floor and wall attachment, threaded fixture studs with nuts and washers, to suit application.

2.3 WALL HUNG, FLUSH VALVE 6-l, BARRIER FREE (W2H)

1. Bowl: ASME A112.19.2; wall hung, siphon jet vitreous china closet bowl, with elongated rim, 38 mm top spud, white, barrier free height
   American Standard "AFWALL" 3351.160
.2 Flush Valve: electronic (hands free), exposed chrome plated 1-1/2" top spud, vacuum breaker, hard wired, 6 LPF, manual override button, wall mounted sensor, seat bumper.
   Sloan Regal 111 ES-S
.3 Seat: Solid white plastic, open front, extended back, brass bolts, with cover for barrier free fixtures.
.4 Wall Mounted Carrier:Extra heavy duty 500-Lb (227-kg) adjustable cast iron frame, integral drain hub and vent, adjustable spud, lugs for floor and wall attachment, threaded fixture studs with nuts and washers, to suit application.

3 Execution

3.1 EXAMINATION AND PREPARATION

.1 Section 15010: Verification of existing conditions before starting work.
.2 Verify that walls and floor finishes are prepared and ready for installation of fixtures.
.3 Verify that electric power is available and of the correct characteristics.

3.2 PREPARATION

.1 Rough-in fixture piping connections to minimum sizes indicated in fixture rough-in schedule for particular fixtures.

3.3 INSTALLATION

.1 Install each fixture with trap, easily removable for servicing and cleaning.
.2 Provide chrome plated rigid supplies to fixtures with screwdriver stops, reducers, and escutcheons.
.3 Install components level and plumb.
.4 Install and secure floor mounted fixtures in place with bolts.
.4 Install and secure wall hung fixtures in place with wall carriers and bolts.
.5 Seal fixtures to wall and floor surfaces with sealant as specified, colour to match fixture.
.6 Solidly attach water closets to floor with lag screws.

3.4 ADJUSTING

.1 Section 15010 - Execution Requirements: Adjusting installed work.
.2 Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

3.5 CLEANING

.1 Section 15010 - Execution Requirements: Cleaning installed work.
.2 Clean plumbing fixtures and equipment.

3.6 PROTECTION OF FINISHED WORK

.1 Section 15010 - Execution Requirements: Protecting installed work.
.2 Do not permit use of fixtures.

End of Section

1 General

1.1 GENERAL

.1 Read and conform to:
- .1 The General Conditions of the Contract
- .2 Comply with Division 1 requirements and documents referred to herein.

1.2 SECTION INCLUDES

.1 Urinals
.2 Flush valves
.2 Carriers

1.3 REFERENCES

.1 CAN/CSA-B125: Plumbing Fittings
.2 CAN/CSA-B45.0: General Requirements
.3 CAN/CSA-B45.1: Vitreous China
.4 CAN/CSA-B45.4: Stainless Steel
.5 Manitoba Electrical Safety Code
.6 ASME A112.6.1 - (Floor Affixed) Supports for Off-the-Floor Plumbing Fixtures for Public Use.
.7 ASME A112.19.5 - Trim for Water-Closet Bowls, Tanks, and Urinals.

1.4 SUBMITTALS FOR REVIEW

.1 Section 15010: Procedures for submittals.
.2 Product Data: Provide catalogue illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.

1.5 SUBMITTALS FOR INFORMATION

.1 Section 15010: Procedures for submittals.
.2 Manufacturer's Instructions: Indicate installation methods and procedures.

1.6 SUBMITTALS AT PROJECT CLOSEOUT

.1 Section 15010: Procedures for submittals.
.2 Maintenance Data: Include fixture trim exploded view and replacement parts lists.
.3 Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.7 QUALITY ASSURANCE

.1 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1.8 REGULATORY REQUIREMENTS

.1 Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.9 WATER EFFICIENCY

.1 The flush cycle for each fixture that is a water closet or urinal, shall not exceed the maximum flush cycle listed in the table as follows:

FIXTURES	MAXIMUM FLUSH I.Gal.	(L)
Urinal	0.84	(3.8)

1.10 DELIVERY, STORAGE, AND PROTECTION

.1 Section 15010: Transport, handle, store, and protect products.
.2 Accept fixtures on site in factory packaging. Inspect for damage.
.3 Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

1.11 WARRANTY

.1 Section 15010.

2 Products

2.1 MANUFACTURERS

.1 All plumbing fixtures, fixture trim and accessories shall be products of one manufacturer to the extent that this is possible.
.2 Vitreous China fixtures:
  .1 Manufacturer: American Standard.
  .2 Other acceptable manufacturers offering equivalent products.
    .1 Crane
    .2 Kohler
    .3 Toto
    .4 Eljer
    .5 Watermatrix
    .6 Substitutions: Section 15010.
.3 Electronic Flush Valves
  .1 Manufacturer: Sloan Regal
  .2 Other acceptable manufacturers offering equivalent products.
    .1 Delta Commercial
    .2 Zurn
    .3 Powers
    .4 Nepitek
    .5 DMP Electronics
    .6 Substitutions: and Section 15010
.4 Carriers
  .1 Manufacturer: Watts Ancon
  .2 Other acceptable manufacturers offering equivalent products.
    .1 Zurn
    .2 J. R. Smith
    .3 MIFAB
    .4 Substitutions: Section 15010.

2.2 WALL HUNG, FLUSH VALVE (U1)

.1 Urinal: white vitreous china, no water, wall hung, integral housing and drain insert, odor barrier liquid, insert key, drainensert with concealed arm carrier.
American standard 'Flowise' flush-free 6154.100 'medium'
.2 Flush Valve: electronic (hands free), exposed chrome plated top spud, vacuum breaker, hard wired, 1.9 LPF, wall mounted sensor.
Sloan Regal 186-0.5 ES-S
.3 Fixture Carrier: urinal carrier to be type as required to suit intended application, complete with all necessary fittings.

3 Execution

3.1 EXAMINATION AND PREPARATION

.1 Section 15010: Verification of existing conditions before starting work.

.2 Verify that walls and floor finishes are prepared and ready for installation of fixtures.

3.2 PREPARATION

.1 Rough-in fixture piping connections to minimum sizes indicated in fixture rough-in schedule for particular fixtures.

3.3 INSTALLATION

.1 Install each fixture with trap, easily removable for servicing and cleaning.
.2 Install components level and plumb.
.3 Install and secure wall hung fixtures in place with wall carriers and bolts.
.4 Seal fixtures to wall and floor surfaces with sealant, colour to match fixture.

3.4 ADJUSTING

.1 Section 15010: Execution Requirements: Adjusting installed work.

3.5 CLEANING

.1 Section 15010: Execution Requirements: Cleaning installed work.
.2 Clean plumbing fixtures and equipment.

3.6 PROTECTION OF FINISHED WORK

.1 Section 15010: Execution Requirements: Protecting installed work.
.2 Do not permit use of fixtures.

End of Section

1 General

1.1 GENERAL

.1 Read and conform to:
  .1 The General Conditions of the Contract
  .2 Comply with Division 1 requirements and documents referred to herein.

1.2 SECTION INCLUDES

.1 Lavatories
.2 Faucets
.3 Supplies
.4 Carriers

1.3 REFERENCES

.1 CAN/CSA-B125: Plumbing Fittings
.2 CAN/CSA-B45.0: General Requirements
.3 CAN/CSA-B45.1: Vitreous China
.4 CAN/CSA-B45.3: Porcelain Enamelled Steel
.5 CAN/CSA-B45.4: Stainless Steel
.6 Manitoba Electrical Safety Code
.7 ASME A112.6.1 - (Floor Affixed) Supports for Off-the-Floor Plumbing Fixtures for Public Use.
.8 ASME A112.18.1 - Plumbing Fixture Fittings.
.9 ASME A112.19.2 - Vitreous China Plumbing Fixtures.
.10 Manitoba Electrical Safety Code

1.4 SUBMITTALS FOR REVIEW

.1 Section 15010: Procedures for submittals.
.2 Product Data: Provide catalogue illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.

1.5 SUBMITTALS FOR INFORMATION

.1 Section 15010: Procedures for submittals.
.2 Manufacturer's Instructions: Indicate installation methods and procedures.

1.6 SUBMITTALS AT PROJECT CLOSEOUT

.1 Section 15010: Procedures for submittals.
.2 Maintenance Data: Include fixture trim exploded view and replacement parts lists.
.3 Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.7 QUALITY ASSURANCE

.1 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1.8 REGULATORY REQUIREMENTS

.1 Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.9 WATER EFFICIENCY

.1 The flow rates of fittings that supply water to a fixture shall nto exceed the maximum, flow rates at the test pressure listed in the table as follows:

FIXTURES	MAXIMUM FLUSH I.Gal.	(L)	TEST PRESSURE PSI	(kPa)
Lavatory Faucet	0.5	(1.9)	60	(413)

1.10 DELIVERY, STORAGE, AND PROTECTION

.1 Section 15010: Transport, handle, store, and protect products.
.2 Accept fixtures on site in factory packaging. Inspect for damage.
.3 Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

1.11 WARRANTY

.1 Section 15010.

2 Products

2.1 MANUFACTURERS

.1 All plumbing fixtures, fixture trim and accessories shall be products of one manufacturer to the extent that this is possible.
.2 Lavatory
  .1 Manufacturer: Dunleavy Cordun
  .2 Other acceptable manufactures offering equivalent products:
    .1 Substitutions: Refer to Section 15010.
.3 Lavatory Faucets
  .1 Manufacturer: Sloan
  .2 Other acceptable manufacturers offering equivalent products:
    .1 Delta Commercial
    .2 Chicago Faucet
    .3 Powers
    .4 Moen
    .5 Symmons
    .6 Kohler
    .7 Zurn
    .8 Substitutions: Refer to Section 15010.
.4 Waste
  .1 Manufacturer: Delta Commercial
  .2 Other acceptable manufacturers offering equivalent products:
    .1 Emco
    .2 Waltec
    .3 Kohler
    .4 Powers
    .5 McQuire
    .6 Zurn
    .7 Substitutions: Refer to Section 15010.

2.2 LAVATORY, SEMI-COUNTERMOUNT (L1)

.1 Lav: semi-counter mount, vitreous china, rear overflow, 4" centres, nominal dimensions 20-3/8"x25-3/8", self rimming, satin finish. Barrier Free
Dunleavy Cordun Lisa L-4704.
.2 Faucet: Chrome plated cast brass, 4" centres, Single Lever, vandal resistant flow control aerator, , 0.5 GPM (1.9L.m), less pop-up.
Delta Commercial 22C151
.3 Waste: 1-1/4" (32mm) O.D., chrome plated cast brass drain with offset open grid strainer.
Delta Commercial 33T290

2.3 LAVATORY, SEMI-COUNTERMOUNT (L2H)

.1 Lav: semi-counter mount, vitreous china, rear overflow, 4" centres, nominal dimensions 20-3/8"x25-3/8", self rimming, satin finish. Barrier Free
Dunleavy Cordun Lisa L-4704.
.2 Faucet: Chrome plated cast brass, 4" centres, electronic infared sensor, vandal proof hard wired, below deck thermostatic mixing valve, 0.5 GPM (1.9L.m), gooseneck spout.
Sloan SF-2200
.3 Waste: 1-1/4" (32mm) O.D., chrome plated cast brass drain with offset open grid strainer.
Delta Commercial 33T290

3 Execution

3.1 EXAMINATION AND PREPARATION

.1 Verification of existing conditions before starting work.
.2 Verify that walls and floor finishes are prepared and ready for installation of fixtures.
.3 Verify that electric power is available and of the correct characteristics.

3.2 PREPARATION

.1 Rough-in fixture piping connections to minimum sizes indicated in fixture rough-in schedule for particular fixtures.

3.3 INSTALLATION

.1 Install each fixture with trap, easily removable for servicing and cleaning.
.2 Install components level and plumb.
.3 Install and secure wall hung fixtures in place with wall carriers and bolts.
.4 Seal fixtures to wall and floor surfaces with sealant as specified in Section 07915, colour to match fixture.

3.4 ADJUSTING

.1 Section 15010: Execution Requirements: Adjusting installed work.

3.5 CLEANING

.1 Section 15010: Execution Requirements: Cleaning installed work.
.2 Clean plumbing fixtures and equipment.

3.6 PROTECTION OF FINISHED WORK

.1 Section 15010: Execution Requirements: Protecting installed work.
.2 Do not permit use of fixtures.

End of Section

1 General

1.1 GENERAL

.1 Read and conform to:
- .1 The General Conditions of the Contract
- .2 Comply with Division 1 requirements and documents referred to herein.

1.2 SECTION INCLUDES

.1 Stainless steel sinks.
.2 Faucets
.3 Hand hoses
.4 Supplies
.5 Traps

1.3 REFERENCES

.1 CAN/CSA-B125: Plumbing Fittings
.2 CAN/CSA-B45.0: General Requirements
.3 CAN/CSA-B45.1: Vitreous China
.4 CAN/CSA-B45.4: Stainless Steel

1.4 SUBMITTALS FOR REVIEW

.1 Section 15010: Procedures for submittals.
.2 Product Data: Provide catalogue illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.

1.5 SUBMITTALS FOR INFORMATION

.1 Section 15010: Procedures for submittals.
.2 Manufacturer's Instructions: Indicate installation methods and procedures.

1.6 SUBMITTALS AT PROJECT CLOSEOUT

.1 Section 15010: Procedures for submittals.
.2 Maintenance Data: Include fixture trim exploded view and replacement parts lists.
.3 Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.7 QUALITY ASSURANCE

.1 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1.8 REGULATORY REQUIREMENTS

.1 Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.9 WATER EFFICIENCY

.1 The flow rates of fittings that supply water to a fixture shall not exceed the maximum flow rates at the test pressures listed in the table as follows:

FITTINGS	MAXIMUM FLOW		TEST RESSURE	
	l.gpm	(L/min)	Psi	(kPa)
Sink Faucet	1.84	(8.35)	60	(413)

1.10 DELIVERY, STORAGE, AND PROTECTION

.1 Section 15010: Transport, handle, store, and protect products.
.2 Accept fixtures on site in factory packaging. Inspect for damage.
.3 Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

1.11 WARRANTY

.1 Section 15010.

2 Products

2.1 MANUFACTURERS

.1 All plumbing fixtures, fixture trim and accessories shall be products of one manufacturer to the extent that this is possible.
.2 Sink
  .1 Manufacturer: Franke
  .2 Other acceptable manufacturers ofering equipment products
    .1 Elkay
    .2 AMI
    .3 Substitutions: Refer to Section 15010.
.3 Sink Faucet
  .1 Manufacturer: Delta Commerical
    .1 Moen
    .2 Chicago Faucet
    .3 Powers
    .4 Kohler
    .5 Symmons
    .6 Zurn
    .7 Substitutions: Refer to Section 15010.
.4 Waste
  .1 Manufacturer: Delta Commercial
  .2 Other acceptable manufacturers offering equivalent products:
    .1 Emco
    .2 Waltec
    .3 Kohler
    .4 Powers
    .5 McQuire
    .6 Zurn
    .7 Substitutions: Refer to Section 15010.

2.2 STAINLESS STEEL SINK - 1 COMP (S1)

.1 Sink: single compartment with ledge, self rimming, 18 gauge, 304 stainless steel, drilled for faucet specified, undercoated, compartment size 17-1/2" x 23-1/2" 12", overall size 20-1/2" x 20" x 12", 3-1/2" wste strainers.
Franke LBS7312P-2/4
.2 Faucet: below deck mount, 8" centres, rigid gooseneck spout, vandal resistant flow control aerator, lever handles with coloured indexes, renewable seats.
Delta Commerical 27C1934.
.3 Waste: Provide 'P' trap, cast brass 1-1/2" with cleanout, union and escutcheon.

2.3 STAINLESS STEEL SINK - 2 COMP (S2)

.1 Sink: double compartment with ledge, self rimming, 18 gauge, 304 stainless steel, drilled for faucet specified, undercoated, compartment size 20" x 18" 14", overall size 25" x 39" x 14", 3-1/2" waste strainers, 4 holes (1 for spray nozzle).
Franke LBD0814P-1

.2 Faucet: below deck mount, 8" centres, Wallform spout, vandal resistant flow control aerator, lever handles with coloured indexes, renewable seats. spray nozzle.
Delta Commerical 27C1234(w/spray).
.3 Waste: Provide 'P' trap, cast brass 1-1/2" with cleanout, union and escutcheon.

2.4 STAINLESS STEEL SINK - 3 COMP (S3)

.1 Sink: Triple compartment with ledge, 18 gauge, type 304 stainless overall size 22-9/16"x52-3/8"x10" compartment size 18"x16"x10", 3-1/2" waste strainers, 4 holes (1 for spray nozzle).
Franke LBT8610P-1
.2 Faucet: below deck mount, 8" centres, double jointed spout, vandal resistant flow control aerator, lever handles with coloured indexes, renewable seats. spray nozzle.
Delta Commerical 27C1934-R17 (w/spray).
.3 Waste: Provide 'P' trap, cast brass with cleanout, union and escutcheon.

3 Execution

3.1 EXAMINATION AND PREPARATION

.1 Section 15010: Verification of existing conditions before starting work.
.2 Verify that walls and floor finishes are prepared and ready for installation of fixtures.

3.2 PREPARATION

.1 Rough-in fixture piping connections to minimum sizes indicated in fixture rough-in schedule for particular fixtures.

3.3 INSTALLATION

.1 Install each fixture with trap, easily removable for servicing and cleaning.
.2 Install components level and plumb.

3.4 ADJUSTING

.1 Section 15010: Execution Requirements: Adjusting installed work.

3.5 CLEANING

.1 Section 15010: Execution Requirements: Cleaning installed work.
.2 Clean plumbing fixtures and equipment.

3.6 PROTECTION OF FINISHED WORK

.1 Section 15010: Execution Requirements: Protecting installed work.
.2 Do not permit use of fixtures.

End of Section

1 General

1.1 GENERAL

.1 Read and conform to:
  .1 The General Conditions of the Contract
  .2 Comply with Division 1 requirements and documents referred to herein.

1.2 SECTION INCLUDES

.1 Mop sinks
.2 Hose Wash
.3 Accessories

1.3 REFERENCES

.1 CAN/CSA-B125: Plumbing Fittings
.2 CAN/CSA-B45.0: General Requirements
.3 CAN/CSA-B45.1: Vitreous China
.4 CAN/CSA-B45.2: Enamelled Cast Iron
.5 CAN/CSA-B45.3: Porcelain Enamelled Steel
.6 CAN/CSA-B45.4: Stainless Steel
.7 CAN/CSA-B45.5: Plastic
.8 ASME A112.6.1 - (Floor Affixed) Supports for Off-the-Floor Plumbing Fixtures for Public Use.
.9 ASME A112.19.5 - Trim for Water-Closet Bowls, Tanks, and Urinals.
.10 Manitoba Electrical Safety Code
.11 ASME A112.6.1 - (Floor Affixed) Supports for Off-the-Floor Plumbing Fixtures for Public Use.
.12 ASME A112.18.1 - Plumbing Fixture Fittings.
.13 ASME A112.19.1 - Enamelled Cast Iron Plumbing Fixtures.
.14 ASME A112.19.2 - Vitreous China Plumbing Fixtures.
.15 ASME A112.19.3 - Stainless Steel Plumbing Fixtures (Designed for Residential Use).
.16 ASME A112.19.4 - Porcelain Enamelled Formed Steel Plumbing Fixtures.

1.4 SUBMITTALS FOR REVIEW

.1 Section 15010: Procedures for submittals.
.2 Product Data: Provide catalogue illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.

1.5 SUBMITTALS FOR INFORMATION

.1 Section 15010: Procedures for submittals.
.2 Manufacturer's Instructions: Indicate installation methods and procedures.

1.6 SUBMITTALS AT PROJECT CLOSEOUT

.1 Section 15010: Procedures for submittals.
.2 Maintenance Data: Include fixture trim exploded view and replacement parts lists.
.3 Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.7 QUALITY ASSURANCE

.1 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1.8 REGULATORY REQUIREMENTS

.1 Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.9 DELIVERY, STORAGE, AND PROTECTION

.1 Section 15010: Transport, handle, store, and protect products.
.2 Accept fixtures on site in factory packaging. Inspect for damage.
.3 Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

1.10 WARRANTY

.1 Section 15010.

2 Products

2.1 MANUFACTURERS

.1 All plumbing fixtures, fixture trim and accessories shall be products of one manufacturer to the extent that this is possible.
.2 Mop Sink
  .1 Manufacturer: Stern Williams
  .2 Other acceptable manufacturers offering equivalent products:
    .1 Fiat
    .2 Zurn
    .3 Substitutions: Refer to Section 15010.
.3 Hose Wash
  .1 Manufacturer: Delta Commercial
  .2 Other acceptable manufacturers offering equivalent products:
    .1 Powers
    .2 Chicago Faucet
    .3 Zurn
    .4 Substitutions: Refer to Section 15010.
.4 Faucet
  .1 Manufacturer: Delta Commercial
  .2 Other acceptable manufacturers offering equivalent products:
    .1 Powers
    .2 Chicago Faucet
    .3 Zurn
    .4 Substitutions: Refer to Section 15010.

2.2 MOP SINKS (MP)

.1 Sink: 5000 PSI (350 kg/cm2) moulded stone sink with 10" (254 mm) high minimum 1" (25 mm) thick walls; cadmium plated cast brass drain body with cast brass locknut and two (2) neoprene gaskets; 302 stainless steel flat strainer, vinyl bumper guard, mop hanger bracket, hose and bracket and silicone sealant.
Stern Williams SB-902 (accessories: T-40 & T-35)
.2 Faucet: 8" (203 mm) exposed wallmount service sink faucet, integral stops, rigid pail hook top brace, spout hose and outlet, body mounted vacuum breaker, 3 blade tamperproof blade handle.
  .1 Delta Commerical 28C2393

2.3 HOSE WASH (HW)

.1 Enclosure: By General Trades, Floor drain by Div 15.
.2 Faucet:Polished chrome plated cast brass, wall mounted, 8' centres, 15" long gooseneck spout, lever handles, 60" flexible hose and self closing head, wall hook
Chicago Faucet 209-GC-L15-XK

3 Execution

3.1 EXAMINATION AND PREPARATION

.1 Section 15010: Verification of existing conditions before starting work.
.2 Verify that walls and floor finishes are prepared and ready for installation of fixtures.
.3 Verify that electric power is available and of the correct characteristics.

3.2 PREPARATION

.1 Rough-in fixture piping connections to minimum sizes indicated in fixture rough-in schedule for particular fixtures.

3.3 INSTALLATION

.1 Install each fixture with trap, easily removable for servicing and cleaning.
.2 Install components level and plumb.
.3 Install and secure wall hung fixtures in place with wall carriers and bolts.
.4 Seal fixtures to wall and floor surfaces with sealant as specified, colour to match fixture.

3.4 ADJUSTING

.1 Section 15010: Execution Requirements: Adjusting installed work.

3.5 CLEANING

.1 Section 15010: Execution Requirements: Cleaning installed work.
.2 Clean plumbing fixtures and equipment.

3.6 PROTECTION OF FINISHED WORK

.1 Section 15010: Execution Requirements: Protecting installed work.
.2 Do not permit use of fixtures.

End of Section

1 General

1.1 GENERAL

.1 Read and conform to:
- .1 The General Conditions of the Contract
- .2 Comply with Division 1 requirements and documents referred to herein.

1.2 SECTION INCLUDES

.1 Showers.

1.3 REFERENCES

.1 ANSI Z124.1 - Gel-Coated Glass-Fibre Reinforced Polyester Resin Bathtub Units.
.2 ANSI Z124.2 - Gel-Coated Glass-Fibre Reinforced Polyester Resin Shower Receptor and Shower Stall Units.
.3 ARI 1010 - Self-Contained Mechanically Refrigerated Drinking Water Coolers.
.4 ASME A112.6.1 - (Floor Affixed) Supports for Off-the-Floor Plumbing Fixtures for Public Use.
.5 ASME A112.18.1 - Plumbing Fixture Fittings.
.6 ASME A112.19.1 - Enamelled Cast Iron Plumbing Fixtures.
.7 ASME A112.19.2 - Vitreous China Plumbing Fixtures.
.8 ASME A112.19.3 - Stainless Steel Plumbing Fixtures (Designed for Residential Use).
.9 ASME A112.19.4 - Porcelain Enamelled Formed Steel Plumbing Fixtures.
.10 ASME A112.19.5 - Trim for Water-Closet Bowls, Tanks, and Urinals.
.11 NFPA 70 - National Electrical Code.

1.4 SUBMITTALS FOR REVIEW

.1 Section 15010: Procedures for submittals.
.2 Product Data: Provide catalogue illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.

1.5 SUBMITTALS FOR INFORMATION

.1 Section 15010: Procedures for submittals.
.2 Manufacturer's Instructions: Indicate installation methods and procedures.

1.6 SUBMITTALS AT PROJECT CLOSEOUT

.1 Section 15010: Procedures for submittals.
.2 Maintenance Data: Include fixture trim exploded view and replacement parts lists.
.3 Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.7 QUALITY ASSURANCE

.1 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1.8 REGULATORY REQUIREMENTS

.1 Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.9 WATER EFFICIENCY

.1 The flow rates of fittings that supply water to a fixtue shall not exceed the maximum flow rates at the test pressures listed in the table as follows:

FITTINGS	MAXIMUM FLOW		TEST RESSURE	
	lgpm	(L/min)	Psi	(kPa)
Shower Head	2.5	9.5	80	(550)

1.10 DELIVERY, STORAGE, AND PROTECTION

.1 Section 15010: Transport, handle, store, and protect products.
.2 Accept fixtures on site in factory packaging. Inspect for damage.
.3 Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

1.11 WARRANTY

.1 Section 15010.

2 Products

2.1 MANUFACTURERS

.1 All plumbuing fixtures, fixture trim and accessories shall be of one manufacturer to the extent that this is possible.
.2 Shower fittings:
  .1 Manufacturer: Delta Commercial
  .2 Other acceptabel manufacturers offering equivalent products
    .1 Symmons
    .2 Kohler
    .3 American Standard
    .4 Powers
    .5 Cicago Faucet
    .6 Lawler
    .7 Substitutions: Refer to Section 15010.

2.2 SHOWERS (SH1)

.1 Shower
  .1 Enclosure: by others.
  .2 Shower and Control Valve: Tempreature & pressure balancing valve, integral volume control, chrome plated brass and bast bronze construction, single lever temperature stops, adjustable temperature stops
    .1 Delta Commercial T13H183

3 Execution

3.1 EXAMINATION AND PREPARATION

.1 Section 15010: Verification of existing conditions before starting work.
.2 Verify that walls and floor finishes are prepared and ready for installation of fixtures.

3.2 PREPARATION

.1 Rough-in fixture piping connections to minimum sizes indicated in fixture rough-in schedule for particular fixtures.

3.3 INSTALLATION

.1 Install each fixture with trap, easily removable for servicing and cleaning.
.2 Install components level and plumb.
.3 Install and secure wall hung fixtures in place with wall carriers and bolts.
.4 Seal fixtures to wall and floor surfaces with sealant as specified in Section 07915, colour to match fixture.

3.4 ADJUSTING

.1 Section 15010: Execution Requirements: Adjusting installed work.

3.5 CLEANING

.1 Section 15010: Execution Requirements: Cleaning installed work.
.2 Clean plumbing fixtures and equipment.

3.6 PROTECTION OF FINISHED WORK

.1 Section 15010: Execution Requirements: Protecting installed work.
.2 Do not permit use of fixtures.

End of Section

1 General

1.1 GENERAL

.1 Read and conform to:
  .1 The General Conditions of the Contract
  .2 Comply with Division 1 requirements and documents referred to herein.

1.2 SECTION INCLUDES

.1 Eye and Face Wash.
.2 Drench Shower.

1.3 REFERENCES

.1 ANSI Z124.1 - Gel-Coated Glass-Fibre Reinforced Polyester Resin Bathtub Units.
.2 ANSI Z124.2 - Gel-Coated Glass-Fibre Reinforced Polyester Resin Shower Receptor and Shower Stall Units.
.3 ANSI Z358.1 - Emergency Eye Wash and Shower Equipment.
.4 ARI 1010 - Self-Contained Mechanically Refrigerated Drinking Water Coolers.
.5 ASME A112.6.1 - (Floor Affixed) Supports for Off-the-Floor Plumbing Fixtures for Public Use.
.6 ASME A112.18.1 - Plumbing Fixture Fittings.
.7 ASME A112.19.1 - Enamelled Cast Iron Plumbing Fixtures.
.8 ASME A112.19.2 - Vitreous China Plumbing Fixtures.
.9 ASME A112.19.3 - Stainless Steel Plumbing Fixtures (Designed for Residential Use).
.10 ASME A112.19.4 - Porcelain Enamelled Formed Steel Plumbing Fixtures.
.11 ASME A112.19.5 - Trim for Water-Closet Bowls, Tanks, and Urinals.
.12 NFPA 70 - National Electrical Code.

1.4 SUBMITTALS FOR REVIEW

.1 Section 15010: Procedures for submittals.
.2 Product Data: Provide catalogue illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.

1.5 SUBMITTALS FOR INFORMATION

.1 Section 15010: Procedures for submittals.
.2 Manufacturer's Instructions: Indicate installation methods and procedures.

1.6 SUBMITTALS AT PROJECT CLOSEOUT

.1 Section 15010: Procedures for submittals.
.2 Maintenance Data: Include fixture trim exploded view and replacement parts lists.
.3 Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.7 QUALITY ASSURANCE

.1 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1.8 REGULATORY REQUIREMENTS

.1 Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.9 DELIVERY, STORAGE, AND PROTECTION

.1 Section 15010: Transport, handle, store, and protect products.
.2 Accept fixtures on site in factory packaging. Inspect for damage.
.3 Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

1.10 WARRANTY

.1 Section 15010.

2 Products

2.1 MANUFACTURERS

.1 All plumbing fixtures, fixture trim and accessories shall be products of one manufacturer to the extent that this is possible.
.2 Manufacturer: Bradley.
.3 Other acceptable manufacturers
  .1 Haws,
  .2 Western,
  .3 Emergency Equipment,
  .4 Speakman,
  .5 Guardian,
  .6 Encon.
  .7 Substitutions: Section 15010.

2.2 EYEWASH/FACEWASH (EW)

.1 Eyewash: chrome plated brass sprayhead assembly complete with pop-off eyewash/facewash head covers with stainless steel bowl.
.2 Valves: stay-open eyewash/facewash valve activated by stainless steel push flag handle.
.3 Pipe and Fittings: galvanized steel protected with safety colour coating.
.4 Acceptable Product: Bradley S19-220T.

2.3 EMERGENCY DRENCH SHOWER/EYEWASH (DEW)

.1 Emergency Drench Shower and Eye/Face Wash - S.S. Bowl - Floor Mounted, SpinTec™ Showerhead 3.1" (78.7mm) diameter highly visible yellow impact-resistant plastic. Includes a 10-3/4" (273mm) diameter corrosion-resistant stainless steel shroud. SpinTec drench showerhead features integral 23 GPM flow control, conserving water and helping to accurately size your tepid water system.
.2 Eyewash Bowl 10-3/4" (273mm) diameter corrosion-resistant stainless steel.
.3 Standard Sprayhead Assembly Twin perforated-disc eye/face wash heads with protective pop-off sprayhead covers, operated by a large, highly visible push handle. Safe, steady water flow under varying water supply conditions from 30-90 PSI is assured by integral flow control in the sprayhead assembly.
.4 Shower Valve Chrome-plated brass 1" NPT stay-open ball valve. Operated by a stainless steel pull rod with triangular handle.
.5 Eyewash Valve Chrome-plated brass 1/2" NPT stay-open ball valve. Hand operated by highly visible safety yellow PVC push handle
.6 Pipe and Fittings 1-1/4" galvanized steel with BRADTECT™ safety yellow coating
.7 Water Supply 1-1/4" NPT.
.8 Acceptable Product: Bradley S19-310TT

3 Excecution

3.1 EXAMINATION AND PREPARATION

.1 Section 15010: Verification of existing conditions before starting work.
.2 Verify that walls and floor finishes are prepared and ready for installation of fixtures.
.3 Verify that electric power is available and of the correct characteristics.

3.2 PREPARATION

.1 Rough-in fixture piping connections to minimum sizes indicated in fixture rough-in schedule for particular fixtures.

3.3 INSTALLATION

.1 Install each fixture with trap, easily removable for servicing and cleaning.
.2 Install components level and plumb.
.3 Install and secure wall hung fixtures in place with wall carriers and bolts.
.4 Seal fixtures to wall and floor surfaces with sealant as specified in Section 07915, colour to match fixture.

3.4 ADJUSTING

.1 Section 15010 - Execution Requirements: Adjusting installed work.

3.5 CLEANING

.1 Section 15010 - Execution Requirements: Cleaning installed work.
.2 Clean plumbing fixtures and equipment.

3.6 PROTECTION OF FINISHED WORK

.1 Section 15010 - Execution Requirements: Protecting installed work.
.2 Do not permit use of fixtures.

End of Section

1 General

1.1 GENERAL

.1 Read and conform to:
  .1 The Project Agreement.
  .2 Comply with Division 1 requirements and documents referred to herein.

1.2 SECTION INCLUDES

.1 Drinking Fountains

1.3 REFERENCES

.1 CAN/CSA-B125: Plumbing Fittings
.2 CAN/CSA-B45.0: General Requirements
.3 CAN/CSA-B45.1: Vitreous China
.4 CAN/CSA-B45.2: Enamelled Cast Iron
.5 CAN/CSA-B45.3: Porcelain Enamelled Steel
.6 CAN/CSA-B45.4: Stainless Steel
.7 CAN/CSA-B45.5: Plastic
.8 Manitoba Electrical Safety Code
.10 ASME A112.6.1 - (Floor Affixed) Supports for Off-the-Floor Plumbing Fixtures for Public Use.
.11 ASME A112.18.1 - Plumbing Fixture Fittings.
.12 ASME A112.19.1 - Enamelled Cast Iron Plumbing Fixtures.
.13 ASME A112.19.2 - Vitreous China Plumbing Fixtures.
.14 ASME A112.19.3 - Stainless Steel Plumbing Fixtures (Designed for Residential Use).
.15 ASME A112.19.4 - Porcelain Enamelled Formed Steel Plumbing Fixtures.

1.4 SUBMITTALS FOR REVIEW

.1 Section 15010: Procedures for submittals.
.2 Product Data: Provide catalogue illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.

1.5 SUBMITTALS FOR INFORMATION

.1 Section 15010: Procedures for submittals.
.2 Manufacturer's Instructions: Indicate installation methods and procedures.

1.6 SUBMITTALS AT PROJECT CLOSEOUT

.1 Section 15010: Procedures for submittals.
.2 Maintenance Data: Include fixture trim exploded view and replacement parts lists.
.3 Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.7 QUALITY ASSURANCE

.1 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1.8 REGULATORY REQUIREMENTS

.1 Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.9 DELIVERY, STORAGE, AND PROTECTION

.1 Section 15010: Transport, handle, store, and protect products.
.2 Accept fixtures on site in factory packaging. Inspect for damage.
.3 Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

1.10 WARRANTY

.1 Section 15010.

2 Products

2.1 MANUFACTURERS

.1 All plumbing fixtures, fixture trim and accessories shall be products of one manufacturer to the extent that this is possible.
.3 Drinking Fountains
  .1 Manufacturer: Haws
  .2 Other acceptable manufacturers offering equivalent products.
    .1 Elkay
    .2 Sunroc
    .3 Halsey-Taylor
    .4 Oasis
.4 Substitutions: Refer to Section 15010.

2.2 HYDRATION STATION (HS)

.1 Station: Electric sensor touch-free operation with 30 second time-out, 0.8 GPM flow, No. 4 satin stainless steel back panel, durable ABS plastic front, hidden lock and hinges, 110V, 60 Hz, 1 amp draw, with chiller.
Haws Model 2000

3 Excecution

3.1 EXAMINATION AND PREPARATION

.1 Section 15010: Verification of existing conditions before starting work.
.2 Verify that walls and floor finishes are prepared and ready for installation of fixtures.
.3 Verify that electric power is available and of the correct characteristics.

3.2 PREPARATION

.1 Rough-in fixture piping connections to minimum sizes indicated in fixture rough-in schedule for particular fixtures.

3.3 INSTALLATION

.1 Install each fixture with trap, easily removable for servicing and cleaning.
.2 Install components level and plumb.
.3 Install and secure wall hung fixtures in place with wall carriers and bolts.
.4 Seal fixtures to wall and floor surfaces with sealant as specified in Section 07915, colour to match fixture.

3.4 ADJUSTING

.1 Section 15010: Execution Requirements: Adjusting installed work.

3.5 CLEANING

.1 Section 15010: Execution Requirements: Cleaning installed work.
.2 Clean plumbing fixtures and equipment.

3.6 PROTECTION OF FINISHED WORK

.1 Section 15010: Execution Requirements: Protecting installed work.
.2 Do not permit use of fixtures.

End of Section

1 General

1.1 GENERAL

.1 Read and conform to:
- .1 The General Conditions of the Contract
- .2 Comply with Division 1 requirements and documents referred to herein.

1.2 SECTION INCLUDES

.1 Domestic Water Heaters.

1.3 REFERENCES

.1 ASHRAE 90A - Energy Conservation in New Building Design.
.2 ASME Section 8D - Boilers and Pressure Vessel Codes - Rules for Construction of Pressure Vessels.

1.4 SUBMITTALS FOR REVIEW

.1 Section 15010: Procedures for submittals.
.2 Product Data:
- .1 Provide dimension drawings of water heaters indicating components and connections to other equipment and piping.
- .2 Indicate pump type, capacity, power requirements.
- .3 Provide certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable.
- .4 Provide electrical characteristics and connection requirements.

.3 Shop Drawings:
- .1 Indicate heat exchanger dimensions, size of tappings, and performance data.

1.5 SUBMITTALS AT PROJECT CLOSEOUT

.1 Section 15010: Procedures for submittals.
.2 Project Record Documents: Record actual locations of components.
.3 Operation and Maintenance Data: Include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.
.4 Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.6 QUALITY ASSURANCE

.1 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
.2 Provide pumps with manufacturer's name, model number, and rating/capacity identified.
.3 Ensure products and installation of specified products are to recommendations and requirements of the following organizations:
- .1 American Gas Association (AGA).
- .2 National Sanitation Foundation (NSF).
- .3 American Society of Mechanical Engineers (ASME).
- .4 National Board of Boiler and Pressure Vessel Inspectors (NBBPVI).
- .5 National Electrical Manufacturers' Association (NEMA).
- .6 Underwriters Laboratories (UL).

.4 Ensure pumps operate at specified system fluid temperatures without vapour binding and cavitation, are non-overloading in parallel or individual operation, operate within 25 percent of midpoint of published maximum efficiency curve.

1.7 REGULATORY REQUIREMENTS

.1 Conform to ASME Section 8D for manufacture of pressure vessels for heat exchangers.
.3 Conform to ASME Section 8D for tanks.
.4 Products Requiring Electrical Connection: Listed and classified by testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.8 DELIVERY, STORAGE, AND PROTECTION

.1 Section 15010: Transport, handle, store, and protect products.
.2 Provide temporary inlet and outlet caps. Maintain caps in place until installation.

1.9 WARRANTY

.1 Section 15010.
.2 Provide five year manufacturer warranty for domestic water heaters packaged water heating systems in-line circulator.

1.10 EXTRA MATERIALS

.1 Section 15010.
.2 Provide two of pump seals.

2 Products

2.1 MANUFACTURERS

.1 Manufacturer: A.O.Smith
.2 Other manufactuers ofering equivalent products:
  .1 Lochinvar
  .2 Rheem
  .3 Bradford White
  .4 Substitutions: Refer to Section 15010.

2.2 DOMESTIC WATER HEATER (GAS FIRED)

.1 General: Shall consist of a direct fired stainless steel heat exchanger mounted on top of a glass lined storage tank. shall bear the ASME "H" stamp and shall be National Board listed, stainless steel combustion chamber, built-in trap shall allow condensation to drain from the heat exchanger assembly, The tank shall have a working pressure of 150 psi. The tank shall be glass lined and fired to 1600°F to ensure a molecular fusing of glass and steel. Tank shall be completely encased in high density insulation of sufficient thickness to meet the energy efficiency requirements of the latest edition of the ASHRAE 90.1 Standard. The tank shall be fitted with a brass drain valve. shall be certified and listed by C.S.A. International under the latest edition of the harmonized ANSI Z21.10.3 test standard for Canada, shall operate at a minimum of 96% thermal efficiency, certified for indoor installation, efficiency shall be verified through third party testing by AHRI, tank shall be constructed with a heavy gauge steel jacket assembly, primed and pre-painted on both sides. The combustion chamber shall be sealed and completely enclosed, flame observation port, burner shall be constructed of high temperature stainless steel with a woven metal fiber outer covering to provide modulating firing rates. Tank shall be supplied with a gas valve designed with negative pressure regulation and be equipped with a variable speed blower system, to precisely control the fuel/air mixture to provide modulating firing rates for maximum efficiency. The heater shall utilize a 24 VAC control circuit and components. The control system shall have an electronic display for set-up, status, and diagnostics. All components shall be easily accessed and serviceable from the front and top. The water heater shall be equipped with; an all-bronze circulating pump; high limit temperature control; ASME certified temperature and pressure relief valve; inlet & outlet water temperature sensors; flue temperature sensor; runtime contacts; alarm contacts; low water flow protection and built-in freeze protection. The manufacturer shall verify proper operation of the burner, all controls and the heat exchanger by connection to water and venting for a factory fire test prior to shipping. Shall feature Smart Control with a 2-line, 16 character LCD display, pump delay with freeze protection and pump exercise. Supply voltage shall be 120 volt / 60 hertz / single

phase.

.2 Venting: Direct Vent Vertical system with a vertical roof top termination of both the vent and combustion air. The flue shall be Stainless Steel sealed vent material terminating at the roof top with the manufacturers specified vent termination. The air inlet pipe shall be Stainless Steel sealed pipe. The air inlet must terminate on the roof top with the manufacturer's specified air inlet cap.

.3 Capacities and Model:

.1 Input (BTUH): 199,999

.2 Capacity: 93 Gallons

.2 Recover @ 100F TR (USGPM): 233

.3 Model: SHIELD SNR200-100

.4 No. Required: 2

.4 Manufacturer: Lochinvar indicated.

3 Execution

3.1 INSTALLATION

.1 Install water heaters to manufacturer's instructions and to AGA requirements.

.2 Coordinate with plumbing piping and related fuel piping work to achieve operating system.

.3 Domestic Water Heat Exchangers:

.1 Install domestic water heat exchangers with clearance for tube bundle removal without disturbing other installed equipment or piping.

.2 Support unit on pipe stand.

.3 Pipe relief valves and drains to nearest floor drain.

.4 Connect steam branch line from top of main. Pipe in flexible manner, pitched with steam flow, with pipe union connections. Provide steam pressure gauge at exchanger inlet.

.5 Provide steam traps and valves as indicated.

.6 Pitch shell for condensate drain to traps.

.4 Domestic Hot Water Storage Tanks:

.1 Provide steel pipe support, independent of building structural framing members.

.2 Clean and flush prior to delivery to site. Seal until pipe connections are made.

End of Section

1 General

1.1 SECTION INCLUDES

.1 Pipe and Pipe Fittings.
.2 Air Compressor.
.3 Hose Reels.

1.2 REFERENCES

.1 ASME - Boiler and Pressure Vessel Code.
.2 ASME B16.3 - Malleable Iron Threaded Fittings.
.3 ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
.4 ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
.5 ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes.
.6 ASME B31.1 - Power Piping.
.7 ASME B31.9 - Building Services Piping.
.8 ASTM A53/A53M - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
.9 ASTM A234/A234M - Piping Fittings of Wrought-Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
.10 ASTM B32 - Solder Metal.
.11 ASTM B88 - Seamless Copper Water Tube.
.12 ASTM D2513 - Thermoplastic Gas Pressure Pipe, Tubing, and Fittings.
.13 ASTM D2683 - Socket-Type Polyethylene Fillings for Outside Diameter-Controlled Polyethylene Pipe and Tubing.
.14 MSS SP-80 - Bronze Gate, Globe, Angle and Check Valves.
.15 MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.
.16 NFPA 70 - National Electrical Code.

1.3 SUBMITTALS FOR REVIEW

.1 Section 15010: Procedures for submittals.
.2 Product Data: Provide manufacturers catalogue literature with capacity, weight, and electrical characteristics and connection requirements.
.3 Shop Drawings: Indicate piping system schematic with electrical characteristics and connection requirements.

1.4 SUBMITTALS FOR INFORMATION

.1 Section 15010: Procedures for submittals.
.2 Test Reports: Submit inspector's certificate for air receiver for inclusion in Operating and Maintenance Manuals.
.3 Certificates: Provide certificate of compliance from authority having jurisdiction indicating approval of air receiver.
.4 Manufacturer's Instructions: Indicate manufacturer's installation instructions, hoisting and setting requirements, starting procedures.

1.5 SUBMITTALS AT PROJECT CLOSEOUT

.1 Section 15010: Procedures for submittals.
.2 Project Record Documents: Record actual locations of equipment and components. Modify shop drawings to indicate final locations.
.3 Operation Data: Submit for air compressor, air receiver and accessories, after cooler, refrigerated air dryer, and pressure reducing station.
.4 Maintenance Data: Submit for air compressor, air receiver and accessories, after cooler, refrigerated air dryer, and pressure reducing station.
.5 Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.6 QUALITY ASSURANCE

.1 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1.7 REGULATORY REQUIREMENTS

.1 Conform to applicable code for installation of pressure vessels.
.2 Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.8 DELIVERY, STORAGE, AND PROTECTION

.1 Section 15010: Transport, handle, store, and protect products.
.2 Accept air compressors, refrigerated air dryer on site in factory fabricated containers with shipping skids and plastic pipe end protectors in place. Inspect for damage.
.3 Protect piping and equipment from weather and construction traffic.

1.9 WARRANTY

.1 Section 15010
.2 Provide five year manufacturer warranty for reciprocating air compressors.

1.10 MAINTENANCE PRODUCTS

.1 Section 15010
.2 Provide two litre containers of compressor oil.

2 Products

2.1 PIPE AND PIPE FITTINGS

.1 Steel Pipe: ASTM A53, Schedule 40 black.
  .1 Fittings: ASME B16.3, malleable iron, or ASTM A234/A234M, forged steel welding type.
  .2 Joints: Threaded or welded to ANSI B31.1.
.2 Copper Tubing: ASTM B88M, Type M, L, K drawn.
  .1 Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
  .2 Joints: ASTM B32, solder, Grade 95TA.
.3 Copper Tubing: ASTM B88M, Type K, L annealed.
  .1 Fittings: ASME B16.26, cast bronze.
  .2 Joints: Flared.

2.2 VALVES

.1 Gate Valves
  .1 Manufacturers:
    .1 Crane Model 428C.
    .2 Jenkins Model 810J
    .3 Red & White Model 293.
    .4 Substitutions: Refer to Section 15010.
  .2 MSS SP-80, Class 125, bronze body, bronze trim, rising stem, handwheel, inside screw, solid wedge disc, solder ends.
.2 Ball Valves
  .1 Manufacturers:
    .1 Crane Model 9322.
    .2 Jenkins Model 902A/902B
    .3 Red & White Model 5049A
    .4 Substitutions: Refer to Section 15010.
  .2 MSS SP-110, Class 150, 2760 kPa CWP, bronze, two piece body, chrome plated brass ball, regular port, teflon seats and stuffing box ring, blow-out proof stem, lever handle with balancing stops, solder ends with union.

.3 Swing Check Valves
.1 Manufacturers:
.1 Crane Model 1342.
.2 Jenkins Model 4093J
.3 Red & White Model 237
.4 Substitutions: Refer to Section 15010.
.2 MSS SP-80, Class 125, bronze body and cap, bronze swing disc with rubber seat, solder ends.

2.3 UNIONS AND COUPLINGS

.1 Unions
.1 Ferrous Pipe: 1034 kPa malleable iron threaded unions.
.2 Copper Tube and Pipe: 1034 kPa bronze unions with soldered joints.
.2 Compressed Air Couplers and Connectors: 100% safety, connect and disconnect at 0 pressure, plug is securely locked before air is turned on, downstream line is exhausted before plug is released eliminating hose whip, tested to 100,000 operations with no leakage, special lubrication to eliminate dry breakaway, to be used a 3-way on-off valve without disconnecting.
Manufacturer: Hose X Press. Other manufacturers with similar products will be considered.
.3 Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

2.4 HOSE REEL

.1 Reel: heavy duty 1/4" plate steel support post and mounting plate, 1" oil-lite self lubricating bearing, 1" solid steel centre support shaft, full flow swivel joint, adjustable arm guide, cartridge style spring motor, 4 roller, non-snag hose guide, locking ratchet/stop with capability of locking air hose at 6'-6" from floor.
Hosexpress "High Performance Reel" Series P. Other manufacturers will equal products will be considered.
.2 Hose: length to suit application, maximum temperature 150 deg.F., pressure 250 psi. Provide quick coupling at the end of hose.
Hosexpress model P-PL. Other manufacturers with equal products will be considered.

2.5 COMPRESSOR

.1 Compressor: 5HP 3 cylinder direct drive unit with splash lubricated pump, cast iron sleeve, stainless steel valves,heavy duty two stage high efficiency air compressor, flywheels pump cooling, factory tested prior to shipment. Electrical requirements: 208/1/60
.2 Capacities and Model:
.1 HP: 5
.2 Capacity: 60 Gallons
.2 CFM @ 100: 15.7 CFM
.3 Model: TE-5060V
.4 No. Required: 1
.4 Manufacturer: Omega Compressors indicated. Other manufacturers with similar products will be considered. Refer to Section 15010.

3 Excecution

3.1 INSTALLATION

.1 Install compressor unit on concrete housekeeping pad.
.2 Install compressor unit on vibration isolators. Level and bolt in place.
.3 Make air cock and drain connection on horizontal casing.
.4 Install line size gate valve and check valve on compressor discharge.
.5 Install replaceable cartridge type filter silencer of adequate capacity for each compressor.
.6 Connect condensate drains to nearest floor drain.

.7 Install valved drip connections at low points of piping system.
.8 Install take offs to outlets from top of main, with shut off valve after take off. Slope take off piping to outlets.
.9 Install compressed air couplings, female quick connectors, and pressure gauges where outlets are indicated.
.10 Install tees instead of elbows at changes in direction of piping. Fit open end of each tee with plug.
.11 Identify piping system and components.
.12 Cooperate with other trades whose work affects or is affected by work of this Section, to ensure satisfactory installation and to avoid delays. Provide all materials to be built-in such as sleeves, anchors, etc., together with accurate dimensions or templates, promptly.
.13 Layout all work accurately, installing piping parallel to lines of building.
.14 Install piping, wherever possible, in partitions and above ceiling. Do not install piping in outside walls unless so shown on drawings. Wrap uninsulated piping in masonry walls with building paper
.15 Install concealed piping close to building structure to minimize furring dimensions.
.16 Use dielectric couplings where piping of dissimilar metals connect.
.17 Where piping passes through concrete floors, or walls, sleeves shall be sized to permit the pipe to expand freely.

3.2 PIPING JOINTS

.1 Make joints in piping installed under this Division using persons familiar with the particular materials being used and in accordance with manufacturer's instructions, and as specified herein.
.2 Use silver solder or Silfos for joining copper compressed air piping.

3.3 VALVES

.1 Use valves of line size unless noted otherwise.
.2 Provide isolating valves in each branch from the main line and where indicated.
.3 Provide isolating valves for all mechanical equipment.

3.4 FIELD QUALITY CONTROL

.1 Compressed Air Piping Leak Test: Arrange and pay for inspection by the Local Inspection Authority prior to initial operation, clean and test compressed air piping to ANSI B31.1.
.2 Piping systems must be inspected by Ministry of Consumer and Commercial Relations Pressure Vessels Safety Inspectors. Make necessary submissions and pay any fees.
.2 Repair or replace compressed air piping as required to eliminate leaks, and retest to demonstrate compliance.
.3 Cap and seal ends of piping when not connected to mechanical equipment.

End of Section

1 General

1.1 GENERAL

.1 Read and conform to:
- .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
- .2 Division 1 requirements and documents refered to therein.

1.2 SECTION INCLUDES

.1 Pipe and pipe fittings for:
- .1 Heating water piping system.
- .2 Glycol water piping system.
- .3 Equipment drains and overflows.

.2 Valves:
- .1 Gate valves.
- .2 Globe or angle valves.
- .3 Ball valves.
- .4 Plug valves.
- .5 Butterfly valves.
- .6 Check valves.
- .7 Circuit balancing valves
- .8 Drain cocks.

1.3 REFERENCES

.1 ASME -Welding and Brazing Qualifications.
.2 ASME B16.3 - Malleable Iron Threaded Fittings Class 50 and 300.
.3 ASME B16.5 Pipe Pumps & Fittings.
.4 ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
.5 ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
.6 ASME B31.5 - Refrigeration Piping and Heat Transfer Components.
.7 ASME B31.9 - Building Services Piping.
.8 ASTM A53/A53M - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
.9 A183 Carbon Steel Track Bolts and Nuts.
.10 ASTM A234/A234M - Piping Fittings of Wrought-Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
.11 ASTM B32 - Solder Metal.
.12 ASTM B88 - Seamless Copper Water Tube.
.13 ASTM F477 - Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
.14 ASTM F708 - Design and Installation of Rigid Pipe Hangers.
.15 ASTM F876 - Crosslinked Polyethylene (PEX) Tubing.
.16 ASTM F877 - Crosslinked Polyethylene (PEX) Plastic Hot - and Cold - Water Distribution Systems.
.17 AWS A5.8 - Filler Metals for Brazing and Braze Welding.
.18 AWS D1.1 - Structural Welding Code - Steel.
.19 MSS SP58 - Pipe Hangers and Supports - Materials, Design and Manufacture.
.20 MSS SP69 - Pipe Hangers and Supports - Selection and Application.
.21 MSS SP89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

1.4 SYSTEM DESCRIPTION

.1 Where more than one piping system material is specified, ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.
.2 Use grooved mechanical couplings and fasteners in accessible locations.

.3 Use unions, flanges, and couplings downstream of valves and at equipment or apparatus connections. Do not use direct welded or threaded connections to valves, equipment or other apparatus.
.4 Use non-conducting dielectric connections whenever jointing dissimilar metals in open systems.
.5 Provide pipe hangers and supports to ASTM B31.9 unless indicated otherwise.
.6 Use gate valves for shut-off and to isolate equipment, part of systems, or vertical risers.
.7 Use globe valves for throttling, bypass, manual flow control services, for balancing & in bypass around control valves.
.8 Use spring loaded check valves on discharge of condenser water pumps.
.9 Use plug cocks for throttling service. Use non-lubricated plug cocks only when shut-off or isolating valves are also provided.
.10 Use butterfly valves in heating water systems interchangeably with gate and globe valves.
.11 Use only butterfly valves in chilled and condenser water systems for throttling and isolation service.
.12 Use lug end butterfly valves to isolate equipment.
.13 Use 3/4 inch (20 mm) gate valves with cap for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment. Pipe to nearest floor drain.
.14 Butterfly valves shall be used for large pipe sizes 2-1/2" and above.
.15 Pipe joint method shall be screwed for 2" and smaller sizes and welded or grooved for 2-1/2" and larger.
.16 Gasket material shall be Grade 'E' EPDM compound conforming of ASTM D2-2000 and suitable for an operating temperature range of -34ºC to 110ºC.
.17 Small runouts, size 3/4" and less for extension of domestic make-up piping may be constructed using hand drawn copper tube type 'K' or "L" and comply to ASTM B88.

1.5 SUBMITTALS

.1 Section 15010: Procedures for submittals.
.2 Product Data: Include data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalogue information. Indicate valve data and ratings.
.3 Welders Certificate: Include welders certification of compliance with ASME SEC 9.
.4 Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.

1.6 PROJECT RECORD DOCUMENTS

.1 Section 15010: Submittals for project closeout.
.2 Record actual locations of valves.

1.7 OPERATION AND MAINTENANCE DATA

.1 Submit to Section 15010.
.2 Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.8 QUALIFICATIONS

.1 Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
.2 Installer: Company specializing in performing the work of this section with minimum 3 years documented experience.
.3 Welders: Certify to ASME SEC 9.

1.9 REGULATORY REQUIREMENTS

.1 Conform to ASME B31.9 code for installation of piping system.

.2 Welding Materials and Procedures: Conform to ASME SEC 9 and applicable provincial labour regulations.
.3 Provide certificate of compliance from authority having jurisdiction indicating approval of welders.

1.10 DELIVERY, STORAGE, AND HANDLING

.1 Section 15010: Transport, handle, store, and protect products.
.2 Accept valves on site in shipping containers with labeling in place. Inspect for damage.
.3 Provide temporary protective coating on cast iron and steel valves.
.4 Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
.5 Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.11 ENVIRONMENTAL REQUIREMENTS

.1 Do not install underground piping when bedding is wet or frozen.

1.12 EXTRA MATERIALS

.1 Section 15010: Submittals for project closeout.
.2 Provide two repacking kits for each size and valve type.

2 Products

2.1 HEATING WATER AND GLYCOL PIPING, ABOVE GROUND

.1 Steel Pipe: ASTM A53, Schedule 40, black.
  .1 Fittings: ASTM B16.3, malleable iron or ASTM A234, forged steel welding type fittings.
  .2 Joints: Threaded, or AWS D1.1,welded.
.2 Copper Tubing: ASTM B88, Type L, hard drawn.
  .1 Fittings: ASME B16.18, cast brass, or ASME B16.22, solder wrought copper.
  .2 Tee Connections: Mechanically extracted collars with notched and dimpled branch tube.
  .3 Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 220 to 280 degrees C.

2.2 EQUIPMENT DRAINS AND OVERFLOWS

.1 Copper Tubing: ASTM B88, Type M and DWV, hard drawn.
  .1 Fittings: ASME B16.18, cast brass, or ASME B16.22 solder wrought copper.
  .2 Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 220 to 280 degrees C.

2.3 PIPE HANGERS AND SUPPORTS

.1 Conform to ASME B31.9.
.2 Hangers for Pipe Sizes 13 to 38 mm: Malleable iron, adjustable swivel, split ring.
.3 Hangers for Cold Pipe Sizes 50 mm and Over: Carbon steel, adjustable, clevis.
.4 Hangers for Hot Pipe Sizes 50 to 100 mm: Carbon steel, adjustable, clevis.
.5 Hangers for Hot Pipe Sizes 150 mm and Over: Adjustable steel yoke, cast iron roll, double hanger.
.6 Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
.7 Multiple or Trapeze Hangers for Hot Pipe Sizes 150 mm and Over: Steel channels with welded spacers and hanger rods, cast iron roll.
.8 Wall Support for Pipe Sizes to 76 mm: Cast iron hook.
.9 Wall Support for Pipe Sizes 100 mm and Over: Welded steel bracket and wrought steel clamp.
.10 Wall Support for Hot Pipe Sizes 150 mm and Over: Welded steel bracket and wrought steel clamp

with adjustable steel yoke and cast iron roll.

.11 Vertical Support: Steel riser clamp.

.12 Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

.13 Floor Support for Hot Pipe Sizes to 100 mm: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

.14 Floor Support for Hot Pipe Sizes 150 mm and Over: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.

.15 Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

.16 Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.

.17 Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.4 UNIONS, FLANGES, AND COUPLINGS

.1 Unions for pipe 2" (50 mm) and Under:
- .1 Ferrous Piping: 1034 kPa malleable iron, threaded.
- .2 Copper Pipe: Bronze, soldered joints.

.2 Flanges for pipe over 2" (50 mm):
- .1 Ferrous Piping: 1034 kPa forged steel, slip-on.
- .2 Copper Piping: Bronze.
- .3 Gaskets: 1.6 mm thick preformed neoprene.

.3 Grooved and Shouldered Pipe End Couplings:
- .1 Housing Clamps: Malleable iron galvanized to engage and lock, designed to permit some angular deflection, contraction, and expansion.
- .2 Sealing Gasket: C-shape elastomer composition for operating temperature range from -34 degrees C to 110 degrees C.
- .3 Accessories: Steel bolts, nuts, and washers.

.4 Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

2.5 VALVES - GENERAL

.1 Conform to requirements of ANSI, ASTM, ASME, and applicable MSS standards.

.2 Provide valves of the same manufacturer where possible.

.3 Manufacturer's name and pressure rating clearly marked on body to MSS-SP-25.

.4 Valid CRN (Canadian Registration Number) required for each valve.

.5 Materials:

.1	Bronze:	ASTM B62 or B61 as applicable
.2	Brass:	ASTM B283 C3770
.3	Cast Iron:	ASTM A126 Class B

.6 End Connections:

.1	Threaded ends:	ANSI B1.20.1
.3	Flanged ends:	ANSI B16.1 (Class 125), ANSI B16.5
.4	Face-to-face dimensions:	ANSI B16.10

.7 Design and Testing:

.1	Bronze Gate & Check valves:	MSS-SP-80
.2	Ball Valves:	MSS-SP-110
.3	Cast Iron Gate Valces:	MSS-SP-70
.4	Cast Iron Globe Valves:	MSS-SP-85
.5	Cast Iron Check:	MSS-SP-71
.6	Butterfly Valves:	MSS-SP-67

.8 First named product as indicated in paragraphs below; other acceptable manufacturers, subject to equivalent products include:
- .1 Jenkins.
- .2 Newman-Hattersley.

.3 Conbraco.
.4 Nibco
.5 Kitz

2.6 ISOLATING VALVES

1. Up To and Including 2-1/2" (65 mm)
   .1 Manufacturer: Crane Model CSC-9202.
   .2 Construction: MSS SP-110, Class 150, 600psi 4140 kPa CWP, forged brass, two piece body, stainless steel ball and stem, full port, virgin PTFE seats and stem packing, blow-out proof stem, lever handle with balancing stops, stem extensions for insulated piping, threaded ends.
2. 3" (75mm) and Larger:
   .1 Manufacturer: Crane Center Line Series 200.
   .2 Construction: MSS SP-67, 200 psi 1380 kPa CWP, cast or ductile iron body, nickel-plated ductile iron disc, resilient replaceable EPDM seat, wafer ends, extended neck, 10 position lever handle. Provide gear operators for valves 150 mm and larger, and chain-wheel operators for valves mounted over 2400 mm above floor.

2.7 THROTTLING VALVES

1. Up To and Including 2" (50mm):
   .1 Manufacturer: Crane Figure 1703 .
   .2 Construction: MSS SP-80, Class 125, 200psi 1380 kPa CWP, rising stem, bronze body globe valve, bronze seat, handwheel, PTFE disc, threaded ends.
2. 2-1/2" (65mm) and Larger:
   .1 Manufacturer: Crane Center Line Series 200.
   .2 Construction: MSS SP-67, 200 psi 1380 kPa CWP, cast or ductile iron body, nickel-plated ductile iron disc, resilient replaceable EPDM seat, wafer ends, extended neck, 10 position lever handle. Provide gear operators for valves 150 mm and larger, and chain-wheel operators for valves mounted over 2400 mm above floor.

2.8 CHECK VALVES

.1 Up To and Including 75 mm:
   .1 Manufacturers: Crane Figure 137
   .2 Construction: MSS SP-80, Class 150, 300 psi 2070 kPa CWP, bronze body and cap, bronze swing disc with rubber seat, threaded ends

.2 100mm and Larger:
   .1 Manufacturers: Crane Figure 375
   .2 Construction: MSS SP-71, Class 125, 200psi 1380 kPa CWP, iron body and bolted cap, bronze trim, bronze swing disc with replaceable bronze seat rings, flanged ends.

2.9 CIRCUIT BALANCING VALVES

1. Circuit Balancing Valves (2" (50 mm) and smaller)
   .1 Screwed connection, globe style design, nonferrous, pressure die-cast, nonporous Ametal Copper Alloy. Each valve shall be such that when installed in any direction, it will not affect flow measurement.
   .2 Valves shall provide the following functions:
      .1 Precise flow measurement.
      .2 Precision flow balancing.

.3 Positive shut off with no drip seat and teflon disc.
.4 Drain connection with protective cap.

.3 Valves shall have four 360° adjustment turns of handwheel for maximum vernier-type setting with "Hidden Memory" feature to program the valve with precision tamper-proof balancing setting.
.4 Valves shall be shipped in a 4.5 R factor polyurethane container that shall be used as insulation after valve in installed.
.5 Provide valves suitable for maximum working pressure of 250 psi (1720 kPa) and maximum operating temperature of 250°F (121°C).
.6 Acceptable Products: S.A. Armstrong CRV I indicated or Tour & Anderson STA-D or Newman Hattersley.

2. Circuit Balancing Valves (2 1/2" (65 mm) and larger)
.1 Flanged, line size connection, globe style design, nonferrous, pressure die-cast, nonporous Ametal Copper Alloy.
.2 Valves, shall provide the following functions:
.1 Precise flow measurement.
.2 Precision flow balancing.
.3 Positive shut off with no drip seat and teflon disc.
.3 Valves shall have twelve 360° adjustment turns of handwheel for maximum vernier-type setting with "Hidden Memory" feature to program the valve with precision tamper-proof balancing setting.
.4 Valves shall be suitable for maximum working pressure of 250 psi (1720 kPa) and maximum operating temperature of 250°F (120°C).
.5 Acceptable Products: S.A. Armstrong CBV II indicated or Tour & Anderson STA-F or Newman Hattersley.

2.10 DRAIN VALVES

.1 Manufacturers:Crane
.2 Brass ball valve with cap and chain, 20 mm hose thread.

3 Execution

3.1 PREPARATION

.1 Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
.2 Remove scale and dirt on inside and outside before assembly.
.3 Prepare piping connections to equipment with flanges or unions.
.4 Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.
.5 After completion, fill, clean, and treat systems. Refer to Section 15505.

3.2 INSTALLATION

.1 Install to manufacturer's instructions.
.2 Install heating water, glycol, water piping to ASME B31.9.
.3 Route piping in orderly manner, parallel to building structure, and maintain gradient.
.4 Install piping to conserve building space, and not interfere with use of space.
.5 Group piping whenever practical at common elevations.
.6 Sleeve pipe passing through partitions, walls and floors.
.7 Slope piping and arrange to drain at low points.
.8 Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
.9 Inserts:
.1 Provide inserts for placement in concrete formwork.
.2 Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

.3 Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 100 mm.
.4 Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
.5 Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.

.10 Pipe Hangers and Supports:
.1 Install to ASTM B31.9.
.2 Support horizontal piping as scheduled.
.3 Install hangers to provide minimum 13 mm space between finished covering and adjacent work.
.4 Place hangers within 300 mm of each horizontal elbow.
.5 Use hangers with 38 mm minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
.6 Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
.7 Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
.8 Provide copper plated hangers and supports for copper piping.
.9 Prime coat exposed steel hangers and supports. Refer to Section 15010. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

.11 Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
.12 Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Section 15115.
.13 Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.
.14 Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.
.15 Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting. Refer to Section 15010.
.16 Install valves with stems upright or horizontal, not inverted.
.17 Air vents shall be selected to suit the system operating pressures and shall be automatic and complete with isolating vavles.
.18 All strainers 1-1/2" & larger shall be fitted with chain valves.
.19 Unless specified otherwise, drain piping shall be sloped down in the direction of flow not less than 1" in 40 feet.
.20 Eccentric reducers shall be provided to keep the bottom of sloped piping aligned in order to minimize risk of water hammer and to facilitate drainage.
.21 Valves shall be installed with stems upright or angled 45 deg. above horizontal unless instructed otherwise.
.22 Pipe all discharge from temp. & safety relief valves to a point of safe discharge directly into a floor drain, hub drain or safe outdoor location.

End of Section

1 General

1.1 WORK INCLUDED

.1 Description: Furnish and install a REHAU radiant floor heating (RFH) system. Systems shall be complete with REHAU piping distribution manifold(s) with balancing and 3-Way control valves, Floor thermostats with slab sensors, manufacturer-approved cold-expansion compression-sleeve pipe repair couplings, nonmetallic pipe fasteners and installation specialties, supervision and field engineering required for complete and proper function of the system. Systems by other manufacturers shall be submitted as alternates with material cost savings. Alternate systems shall be responsible for any costs associated with changes to design, installation and performance.

.2 Manufacturer: Rehau

.3 Other acceptable manufacturers: Heat Link

1.2 REGULATORY REQUIREMENTS

.1 Cross-linked polyethylene (PEXa) pipe shall be manufactured by the high-pressure peroxide (Engel) method with a minimum degree of cross-linking of 80%, and conform to ASTM F 876, F 877 and CSA B 137.5. Fittings shall conform to ASTM F 877, F 2080 and CSA B 137.5. Pipe oxygen diffusion barrier shall conform to DIN 4726.

1.3 REFERENCES

.1 ASTM F 876: Standard Specification for Cross-linked Polyethylene (PEX) Pipe

.2 ASTM F 877: Cross-linked Polyethylene (PEX) Plastic Hot- and Cold-Water Distribution Systems

.3 ASTM F 2080: Standard Specification for Cold-Expansion Fittings with Metal Compression-Sleeves for use with Cross-linked Polyethylene (PEX) Pipe

.4 CSA B 137.5: Cross-linked Polyethylene (PEX) Tubing Systems for Pressure Applications

.5 DIN 4726: German Standard for Plastic Piping Used in Warm Water Floor Heating Systems

1.4 SUBMITTALS

.1 Provide submittals and shop drawings in accordance with the General Requirements and as specified herein. Submit shop drawings indicating schematic layout of system, including equipment, critical dimensions and piping/slab penetration details as well as details for protecting exposed PEX piping.

.2 Submit manufacturer's technical installation instructions.

.3 Submit independent certification results for the piping systems from a recognized testing laboratory.

.4 Submit computer-generated RFH system design indicating pipe sizing and panel performance at pipe spacing and water temperatures selected. RFH design calculations to be performed on pipe manufacturer's software.

.5 Submit catalog data on all equipment, fittings, fasteners and associated items necessary for the installation of the piping and manifolds.

.6 System shall be installed by a contractor experienced in radiant floor cooling / heating system pipe installation. Submit installer's installation certification and project installation resume of experience.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Deliver and store piping and equipment in shipping containers with labeling in place. Pipe to be kept in original shipping boxes until required for installation. Do not expose pipe to ultraviolet (sunlight) light for more than 90 days.

.2 Protect piping and manifolds from entry of contaminating materials by installing suitable plugs in all open pipe ends until installation. Where possible, connect pipes to assembled manifolds to eliminate possibility of contaminants.

.3 Piping shall not be dragged across the ground or concrete surfaces, and shall be stored on a flat surface with no sharp edges.

.4 Pipe shall be protected from oil, grease, paint, direct sunlight and other elements as recommended by manufacturer.

1.6 WARRANTY

.1 The radiant floor heating pipe manufacturer shall warrant the cross-linked polyethylene piping to be free from defects in material and workmanship for a period of twenty-five (25) years. The design shall be approved either by submittal or stamped by a registered engineer as being complete and accurate.

.2 All manifolds and controls shall be warranted for 18 months and/or two heating seasons.

1.7 Copy of WARRANTY

.1 The radiant floor heating pipe manufacturer shall warrant the cross-linked polyethylene piping to be free from defects in material and workmanship for a period of twenty-five (25) years. The design shall be approved either by submittal or stamped by a registered engineer as being complete and accurate.

.2 All manifolds and controls shall be warranted for 18 months and/or two heating seasons.

2 Products

2.1 PIPING

.1 Material: All radiant floor heating piping shall be nominal high density cross-linked polyethylene as manufactured by REHAU using the peroxide method of cross-linking (PEXa) and with an approved cell classification in accordance with ASTM D 3350. Pipe shall conform with ASTM F 876 and CSA B 137.5, and be certified by CSA or equivalent testing organization.

.2 Temperature and Pressure Ratings: Piping shall be rated for 100 PSIG gauge pressure at 180oF temperature (690 kPa @ 82°C) continuous, and 80 PSIG gauge pressure at 200oF temperature (550 kPa @ 93°C) continuous.

.3 Oxygen Diffusion Barrier: Piping shall have a co-extruded oxygen diffusion barrier capable of limiting oxygen diffusion through the pipe to less than 0.10 mg/l/day at 104oF (40°C) water temperature, in accordance with DIN 4726.

.4 Bend Radius: The minimum bend radius for cold bending of the pipe shall be not less than five (5) times the outside diameter. Bends with a radius less than this shall require the use of a bending template as supplied by the pipe manufacturer, and/or hot air.

.5 All floor heating piping shall be fastened using nylon cable binders to a middle rebar mesh (provided by general contractor) maintaining 800 mm pipe clearance from top and bottom of the concrete slab and keeping the pipe centered in the concrete slab.

2.2 FITTINGS

.1 Fittings shall be manufactured of dezincification-resistant brass and shall be supplied by the piping manufacturer as part of a proven cataloged system. Manifold fittings to be compression nut style with split compression ring.

.2 Fittings shall be certified to ASTM F 877, F 2080 and CSA B 137.5 as part of the manufacturer's PEX piping system. Pipe couplings embedded within the thermal mass shall be EVERLOC® cold-expansion compression-sleeve fittings.

2.3 MANIFOLDS

.1 Material: Distribution manifolds shall be manufactured of brass and be supplied by the piping manufacturer as a proven cataloged part of the manufacturer's system.

.2 Balancing Manifolds: Where required by design, brass balancing manifolds shall be equipped with visual flow gauges, balancing and isolation valves for each circuit, header isolation valves and air vent/fill ports. Manifolds shall be pre-assembled, mounted on metal brackets and ready to install.

.3 Each manifold shall be provided with automatic air vents

.4 Provide manifold cabinets of sufficient size to allow BMS controls and manifold zone valves to be installed within the cabinet.

2.4 CONTROLS

.1 Space Sensors / Slab Sensors shall be Rehau Temperature controllers with space sensors and slab sensors. Controls shall interlocked with 3-Way control valves and pump through the Rehau zone board. Controller shall be provided with a lockable cover.

.2 Valves and Actuators: 3-Way control valves for each manifold shall be installed and shall allow fluid circulation through the slab heating system on a call for heat. Valves and actuators shall be supplied by REHAU supplier.

2.5 ACCESSORIES

.1 Utilize manufacturer's system installation accessories including: nylon cable binders, pipe sleeves, protective sleeving, pipe cutters, pipe uncoilers and other installation tools and aids.pipe ties.

2.6 PERFORMANCE

.1 As per schedule on drawings.

3 Excecution

3.1 PREPARATION

.1 Preparation

.1 Concrete Slab on Grade: Subgrade should be compacted, flat and smooth to prevent damage to pipe or insulation. Approved vapor barrier material should be installed. Insulation should be installed vertically along all exterior walls or footings to which the edge of the slab will meet against. Horizontal insulation should be installed flat against the vapor barrier under where the slab will be poured. Rigid foam board insulation panels should be taped together at the seams. Reinforcing wire mesh or rebar, if required by structural design, must be flat and level, with all sharp ends pointing down. Finished grade of the thermal mass must be a minimum of 3/4" (19 mm) above the top of PEX heating pipes.

.2 All floor heating piping shall be fastened using nylon cable binders to a middle rebar mesh (provided by general contractor) maintaining 800 mm pipe clearance from top and bottom of the concrete slab and keeping the pipe centered in the concrete slab.

.3 Pre-cast Concrete Subfloor: Subfloor must be clean and free from all construction debris, which could potentially damage the pipe. Replace any areas that appear weak. If called for by design, approved vapor barrier material should be installed and insulation should be installed vertically along all exterior walls or footings to which the edge of the slab will meet against, as well as flat against the vapor barrier under where the slab will be poured. Rigid foam board insulation panels should be taped together at the seams. Finished grade of the thermal mass overpour must be a minimum of 3/4" (19 mm) above the top of PEX heating pipes.

3.2 INSTALLATION

.1 Install in accordance with manufacturer's published installation manual and/or published guidelines.

.2 Mount manifolds in the locations previously prepared or in previously installed cabinets, if used. Manifolds should be mounted as level as possible.

.3 Route piping in orderly manner, according to layout and spacing shown in approved submittal drawings. All notes on drawings shall be followed.

.4 At connections and fittings, use a plastic pipe cutter to ensure square and clean cuts, and join pipes immediately or cap ends of pipe to seal from contaminants. Where fittings are installed within the thermal mass, they shall be wrapped in chloride-free tape or sealed within a heat-shrink material approved by the manufacturer.

.5 Pipe should be dispensed using a suitable uncoiling device. Remove all twists prior to securing pipe. Pipe must lie flat on an even plane. Finished grade of a thermal mass must be a minimum of 3/4" (19 mm) above the top of PEX heating pipes. Fasten piping at no more than 3 feet (90 cm) intervals, being careful not to twist the pipe. In thin concrete slabs, it may be necessary to secure piping every 2 feet (60 cm). Use only fasteners supplied or approved by the manufacturer of the

PEX pipe.

.6 Piping that must pass through expansion joints shall be covered in protective polyethylene convoluted sleeving (flexible conduit) extending 15 inches (38 cm) on each side of the joint. Sleeving must be secured on pipe to prevent movement during installation of thermal mass.

.7 Where piping exits the thermal mass, a protective conduit shall be placed around the pipe, with the conduit extending a minimum of 6 inches (15 cm) into the floor and exiting by a minimum of 6 inches. For penetrations at manifolds, use rigid PVC bend guides secured in place to prevent movement.

.8 At the time of installation of each circuit of pipe, connect the pipe to the correct manifold outlet and record pipe length for balancing. If manifold is not installed, cap the end of the pipe and label the pipe's circuit numbers along with S for supply and R for return. Connect pipes to manifold as soon as possible and record circuit lengths. All circuits shall be labeled to indicate circuit length and serviced area.

.9 The following precautions shall be taken in areas intended for carpet:
- .1 Notify carpet installer that radiant heating pipes have been installed.
- .2 Keep pipes 6 inches (15 cm) from all wall baseplates.
- .3 Install metal guards where pipe will pass through wall baseplates and where carpet tack strips will be installed.

.10 The following precautions shall be taken in areas intended for hardwood flooring:
- .1 Ensure that nailing areas for hardwood flooring (if nailing is required) are clearly marked and known to hardwood installers.
- .2 The heating system should not be put into operation until the poured concrete thermal mass has cured a minimum of 28 days, unless otherwise specified and approved by thermal mass supplier. If it is necessary to operate the heating system to prevent freezing, a maximum flow temperature of 72o F (22°C) must not be exceeded while the thermal mass is curing. After curing, gradually increase the flow temperature by no more than 10oF (6°C) each day until system reaches the required operating temperature.

.11 Contractor shall be responsible for provision of
- .1 Wire mesh or rebar to secure tubing and any insulations to be provided by the general contractor
- .2 Labour to install Radiant Floor Heating system
- .3 Water, glycol and any chemical solutions.
- .4 Field coordination of the pressure test equipment. (It is recommended to use the REHAU hydraulic pressure test unit available through Klimatrol to conduct pressure tests.)
- .5 Supervision of concrete pours to instruct concrete installers on maintenance of pipe integrity and position of pipe in slab during concrete installation.
- .6 Installation of control valves, pumps, supply and return piping, all valves and fittings.
- .7 Electrical control interconnection and testing.

3.3 FIELD QUALITY CONTROL

.1 Filling, Testing & Balancing: Tests of hydronic heating systems shall comply with local codes, and, where required, shall be witnessed by the building official. (Reference BOCA, ICBO, SBCCI or the acceptable code body for the jurisdiction).
- .1 Pressure gauges used must show pressure increments of 1 PSIG and should be located at or near the lowest points in the distribution system.

.2 Air Test: Charge the completed, yet unconcealed pipes with air. Do not exceed 150 PSIG. Use liquid gas detector or soap solution to check for leakage at manifold connections.
- .1 Perform a preliminary pressure test pressurizing the system to the greater of 1.5 times the maximum operating pressure or 100 psi for 30 minutes. As the piping expands, restore pressure, first at 10 minutes into the test and again at 20 minutes. At the end of the 30 minute preliminary test, pressure must not fall by more than 5 PSIG from the maximum, and there shall be no leakage.
- .2 After performing the preliminary test, perform the main pressure test immediately. The main pressure test shall last 2 hours. The test pressure should be restored and must not fall more than 3 PSIG after 2 hours. No leakage should be detected.
- .3 Pressure shall be maintained and monitored during installation of the thermal mass. If any leak is detected during installation of thermal mass, the leak must be found immediately

and the area cleared for repair using manufacturer approved repair coupling. Retest before covering repair.

.3 Water Test: Purge all air from pipes. Charge the completed, yet unconcealed pipes with water. Take necessary precautions to prevent water from freezing. Check the system for leaks, especially at all pipe joints.

.1 Perform the same procedures as used in the Air Test (3.3.2.1 - 3.3.2.3.).

End of Section

1 General

1.1 GENERAL

.1 Read and conform to:
- .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
- .2 Division 1 requirements and documents refered to therein.

1.2 SECTION INCLUDES

.1 Cleaning of pipe and fittings.
.2 Chemical feeder equipment.
.3 Chemical treatment.

1.3 SUBMITTALS

.1 Section 15010: Procedures for submittals.
.2 Shop Drawings: Indicate system schematic, equipment locations, and controls schematics, electrical characteristics and connection requirements.
.3 Product Data: Provide chemical treatment materials, chemicals, and equipment including electrical characteristics and connection requirements.
.4 Manufacturer's Installation Instructions: Indicate placement of equipment in systems, piping configuration, and connection requirements.
.5 Manufacturer's Field Reports: Submit to Section 15010.
.6 Manufacturer's Field Reports: Indicate start-up of treatment systems when completed and operating properly. Indicate analysis of system water after cleaning and after treatment.

1.4 PROJECT RECORD DOCUMENTS

.1 Section 15010: Submittals for project closeout.
.2 Record actual locations of equipment and piping, including sampling points and location of chemical injectors.

1.5 OPERATION AND MAINTENANCE DATA

.1 Section 15010: Submittals for project closeout.
.2 Operation and Maintenance Data: Include data on chemical feed pumps, agitators, and other equipment including spare parts lists, procedures, and treatment programs. Include step by step instructions on test procedures including target concentrations.

1.6 QUALIFICATIONS

.1 Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum three years documented experience. Company to have local representatives with water analysis laboratories and full time service personnel.
.2 Installer: Company specializing in performing the work of this section with minimum three years documented experience and approved by manufacturer.

1.7 REGULATORY REQUIREMENTS

.1 Conform to applicable code for addition of non-potable chemicals to building mechanical systems, and for to public sewage systems.

.2 Products Requiring Electrical Connection: Listed and classified by CSA as suitable for the purpose specified and indicated.

1.8 MAINTENANCE MATERIALS

.1 Section 15010: Submittals for project closeout.
.2 Provide sufficient chemicals for treatment and testing during warranty period.

2 Products

2.1 MANUFACTURERS

.1 GE Water Tech (Dearborn)
.2 Buckman Laboratories
.3 Bird Archer.
.4 Ashland Drew
.5 Substitutions: Refer to Section 15010.

2.2 MATERIALS

.1 System Cleaner:
  .1 Liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products ; sodium tripoly phosphate and sodium molybdate.
  .2 Biocide ; chlorine release agents such as sodium hypochlorite or calcium hypochlorite, or microbiocides such as quarternary ammonia compounds, tributyl tin oxide, methylene bis (thiocyanate), or isothiazolones.
.2 Closed System Treatment (Water):
  .1 Sequestering agent to reduce deposits and adjust pH ; polyphosphate.
  .2 Corrosion inhibitors ; liquid boron-nitrite, sodium nitrite and borax, sodium totyltriazole, low molecular weight polymers, phosphonates, sodium molybdate, or sulphites.
  .3 Conductivity enhancers ; phosphates or phosphonates.

2.3 BY-PASS (POT) FEEDER

.1 6.8L quick opening cap for working pressure of 1200 kPa.

2.4 SOLUTION METERING PUMP

.1 Positive displacement, diaphragm pump with adjustable flow rate, thermoplastic construction, continuous-duty fully enclosed electric motor and drive, and built-in relief valve.
.2 Electrical Characteristics:
  .1 120 volts, single phase, 60 Hz.
  .2 Cord and Plug: Provide unit with 2 m cord and plug for connection to electric wiring system including grounding connector.

2.5 SOLUTION TANKS

.1 114 L capacity, polyethylene, self-supporting, 3.8 L graduated markings; moulded fibreglass cover with recess for mounting pump, agitator, and liquid level switch.

2.6 AGITATOR

.1 Totally enclosed electric motor, cast iron clamp and motor mount, 13 mm diameter coated Type 316 stainless steel propeller.
.3 Electrical Characteristics:
  .1 120 volts, single phase, 60 Hz.
  .2 Cord and Plug: Provide unit with 2 m cord and plug for connection to electric wiring system including grounding connector.

2.7 TEST EQUIPMENT

.1 Provide white enamel test cabinet with local and fluorescent light, capable of accommodating 4 - 10 ml zeroing titrating burettes and associated reagents.
.2 Provide the following test kits:
  .1 Alkalinity titration test kit.
  .2 Chloride titration test kit.
  .3 Sulphite titration test kit.
  .4 Total hardness titration test kit.
  .5 Low phosphate test kit.
  .6 Conductivity bridge, range 0 - 10,000 microhms.
  .7 Creosol red pH slide complete with reagent.
  .8 Portable electronic conductivity meter.
  .9 High nitrite test kit.

3 Execution

3.1 PREPARATION

.1 Systems to be operational, filled, started, and vented prior to cleaning. Use water meter to record capacity in each system.
.2 Place terminal control valves in open position during cleaning.
.3 Verify that electric power is available and of the correct characteristics.

3.2 CLEANING SEQUENCE

.1 Concentration:
  .1 As recommended by manufacturer.
  .2 1 kg per 1000 L of water contained in the system.
  .3 1 kg per 1000 L of water for hot systems and 1 kg per 500 L of water for cold systems.
  .4 Fill steam boilers only with cleaner and water.
.2 Hot Water Heating Systems:
  .1 Apply heat while circulating, slowly raising temperature to 71 degrees C and maintain for 12 hours minimum.
  .2 Remove heat and circulate to 37.8 degrees C or less; drain systems as quickly as possible and refill with clean water.
  .3 Circulate for 6 hours at design temperatures, then drain.
  .4 Refill with clean water and repeat until system cleaner is removed.
.3 Use neutralizer agents on recommendation of system cleaner supplier and approval of Consultant.
.4 Flush open systems and glycol filled closed systems with clean water for one hour minimum. Drain completely and refill.
.5 Remove, clean, and replace strainer screens.
.6 Inspect, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required.

3.3 INSTALLATION

.1 Install to manufacturer's instructions.

3.4 CLOSED SYSTEM TREATMENT

.1 Provide one bypass feeder on each system. Install isolating and drain valves and necessary piping. Install around balancing valve downstream of circulating pumps unless indicated otherwise.
.2 Introduce closed system treatment through bypass feeder when required or indicated by test.
.3 Provide 19 mm water coupon rack around circulating pumps with space for 4 test specimens.

End of Section

1 General

1.1 GENERAL

.1 Read and conform to:
- .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
- .2 Division 1 requirements and documents refered to therein.

1.2 SECTION INCLUDES

.1 In-line circulators.
.2 Vertical in-line pumps.

1.3 REFERENCES

.1 UL 778 - Motor-Operated Water Pumps.

1.4 PERFORMANCE REQUIREMENTS

.1 Ensure pumps operate at specified system fluid temperatures without vapour binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

1.5 SUBMITTALS

.1 Section 15010: Procedures for submittals.
.2 Product Data: Provide certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements.
.3 Manufacturer's Installation Instructions: Indicate hanging and support requirements and recommendations.
.4 Millwright's Certificate: Certify that base mounted pumps have been aligned.

1.6 OPERATION AND MAINTENANCE DATA

.1 Section 15010: Submittals for project closeout.
.2 Operation and Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

1.7 QUALIFICATIONS

.1 Manufacturer: Company specializing in manufacture, assembly, and field performance of pumps with minimum three years experience.
.2 Alignment: Align base mounted pumps by qualified millwright.

1.8 REGULATORY REQUIREMENTS

.1 Products Requiring Electrical Connection: Listed and classified by UL as suitable for the purpose specified and indicated.

1.9 EXTRA MATERIALS

.1 Section 15010: Submittals for project closeout.
.2 Provide one set of mechanical seals for each pumps.
.3 Provide 2 sets of cartridges for each side-stream filter.

2 Products

2.1 MANUFACTURERS

.1 ITT Bell & Gosset
.2 Other acceptable manufacturers offering equivalent products.
  .1 S. A. Armstrong
  .2 Darling-Duro
  .3 Grundfos
.3 Substitutions: Refer to Section 15010.

2.2 IN-LINE CIRCULATORS

.1 Type: Horizontal shaft, single stage, direct connected, with resiliently mounted motor for in-line mounting, oil lubricated, for 860 kPa maximum working pressure.
.2 Casing: Cast iron, with flanged pump connections.
.3 Impeller: Cadmium plated steel, keyed to shaft.
.4 Bearings: Two, oil lubricated bronze sleeves.
.5 Shaft: Alloy or stainless steel with copper or bronze sleeve, integral thrust collar.
.6 Seal: Carbon rotating against a stationary ceramic seat, 107 degrees C maximum continuous operating temperature.
.7 Seal: Carbon rotating against a stationary ceramic seat, viton fitted, 135 degrees C maximum continuous operating temperature.
.8 Drive: Flexible coupling.
.9 Performance: as scheduled
.10 Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to code.

2.3 VERTICAL IN-LINE PUMPS

.1 Type: Vertical, single stage, close coupled, radially or horizontally split casing, for in-line mounting, for 1200 kPa working pressure.
.2 Casing: Cast iron, with suction and discharge gauge port, casing wear ring, seal flush connection, drain plug, flanged suction and discharge.
.3 Impeller: Bronze, fully enclosed, keyed directly to motor shaft or extension.
.4 Shaft: Carbon steel with stainless steel impeller cap screw or nut and bronze sleeve.
.5 Seal: Carbon rotating against a stationary ceramic seat, viton fitted, 107 degrees C maximum continuous operating temperature.
.6 Performance: as scheduled
.7 Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to code.

3 Execution

3.1 PREPARATION

.1 Verify that electric power is available and of the correct characteristics.

3.2 INSTALLATION

.1 Install to manufacturer's instructions.
.2 Provide access space around pumps for service. Provide no less than minimum as recommended by manufacturer.
.3 Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings. For close coupled or base mounted pumps, provide supports under elbows on pump suction and discharge line sizes 102 mm and over.
.4 Provide line sized shut-off valve and strainer on pump suction, and line sized soft seat check valve and balancing valve on pump discharge.
.5 Provide air cock and drain connection on horizontal pump casings.
.6 Provide drains for bases and seals, piped to and discharging into floor drains.
.7 Check, align, and certify alignment of base mounted pumps prior to start-up.
.8 Lubricate pumps before start-up.

End of Section

1 General

1.1 GENERAL

.1 Read and conform to:
- .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
- .2 Division 1 requirements and documents refered to therein.

1.2 SECTION INCLUDES

.1 Expansion tanks.
.2 Air vents.
.3 Air separators.
.4 Strainers.
.5 Pump suction fittings.
.6 Combination fittings.
.7 Relief valves.
.8 Glycol specialties.

1.3 REFERENCES

.1 ASME - SEC 8D - Boilers and Pressure Vessels Code - Rules for Construction of Pressure Vessels.

1.4 SUBMITTALS

.1 Section 15010: Procedures for submittals.
.2 Product Data: Provide product data for manufactured products and assemblies required for this project. Include component sizes, rough-in requirements, service sizes, and finishes. Include product description, model and dimensions.
.3 Submit inspection certificates for pressure vessels from TSSA.
.4 Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.

1.5 PROJECT RECORD DOCUMENTS

.1 Section 15010: Submittals for project closeout.
.2 Record actual locations of flow controls.

1.6 OPERATION AND MAINTENANCE DATA

.1 Section 15010: Submittals for project closeout.
.2 Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

1.7 QUALIFICATIONS

.1 Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1.8 DELIVERY, STORAGE, AND HANDLING

.1 Section 15010: Transport, handle, store, and protect products.
.2 Accept valves on site in shipping containers with labeling in place. Inspect for damage.
.3 Provide temporary protective coating on cast iron and steel valves.
.4 Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
.5 Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.9 MAINTENANCE SERVICE

.1 Provide service and maintenance of glycol system for one year from date of substantial completion.
.2 Monthly visit to make glycol fluid concentration analysis on site with refractive index measurement instrument. Detail findings with maintenance personnel in writing of corrective actions needed including analysis and amounts of glycol or water added.

1.10 EXTRA MATERIALS

.1 Section 15010: Submittals for project closeout.
.2 Provide one extra 4 L drum of propylene glycol.

2 Products

2.1 DIAPHRAGM-TYPE EXPANSION TANKS

.1 Manufacturers:
  .1 Amtrol Model as specified in Mechanical Equipment Schedule.
  .2 Other acceptable manufacturers offering equivalent products.
    .1 Expanflex.
    .2 ITT Bell & Gosset.
  .3 Substitutions: Refer to Section 15010.
.2 Construction: Welded steel, tested and stamped to ASME SEC 8-D; supplied with National Board Form U-1, rated for working pressure of 860 kPa, with flexible butyl diaphragm sealed into tank , and steel support stand.
.3 Accessories: Pressure gauge and air-charging fitting, tank drain; precharge to 80 kPa.
.4 Automatic Cold Water Fill Assembly: Pressure reducing valve, reduced pressure double check back flow preventer, test cocks, strainer, vacuum breaker, and valved by-pass.

2.2 AIR VENTS

.1 Manual Type: Short vertical sections of 50 mm diameter pipe to form air chamber, with 3 mm brass needle valve at top of chamber.
.2 Float Type:
  .1 Manufacturers:
    .1 Armstrong.
    .2 Amtrol.
    .3 Taco.
    .4 Substitutions: Refer to Section 15010.
  .2 Brass or semi-steel body, copper, polypropylene, or solid non-metallic float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve.

2.3 AIR SEPARATORS

.1 In-line Air Separators:
  .1 Manufacturers:
    .1 Amtrol.
    .2 Armstrong.
    .3 ITT Bell & Gossett.
    .4 Substitutions: Refer to Section 15010.
.2 Combination Air Separators/Strainers:
  .1 Manufacturers:
    .1 Amtrol.
    .2 Armstrong.
    .3 ITT Bell & Gossett.
    .4 Substitutions: Refer to Section 15010.
  .2 Steel, tested and stamped to ASME SEC 8-D; for 860 kPa operating pressure, with integral bronze strainer, tangential inlet and outlet connections, and internal stainless steel air collector tube.

2.4 STRAINERS

.1 Size 50 mm and Under:
  .1 Manufacturers:
    .1 Sarco SB
    .2 Crane
    .3 Armstrong
.2 Screwed brass or iron body for 1200 kPa working pressure, Y pattern with 0.8 mm stainless steel perforated screen.
.3 Size 65 mm to 100 mm:
  .1 Flanged iron body for 1200 kPa working pressure, Y pattern with 1.2 mm stainless steel perforated screen.
.4 Size 125 mm and Larger:
  .1 Flanged iron body for 1200 kPa working pressure, basket pattern with 3.2 mm stainless steel perforated screen.

2.5 PUMP SUCTION FITTINGS

.1 Manufacturers:
  .1 Armstrong.
  .2 Other acceptable manufacturers offering equivalent products.
    .1 ITT Bell & Gossett.
  .3 Substitutions: Refer to Section 15010
.2 Fitting: Angle pattern, cast-iron body, threaded for 50 mm and smaller, flanged for 65 mm and larger, rated for 1200 kPa working pressure, with inlet vanes, cylinder strainer with 5 mm diameter openings, disposable fine mesh strainer to fit over cylinder strainer, and permanent magnet located in flow stream and removable for cleaning.
.3 Accessories: Adjustable foot support, blowdown tapping in bottom, gauge tapping in side.

2.6 COMBINATION PUMP DISCHARGE VALVES

.1 Manufacturers:
  .1 Armstrong.
  .2 Other acceptable manufacturers offering equivalent products.
    .1 ITT Bell & Gossett.
  .3 Substitutions: Refer to Section 15010.
.2 Valves: Straight or angle pattern, flanged cast-iron valve body with bolt-on bonnet for 1200 kPa

operating pressure, non-slam check valve with spring-loaded bronze disc and seat, stainless steel stem, and calibrated adjustment permitting flow regulation.

2.7 RELIEF VALVES

.1 Manufacturers:
  .1 Sarco.
  .2 Other acceptable manufacturers offering equivalent products.
    .1 Watts
    .2 ITT Bell & Gossett
  .3 Substitutions: Refer to Section 15010.

.2 Bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labelled.

2.8 GLYCOL SYSTEM

.1 Mixing Tank: 205 L steel drum with fittings suitable for filling and hand pump for charging, rubber hose for connection of hand pump to system.

.2 Storage Tank: Closed type, welded steel constructed, tested and stamped to ASME SEC 8-D; 690 kPa rating; cleaned, prime coated, and supplied with steel support saddles. Construct with tappings for installation of accessories.

.3 Expansion Tank: Diaphragm type with vent fitting with air separator, and automatic air vent.

.4 Air Pressure Reducing Station: Pressure reducing valve with shut-off valves, strainer, check valve and needle valve bypass.

.5 Glycol Solution: Inhibited ethylene glycol and water solution mixed 50 percent glycol - 50 percent water, suitable for operating temperatures from -40 degrees C to 121 degrees C.

3 Execution

3.1 INSTALLATION

.1 Install specialties to manufacturer's instructions.
.2 Where large air quantities can accumulate, provide enlarged air collection standpipes.
.3 Provide manual air vents at system high points and as indicated.
.4 For automatic air vents in ceiling spaces or other concealed locations, provide vent tubing to nearest drain.
.5 Provide air separator on suction side of system circulation pump and connect to expansion tank.
.6 Provide valved drain and hose connection on strainer blow down connection.
.7 Provide pump suction fitting on suction side of base mounted centrifugal pumps where indicated. Remove temporary strainers after cleaning systems.
.8 Provide combination pump discharge valve on discharge side of base mounted centrifugal pumps where indicated.
.9 Support pump fittings with floor mounted pipe and flange supports.
.10 Provide relief valves on pressure tanks, low pressure side of reducing valves, heat exchangers, and expansion tanks.
.11 Select system relief valve capacity so that it is greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.
.12 Pipe relief valve outlet to nearest floor drain.
.13 Where one line vents several relief valves, make cross sectional area equal to sum of individual vent areas.
.14 Clean and flush glycol system before adding glycol solution.
.15 Feed glycol solution to system through make-up line with pressure regulator, venting system high points. Set to fill at 80 kPa.
.16 Perform tests determining strength of glycol and water solution and submit written test results.

End of Section

1 General

1.1 GENERAL

.1 Read and conform to:
- .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
- .2 Division 1 requirements and documents refered to therein.

1.2 SECTION INCLUDES

.1 Pipe and pipe fittings.
.2 Valves.
.3 Accessories.

1.3 REFERENCES

.1 ANSI B31.1 - Power Piping.
.2 ANSI B31.9 - Building Service Piping.
.3 ASME SEC IX - Welding and Brazing Qualifications.
.4 ASME B16.3 - Malleable Iron Threaded Fittings.
.5 ASME B36.10 - Welded and Seamless Wrought Steel Pipe.
.6 ASTM A53/A53M - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
.7 NFPA 31 - Installation of Oil-Burning Equipment.

1.4 SUBMITTALS FOR REVIEW

.1 Section 15010: Procedures for submittals.
.2 Product Data: Provide data on pipe materials, pipe fittings, valves and accessories. Provide manufacturers catalogue information. Indicate valve data and ratings.

1.5 SUBMITTALS FOR INFORMATION

.1 Section 15010: Procedures for submittals.
.2 Contracotr's material and test cerificates.

1.6 SUBMITTALS AT PROJECT CLOSEOUT

.1 Section 15010: Procedures for submittals.
.2 Project Record Documents: Record actual locations of piping system, storage tanks, and system components.
.3 Maintenance Data: Include installation instructions, spare parts lists , exploded assembly views.
.4 Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.7 QUALITY ASSURANCE

.1 Welding Materials and Procedures: Conform to ASME Code.
.2 Welders Certification: To ASME SEC IX.
.3 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
.4 Installer Qualifications: Company specializing in performing the work of this section with minimum 5 years documented experience.
.5 Valves: Manufacturer's name and pressure rating marked on valve body.

1.8 REGULATORY REQUIREMENTS

.1 Conform to CSA B149.1 Natural Gas and Propane installation code
.2 Conform to ANSI B31.1 for installation of fuel oil piping.

1.9 DELIVERY, STORAGE, AND PROTECTION

.1 Section 15010: Transport, handle, store, and protect products.
.2 Protect piping and fittings from soil and debris with temporary end caps and closures. Maintain in place until installation.

1.10 WARRANTY

.1 Section 15010.

1.11 EXTRA MATERIALS

.1 Section 15010.
.2 Provide two repacking kits for each size valve.

2 Products

2.1 BURIED PIPING

.1 Copper Tubing: ASTM B88M, Type K,.
  .1 Fittings: ASME B16.18, cast copper alloy or ASTM B16.22 wrought copper or bronze.
  .2 Joints: AWS A5.8 Classification BCuP-3 or BCuP-4 silver braze.
.2 Copper Tubing: ASTM B88M, Type K, annealed.
  .1 Fittings: ASME B16.26, cast bronze.
  .2 Joints: Flared.
.3 Steel Pipe: ASTM A53, Schedule 40 black.
  .1 Fittings: ASTM A234/A234M, wrought carbon steel and alloy steel welding type.
  .2 Joints: ANSI B31.1 welded.
  .3 Jacket: AWWA C105 polyethylene or double layer, half-lapped 0.25 mm polyethylene tape.

2.2 ABOVE GROUND PIPING

.1 Copper Tubing: ASTM B88M, Type K, hard drawn.
  .1 Fittings: ASME B16.18, cast copper alloy or ASTM B16.22 wrought copper and bronze.
  .2 Joints: AWS A5.8 Classification BCuP-3 or BCuP-4 silver braze.
.2 Copper Tubing: ASTM B88M, Type K, annealed.
  .1 Fittings: ASME B16.26, cast bronze.
  .2 Joints: Flared.
.3 Steel Pipe: ASTM A53 or ASME B36.10, Schedule 40 black.
  .1 Fittings: ASTM B16.3, malleable iron, or ASTM A234/A234M, wrought carbon steel and alloy steel welding type.
  .2 Joints: NFPA 30, threaded or welded to ANSI B31.1.

2.3 PIPE HANGERS AND SUPPORTS

.1 Conform to NFPA 31.
.2 Hangers for Pipe Sizes 15 to 40 mm: Malleable iron, adjustable swivel, split ring.
.3 Hangers for Pipe Sizes 50 mm and Over: Carbon steel, adjustable, clevis.
.4 Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.

.5 Wall Support for Pipe Sizes to 80 mm: Cast iron hook.
.6 Vertical Support: Steel riser clamp.
.7 Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
.8 Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

2.4 FLANGES, UNIONS, AND COUPLINGS

.1 Pipe Size 50 mm and Under:
  .1 Ferrous pipe: 1034 kPa malleable iron threaded unions.
  .2 Copper tube: 1034 kPa bronze unions with brazed joints.
.2 Pipe Size Over 50 mm:
  .1 Ferrous pipe: 1034 kPa forged steel slip-on flanges; 1.6 mm thick preformed neoprene gaskets.
  .2 Copper tube: 1034 kPa slip-on bronze flanges; 1.6 mm thick preformed neoprene gaskets.

2.5 VALVES - GENERAL

.1 Conform to requirements of ANSI, ASTM, ASME, and applicable MSS standards.
.2 Provide valves of the same manufacturer where possible.
.3 Manufacturer's name and pressure rating clearly marked on body to MSS-SP-25.
.4 Valid CRN (Canadian Registration Number) required for each valve.
.5 Materials:

.1	Bronze:	ASTM B62 or B61 as applicable
.2	Brass:	ASTM B283 C3770
.3	Cast Iron:	ASTM A126 Class B

.6 End Connections:

.1	Threaded ends:	ANSI B1.20.1
.2	Flanged ends:	ANSI B16.1 (Class 125), ANSI B16.5
.3	Face-to-face dimensions:	ANSI B16.10

.7 Design and Testing:

.1	Ball Valves:	MSS-SP-110
.2	Cast Iron Check:	MSS-SP-71

.8 First named product as indicated in paragraphs below; other acceptable manufacturers, subject to equivalent products include:
  .1 Jenkins.
  .2 Newman-Hattersley.
  .3 Conbraco.
  .4 Nibco
  .5 Kitz

3 Execution

3.1 EXAMINATION

.1 Section 15010: Verification of existing conditions before starting work.
.2 Verify that excavations are to required grade, dry, and not over-excavated.

3.2 PREPARATION

.1 Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
.2 Remove scale and dirt, on inside and outside, before assembly.

.3 Prepare piping connections to equipment with flanges or unions.
.4 Excavate to applicable sections for work of this Section.
.5 Backfill to applicable sections for work of this Section.

3.3 INSTALLATION

.1 Install to code.
.2 Provide non-conducting dielectric connections wherever jointing dissimilar metals. Install to NACE RP-01-69.
.3 Route piping in orderly manner and maintain gradient.
.4 Install piping to conserve building space and not interfere with use of space.
.5 Group piping whenever practical at common elevations.
.6 Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
.7 Provide clearance for installation of insulation and access to valves and fittings.
.8 Provide access where valves and fittings are not exposed. Coordinate size and location of access doors.
.9 Establish elevations of buried piping outside the building to ensure not less than 1.0 of cover.
.10 Where pipe support members are welded to structural building framing, scrape, brush clean, weld, and apply one coat of zinc rich primer.
.11 Prepare pipe, fittings, supports, and accessories not prefinished, ready for finish painting.
.12 Identify piping systems including underground piping.
.13 Install valves with stems upright or horizontal, not inverted.
.14 Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

3.4 TESTING

End of Section

1 General

1.1 GENERAL

.1 Read and conform to:
- .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
- .2 Division 1 requirements and documents refered to therein.

1.2 SECTION INCLUDES

.1 Boilers.
.2 Controls and boiler trim.
.3 Hot water connections.
.4 Fuel connection.

1.3 REFERENCES

.1 AGA - Directory of Certified Appliances and Accessories.
.2 AGA Z21.13 - Gas-Fired Low-Pressure Steam and Hot Water Boilers.
.3 ASME SEC 4 - Boiler and Pressure Vessel Codes - Rules for Construction of Heating Boilers.
.4 ASME SEC 8D - Boilers and Pressure Vessel Codes - Rules for Construction of Pressure Vessels.
.5 HI (Hydronics Institute) - Testing and Rating Standard for Cast Iron and Steel Heating Boilers.
.6 NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
.7 NFPA 54 (AGA Z223.1) - National Fuel Gas Code.
.8 UL - Gas and Oil Equipment Directory.

1.4 SUBMITTALS FOR REVIEW

.1 Section 15010: Procedures for submittals.
.2 Product Data: Provide data indicating general layout, dimensions, and size and location of water, gas, and vent connections, and electrical characteristics and connection requirements.
.3 Section 15010: Submittals for information.
.4 Submit manufacturer's installation instructions.
.5 Manufacturer's Field Reports: Indicate condition of equipment after start-up including control settings and performance chart of control system.
.6 Section 15010: Submittals for project closeout.
.7 Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, cleaning procedures, replacement parts list, and maintenance and repair data.

1.5 QUALITY ASSURANCE

.1 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1.6 REGULATORY REQUIREMENTS

.1 Conform to applicable code for internal wiring of factory wired equipment.
.2 Conform to ASME SEC 4 and SEC 8D for boiler construction.
.3 Units: AGA certified.
.4 Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.7 DELIVERY, STORAGE, AND PROTECTION

.1 Section 15010: Transport, handle, store, and protect products.
.2 Protect units before, during, and after installation from damage to casing by leaving factory shipping packaging in place until immediately prior to final acceptance.

1.8 WARRANTY

.1 Section 15010: Submittals for project closeout.
.2 Provide a ten year pro-rated warranty for cast iron boiler sections.

2 Products

2.1 GENERAL

.1 Furnish and install hydronic heating cast aluminum condensing boilers as manufactured by De Dietrich in accordance with all applicable codes and authorities having local, state and federal jurisdiction. Each boiler shall be CSA (US and Canada) listed to ANSI Z2113, UL795 Standards, CSD-1 approved, ASME coded and stamped. The gas train shall be designed in accordance with FM or CSD-1 (GE GAP). Each boiler shall have an input as specified by the mechanical equipment schedule. Electrical service to each unit shall be 120V/1/60Hz 20 amp service. The burner/boiler control shall incorporate the functions of temperature control, combustion safeguard control, message annunciation, and fault diagnostic display. Boiler shall be approved to be directly vented for outside air.

.2 Construction: Boiler shall be natural gas fired, condensing cast aluminum designed with a fully modulating premix stainless steel burner and positive pressure vent discharge. The boiler shall have an ASME approved relief valve.

.3 Burner: The Gas C230 boiler burner shall be a 5 to 1 turndown ratio of the firing rate without loss of combustion efficiency or staging of gas valves. If turn downs of greater than 5 to 1 are given then warranty on combustion head must be extended to 10 years. Published burner turn down shall be proven prior to installation via start up reports of existing government installations. The burner shall produce no more than 30ppm of NOx corrected to 3% excess oxygen. The burner shall be a stainless steel cylinder with perforated holes for precise air-fuel mixture and velocity with a woven stainless steel fibre for flame stability and heat insulation, with spark ignition and flame rectification. All burner material exposed to the combustion zone shall be of stainless steel construction. There shall be no moving parts within the burner itself. The air-gas ratio valve shall meter natural gas input. The PWM (Pulse width modulation) controlled combustion air fan shall be utilized to ensure the optimum mixing of air & fuel between the air/fuel valve and the burner. There shall be no linkages of any kind controlling the burner and or firing rate.

.4 Cast Aluminum Heat Exchanger: The boiler shall be capable of handling water temperature operating ranges of 68°F to 194°F or 81° F ?T without any failure due to thermal shock or fireside condensation. The heat exchangers shall be ASME stamped for a working pressure of 100 psig. The sections shall be constructed of cast aluminum. The boiler shall be designed so that the thermal efficiency increases as the boiler firing rate decreases.

.5 Vent and Condensate Manifold: The exhaust and condensate manifold shall be of corrosion resistant with a 6"diameter flue connection. The exhaust manifold shall have a gravity drain for the elimination of the condensation with collecting reservoir. There shall be a port on the collector for annual cleaning and inspections. The boiler shall be provided with "condensation neutralized kit" as per manufacturer recommendation. The direct venting system shall be installed in accordance with the boiler manufacturer's installation instructions. The horizontal portions of the venting system shall be supported to prevent sagging. Follow the instructions of the supplier of the venting system. All direct vent and sealed combustion systems must be finished with TEE termination type, the combustion air inlet must be a 90° and must be provided with a debris/bird-rodent screen. All terminals shall be arranged to avoid and prevent the accumulation of flue gas condensation. The air supply pipe must also be airtight. Horizontal sections in the air supply must slope away from the boiler towards the supply opening and incorporate a drain connection if the route rises from a lower point. It is necessary to provide an easily removable air vent for maintenance reasons. Installation

of the combustion and ventilation air systems shall be in accordance with Natural Gas and Propane Installation Code, CAN/CSA B149.1, or applicable provisions of the local building codes. Use only an approved gas vent category IV type "BH" (AL29-4C stainless steel vent material). The venting shall be suitable for exterior applications, the flue exit point shall be provided with a tapered finishing cone, with a debris/bird-rodent screen, combustion air inlet shall be provide with a termination 90° elbow with a debris/bird-rodent screen.

.6 Boiler Controls: The boiler control system shall be a solid state micro processor based boiler & burner control with three access levels, one for the end user, one for advance trained set up and service technicians, and the last one for the factory. The control shall have a BMS control & enable/disable contacts. The control must be capable to communicate to a PC or PDA with ReCom communication software and interface cable. The boiler control must also have the following, adjustable Operating Limit 68 - 194°F or 20 to 90°C, fixed safety Hi Limit temperature : 230° F or 110°C.Each boiler control to offer as a standard; On-Off switch, temperature indication, flow and return, heat exchanger block and flue sensor, blocked vent sensor, Comprehensive operating, service and fault diagnostic - coding, flue gas adaptation proving system and control code-key specific to applied boiler model and specific applied parameters. The control shall have the option of being set up with a computer or without. The boiler shall be provided with low water flow and high limit automatic switch control.

.7 Temperature Control Modes: The GAS C230-boiler(s) shall be able to operate with either an internal set point, with an indoor outdoor reset controller, with a BMS 0 to 10 VDC signal or from a lead lag boiler control system.

.8 Installation: The vent system must conform to all manufacturer's recommendations. Boiler plant piping shall be field constructed of materials as specified. Each boiler shall have individually isolating shutoff valves for service and maintenance. Each boiler shall require a minimum gas pressure of 3.5" W.C. to 14" W.C. Install boiler as per manufacturer manual installation, and local authorities having jurisdiction.

.9 Warranty: The cast aluminum heat exchanger shall carry a non-prorated 10-year warranty against failure due to condensate corrosion, thermal stress, mechanical defects or workmanship. All other components and controls supplied with the boiler shall carry a 2 year warranty against failure due to defective materials or workmanship. Boiler must be register with manufacturer at time of start up with warranty card and start up report.

.10 Field Services: A boiler factory authorized service technician must be used to start-up and service boilers. Technicians that have not been trained and authorized for start up and servicing by the installation factory cannot be used for any service on the boilers.

2.2 MANUFACTURER

.1 DeDietrich

.2 Other acceptable manufacturers offering equivalent products:

- .1 Viessmann
- .2 Lochnivar
- .3 Substitutions: Refer to Section 15010

3 Execution

3.1 INSTALLATION

.1 Install to manufacturer's instructions.

.2 Install to NFPA 54.

.3 Install boiler on concrete housekeeping base, sized minimum 100 mm larger than boiler base.

.4 Provide connection of natural gas service to NFPA 54 (AGA Z223.1).

.5 Provide piping connections and accessories as indicated.

.6 Provide piping connections and accessories as indicated.

.7 Pipe relief valves to nearest floor drain.

.8 Install circulator and diaphragm expansion tank on boiler.

.9 Provide for connection to electrical service.

3.2 MANUFACTURER'S FIELD SERVICES

.1 Prepare and start systems to Section 15010.
.2 Instruct operating personnel in operation and maintenance of units.

End of Section

1 General

1.1 GENERAL

.1 Read and conform to:
- .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
- .2 Division 1 requirements and documents refered to therein.

1.2 SECTION INCLUDES

.1 Plate type heat exchangers.
.2 Accessories and trim.

1.3 REFERENCES

.1 ASME SEC 8 - Boilers and Pressure Vessels Code.

1.4 SUBMITTALS FOR REVIEW

.1 Section 15010- Administrative Requirements: Procedures for submittals.
.2 Product Data: Provide data with dimensions, locations, and size of tappings and performance data.
.3 Shop Drawings: Indicate dimensions, locations, and size of tappings and performance data.

1.5 SUBMITTALS FOR INFORMATION

.1 Section 15010: Submittals for information.
.2 Design Data: Indicate in sufficient detail to verify that heat exchangers meet or exceed specified requirements.
.3 Test Reports: Indicate tube bundle pressure tests.
.4 Certificates: Certify that Products meet or exceed specified requirements.
.5 Manufacturer's Instructions: Indicate installation and support requirements.

1.6 SUBMITTALS AT PROJECT CLOSEOUT

.1 Section 15010: Submittals for project closeout.
.2 Operation and Maintenance Data: Include start up and shut down instructions, assembly drawings, and spare parts lists.
.3 Warranty: Submit manufacturer warranty and ensure forms have been completed in Owners name and registered with manufacturer.

1.7 REGULATORY REQUIREMENTS

.1 Conform to ASME Boilers and Pressure Vessels Code, SEC 8 for manufacture of tubular heat exchangers and heat exchanger shells.

1.8 DELIVERY, STORAGE, AND HANDLING

.1 Section 15010: Transport, handle, store, and protect products.
.2 Protect internals from entry of foreign material by temporary caps on flanged openings.

1.9 WARRANTY

.1 Section 15010: Submittals for project closeout.
.2 Provide five year manufacturer warranty for heat exchangers.

1.10 EXTRA MATERIALS

.1 Section 15010: Submittals for project closeout.
.2 Provide two sets of replacement gaskets.
.3 Provide one set of wrenches for disassembly of plate type heat exchangers.

2 Products

2.1 PLATE AND FRAME TYPE HEAT EXCHANGER

.1 Manufacturer: ITT Bell & Gossett
.2 Other acceptable manufacturers offering equivalent products:
  .1 S. A. Armstrong.
  .2 Graham
  .3 Substitutions: Refer to Section 15010.
.3 The plate heat exchanger shall be shipped to the site as completely assembled units. The heat exchanger shall be pressure tested and flushed clean at the factory prior to shipment. All nozzle connections shall be factory sealed prior to shipment to prevent the entrance of foreign matter into the heat exchanger during shipment, storage, and installation.
.4 Corrugated channel steel plates shall be of type 304 or 316 SS. Titanium plates should be used under pool water application. Channel plate ports shall be double gasketed to prevent cross contamination of hot and cold side fluids. Gaskets shall be of a one piece design formulated from Nitrile rubber. Plates shall be grooved to accept the gaskets and gasket clips to minimize movement.
.5 Channel carrying bar shall be of carbon steel, aluminum or stainless steel with zinc yellow chromate finish.
.6 Fixed frame plates and movable pressure plates shall be corrosion resistant epoxy painted carbon steel. Flow through the plates shall be of a counter flow design to maximize the heat transfer capability of the unit.
.7 Connection 2" and smaller shall be carbon steel NPT tappings. Connections 4" and larger shall be studded port design to accept ANSI flange connection. Connection ports shall be integral to the frame or pressure plate.
.8 Unit to be supplied with OSHA approved splash guard, enclosing exterior channel plate and gasketed surfaces. Heat exchanger shall be provided with the scheduled square footage of heat transfer area.
.9 Nozzles: 860 kPa rated lined flange type.
.10 Performance: as scheduled on drawings
.11 Unit shall be constructed in accordance with ASME Code Rules and shall have a manufacturer's data report for pressure vessels, form No. U-1. Form U-1 shall be furnished to the engineer for the owner upon request. An authorized inspector, holding a National Board commission, certifying that construction conforms to the latest ASME Code for pressure vessels must sign this form. The ASME "U" symbol should also be stamped on the Heat Exchanger(s).
.12 Heat exchanger manufacturer shall be ISO-9001 certified.
.13 Where indicated heat exchanger shall be provided with alternate materials of construction as noted on schedule and installation drawings.
.14 The manufacturer shall confirm its ability to comply with ARI Standard 400 for liquid to liquid heat exchangers.

3 Execution

3.1 INSTALLATION

.1 Install to manufacturers instructions.
.2 Install to permit removal of tube bundle with minimum disturbance to installed equipment and piping.
.3 Support heat exchangers on welded steel pipe and angle floor stand from structure] on concrete housekeeping pad.
.4 Pitch shell to completely drain condensate.
.5 Pipe relief valves to nearest floor drain.
.6 Pipe drain valves to nearest floor drain.

3.2 PLATE TYPE HEAT EXCHANGER

.1 Install heat exchangers where indicated.
.2 Install all necessary structural supports.
.3 Make all necessary piping connections.
.4 Install pressure relief valve in the outlet pipe of heat exchanger prior to any shut-off valves. Provide and install relief discharge pipe to nearest funnel floor drain or service sink.

3.3 WATER TO WATER HEAT EXCHANGER TRIM

.1 Water Inlets and Outlets: Thermometer wells, pressure gauge tappings.
.2 Heated Water Outlet: Thermometer well for temperature regulator sensor, ASME rated pressure and temperature relief valve, valved drain.

End of Section

1 General

1.1 GENERAL

.1 This Section was prepared by Geo-Xergy Systems Inc.
.2 Read and conform to:
  .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
  .2 Division 1 requirements and documents refered to therein.
  .3 Conform to Section 15010 General Requirements.

1.2 REFERENCES

.1	ASHRAE, 1997	Fundamentals Handbook.
.2	ASHRAE	Commercial/Institutional Ground Source Heat Pump Engineering Manual (ISBN 1-883413-21-4).
.3	ASHRAE	Ground-Source Heat Pumps-Design of Geothermal Systems for Commercial and Institutional Buildings (S.P. Kavanaugh and K. Rafferty) (ISBN 1-883413-52-4)
.4	ASHRAE, 1998	Operating Experiences with Commercial Ground-Source Heat Pump System
.5	ASTM D-1693	Condition C
.6	ASTM D-2321	
.7	ASTM D-2513	Sections 4.1 and 4.2
.8	ASTM D-2683	Socket Fusion Fittings
.9	ASTM D-2837	
.10	ASTM D-3035	
.11	ASTM D-3035-93 or D-2447	
.12	ASTM D-3261	Butt/Saddle Fusion Fittings
.13	ASTM D-3350	
.14	CSA C448.1-02	Design and Installation of Earth Energy Systems

1.3 SCOPE

.1 The Work covered under this Section of the Specifications is intended to include the furnishing of all equipment, materials and labour reasonably incidental to the complete operating installation of the horizontally bored closed-loop ground heat exchanger (GHX). This includes installation and testing of the horizontal GHX circuits and horizontal supply and return runout components of the GHX. Also included is the drilling of the horizontal boreholes, installation of the piping, grouting of horizontal boreholes (if required) and connection of the GHX circuits to the supply and return runout pipe and secondary headers, backfilling and pressure testing. The work also includes flushing and purging of the GHX piping and charging the system with the water and antifreeze mixture.
.2 The extent of ground heat exchanger work is indicated on the drawings and by requirements of this section. The closed-loop ground heat exchanger consists basically of high-density polyethylene (HDPE) piping heat fused into U-tube assemblies with runout connections forming the GHX circuits for the horizontally bored GHX described in the drawings and specifications.
.3 The Contractor is responsible for obtaining necessary permits to use boulevard, sidewalks and roadways as required.
.4 The Contractor shall protect and/or replace boulevard trees, grass and sidewalks during GHX construction.
.5 The Contractor shall coordinate installation of GHX with site services around the GHX.

1.4 DEFINITIONS

.1 The definition of the terms used in the specifications and drawings is intended to clarify the work indicated on the drawings and referred to in the specifications.
.2 GHX: Refers to ground heat exchanger, and may include vertical, horizontal trenching, horizontal boring, pond or lake heat exchanger buried in the ground or submerged in a body of water.
.3 GHX circuits: HDPE pipe buried in the ground in horizontal or vertical orientation designed to transfer energy to and from the ground. Typically a number of GHX circuits are fusion welded to a GHX header that is in turn fusion welded to a supply and return runout pair. Heat transfer fluid is circulated through the assembly to a building.
.4 U-tube: An assembly of two lengths of HDPE pipe connected on one end with a molded, purpose built U-bend.
.5 GHX header: Connection points between supply and return runout piping and GHX circuits. GHX headers are buried in the ground adjacent to the GHX field and are comprised of an assembly of fusion welded fittings and pipe. Fittings and pipe are manufactured using HDPE resin and are connected using heat fusion (butt fusion, socket fusion or electro-fusion).
.6 Runout piping: Supply and return runout piping refers to the high-density polyethylene (HDPE) piping installed to connect the GHX circuit piping to the Pump House header.
.7 GHX manifold: Connection point for supply and return runout piping from GHX field. A GHX manifold is typically located inside a building or in geothermal vault located away from the building.
.8 GHX module: Completed assembly of GHX components, including GHX manifold, supply and return runout piping, GHX header and GHX circuits.
.9 GHX field: Assembly of all GHX modules connected to a single building or group of buildings.

1.5 INTENT

.1 These Specifications are intended to define the contractor's Scope of Work, establish the quality and safety requirements, and set general precautions to protect further construction of the project. Incidental items not specified therein or not shown on the drawings but which are required and necessary to complete the work shall be furnished by the contractor in the best available quality.

1.6 WORK COMPLETED BY OTHERS

.1 Any and all work not directly relating to the installation of the Closed-Loop GHX, as described in these Specifications and Drawings shall be provided by others.
.2 The point of connection between the GHX and the building heat pump system is the GHX header butterfly isolation valves, whereby the geothermal contractor provides the header, isolation valves and the GHX flush ports. All piping from the GHX header isolation valves to the GHX headers is provided by the geothermal contractor. The mechanical piping connecting the interior mechanical system, including interior piping, heat pumps, circulation pumps, and mechanical flush ports, to the GHX isolation valve is to be completed by the interior mechanical system contractor. The mechanical system contractor is to provide temperature and pressure gauges for measuring the ground loop fluid, to and from the GHX header.

1.7 SPECIFIC ITEMS TO BE FURNISHED BY THE CONTRACTOR

.1 The contractor shall furnish all labour, supervision, proper equipment in good working condition, supplies, tools, and materials required to complete the work specified in this specification and contractor's Scope of Work.
.2 The contractor shall, as a minimum, provide all safety equipment to meet the requirements of all applicable Provincial and Federal codes and standards.
.3 The contractor shall lock and secure their equipment and storage areas. The Owner shall not be held responsible for loss of or damage to any of contractor's equipment, tools, materials or personal effects.
.4 If necessary, the contractor may provide their own lockable field office which may be located in the designated staging area.
.5 The contractor shall develop and follow procedures for controlling any and all health risks

associated with fugitive dust and Worker protection. The contractor's procedures shall ensure Workers are protected from fugitive dust during the Work.

.6 The contractor shall be responsible for performing all testing and monitoring as well as maintaining all necessary documentation, as specified in CCOHS (Canadian Center for Occupational Health and Safety). A copy of the test results and any other documentation required by these codes shall be available for inspection by Architect/Engineer on Site.

1.8 DELIVERY, STORAGE AND HANDLING

.1 Pipe and fittings shall be stored on Site in Owner's designated area that will not interfere with the operations of the Owner or the operation of the other contractors at the Site.

.2 All pipes are to be sealed with fusion welded end caps, to the satisfaction of the Engineer, to prevent debris, rodents and other foreign material from entering the piping system. All closed loop components shall be handled in such a way as to eliminate the chance of internal contamination during storage, pressure testing, installation or final manifolding. Pipe and fittings integrity and cleanliness are a priority for the closed loop GHX system.

.3 All fittings are to be stored on site in sealed bags to prevent contamination with dirt, debris and other potential contaminants.

1.9 MATERIALS AND WORKMANSHIP

.1 The contractor shall maintain adequate quality control to assure compliance with all items detailed in this specification.

.2 All materials shall be new and of the type and quality specified and free from all defects of materials or workmanship that would adversely affect performance or service life of the installed Work, or which would cause unsightly or un-workmanlike appearance.

.3 The Engineer shall have the right to inspect material at any time after delivery to the Site. Any material that is damaged, defective, or does not meet requirements of this Contract may be rejected, and shall be corrected or replaced at the contractor's expense.

1.10 QUALITY CONTROL

.1 The Architect/Engineer may, at any time, suspend any portion of the Work when satisfactory results are not being met or when results are doubtful.

.2 The Work shall not proceed after suspension until the contractor makes necessary corrections to bring Work into compliance. The contractor shall not be entitled to additional compensation or an extension of time for the performance of this Contract in the event Architect/Engineer suspends Work due to contractor noncompliance or inability to produce satisfactory results in accordance with the Scope of Work and Specifications.

1.11 SITE RESTORATION AND CLEANUP

.1 The Contractor shall keep the job site clean and orderly at all times during the Work. Upon completion of the Work, the contractor shall repair all damage caused by equipment, remove all of their equipment, tools, materials, containers and debris and leave the project and staging area free of rubbish, protective materials or excess materials of any kind.

.2 All wastes generated by the contractor shall be properly contained and disposed of in accordance with local Provincial and Federal regulations.

1.12 QUALITY ASSURANCE

.1 Manufacturer's Qualifications

.1 Firms regularly engaged in manufacture of closed-loop GHX installation and construction products and tools of the types, material and size required; whose products have been in satisfactory use in similar service for not less than three (3) years.

.2 All key GHX construction personnel to be Canadian GeoExchange Coalition (CGC) or the

International Ground Source Heat Pump Association (IGSHPA) Installer Accredited.

.3 All field personnel shall provide proof of current accreditation with associated fusion card or certificate from a major HDPE pipe vendor or distributor. Personnel without current accreditation are prohibited from working on this project.

.2 Installer's Qualifications - Horizontal bored GHX

.1 The Drilling Contractor shall have at least two (2) years of successful installation experience on projects with closed-loop GHX work and/or projects of similar scope to that required for this project. Drilling Contractor must have experience at mixing, pumping and injecting bentonite grouting materials into a horizontal borehole. In addition, all key GHX installation personnel are to be accredited either by the Canadian GeoExchange Coalition (CGC) or the International Ground Source Heat Pump Association (IGSHPA).

.2 All field personnel shall provide proof of current CGC and/or IGSHPA Installer Accreditation with associated fusion card or certificate from a major HDPE pipe vendor or distributor.

.3 Fabricator's Qualifications

.1 Fabricators must have completed a certification training program offered by the Canadian GeoExchange Coalition (CGC) or the International Ground Source Heat Pump Association (IGSHPA) or approved manufacturers' certification program and shall have at least two (2) years of successful installation experience. The installation personnel must be able to prove CURRENT accreditation. The only acceptable method of joining buried plastic pipe systems is by heat fusion process (socket fusion, butt fusion or electrofusion). Each GHX fabricator must have performed a fusion procedure under direct supervision of an IGSHPA Accredited Heat Fusion Technician, an IGSHPA approved manufacturer's certification program, a CGC certified instructor, or a DOT certified heat fusion technician. The contractor shall provide proof of current accreditations (CGC or IGSHPA) or certifications.

2 Products

2.1 SCOPE

.1 The Work covered under this section of the Specifications is intended to include the furnishing of all equipment, materials and labour reasonably incidental to the complete operating installation of the Closed-Loop Ground Heat Exchanger and pertaining equipment and all piping as indicated on the drawing.

2.2 DESCRIPTION OF WORK

.1 The work included in this section of the Specifications consists generally of, but is not limited to the following major systems or categories of Work:

.1 Borehole system, including the horizontal borehole, and HDPE U-bend assembly.\

.2 Supply and return runout pipes from the mechanical room in the building to the GHX piping including trenching, pipe and backfill.

.3 Flushing and purging and filling of the closed-loop GHX. (This portion of the project may be addressed by the internal mechanical contractor instead pending coordination of the project.) (NOTE: The supply of the antifreeze for this project MUST be coordinated with the internal building contractor to ensure that all fluid is supplied by the same manufacturer in order to avoid incompatible inhibitors and chemicals in the fluid.)

.4 All other miscellaneous material and labour.

2.3 MATERIALS AND PRODUCTS

.1 Provide new piping materials and factory-fabricated piping products of size, types, pressure and temperature rating and capacities as indicated.

2.4 GHX IDENTIFICATION

.1 The contractor shall provide a means to identify the location of the GHX circuit piping, supply and return headers and supply and return runout piping. Supply and return header trenches shall be identified using either purpose built metallic tracer tape or tracer wire located at a depth of 300 mm to 450 mm (12" to 18") below grade. The tape shall be highly resistant to alkalis, acids, and other destructive agents found in the ground. Horizontal borehole locations shall be identified either with GPS coordinates at each end of the borehole and any change in horizontal direction of the borehole, or by providing triangulation measurements of the locations from specifically identified locations of the building. The As Built construction drawings must clearly indicate the method of identifying the location of the horizontal boreholes, supply and return runout pipes and supply and return header trenches along with coordinates and /or triangulation measurements.

2.5 CLOSED-LOOP GROUND HEAT EXCHANGER MATERIALS

.1 The only acceptable pipe and fittings material for the underground portion of the ground heat exchanger is high-density polyethylene (HDPE). Specifications for the polyethylene heat exchanger are as follows:

.1 General: All pipe and heat-fused material shall be manufactured from virgin polyethylene extrusion compound material in accordance with ASTM D-2513, Sections 4.1 and 4.2. Pipe shall be manufactured to outside diameters, wall thickness and respective tolerances as specified in ASTM D-3035-93 or D-2447. Pipe material shall be manufactured by IPEX, ISCO Industries, Oxford Plastics, or approved equal product must be purpose-milled for closed loop ground heat exchanger applications, with applicable documentation from the manufacturer with warranty confirming product compatibility with these requirements.

.2 Material: The HDPE SDR 11 material shall maintain a 1,103 kPa (160 psi) Hydrostatic Design Basis at 23°C (73.4°F) per ASTM D-2837, and shall be listed in PPI TR4 as a PE3408 piping formulation. The HDPE SDR 13.5 material shall maintain an 862 kPa (125 psi) Hydrostatic Design Basis at 23°C (73.4°F) per ASTM D-2837, and shall be listed in PPI TR4 as a PE3408 piping formulation. (NOTE: The geothermal industry is in transition from pipe resin PE3408. Pipe resin PE4710 will be acceptable if it is produced to the same or better performance specifications, with the approval of the Engineer). The material shall be a high-density extrusion compound having a minimum cell classification of PE345434C or higher as specified in ASTM D-3350 with the following exceptions: this material shall exhibit zero failure (F0) when tested for a minimum of 192 hours under ASTM D-1693, condition C, as required in ASTM D- 3350

.3 Fittings shall meet the requirements of ASTM D-2683 (for socket fusion fittings) or ASTM D-3261 (for butt/saddle fusion fittings). Electrofusion fittings are also acceptable.

.4 All pipe sizes shall be manufactured in accordance with ASTM D-3035 with a dimension ratio (DR) of 11 or 13.5, as specified on the drawings and shown in the following chart.

Pipe Resin Formulation	GHX Circuits	Runout Piping
PE4710	DR11 (202 psi/ 1,93 kPa)	DR13.5 (162 psi/ 1,117kPa)
PE3408	Not Acceptable	DR11 (160 psi/ 1,103 kPa)

.2 Markings

.1 Sufficient information, including numerical markings every 600mm (2 feet), shall be permanently marked on the length of the pipe. This information is defined by the appropriate ASTM pipe standard. All fittings shall also be similarly marked. Marked information shall include:

.1 Manufacturer's Name
.2 Nominal Size
.3 Pressure Rating
.4 Relevant ASTM Standards
.5 Cell Classification Number
.6 Date of Manufacture

.2 All piping used for the GHX will have factory hot-stamped lengths impressed on the side of the piping indicating the length of the heat exchanger to that point. The length shall read

"0" (zero) on one end and the actual heat exchanger total length on the other end.

.3 Warranty: The pipe manufacturer shall provide a minimum warranty of fifty (50) years, non-prorated. The warranty shall be transferable.

2.6 HEAT TRANSFER FLUID

.1 Heat transfer fluid shall be a mixture of methanol (15% by volume) and water (85% by volume).

.2 The heat transfer fluid shall not be introduced to the GHX until: the completed GHX assembly has been pressure tested as outlined in the section 3.6.3 and the system is completely flushed to remove dirt, plastic cuttings, debris and other material from the GHX as described in section 3.7.

2.7 PIPE JOINING METHODS

.1 The only acceptable method for joining the buried pipe system is by a heat fusion process.

.2 Joining shall be by the socket, butt or electrofusion method in accordance with the pipe manufacturer's procedures. The fusion technician shall be properly trained and shall have executed quality fusion joints. Saddle fusion may be used for the HDPE headers, as per manufacturer's procedures.

.3 The HDPE U-bend assemblies for the horizontal boreholes may be assembled on site as the boreholes are completed. Either manufactured U-bend fittings or short elbow and street elbow fittings may be used to assemble U-bends. If U-bends are assembled on site, each U-bend assembly must be pressure tested immediately after insertion in the borehole and capped and pressurized until connected to the supply and return headers.

.4 Alternately, manufactured U-bends or shop-fabricated U-bends constructed of the same material designation may be installed in the boreholes. Each U-bend must be pressurized before insertion and remain pressurized until connected to the supply and return headers.

.5 No open pipe ends are to be left unattended at any time.

2.8 TRENCH BACKFILL MATERIAL

.1 All trenches to be backfilled using excavated spoils or other native soil; soil surrounding pipes (within 305 mm [1 foot] radius) must be free of any rocks and abrasive material.

.1 Fill from excavated spoils may be used if fine grained (>200 sieve size). Shall include clean, natural or prepared soil with fines.

.2 Fine dirt fill from an off-site source may be used if spoils cannot provide proper bedding material. Shall include clean, natural or prepared soil with fines.

.3 Large rocks and boulders greater than 610 mm (2 feet) in diameter may not be used in the trench and must be removed from the site

.4 All general debris and foreign matter must not be used in the trench.

.2 Topsoil: Topsoil shall be natural, fertile, friable, natural soil. It shall be of uniform composition, free of stones, lumps, live plants and their roots, sticks and other extraneous matter. It shall have a pH of 5.0 to 7.0 and contain not less than three (3) percent organic matter. It shall be capable of sustaining vigorous plant growth. Topsoil that is suitable for use on Site may be stockpiled at the Site. Provide new topsoil that is similar in characteristic to that found at the project Site where required. (This may not be applicable depending upon post installation landscaping.)

.3 Care shall be taken to avoid driving construction equipment over newly filled trenches unless bridging is provided to support load over trenches. Refer to ASTM D-2321 for backfill procedures. Compact trenches to 95% dry density.

.4 If the trenches are located under an area that is to be paved, the GHX contractor must coordinate their work with the paving contractor and ensure that the trenches are backfilled and compacted to the specifications required by the engineer responsible for the paving on the site.

3 Excecution

3.1 GENERAL INSTALLATION REQUIREMENTS

.1 Inspect work in conformance with General Mechanical Requirements.

3.2 COORDINATION

.1 The contractor selected to install the closed-loop GHX shall coordinate his Work activities with the Mechanical and General Contractor.

.2 All testing procedures shall be coordinated with the General Contractor Construction Manager or its designated representative(s).

3.3 INSPECTION

.1 Examine areas and conditions under which the GHX systems are to be installed. Do not proceed with Work until unsatisfactory conditions have been corrected in a manner acceptable to the Engineer. During the installation, inspections will be conducted by the Engineer or their designated representative(s).

3.4 CLEANLINESS

.1 During the installation, trash, soil and small animals shall be kept out of the pipe. This project is located near an urban environment and extra care shall be taken to avoid contamination of the loop by vandalism. All borehole piping shall be filled with water during the installation process, and have fusion welded end caps at the completion of the borehole grouting. Each circuit and runout pipe shall be visually checked to verify that no obstructions, kinks, abrasions or other damage exist. No installed circuit pipe shall be allowed to be unattended in an open, unsealed condition. Taped, clamped or other mechanical sealing methods of pipe ends are not acceptable.

.2 The contractor shall take precautions to keep the site clean and prevent drilling mud, water, etc from entering the municipal drainage system.

3.5 DOCUMENTATION

.1 The contractor shall document the installation of the GHX field using a digital camera. Each connection of the GHX circuit to the supply & return headers and the supply and return runout piping shall be photographed with an identification number as shown on the GHX layout.

.2 As each GHX module is completely connected to the supply and return headers, a digital photograph of the completed assembly shall be taken showing the location of the runout completed headers and runout pipe laid in the excavation before backfilling commences.

.3 Digital photographs shall be emailed to the engineer on a daily basis as the system is being assembled.

3.6 INSTALLATION OF COMPONENTS

.1 Ground Heat Exchanger

- .1 The GHX boreholes and connections shall be laid out in a pattern as indicated in the drawings.
- .2 Drill borehole in accordance with local, provincial or Federal requirements. Follow all requirements for borehole drilling as prescribed by the Province of Manitoba, and/or standard industry practice. If required by provincial law or code, the CONTRACTOR will be responsible for receiving, permission in writing from the Province prior to proceeding and shall be responsible for maintaining any drilling logs that may be required. Borehole installation may not proceed until the CONTRACTOR has provided written proof of permission given by the Province of Manitoba.
- .3 The borehole shall be of sufficient diameter to facilitate the installation of a complete pipe

sub-circuit (i.e. Supply and return portion of the sub-circuit). Care shall be taken so as not to crush, cut or kink the pipe during transportation to the Site. If damaged, the area of damage shall be removed and replaced, at no additional cost to the Owner.

.2 As Built Drawings

.1 The location of each U-bend shall be surveyed after it is pulled into the horizontal borehole. The survey shall locate the end of the U-bend, the connection to the supply and return header and the location of any change in direction of the horizontal borehole. Final borehole locations may be surveyed by one of the following three methods:

.2 Surveyed must be completed for each location from one or more local survey benchmarks.

.3 Location must be completed by triangulation from two corners of the building site with measurements shown on "as-built" drawings.

.4 Survey must be completed using a GPS unit with an accuracy of one meter or better. Specifications of the GPS unit that is used must be submitted indicating the accuracy of the equipment.

.3 Testing

.1 Before the pipe is installed in the borehole, it shall be flow tested to ensure that there are no kinks, bends or pinches. The test shall consist of forcing clean water into one end of the assembly, and visually inspecting the discharge. If it is apparent that an obstruction exists, the obstructed section of pipe shall be removed and replaced with an equal length section which is free of obstructions and re-attached by heat fusion.

.2 The water flow test will be repeated for the U-bend assembly when the pipe has been completely installed into the borehole. Drilling of a new borehole (if U-bend cannot be removed) and installation of a new U-bend assembly is required if the flow test fails.

.3 After all borehole circuits are fusion welded to the supply and return run-out piping, each supply and return run-out assembly is to be water filled and pressure tested to 552 kPa gauge (80 psig) for a minimum of 24 hours prior to backfill of the trenches. Allowances in pressure loss shall be made for expansion as per pipe manufacturer's recommendations.

.4 The pipe circuits will be connected to the supply and return headers and runouts as shown on the drawings, ensuring that the reducing tees are located at the specified location. When all circuits for a supply and return header pair are fusion welded the entire assembly will be pressure tested as specified in section 3.6.3.3.

.5 Every weld shall be visually and physically examined. If any leaks are detected at a fusion joint, it shall be cut out and replaced at which time that section shall be re-tested according to this section.

.6 A visual inspection of the pipe circuits and runout pipes shall be performed to ensure no kinks, obstructions, abrasions or other damage exists.

.7 Refer to manufacturer's specifications for allowable pressure changes due to thermal expansion/contraction for pressure test.

.8 Pressure test and visual log must be approved by the Engineer before backfilling.

.4 U-bend Assembly

.1 Immediately after completion of the horizontal borehole the pre-tested pipe assembly shall be installed onto the borehole drill shaft, and installed as the drill stem is removed from the borehole. A clay stabilizer that does not present potential damage to the HDPE pipe, shall be used during installation to prevent damage from occurring to the horizontal piping while being pulled through the horizontal borehole.

.5 Earthwork

.1 General: The horizontal trenches for the closed-loop GHX runouts may be excavated with a backhoe or other acceptable excavation device. Perform excavation of every description and of whatever substance encountered to the depths indicated on drawings. During excavation, deposit material suitable for backfill in an orderly manner, a sufficient distance from the excavation banks to avoid overloading and to prevent slides or cave-ins. Grade as necessary to prevent surface water from flowing into trenches or other excavations, and remove water accumulating therein by pumping or other acceptable method. Unless otherwise indicated, excavation shall be by open cut. Keep banks of trenches and excavation for structures as nearly vertical as practicable and where required, properly sheet and brace (proper shoring takes precedence over keeping trenches vertical). Fill unauthorized excavation below levels indicated for pipe with clean, native material, or sand.

.2 Trench Excavation: Excavate true to line to a depth as shown on the drawings with 1.83 m

(6 feet) depth from top of pipe to surface. Grade bottom of trenches accurately to provide uniform bearing and support for each section of pipe. If bottom of trench is not completely uniform, 150 mm (6 inches) of fine, clean fill dirt from trenching spoils if available, or sand along its entire length, shall be provided.

.3 Shoring Requirements: Perform all shoring and sheeting that is required to protect the excavation and to safeguard employees in accordance with CCOHS (Canadian Center for Occupational Health and Safety), and the Manitoba Building Code. Widen excavation to provide for space occupied by shoring and sheeting. Shoring shall meet the requirements of all applicable codes and regulations.

.4 Personnel access: All trenches shall utilize excavated sloped ramps instead of ladders or other mechanical devises for easy, safe access and egress of GHX installation personnel.

.5 De-Watering: Prevent surface water and subsurface or groundwater from flowing into excavations and from flooding project Site and surrounding area. Do not allow water to accumulate in excavations. Remove water to prevent softening of foundation bottoms, undercutting footings and soil changes detrimental to stability of sub-grades and foundations. Provide and maintain pumps, well points, sumps, suction and discharge lines and other de-watering system components necessary to convey water away from excavations. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey rain water and water removed from excavations to collecting or runoff areas. Do not use trench excavations as temporary ditches.

.6 Backfill: Prepare dimensioned drawings of the complete GHX piping system before backfilling. The trench shall be backfilled with native material or excavated spoils, free of abrasive material and large rocks surrounding the pipe for at least 300 mm (12 inches). If the quality of the backfill is suspect, a minimum of 150 mm (6 inches) of sand or fine soil material on each side and on top of the pipes shall be backfilled by hand. A horizontal underground-type metallic tracer warning tape shall be placed 0.3 m (12 inches) to 0.45 m (18 inches) below grade for the entire length of each runout pipe. After piping is installed, tested, purged, inspected and approved, the remaining trench fill may be excavated material, free of boulders, large rocks, general debris or foreign matter. Care shall be taken to avoid driving construction equipment over newly filled trenches unless bridging is provided to support load over trenches. Refer to ASTM D-2321 for backfill procedures. Compact trenches to 95% dry density.

.7 No petroleum based products are to be in contact with HDPE pipe.

.6 Fusion Work

.1 All fusion work shall be completed by personnel with a current fusion certification from a known HDPE pipe or fittings manufacturer, HDPE product distributor of known integrity, or equivalent independent training resource (i.e., CGC, IGSHPA installer accreditation, etc.). Personnel must be prepared to show proof of training and current ability.

.2 Equipment must be maintained in safe, reliable condition, and operator(s) shall maintain heater faces in clean condition.

.3 Example fusion samples from scrap pieces may be asked for as required for destructive testing to examine cross-sections of fusion welds by engineer or engineer's representative.

.4 Fusion equipment must be tested routinely during fusion work to demonstrate proper heater face temperature. A digital pyrometer with proof of calibration is required for each fusion crew. Temperature stick crayons may be used for occasional testing but a digital pyrometer test is required for daily baseline testing.

.5 Each joint shall be visually and physically inspected, using industry standards, for cold joints. Any joints failing the test shall be completely removed from the system and a new joint or fitting installed with the test being repeated.

.6 Suggested temperature range, socket fusion 260° to 274°C (500° to 525°F), however, the pipe and fitting manufacturer's recommendations for time and temperature requirements shall be followed.

.7 Suggested temperature range, butt fusion 227° to 260°C (440° to 500°F), however, the pipe and fitting manufacturer's recommendations for time and temperature requirements shall be followed.

.7 Connections

.1 Run-out pipes shall be installed and fusion welded to the horizontal U-bend assembly. The pipe and fittings must be joined using the socket, butt fusion or electro-fusion process. No

other method is acceptable. The quantity of fusion joints in the system shall be kept to an absolute minimum. Reduction fittings shall be used at all pipe reductions to facilitate the removal of air during flushing. Use reducing tees and pre-fabricated reducing type close headers. Consult pipe and/or fitting manufacturer for available fittings and headers.

.2 Avoid sharp bends in piping runs. The minimum bend diameter shall be determined by the following: Minimum Diameter = Pipe O.D. (actual) x 30. It is preferable to have larger bend diameters, and it is typically 30 times the actual pipe outside diameter or greater.

.3 Use only continuous lengths of pipe in bends. Install elbow fittings for required bends which are tighter radii than calculated above.

.4 Lateral piping supply and return lines or bundles shall be separated to minimize thermal interference between the two. The number of points where the supply and return lines cross one another shall be minimized.

.8 Building Penetration

.1 HDPE supply and return lines to and from the building's mechanical room shall be installed as per the Drawings.

.2 The 51 mm (2") HDPE runout pipes will have 13 mm (0.5") thick Armaflex insulation from the GHX header to at least 1.22 metres (4 feet) below grade.

.3 Each 51 mm (2") HDPE runout pipes shall be sleeved and sealed where penetrations through concrete or other structure exist. The GHX runout pipes shall be placed inside a 102 mm (4") corrugated, un-perforated drainage pipe ("Big-O" or equivalent). The ends inside and outside the building shall be sealed with urethane spray foam insulation to prevent water from entering the sleeve. The sleeves shall be placed beneath the foundation grade beams.

.9 Supply and Return Termination

.1 The 51 mm (2") HDPE supply and return runout pipes from the GHX shall be terminated within the building mechanical room, in the configuration as described on the drawings.

.2 Each 51 mm (2") end pipe shall be terminated at least 2 m (6.56 feet) from the floor or wall penetration prior to connection to the HDPE header, with 305 mm (12") separation between each HDPE pipe.

3.7 FLUSHING AND PURGING

.1 When the assembly of 51 mm (2") HDPE GHX circuits have been positioned in the trenches, the assemblies shall be individually flushed and purged of air and tested to ensure all portions of the GHX are filled with fluid and flowing as required. A purpose built purging pump (not the designated system pump), shall be used to flush air and debris from the system and introduce the mixture of water and antifreeze solution to the piping. The purging pump shall consist of:

.1 Purge Pump - the pump must be capable of pumping a minimum of 136.3 l/m (36 USgpm) at minimum pressure drop of 125.5 kPa (18.2 psi) [based on minimum temperature of 4.5oC or 40oF] through each 51 mm (2") HDPE circuit.

.2 Fluid reservoir

.3 Filter Assembly or strainer with a minimum of 20 mesh filter material

.4 Flow meter

.5 Pressure Gauge

.6 Connecting Piping

.7 Connecting Hoses - minimum hose size 51 mm (2"). Each hose will have shut-off valve to allow full control of the flow through the system.

.2 From the flushing ports located in the mechanical room, each supply and return runout pair of the GHX shall be flushed individually by closing the valves to all of the other runout pairs. In this manner, each 51 mm (2") circuit will be flushed separately. Each horizontal GHX section shall be flushed at a minimum rate of 136.3 l/m (36 USGPM) for a minimum of 15 minutes. This will ensure a fluid velocity of greater than 0.61 m/s (2 ft/s) through each circuit.

.3 After 15 minutes of flushing, the valve in the hose connecting the horizontal GHX to the purge pump reservoir shall be closed while the purge pump is operating, in effect "dead-heading" the pump. As the valve is closed the water level in the reservoir must be monitored. If the water level in the reservoir drops more than 25mm (1") as the valve is closed, that is a sign that air remains in the horizontal GHX section being flushed. Flushing must continue until the water level drop is less than

25mm (1") as the valve is closed.

.4 It is estimated that the horizontal GHX will have a total volume of 2,536 litres (670 US Gallons) of fluid, which includes the header, run-out supply and return pipes, and the 25 mm (1") circuits. (NOTE: This volume calculation is only a guide for the contractor. It does NOT include piping inside the building. It is the responsibility of the contractor to ensure the estimated volume is accurate based on the exact length of supply and return run-out piping actually installed in the horizontal GHX.)

.5 It is important that the antifreeze fluid used in the horizontal GHX is supplied by the same chemical manufacturer that supplies the antifreeze fluid for the interior building mechanical system for compatibility. It is the responsibility of the GHX contractor to coordinate with the interior mechanical contractor to ensure the fluid installed in the GHX is identical to the heat transfer fluid installed in the building piping system.

.6 Utilizing the purging unit, conduct a pressure and flow test on the ground heat exchanger to ensure the system is free of blockage. If the flow test indicates blockage, locate blockage using manufacturer's recommendation, remove blockage, then re-purge and conduct the pressure and flow test again until all portions of the system are flowing properly. The flow test must be observed and approved by the General Contractor before the system is to be considered completed.

.7 Contractor must provide proof of purge pump performance (manufacturer's pump curves or independent flow test provided by recognized pump vendor), submitted to Engineer for approval.

.8 Installing the antifreeze solution

- .1 Option 1: The fluid may be supplied as a pre-mixed fluid to the required percentage and shipped to the site by tanker truck. The fluid itself is then used to flush and purge the piping in the horizontal GHX.
- .2 Option 2: De-ionized or reverse osmosis water may be introduced into the piping system and used to flush and purge the horizontal GHX. The antifreeze solution may then be introduced into the system after the system is flushed and purged to the required percentage. [Potable city water is not acceptable for the building and GHX loop fluid.]
- .3 After all the horizontal GHX sections are flushed, purged and filled with the required amount of water and antifreeze solution, the system must be pressurized to 207 kPa gauge (30 psig) static pressure.

3.8 WARRANTY SUBMITTALS

.1 The contractor shall supply to the Customer the following information prior to system acceptance and final payment:

- .1 All warranties including material and labour.
- .2 Manufacturer certifications.
- .3 Supplier and manufacture warranties, guarantees, and certifications.
- .4 Full set of complete, accurate, dimensioned, as-constructed installation drawings.

End of Section

1 General

1.1 GENERAL

.1 Read and conform to:
- .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
- .2 Division 1 requirements and documents refered to therein.

1.2 SECTION INCLUDES

.1 Piping.
.2 Refrigerant.
.3 Moisture and liquid indicators.
.4 Valves.
.5 Strainers.
.6 Check valves.
.7 Pressure relief valves.
.8 Filter-driers.
.9 Solenoid valves.
.10 Expansion valves.
.11 Receivers.
.12 Flexible connections.

1.3 REFERENCES

.1 ARI 495 - Refrigerant Liquid Receivers.
.2 ARI 710 - Liquid-Line Driers.
.3 ARI 730 - Flow-Capacity Rating and Application of Suction-Line Filters and Filter-Driers
.4 ARI 750 - Thermostatic Refrigerant Expansion Valves.
.5 ARI 760 - Solenoid Valves for Use With Volatile Refrigerants.
.6 ASHRAE 15 - Safety Standard for Refrigeration Systems.
.7 ASHRAE 34 - Designation and Safety Classification of Refrigerants.
.8 ASME - SEC 9 - Welding and Brazing Qualifications.
.9 ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
.10 ASME B16.26 - Cast Copper Alloy Fittings For Flared Copper Tubes.
.11 ASME B31.5 - Refrigeration Piping and Heat Transfer Components.
.12 ASME B31.9 - Building Services Piping.
.13 ASME SEC 8D - Boilers and Pressure Vessels Code - Rules for Construction of Pressure Vessels.
.14 ASTM A53/A53M - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
.15 ASTM A234/A234M - Piping Fittings of Wrought-Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
.16 ASTM B88 - Seamless Copper Water Tube.
.17 ASTM B280 - Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
.18 ASTM F708 - Design and Installation of Rigid Pipe Hangers.
.19 AWS A5.8 - Filler Metals for Brazing and Braze Welding.
.20 AWS D1.1 - Structural Welding Code - Steel.
.21 MSS SP58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
.22 MSS SP69 - Pipe Hangers and Supports - Selection and Application.
.23 MSS SP89 - Pipe Hangers and Supports - Fabrication and Installation Practices.
.24 UL 429 - Electrically Operated Valves.

1.4 SYSTEM DESCRIPTION

.1 Where more than one piping system material is specified ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.
.2 Provide pipe hangers and supports to ASTM B31.5 unless indicated otherwise.
.3 Liquid Indicators:
  .1 Use line size liquid indicators in main liquid line leaving condenser.
  .2 If receiver is provided, install in liquid line leaving receiver.
  .3 Use line size on leaving side of liquid solenoid valves.
.4 Valves
  .1 Use service valves on suction and discharge of compressors.
  .2 Use gauge taps at compressor inlet and outlet.
  .3 Use gauge taps at hot gas bypass regulators, inlet and outlet.
  .4 Use check valves on compressor discharge.
  .5 Use check valves on condenser liquid lines on multiple condenser systems.
.5 Refrigerant Charging (Packed Angle) Valve: Use in liquid line between receiver shut-off valve and expansion valve.
.6 Strainers:
  .1 Use line size strainer upstream of each automatic valve.
  .2 Where multiple expansion valves with integral strainers are used, use single main liquid line strainer.
  .3 On steel piping systems, use strainer in suction line.
  .4 Use shut-off valve on each side of strainer.
.7 Pressure Relief Valves: Use on ASME receivers and pipe to outdoors.
.8 Permanent Filter-Driers:
  .1 Use in low temperature systems.
  .2 Use in systems utilizing hermetic compressors.
  .3 Use filter-driers for each solenoid valve.
.9 Replaceable Cartridge Filter-Driers:
  .1 Use vertically in liquid line adjacent to receivers.
  .2 Use filter-driers for each solenoid valve.
.10 Solenoid Valves:
  .1 Use in liquid line of systems operating with single pump-out or pump-down compressor control.
  .2 Use in liquid line of single or multiple evaporator systems.
  .3 Use in oil bleeder lines from flooded evaporators to stop flow of oil and refrigerant into the suction line when system shuts down.
.11 Receivers:
  .1 Use on systems 18 kW and larger, sized to accommodate pump down charge.
  .2 Use on systems with long piping runs.
.12 Flexible Connectors: Utilize at or near compressors where piping configuration does not absorb vibration.

1.5 SUBMITTALS

.1 Section 15010: Procedures for submittals.
.2 Shop Drawings: Indicate schematic layout of system, including equipment, critical dimensions, and sizes.
.3 Product Data: Provide general assembly of specialties, including manufacturers catalogue information. Provide manufacturers catalogue data including load capacity.
.4 Design Data: Submit design data indicating pipe sizing. Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.
.5 Test Reports: Indicate results of leak test, acid test.
.6 Manufacturer's Installation Instructions: Indicate support, connection requirements, and isolation for servicing.
.7 Submit welders certification of compliance with ASME SEC 9.

1.6 PROJECT RECORD DOCUMENTS

.1 Section 15010: Submittals for project closeout.
.2 Record exact locations of equipment and refrigeration accessories on record drawings.

1.7 OPERATION AND MAINTENANCE DATA

.1 Section 15010: Submittals for project closeout.
.2 Maintenance Data: Include instructions for changing cartridges, assembly views, spare parts lists.

1.8 QUALIFICATIONS

.1 Installer: Company specializing in performing the work of this section with minimum 5 years documented experience.
.2 Design piping system under direct supervision of a Professional Engineer experienced in design of this work and licensed at the place where the Project is located.

1.9 REGULATORY REQUIREMENTS

.1 Conform to ASME B31.9 for installation of piping system.
.2 Welding Materials and Procedures: Conform to ASME SEC 9 and applicable provincial labour regulations.
.3 Welders Certification: To ASME SEC 9.
.4 Products Requiring Electrical Connection: Listed and classified by UL, as suitable for the purpose indicated.

1.10 DELIVERY, STORAGE, AND HANDLING

.1 Section 15010: Transport, handle, store, and protect products.
.2 Deliver and store piping and specialties in shipping containers with labeling in place.
.3 Protect piping and specialties from entry of contaminating material by leaving end caps and plugs in place until installation.
.4 Dehydrate and charge components such as piping and receivers, seal prior to shipment, until connected into system.

1.11 MAINTENANCE MATERIALS

.1 Section 15010: Submittals for project closeout.
.2 Provide two refrigeration oil test kits each containing everything required to conduct one test.
.3 Provide two filter-dryer cartridges of each type.

2 Products

2.1 PIPING

.1 Copper Tubing: ASTM B280, Type ACR hard drawn or annealed.
  .1 Fittings: ASME B16.22 wrought copper.
  .2 Joints: Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy with melting range 640 to 805 degrees C.
.2 Copper Tubing to 22 mm OD: ASTM B88, Type K, annealed.
  .1 Fittings: ASME B16.26 cast copper.
  .2 Joints: Flared.
.3 Pipe Supports and Anchors:
  .1 Conform to ASME B31.5.
  .2 Hangers for Pipe Sizes 13 to 38 mm: Malleable iron adjustable swivel, split ring.

.3 Hangers for Pipe Sizes 50 mm and Over: Carbon steel, adjustable, clevis.
.4 Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
.5 Wall Support for Pipe Sizes to 75 mm: Cast iron hook.
.6 Wall Support for Pipe Sizes 100 mm and Over: Welded steel bracket and wrought steel clamp.
.7 Vertical Support: Steel riser clamp.
.8 Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
.9 Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
.10 Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
.11 Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.2 MOISTURE AND LIQUID INDICATORS

.1 Indicators: Single port type, UL listed, with copper or brass body, flared or solder ends, sight glass, colour coded paper moisture indicator with removable element cartridge and plastic cap; for maximum working pressure of 3450 kPa, and maximum temperature of 93 degrees C.

2.3 VALVES

.1 Ball Valves:
  .1 Two piece bolted forged brass body with teflon ball seals and copper tube extensions, brass bonnet and seal cap, chrome plated ball, stem with neoprene ring stem seals; for maximum working pressure of 3450 kPa and maximum temperature of 149 degrees C.
.4 Service Valves:
  .1 Forged brass body with copper stubs, brass caps, removable valve core, integral ball check valve, flared or solder ends, for maximum pressure of 3450 kPa.

2.4 STRAINERS

.1 Straight Line or Angle Line Type:
  .1 Brass or steel shell, steel cap and flange, and replaceable cartridge, with screen of stainless steel wire or monel reinforced with brass; for maximum working pressure of 2960 kPa.
.2 Straight Line, Non-Cleanable Type:
  .1 Steel shell, copper plated fittings, stainless steel wire screen, for maximum working pressure to suit application.

2.5 CHECK VALVES

.1 Globe Type:
  .1 Cast bronze or forged brass body, forged brass cap with neoprene seal, brass guide and disc holder, phosphor-bronze or stainless steel spring, teflon seat disc; for maximum working pressure of 2930 kPa and maximum temperature of 149 degrees C.
.2 Straight Through Type:
  .1 Brass body and disc, phosphor-bronze or stainless steel spring, neoprene seat; for maximum working pressure of 3450 kPa and maximum temperature of 93 degrees C.

2.6 PRESSURE REGULATORS

.1 Brass body, stainless steel diaphragm, direct acting, adjustable over 0 to 550 kPa range, for maximum working pressure of 3100 kPa.

2.7 PRESSURE RELIEF VALVES

.1 Straight Through or Angle Type: Brass body and disc, neoprene seat, factory sealed and stamped with ASME UV and National Board Certification NB; for standard 1620 kPa setting; selected to ASHRAE 15.

2.8 FILTER-DRIERS

.1 Replaceable Cartridge Angle Type:
- .1 Shell: ARI 710, UL listed, brass, removable cap, for maximum working pressure of 2410 kPa.
- .2 Filter Cartridge: Pleated media with integral end rings, stainless steel support.
- .3 Filter/Dryer Cartridge: Pleated media with solid core sieve with activated alumina.
- .4 Wax Removal Cartridge: Moulded bonded core of activated charcoal with integral gaskets.

.2 Permanent Straight Through Type:
- .1 ARI 710, UL listed, steel shell with moulded desiccant filter core, for maximum working pressure of 2410 kPa.

2.9 SOLENOID VALVES

.1 Valve: ARI 760, pilot operated, copper or brass or steel body and internal parts, synthetic seat, stainless steel stem and plunger assembly, integral strainer, with flared, solder, or threaded ends; for maximum working pressure of 3450 kPa. Stem to permit manual operation in case of coil failure.

.2 Coil Assembly: UL 429, UL listed, replaceable with moulded electromagnetic coil, moisture and fungus proof, with surge protector and colour coded lead wires, integral junction box with pilot light.

.3 Electrical Characteristics: 120 volts, single phase, 60 Hz.

2.10 EXPANSION VALVES

.1 Angle or Straight Through Type: ARI 750; design suitable for refrigerant, brass body, internal or external equalizer, bleed hole, superheat setting, replaceable inlet strainer, with non-replaceable capillary tube and remote sensing bulb and remote bulb well.

.3 Selection: Evaluate refrigerant pressure drop through system to determine available pressure drop across valve. Select valve for maximum load at design operating pressure and minimum 6 degrees C superheat. Select to avoid being undersized at full load and excessively oversized at part load.

2.11 RECEIVERS

.1 Internal Diameter 150 mm and Smaller:
- .1 ARI 495, UL listed, steel, brazed; 2760 kPa maximum pressure rating, with tappings for inlet, outlet, and pressure relief valve.

.2 Internal Diameter Over 150 mm:
- .1 ARI 495, welded steel, tested and stamped to ASME SEC 8D; 2760 kPa with tappings for liquid inlet and outlet valves, pressure relief valve , and magnetic liquid level indicator.

2.12 FLEXIBLE CONNECTORS

.1 Corrugated stainless steel hose with single layer of stainless steel exterior braiding, minimum 230 mm long with copper tube ends; for maximum working pressure 3450 kPa.

3 Execution

3.1 PREPARATION

.1 Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
.2 Remove scale and dirt on inside and outside before assembly.
.3 Prepare piping connections to equipment with flanges or unions.

3.2 INSTALLATION

.1 Install refrigeration specialties to manufacturer's instructions.
.2 Route piping in orderly manner, with plumbing parallel to building structure, and maintain gradient.
.3 Install piping to conserve building space and not interfere with use of space.
.4 Group piping whenever practical at common elevations and locations. Slope piping one percent in direction of oil return.
.5 Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
.6 Inserts:
  .1 Provide inserts for placement in concrete formwork.
  .2 Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
  .3 Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 100 mm.
  .4 Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
  .5 Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.
.7 Pipe Hangers and Supports:
  .1 Install to ASTM B31.5.
  .2 Support horizontal piping as scheduled.
  .3 Install hangers to provide minimum 13 mm space between finished covering and adjacent work.
  .4 Place hangers within 300 mm of each horizontal elbow.
  .5 Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
  .6 Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
  .7 Provide copper plated hangers and supports for copper piping.
.8 Arrange piping to return oil to compressor. Provide traps and loops in piping, and provide double risers as required. Slope horizontal piping 0.40 percent in direction of flow.
.9 Provide clearance for installation of insulation and access to valves and fittings.
.10 Provide access to concealed valves and fittings. Coordinate size and location of access doors with Section 15010.
.11 Flood piping system with nitrogen when brazing.
.12 Where pipe support members are welded to structural building frame, brush clean, and apply one coat of zinc rich primer to welding.
.13 Prepare unfinished pipe, fittings, supports, and accessories ready for finish painting. Refer to Section 15010.
.14 Insulate piping and equipment.
.15 Follow ASHRAE 15 procedures for charging and purging of systems and for disposal of refrigerant.
.16 Provide replaceable cartridge filter-driers, with isolation valves and valved bypass.
.17 Locate expansion valve sensing bulb immediately downstream of evaporator on suction line.
.18 Provide external equalizer piping on expansion valves with refrigerant distributor connected to evaporator.
.19 Install flexible connectors at right angles to axial movement of compressor, parallel to crankshaft.
.20 Fully charge completed system with refrigerant after testing.
.21 Provide electrical connection to solenoid valves. Refer to Division 16.

3.3 FIELD QUALITY CONTROL

.1 Field inspection and testing will be performed to Section 15010.
.2 Test refrigeration system to ASME B31.5.
.3 Pressure test system with dry nitrogen to 1470 kPa. Perform final tests at 92 kPa vacuum and 1470 kPa using halide torch. Test to no leakage.

End of Section

1 General

1.1 GENERAL

.1 Read and conform to:
- .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
- .2 Division 1 requirements and documents refered to therein.

1.2 SECTION INCLUDES

.1 PQRY-P-THMU Modular Water-Cooled Condensing Unit
.2 Branch Circuit BC Controllers for WR2-Series Systems
.3 Citymulti Variable Refrigerant Flow Indoor Units
.4 PLFY-P**NBMU-E (4-Way Ceiling-Recessed Cassette With Grille) Indoor Unit
.5 PEFY (Ceiling-Concealed Ducted) Indoor Unit

1.3 REFERENCES

.1 Local and District By-Laws, Regulations and Published Engineering Standards.
.2 CAN/CSA - B52-92: Mechanical Refrigeration Code.

1.4 SUBMITTALS FOR REVIEW

.1 Section 15010: Procedures for submittals.
.2 Product Data: Provide catalogue data indicating rated capacity, dimensions, duct and service connections, electric nameplate data and wiring diagrams.
.3 Shop Drawings: Indicate layout of system and components.

1.5 SUBMITTALS FOR INFORMATION

.1 Section 15010: Submittals for information.
.2 Manufacturer's Instructions: Indicate installation instructions and recommendations.

1.6 SUBMITTALS AT PROJECT CLOSEOUT

.1 Section 15010: Submittals for project closeout.
.2 Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listing.
.3 Warranty: Submit manufacturer warranty and ensure forms have been completed in Owners name and registered with manufacturer.

1.7 QUALITY ASSURANCE

.1 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1.8 REGULATORY REQUIREMENTS

.1 Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.9 WARRANTY

.1 Section 15010: Submittals for project closeout.
.2 Provide five year manufacturer warranty for compressors.

1.10 EXTRA MATERIALS

.1 Section 15010: Submittals for project closeout.

2 Products

2.1 PQRY-P-THMU MODULAR WATER-COOLED CONDENSING UNIT

.1 General:
.1 The WR2-Series shall consist of the PQRY-P-THMU condensing unit, indoor units, and M-NET DDC (Direct Digital Controls). The PQRY-P-THMU condensing unit shall be specifically used with CITY MULTI VRF indoor and control components. The PQRY outdoor units shall be equipped with multiple circuit boards that interface to the M-NET controls system and shall perform all functions necessary for operation. The condensing unit shall be suitable for indoor location. The condensing unit shall be completely factory assembled, piped and wired. Each unit shall be thoroughly run tested at the factory without exception. Alternate product offerings shall provide the owner with written confirmation and results for the factory run test on each unit.
.2 System Performance Rating
.1 The model PQRY-P-THMU system shall consist of two (2) PQRY-P- THMU modular units piped together in the field using a factory supplied twinning kit. Once connected they shall operate as one unit alternating compressor run cycles to balance total compressor operation hours. The sum of connected capacity of all indoor air handlers shall range from 50% to 150% of outdoor rated capacity. with the option of extending the connected capacity to 200% with additional software. If the indoor unit connected design capacity exceeds 120%, it is recommended a local Mitsubishi representative is consulted for a design review.
.3 Acoustic Performance
.1 PQRY-P-THMU condensing unit shall have a sound pressure level (SPL) rating no higher than a maximum of 54 dB(A) as measured a horizontal distance 1 m from the unit. Alternate product offerings shall provide all necessary factory or field acoustic treatment as required to achieve or exceed the above performance levels at no additional cost to the owner.
.4 System Refrigerant Pipework
.1 Both refrigerant lines from the outdoor unit to indoor units shall be individually insulated. (Note PQRY-P-THMU is a simultaneous heating and cooling system).The outdoor unit shall have an accumulator with refrigerant level sensors and controls. The outdoor unit shall have a high pressure safety switch, over-current protection and DC bus protection. The PQRY-P-THMU outdoor units shall have the ability to operate with a maximum height difference of 164 feet and can, when combined in a modular format have a total refrigerant tubing length of 1,804 - 2,624 feet when serving up to Qty 50 indoors units.
The greatest length is not to exceed 541 feet between the outdoor unit and the indoor units without the need for line size changes or traps.
Please confirm system layout limitations and piping sizes with the Mitsubishi Electric Design Tool Software. The Modular Variable Speed Drive PQRY-P-THMU outdoor unit shall have rated performance for operation in heating and cooling mode as detailed is the product technical data sheets. The outdoor unit shall have a high efficiency oil separator plus additional logic controls to ensure adequate oil volume in the compressor is maintained.
.5 Refrigerant
.1 R410A refrigerant shall be required for PQRY-P-THMU-A modular unit system.
.2 Refrigerant to Water Heat Exchanger:
The water-cooled condensing unit shall be furnished with a refrigerant to water brazed plate and frame heat exchanger offering an operating entering condenser water temperature

range of 23 - 113 F. The refrigerant to water plate and frame heat exchanger shall be rated for a maximum operation pressure of 2.0 MPa.

.6 Variable Speed Scroll Compressor:

.1 The PQRY-P-THMU-A High Efficiency Modular water-cooled outdoor units shall be provided complete with an inverter driven scroll hermetic compressor(s) as manufactured and designed by Mitsubishi Electric. The compressor motor shall be of DC Brushless configuration with AUTO TUNING INVERTER control to achieve optimum compressor/motor performance levels particularly during off design conditions. Non inverter-driven compressors shall not be deemed acceptable for this application. Compressors driven by induction are not allowed in this instance. A crankcase heater(s) shall be factory mounted on the compressor(s).Each compressor shall be capable of modulation down to 19% of rated capacity. The compressor shall be equipped with an internal thermal overload. The compressor shall be mounted to avoid the transmission of vibration.

.7 Electrical:

.1 The outdoor unit electrical power shall be 208/230 volts, 3 phase, 60 hertz. The unit shall be capable of satisfactory operation within voltage limitations of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz). The condensing unit shall be controlled by integral microprocessors. The control circuit between the indoor units and the outdoor unit shall be 24VDC completed using a 2-conductor, twisted pair non-polar shielded cable to provide total integration of the system. The BC Controller shall be controlled by integral microprocessors. The inrush current to the outdoor unit shall not exceed the design full load amp FLA rating for the unit. Alternate systems with solid state or constant speed scroll compressors with significant inrush current characteristic will not be acceptable for this application.

.8 Modular Configuration

.1 The PQRY-P-THMU condensing units shall consist of one or two modules each rated for the designated proportion of the total system cooling/heating capacity. Each module is furnished with a Mitsubishi designed and manufactured inverter driven scroll compressor and inverter driven variable speed propeller type condenser fan. Single compressor individual outdoor condensing units with capacities in excess of 120,000 Btu's are not acceptable for this application based on reduced operational life cycles and limited compressor redundancy levels. The modular outdoor unit combinations are designed so as to balance the run hours seen by each individual inverter driven scroll compressor in order to extend overall outdoor unit life cycle and reduced on going maintenance costs. The PQRY-P-THMU modules shall be installed in a side by side configuration without the need for intermediate oil balancing pipework. Alternate modular systems which require additional on site oil balancing infrastructure between modules shall not be deemed appropriate for this application.

.2 The PQRY-P-THMU individual modules shall be manufactured to dimensions which allow each individual be moved through a standard 32" wide doorway particularly beneficial for retrofit applications. Alternate units that are not designed to the above dimensional specifications must show significant savings to the customer in order to compensate for the associated impact on system installation costs.

.9 Factory Twinning Kits

.1 Factory manufactured twinning kits will be supplied loose to facilitate the field connection of a maximum of two (2) modular condensing units per system. The CMY-Q100 high pressure side twinning kit must be installed external to the unit where as the low pressure side CMY-R100BK twinning kits is installed in the master unit. Please reference installation instructions for further details.

2.2 BRANCH CIRCUT BC CONTROLLES FOR WR2-SERIES SYSTEMS

.1 General:

.1 The BC (Branch Circuit) Controllers shall be specifically used with R410A WR2-Series systems. These units shall be equipped with a circuit board that interfaces to the M-NET

controls system and shall perform all functions necessary for operation. The unit shall have a galvanized steel finish. The BC Controller shall be completely factory assembled, piped and wired. Each unit shall be run tested at the factory. This unit shall be mounted indoors, with access and service clearance provided for each controller. The sum of connected capacity of all indoor air handlers shall range from 50% to 150% of rated capacity.

.2 BC Controller Configuration

.1 The BC controller shall be constructed from galvanised steel plate partially insulated with polyurethane foam. The base of the unit shall have a foamed polystyrene tray. BC controller models shall be NU-GA. type. The NU-G master BC shall be connected to the outdoor unit via a high pressure and low pressure pipe. The NU-GA master BC controller shall include a gas/liquid separator, which will separate high pressure liquid and high pressure gas. A brass header pipe with three solenoid valves for each distribution port shall distribute the correct phase of refrigerant to each indoor unit.
The BC controller shall also include a tube in tube heat exchanger which will recover waste heat from units in cooling operation and distribute this to units requiring heating. The opposite will happen in cooling operation. An integral condensate pan and drain shall be provided. The refrigeration process in the BC controller shall be maintained by LEV's (linear expansion valves) which will be controlled by pressure and temperature sensors.
The NU-G standard BC controller range will have 13 ports to connect to indoor units. A brass header pipe with three solenoid valves for each distribution port shall distribute the correct phase of refrigerant to each indoor unit. The NU-G,NU-GA,NU-GB and NU-HB BC boxes will all require 208-230/1/60 VAC mains supply. Control will be via the 30 V DC signal from the outdoor unit. The unit shall be furnished with multiple branch circuits which can individually accommodate up to 54,000 BTUH and/or three indoor units. Branches may be twinned to allow more than 54,000 BTUH. Each branch shall have multiple two-position valves to control refrigerant flow. Service shut-off valves shall be field-provided/installed for each branch to allow service to any indoor unit without field interruption to overall system operation. Linear electronic expansion valves shall be used to control the variable refrigerant flow.

2.3 CITYMULTI VARIABLE REFRIGERANT FLOW INDOOR FAN COIL UNITS

.1 General

The total capacity of the indoor units shall be between 50 and 130% of the capacity of the outdoor unit. Each indoor unit will have a heat exchanger which shall be constructed from copper tubing with aluminium fins. The flow of refrigerant through the heat exchanger will be controlled by a linear expansion valve. This valve will be controlled by two pipe thermistors and a return air thermistor and shall be capable of controlling the variable capacity of the indoor unit between 25% and 100%.Each indoor unit will require a 208-230 vac power supply. Control will be via the 30 VDC M-net data control signal from the outdoor unit. There will be nine alternative models of indoor units to suit different applications. As follows:-

.1 PLFY-P**NBMU-E (4-way Ceiling-Recessed Cassette With Grille) Indoor Unit

.1 General

PLFY-P**NBMN-E shall be a four-way cassette style indoor unit that recesses into the ceiling with a ceiling grille. The PLFY shall be used with the PQRY-P-THMU Series condensing unit(s). The PLFY shall support individual control using M-NET DDC controllers.

.2 Indoor Unit

The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor.
The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, an emergency operation function, a test run switch, and the ability to adjust airflow patterns for different ceiling heights. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory

.3 Unit Cabinet:

The cabinet shall be space-saving ceiling-recessed cassette. The cabinet panel shall have provisions for a field installed filtered outside air intake. Branch ducting shall be allowed from cabinet. Four-way grille shall be fixed to bottom of cabinet allowing two, three or four-way blow. The grille vane angles shall be individually adjustable from the wired remote controller to customize the airflow pattern for the conditioned space

.4 Fan:

The indoor fan shall be an assembly with a turbo fan direct driven by a single motor. The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings. The indoor fan shall consist of five (5) speed settings, Low, Mid1, Mid2, High and Auto. The fan shall have a selectable Auto fan setting that will adjust the fan speed based on the difference between controller set-point and space temperature. The indoor unit shall have an adjustable air outlet system offering 4-way airflow, 3-way airflow, or 2-way airflow. The indoor unit shall have switches that can be set to provide optimum airflow based on ceiling height and number of outlets used. The indoor unit vanes shall have 5 fixed positions and a swing feature that shall be capable of automatically swinging the vanes up and down for uniform air distribution.

The vanes shall have an Auto-Wave selectable option in the heating mode that shall randomly cycle the vanes up and down to evenly heat the space. If specified, the grille shall have an optional i-see sensor that will measure room temperature variations and adjust the airflow accordingly to evenly condition the space.

.5 Filter:

Return air shall be filtered by means of a long-life washable filter

.6 Coil:

The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing. The tubing shall have inner grooves for high efficiency heat exchange. All tube joints shall be brazed with phos-copper or silver alloy. The coils shall be pressure tested at the factory. A condensate pan and drain shall be provided under the coil. The unit shall be provided with an integral condensate lift mechanism that will be able to raise drain water 33 inches above the condensate pan. Both refrigerant lines to the PLFY indoor units shall be insulated.

.7 Electrical:

The unit electrical power shall be 208/230 volts, 1-phase, 60 hertz. The system shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz).

.8 Controls:

This unit shall use controls provided by Mitsubishi Electric to perform functions necessary to operate the system.

.2 PEFY (Ceiling-Concealed Ducted) Indoor Unit

.1 General

The PEFY shall be a ceiling-concealed ducted indoor fan coil design that mounts above the ceiling with a 2-position, field adjustable return and a fixed horizontal discharge supply and shall have a modulating linear expansion device. The PEFY shall be used with the PQRY-P-THMU Series heating/cooling and heat recovery condensing unit. The PEFY shall support individual control using M-NET DDC controllers.

.2 Indoor Unit

The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, and an auto restart function. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.

.3 Unit Cabinet:

The unit shall be space saving, ceiling-concealed, ducted.

The cabinet panel shall have provisions for a field installed filtered outside air intake.

.4 Fan:
The indoor unit fan shall be an assembly with one or two Sirocco fan(s) direct driven by a single motor. The indoor fan speed can be modulated based on a 0-10 V external signal from a 3rd party control system. The indoor fan shall be statically and dynamically balanced and run on a motor with permanently lubricated bearings. The indoor unit shall have a ducted air outlet system and ducted return air system.

.5 Filter:
Return air shall be filtered by means of a standard factory installed return air filter. Optional return filter box (rear or bottom placement) with high-efficiency filter shall be available for all PDFY indoor units.

.6 Coil:
The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing. The tubing shall have inner grooves for high efficiency heat exchange.
All tube joints shall be brazed with phos-copper or silver alloy. The coils shall be pressure tested at the factory.
A condensate pan and drain shall be provided under the coil. The condensate shall be gravity drained from the fan coil. Both refrigerant lines to the PDFY indoor units shall be insulated.

.7 Electrical:
The unit electrical power shall be 208/230 volts, 1-phase, 60 hertz. The system shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz).

.8 Controls:
This unit shall use controls provided by Mitsubishi Electric to perform functions necessary to operate the system. Please refer to the controls section of this guide specification for details on controllers and other control options.

2.4 HEAT EXCHANGE INDOOR UNIT

.1 Unit Description: The - Heat Exchange Indoor Module shall be rated for 36,000 /72,000 BTUs nominal cooling capacity generating chilled or hot water in the temperature range 44 - 115°F (6 - 45°C) based on design operating conditions (flow rates etc). The HEX unit shall have the capacity to take advantage of internal heat recovery within a mechanical heating/cooling system and provide an efficient means of generating chilled or hot water from the heating/cooling modular condensing unit(s). The unit shall be supplied with the following components:
- .1 Refrigerant - Water Plate & Frame Heat Exchanger
- .2 Heat Exchanger Bypass c/w Solenoid Valve
- .3 Linear Expansion Valve/Valves
- .4 Strainer
- .5 Internal Pipework
- .6 Temperature & Pressure Sensor
- .7 Pressure Switch
- .8 Drain Pan
- .9 Electronic Board

.2 Water-side System Design: A drain pipe connection is required to remove any condensate caused by the inlet water temperature.

.3 Water Quality: The module shall form part of a closed loop system in order to prevent extreme fouling or scaling of heat exchangers or pipework. Ground, rain or sea water should not be used directly with the unit.

.4 Water Piping: Copper, stainless steel, polybutylene and polyethylene are materials that can be used for the water pipework based on their capacity to withstand fluid temperatures of 90C. Steel piping should not be used in this instance. If there is a possibility of steel usage in existing equipment this can not be used in as part of the water circuit for this unit. The water circuit within the booster unit is rated for a maximum hydraulic pressure of 1.0 MPa.

.5 Refrigeration Circuit: The refrigeration circuit is comprised of one (1) brazed plate-frame heat exchanger - one optimized for refrigerant to water (R410 a) heat transfer,

.6 Water-Temperature Operating Range: The unit shall have a water temperature operating range of 6 - 45°C. The temperature operation range on the controller is 10 - 45°C or 50 - 105°F.

.7 Installation: The heat exchange unit is designed for indoor installation only. Outdoor installation is strictly prohibited. For water pipes - do not use steel pipes; copper pipes are recommended. Install the drain pipe with an inclination of between 1/100 and 1/200 to provide a downward flow of drain water. In cold climate installations take appropriate consideration to prevent the drain from freezing. Install a strainer near to the unit to prevent foreign materials from entering the water-side heat exchanger and causing excessive fouling. Beware of unit surfaces as they can be hot up to temperatures of 550C.
Provide minimum service space of 2ft (24"/600 mm) in front of the unit and 16" (400 mm) to the right hand side (as viewed facing the unit) for sufficient access and routine maintenance purposes. The booster unit can be floor, wall or ceiling suspended

.8 Unit Control: External pump operation can be interlocked with the operation of the booster unit through short circuiting the circuit through TB142A (booster unit ON) and opening of circuit will deactivate the unit (OFF). The units have an integral anti-freeze control mode (DIP SW3-4 ON) to prevent the water pipe from freezing. When Anti-freeze mode is effective, the unit will sustain set water temperature. A field supply control board for separate water pump interlock is required. When in HEATING ECO mode (DIP SW4-3 ON) the booster unit is in energy saving mode. During this mode of operation the outlet water temperature will automatically change based on the external ambient or condenser water temperature.

.9 Remote Control: The booster unit can be controlled via an external analog 4-20 mA input or remotecontroller. The controller can provide the following functions:

.10 Circulation Pumps & Circuit Valving: Water-circulation pumps are not provided as part of the booster unit package. The water-pumps are field supplied and need to be selected depending on hot water system design.
External flow control valves are by others to facilitate specific system design formats.

2.5 CONTROLS NETWORK

.1 Overview: The Controls Network (CN) shall be capable of supporting remote controllers, schedule timers, system controllers, centralized controllers, an integrated web based interface, graphical user workstation, and system integration to Building Management Systems via BACnet® and LonWorks®.

.2 Electrical Characteristics

.1 General: The CN shall operate at 30VDC. Controller power and communications shall be via a common non-polar communications bus.

.2 Wiring: Control wiring shall be installed in a system daisy chain configuration from indoor unit to ME remote controller to indoor unit, to the BC controller (main and subs, if applicable) and to the outdoor unit. Control wiring to remote controllers shall be run from the indoor unit terminal block to the controller associated with that unit.
Control wiring for schedule timers, system controllers, and centralized controllers shall be installed in a daisy chain configuration from outdoor unit to outdoor unit, to system controllers, to the power supply. Control wiring for the Deluxe MA, Simple MA, and Wireless MA remote controllers shall be from the remote controller to the first associated indoor unit (TB-15) then to the remaining associated indoor units (TB-15) in a daisy chain configuration...The AG-150A and GB-50A system controller shall be capable of being networked with other AG-150A and GB-50A system controllers for web based control.

.3 Wiring type: Wiring shall be 2-conductor (16 AWG or 18 AWG), twisted shielded pair, stranded wire. Network wiring shall be CAT-5e with RJ-45 connection.

.4 Controls Network: The Controls Network (CN) consists of remote controllers, schedule timers, system controllers, centralized controllers, and/or integrated web based interface communicating over a high-speed communication bus. The Controls Network shall support operation monitoring, scheduling, error email distribution, personal browsers, tenant billing, online maintenance support, and integration with Building Management Systems (BMS) using either LonWorks® or BACnet® interfaces. The below figure illustrates a sample CN System.

.3 Remote Controllers

The Remote Controller shall be capable of controlling up to 16 indoor units (defined as 1 group) from this compact 5" x 5" (approximate) wall-mounted controller. The Remote Controller shall be capable of connecting anywhere on the communication bus and shall not require being physically located in the same room as the indoor unit(s) under its control.
The Remote Controller shall control the following grouped operation for up to sixteen indoor units collectively: On/Off, Operation Mode (cool, heat, auto (R2-Series only), dry, and fan), temperature setting, fan speed setting, and airflow direction setting. The Remote Controller shall have three timer options: one on/off setting defined for one day, repeated daily timer, and auto-off timer function. The room temperature shall be sensed at either the Remote Controller or the Indoor Unit dependent on the indoor unit dipswitch setting. The Remote Controller shall display a four-digit error code in the event of system abnormality/error.
The Remote Controller shall only be used in same group with other Remote Controllers with a maximum of two Remote Controllers per group. The Remote Controller shall require manual addressing using rotary dial switch to the communication bus. The Remote Controller shall connect using two-wire, stranded, non-polar control wire to TB5 connection terminal on the indoor unit.

.4 Input/Output (IO) Boards:

.1 Digital Input Digital Output (DIDO) Board: The DIDO IO board shall be capable of providing On/Off control for equipment via the G-50A/GB-50A Centralized Controller's licensed web browser functions and the TG-2000A software. Each DIDO board shall have two digital inputs and two digital outputs and shall be capable of expanding to a total of six digital inputs and six digital outputs. Each digital output shall be capable of supporting an independent schedule via the G-50A/GB-50A Centralized Controller's licensed web browser functions and the TG-2000A software. Status indication of the On/Off state of the non-Mitsubishi equipment shall be either via the On/Off status of the digital output or by receipt of a digital input to the DIDO board.

.2 The DIDO IO board shall be capable of receiving a digital input for interlock settings with the indoor units or digital outputs on the DIDO board. Based on the digital input status the DIDO board shall be capable of setting the following parameter on the indoor unit On/Off, Mode, and Set Temperature to predefined settings. The DIDO board shall also be capable of interlocking the On/Off state of a digital output on the DIDO board based on a digital input status.

.5 Analog Input (AI) Board

The AI IO board shall be capable of monitoring temperature or humidity via the G-50A/GB-50A Centralized Controller's licensed web browser functions and the TG-2000A software. Each AI board shall have two analog inputs. Each input shall be capable of receiving a 4/20mA, 0/10 VDC, or 1/5 VDC signal for monitoring temperature or humidity. The AI board shall be capable of monitoring the temperature or humidity input and shall be capable of displaying graphical trending of the temperature or humidity values via the G-50A/GB-50A Centralized Controller's licensed web browser functions and the TG-2000A software. Notification of user adjustable high and low level alarms shall be capable of being emailed to distribution list or outputted via a digital output.
The AI IO board shall be capable of setting the following parameters on the indoor unit On/Off, Mode, and Set Temperature to predefined settings based on the input value of the temperature or humidity. The AI board shall also be capable of interlocking the On/Off state of a digital output on the input value of the temperature or humidity.

.6 BAC-HD150 BACNET® Interface

.1 General

BAC-HD150 has functions allowing communication from an air conditioning system via a protocol converted to BACNET communication, that command from a Building Management System is converted and transmitted to the air conditioning system where the air conditioning system data is collected and the status changed is detected. BAC-HD150 also collects data on air conditioning units operation status and transmits data upon request from the building management system.

.2 Communication Protocol Specification

BACNET IP which applied to ANSI/ASHRAE 135-2004 correspondingly on UDP/IP of Ethernet is used as per the following:

.1 Ethernet Header
.2 IP Header
.3 UDP Header

.4 BVLL Header
.5 NPCI
.6 APDU
Ethernet Header
Physical Layer: Ethernet
Transmission Medium: 10BASE-T
IP Header
Class C private address is recommended. (*1) Subnet Mask: 255.255.255.0
*1: Recommended value (range): (192.168.1.1) - (192.168.254.254)
Do not use (192.168.0.0) and (192.168.255.255) as a device address
UDP Header
The default UDP port of unicast and broadcasting is set to 47808 (0xVAC0).
BVLL Header (BVLL: BACNET Virtual Link Layer)
BVLC Type (1 octet)
BVLC Function (1 octet)
Fixed to 0x81 (BVLL against BACNET IP)
Unicast 0x0A
Broadcast 0x0B
Varialbe (BVLL header (4 octets) + NPCI data length + APDU data length)
BVLC Length (2 octets)
The typical examples are listed in the above Refer to ANSI/ASHRAE 135-2004 for details.
NPCI (NPC: Network Layer Protocol Code Information)
Version (1 octet)
Control (1 octet)
Fixed to 0x01
Response is received 0x04
No response 0x00
The typical examples are listed in the above Refer to ANSI/ASHRAE 135-2004 for details.
APDU (APDU: Application Layer Protocol Data Unit)
Data: 1024 octets or less
The typical examples are listed in the above Refer to ANSI/ASHRAE 135-2004 for details.

.3 Configuration

The Mitsubishi Electric HVAC BACNET® interface, BAC-HD150, shall support up to fifty indoor units with a variety of network variables on a per indoor unit basis. Future upgrades will allow 150 units via EC (Expansion Controller - groups of 50) using LAN connection. Initial setting software and a PC are required for initial set up purposes only. The BACNET communication port is fixed to 47808 and the port can't be changed. The BAC-HD150 interface allows seamless BACNET over IP integration allowing the operation and monitoring capabilities as summarized in the following:

.1 BAC-HD150 Operation Points
- .1 On/Off
- .2 Mode
- .3 Fan Speed
- .4 Airflow Direction
- .5 Temperature Set point
- .6 Filer Sign Reset
- .7 Prohibit Local On/Off
- .8 Prohibit Local Mode
- .9 Prohibit Local Filter Sign Reset
- .10 Prohibit Local Temperature Set Point
- .11 Forced Off

.2 BAC-HD150 Monitoring Points
- .1 On/Off
- .2 Mode
- .3 Fan Speed
- .4 Airflow Direction
- .5 Space Temperature
- .6 Temperature Set point

.7 Filer Sign
.8 Prohibit Local On/Off
.9 Prohibit Local Mode
.10 Prohibit Local Filter Sign Reset
.11 Prohibit Local Temperature Set Point
.12 Forced Off
.13 Alarm Signal
.14 Error Code
.15 Communication State

The minimum recommended requirements for application of the system are summarized in the following;

.1 BAC-HD150 Panel
.2 Initial Setting Software
.3 Experienced 3rd party integrator
.4 Ethernet cables and HUB

.7 Control Wiring: The contractor shall be responsible for the interconnecting control wiring between the indoor and outdoor units and control wiring between remote controllers, centralized control and relevant components. This work shall be co-ordinated with the Electrical / Controls Contractor for the rooting and trunking of the cables.
All control wiring are to be carried out in 2 core 16 AWG shielded cabling with colour coding and tagged with ID number at 3 metre intervals as per schematics for ease of identification and maintenance.
Control wiring shall not be run next to power wiring. A minimum space of 100mm between both control and power cables shall apply.

.8 Installation: The fixing of all air conditioning equipment, installation of all refrigerant pipework and full commissioning shall be performed by a licensed refrigeration mechanic / installer who shall be trained, and authorized to install the VRF equipment. The installation of all internal and external units, refrigerant pipework, inter-connecting wiring, commissioning and testing shall be carried out by an approved refrigeration systems installers. All the required permits, system registration, and witnessed tests by TSSA shall be the responsibility of this installer.
Full access shall be afforded to site during the installations stage of the project to allow them to verify that installation methods are fully in accordance with manufacturer requirements and also TSSA (the enforcing authority) so that the equipment warranties will not be invalidated.

.9 Refrigerant Pipework: Supply, install, test, and commission all interconnecting refrigeration pipework between the outdoor and indoor units.
All pipework to be carried out in refrigerant quality ACR copper tubing and complete with the appropriate headers and joints. All pipework must be suitable for R410A.
Longest possible lengths of copper pipe should be utilized to minimize joints on site.
Appropriate refrigeration installation tools must be utilised. Dry Nitrogen must be utilized at all times in the system during brazing.
All pipework (suction and liquid lines) to be insulated with slip on close cell elastomeric pipe insulation (as manufactured by Armaflex or equal and approved) having a wall thickness of not less that ½".
After installation of pipework, and prior to sealing of insulation joints and starting of equipment, pipework should be pressure tested. 44 PSIG test for 3 minutes minimum, then 217 PSIG for 3 minutes minimum, then 478 PSIG for 3 minutes minimum, then strength test to 600 PSIG. Check the system for leaks and deformation, then lower the pressure back to 478 PSIG and pressure test for 24 hours and check for leaks. The system should then be vacuumed/dehydrated to 300 microns, and hold at that vacuum for 12 hours (minimum)
Refrigerant (R410A) charge (by weight) must be calculated based on the actual installed length of pipe work in accordance with Mitsubishi recommendations. See local manufacturer representative for assistance with refrigerant charge calculations.
The charging should be carried out with an appropriate charging station.
Pipework to be properly fixed and supported at a minimum of 1.5 metres (5 feet) centres or as specified by local code, and where required should be run on galvanized uni-strut trays. All pipework to be labelled with ID number (condensing unit ref.) at 3 metre (10 foot) intervals.
Joints in copper pipe shall be brazed. Brazing shall be carried out to the requirements of the local codes and as per the Canadian copper & brass development association recommendations.

.10 Condensate Pipework: A condensate line shall be installed to each fan coil unit. This shall be installed and insulated all as per the standard specification. Minimum size of condensate pipes to be 25mm (1 inch) copper or plastic, insulated and pumped or by gravity from each fan coil/cassette, drains to run 1:80 min falls as indicated on drawings.

.11 Log Books: Full commissioning Logs shall be supplied by the local manufacturer distributor. These shall be completed fully and included with the main Installation and Operation Manuals prior to hand over. In addition, commissioning logs shall be returned to manufacturer.

.12 Warranty:

.1 Limited Warranty: 1-yr parts + 7-yr compressor

.2 Warranty is as above provided maintenance is carried out to a proven satisfactory level.

3 Execution

3.1 AIR CONDITIONING - SPLIT SYSTEM

.1 Install indoor unit in accordance with manufacturer's installation instructions. Make all duct and piping connections necessary.

.2 Install outdoor unit plumb and level on concrete pad or wall mounted as required, making all necessary piping connections.

.3 Install refrigerant line kits in accordance with manufacturer's installation instructions.

.4 Refrigeration Equipment: prepare system for start-up by having manufacturer's field engineer or factory trained representative supervise testing, and charging of machines.

End of Section

1 General

1.1 GENERAL

.1 Read and conform to:
- .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
- .2 Division 1 requirements and documents refered to therein.

1.2 SECTION INCLUDES

.1 Indirect fired make-up air heater.
.2 Service platform.
.3 Controls.

1.3 REFERENCES

.1 ASHRAE - 90A - Energy Conservation in New Building Design.
.2 NFPA 54 (AGA Z223.1) - National Fuel Gas Code.
.3 NFPA 90A - Installation of Air Conditioning and Ventilating Systems.

1.4 SUBMITTALS FOR REVIEW

.1 Section 15010: Procedures for submittals.
.2 Product Data: Provide data with dimensions, duct and service connections, accessories, controls, electrical nameplate data, and wiring diagrams.
.3 Shop Drawings: Indicate dimensions, duct and service connections, accessories, controls, electrical nameplate data, and wiring diagrams.

1.5 SUBMITTALS FOR INFORMATION

.1 Section 15010: Procedures for submittals.
.2 Manufacturer's Instructions: Indicate rigging, assembly, and installation instructions.

1.6 SUBMITTALS AT PROJECT CLOSEOUT

.1 Section 15010: Submittals for project closeout.
.2 Project Record Documents: Record actual locations of system and components.
.3 Operation And Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listing.
.4 Warranty: Submit manufacturers warranty and ensure forms have been filled out in Owners name and registered with manufacturer.

1.7 QUALITY ASSURANCE

.1 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
.2 Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience.

1.8 REGULATORY REQUIREMENTS

.1 Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.9 WARRANTY

.1 Section 15010: Submittals for project closeout.
.2 Provide five year manufacturers warranty for compressor/condenser unit.

1.10 MAINTENANCE SERVICE

.1 Section 15010: Submittals for project closeout.
.2 Provide service and maintenance of units for one year from Date of Substantial Completion.

1.11 EXTRA MATERIALS

.1 Section 15010: Submittals for project closeout.
.2 Provide two sets of filters.

2 Products

2.1 MANUFACTURERS

.1 Engineered Air Model DJX60.
.2 Other Acceptable Manufacturers:
  .1 Reznor.
  .2 Haakon.
.3 Substitutions: Refer to Section 15010.

2.2 MANUFACTURED UNITS

.1 Indoor installation air handling units shall be built to the level of quality as herein specified and to the description of the Air Handling Unit Schedule.
.2 Substitution of any product other than that specified, must assure no deviation below the stated capacities, air flow rate, heat transfer rate, filtration efficiency and air mixing quality. Power requirements must not be exceeded, and where specifically defined, sound power levels must not be exceeded. Applications for "equal" or "alternate" must address these factors.
.3 Unless stated otherwise, air handling units are to be shipped to the job in one piece, factory assembled. Modular units assembled to achieve a close proximation to the intent of this specification will not be considered equal. All equipment shall where specified and applicable, be pre-wired, and factory certified by an approved testing agency such as CETL, ETL, UL, CSA prior to shipment.
.4 Prewired air handling units shall bear an approved label with all the necessary identification marks, electrical data, and any necessary cautions as required by the National Electric Code, Part 2 (Canada).
.5 All electrical circuits shall undergo a dielectric strength test, and shall be factory tested and checked as to proper function.
.6 Provide a system of motor control, including all necessary terminal blocks, motor contractors, motor overload protection, grounding lugs, control transformers, auxiliary contactors and terminals for the connection of external control devices or relays. Gas fired units shall also include high limit and combustion air flow switch. Fire alarm circuits (where required) shall be powered from a relay in unit circuitry. Factory installed and wired non-fused disconnect switch in CEMA/NEMA 1 configuration.
.7 Automatic controls shall be housed in a control panel mounted in or on the air handling unit, which will meet the standard of the specific installation.
.8 The air handling units and major components shall be products of manufacturers regularly engaged in the production of such equipment and with a minimum of fifteen continuous years of proven production experience.

.9 Manufacturer shall have a fully implemented and auditable quality assurance program, equal to the ISO-9002 Quality Standard.

.10 Air Handling Units shall be as manufactured by Engineered Air and be base bid. Alternate products must show savings and clearly indicate all areas where they do not meet specified product.

2.3 UNIT CONSTRUCTION

.1 Unit casing shall be of minimum 16 (1.6 mm) gauge satin coat galvanized sheet metal. Surfaces shall be cleaned with a degreasing solvent to remove oil and metal oxides and primed with a two part acid based etching primer. Finish coat shall be an electrostatically applied enamel, to all exposed surfaces. All unprotected metal and welds shall be factory coated.

.2 All high pressure [5" (1250Pa) to 9" (2250Pa) w.c.] fan sections shall be constructed of 14 (0.2 mm) gauge metal. Continuous high pressure sealant shall be provided between all panels.

.3 All walls, roofs and floors shall be of formed construction, with at least two breaks at each joint. Joints shall be secured by sheet metal screws or pop rivets. Wall and floor joints shall be broken in and, on all outdoor units roof joints broken out (exposed) for rigidity. All joints shall be caulked with a water resistant sealant.

.4 Units shall be provided with access doors to the following components: fans and motors; filters; dampers and operators; access plenums and humidifiers/wet cells/ electrical control panels; burner compartments; compressor compartments. Access doors shall be large enough for easy access. Removal of screwed wall panels will not be acceptable. Provide hinged access doors, fully lined, with Leverlok handles, operable from both sides for all units over 48 in. (1220 mm) high. Whenever possible, hinged access doors to areas of negative pressure shall open out, and to areas of positive pressure shall open in. Where space constrictions require the use of outward opening doors to an area of positive pressure, a clear warning label must be affixed.

.5 Casings shall be supported on formed galvanized steel channel or structural channel supports, designed and welded for low deflections. Integral lifting lugs shall be provided for hoisting. All units shall be internally insulated with 2" (50 mm) thick 3.0 lb./cu.ft. (48 kg./cu.m.) density, neoprene coated fibre glass thermal insulation. Nominal 3 lb/cu.ft. (48 kg/cu.m.) insulation is secured with steel angles. All longitudinal insulation joints and butt ends shall be covered by a sheet metal break to prevent erosion of exposed edges. Drain pans and all floor areas shall be insulated on the underside.

.6 Air handling units shall be weatherproofed and equipped for installation outdoors. This shall include generally for the prevention of infiltration of rain and snow into the unit, louvers or hoods on air intakes and exhaust openings with 1" (25 mm) galvanized inlet screens; rain gutters or diverters over all access doors' all joints caulked with a water resistant sealant; roof joints turned up 2" (50 mm) with three break interlocking design; outer wall panels extend a minimum of ¼ inch (6 mm) below the floor panel; drain trap(s) connections for field supply & installation of drain traps.

.7 Provide full perimeter roof mounting curb of heavy gauge sheet metal, minimum of 12 inches (300 mm) high, and complete with wood nailer, neoprene sealing strip, and fully welded "Z" bar with 1" (25 mm) upturn on inner perimeter, to provide a complete seal against the elements. External insulation of the roof mounting curb shall be provided by the Roofing Subcontractor. Continuous structural support of curb by others.

2.4 FANS

.1 Centrifugal fans shall be rated in accordance with AMCA Standard Test Code, Bulletin 210. Fan manufacturer shall be a member of AMCA. All fans and fan assemblies shall be dynamically balanced during factory test run. Fan shafts shall be provided with a rust inhibiting coating.

.2 Single low pressure forward curved fans of 18" (450 mm) or less diameter, shall be equipped with permanently lubricated cartridge ball bearings, supported by a 3 point "spider" bearing bracket in the fan inlets. All other forward curved fan assemblies shall be equipped with greaseable pillow block bearings, supported on a rigid structural steel frame.

.3 Motor, fan bearings and drive assembly shall be located inside the fan plenum to minimize bearing wear and to allow for internal vibration isolation of the fan-motor assembly, where required. Motor mounting shall be adjustable to allow for variations in belt tension.

.4 Fan-motor assemblies shall be provided with vibration isolators. Isolators shall be bolted to steel

channel welded to unit floor which is welded to the structural frame of the unit. The isolators shall be neoprene-in-shear type of single 9" (230 mm) to 15" (380 mm) forward curved fans. All other fans shall incorporate vertical spring type isolators with leveling bolts, bridge bearing waffled pads with minimum 1" (25 mm) static deflection designed to achieve high isolation efficiency. Fans shall be attached to the discharge panel by a polyvinyl chloride coated polyester woven fabric, with a sealed double locking fabric to metal connection.

.5 Fan motors shall be premium efficiency open drip proof, ODP type, invertor rated.

.6 Provide a discharge air low limit equipped with an automatic by-pass time delay to allow for cold weather start-up. On a heating system failure this device will shut down the fan and close the outdoor air damper. This device shall require resetting by interrupting the electrical circuit.

2.5 VARIABLE FREQUENCY DRIVES

.1 Furnish complete variable frequency drives for AHU Supply Fan Motors. All standard and optional features shall be included within the VFD enclosure. VFD enclosure shall be NEMA 1 with inlet air filters. The entire package shall be CSA approved.

.2 Variable frequency drives shall be complete with non-fused disconnect switch.

.3 The VFD shall convert three-phase, 60 HZ utility power to adjustable voltage and frequency, three phase power for stepless motor speed control. The input voltage shall be as indicated in the Mechanical-Electrical Schedule.

.4 The VFD shall include a converter and an inverter section. The converter section shall convert fixed frequency and voltage AC utility power to DC voltage. All VFDs shall include input line reactors.

.5 The inverter section of the VFD shall invert the DC voltage into a quality output waveform, with adjustable voltage and frequency for stepless motor speed control. The VFD shall maintain a constant V/Hz ratio.

.6 Power line noise shall be limited to a voltage distortion factor and line notch depth as defined in IEEE Standard 519-19851, Guide for Harmonic Control. The total voltage distortion shall not exceed 5%.

.7 The VFD shall not emit radiated RFI in excess of the limitations set forth in the FCC Rules, Part 15 for Class A computing devices. PWM drives shall include RFI filters.

.8 Protective Features

- .1 Motor overload protection for each motor controlled.
- .2 Protection against:
  - .1 Input power under and overvoltage, phase loss.
  - .2 Output current overload and instantaneous overcurrent
  - .3 Overtemperature within VFD enclosure.
  - .4 Overvoltage on the DC bus.
  - .5 Sustained power or phase loss
- .3 Automatically reset faults due to undervoltage, phase loss, overvoltage and overtemperature.
- .4 Protection against output short circuit and motor winding shorting to cause faults, as defined by UL508.
- .5 Status lights or digital display English language of individual faults.
- .6 Controller capable of operating without a motor to facilitate start-up and troubleshooting.
- .7 Input line reactors shall be provided to minimize harmonics introduced to the AC line and to provide protection to AC line transients.

.9 Interface Features

- .1 Door mounted Hand/Off/Auto selector switch.
- .2 Local/Remote selector switch. In the remote position motor speed is determined by the follower signal. In the local position motor speed is determined by a manual switch mounted on the panel faceplate.
- .3 Power "ON" light.
- .4 Fault lights to indicate that the VFD has tripped on a fault condition.
- .5 Digital meter to indicate percent speed and percent load.
- .6 Form-C dry contacts to indicate when the VFD is in the run mode and to indicate when the VFD is in the fault mode.

.7 A 0-10 Vdc signal proportional to the speed.
.8 Safety shutdown from safety contacts (smoke, freeze) in drive or bypass mode.
.9 VFD shall accept 4-20 ma, 0-10 Vdc control signal.
.10 All alarms shall read out in full english language, coded messages are not acceptable.

.10 Adjustments
.1 Maximum speed (50-100% base), minimum (0-50% base)
.2 Acceleration time, adjustable 3 to 300 seconds
.3 Deceleration time, adjustable 3 to 300 seconds
.4 Current limit, adjustable 0 to 105%
.5 Overload trip setpoint
.6 Offset and gain to condition the input speed signal

.11 Service Conditions
.1 Ambient temperature 0 to 40 C
.2 0 to 95% RH non condensing
.3 Elevation to 1000 meters without derating
.4 AC line voltage variation, -10 to +10% nominal

.12 Special Features
.1 The following special features shall be included in the VFD enclosure. The unit shall maintain CSA listing.
.1 Manual bypass shall provide necessary circuitry to transfer the motor from the VFD to the power line or from the line to the controller. Motor overload protection shall be provided in both drive and bypass.
.2 The bypass function shall be accomplished by a four position Drive/Off/Line/Test switch. In the test position the motor shall operate in the full speed mode but the drive shall be energized to enable testing of drive functions.

.13 The manufacturer shall provide start-up commissioning of the variable frequency drive and its optional circuits by a factory trained certified technician. The commissioning personnel shall be the same personnel that will provide service and warranty repairs at the customer's site.

.14 Warranty
.1 The VFD shall be warranted by the manufacturer for a period of 36 months from the date of shipment. The warranty shall include parts and labour, travel costs, and living costs to provide authorized on-site service. The manufacturer shall maintain a fully stocked depot within 100 KM of the site.
.2 The motors which are directly connected to the VFD shall be warranted by the VFD manufacturer against insulation breakdown which is directly attributed to the VFD, for a period of 36 months.

.15 Acceptable Manufacturers: Graham base bid or Allan-Bradley. Magnetek or Siemens as alternate only.

2.6 GAS HEAT SECTION (DJX) - INDIRECT FIRED

.1 General
.1 Heating units shall be indirect natural gas fired approved for both sea level and high altitude areas. The entire package, including damper controls, fan controls, and all other miscellaneous controls and accessories shall be approved by an independent testing authority, and carry the approval label of that authority as a complete operating package.
.2 All units must exceed the ASHRAE 90.1 requirement of steady state efficiency at low fire.
.3 Operating natural gas pressure at unit(s) manifold shall be 7" (1750 Pa) w.c.

.2 Heat Exchanger
.1 Heat exchanger shall be a primary drum and multi-tube secondary assembly constructed of 409 grade titanium stainless steel with multi-plane tubulators, and shall be of a floating stress relieved design. Heat exchanger shall be provided with condensate drain connection. The heat exchanger casing shall have 1" (25 mm) of insulation between the outer cabinet and inner liner. Blower assemblies close coupled to duct furnace type heat exchangers are not acceptable.
.2 Units with optional high efficiency heat exchangers (DJX) shall be tested and certified to ANSI standards to provide a minimum of 90% efficiency throughout the entire operating

range as required by ASHRAE 90.1. The manufacturer shall be routinely engaged in the manufacture of this type of high efficiency equipment.

.3 A condensate neutralization tank to be shipped loose by the unit supplier and installed down stream of heat exchanger inside the building. Condensate piping shall be stainless steel tubing and piped from the heat exchanger to the dilution tank. The piping from the Dilution tank to be piped to an inside building drain. Where required the condensate may be required to be heat traced for freeze protection. (Note: Condensation in the heat exchanger will be one gallon per 100,000 btu per hour.)

.3 Burner

.1 The burner assembly shall be a blow through positive pressure type with an intermittent pilot ignition system to provide a high seasonal efficiency. Flame surveillance shall be with a solid state programmed flame relay c/w flame rod. The burner and gas train shall be in a cabinet enclosure. Insulation in the burner section shall be covered by a heat reflective galvanized steel liner. Atmospheric burners, or burners requiring power assisted venting are not acceptable.

.2 Unit(s) incorporating discharge air control and wherever specified, shall include 15:1 turndown (HT burner) for all inputs in range from 40 MBH to 450 MBH (12 kw to 132 kw). The high turndown burner minimum input shall be capable of controlling at 6.7% of its rated input without on-off cycling and include built in electronic linearization of fuel and combustion air. Efficiency shall increase from High to Low fire.

.4 Venting

.1 Installation and venting provisions must be in accordance with C.G.A. Standards B149.1, ANSI Z223.1-NFPA54, and local authorities have jurisdiction. Type A, Class 2 venting suitable for condensing appliances is required on indoor units.

.5 Controls

.1 Electronic (Modulating Fuel w/ Modulating Combustion Air)

.2 Solid state analyzer complete with proportional and integral control and with a discharge air sensor to maintain set point temperature and provide rapid response to incremental changes in discharge air temperature. Combustion air motor speed varies in response to the modulation of gas flow to provide optimum fuel/air mixture and efficiency at all conditions.

.3 Combustion efficiency of standard efficiency heat exchangers shall increase 4 - 5% from high fire to low fire on units incorporating 15:1 turndown (HT Burner).

.4 Alternate manufacturers units which do not incorporate a variable speed combustion air blower shall have a modulating gas valve and a combustion air damper with a linear linkage connected to an actuator which has a minimum of 100 steps of control.

.5 Controllers for heating units only shall include the following standard features:

.1 linear gas and combustion air flow obtained via a built in solid state linear algorithm
.2 -40°F (-40°C) minimum operating ambient temperature
.3 four (4) air change pre-purge on units with over 400 MBH (117 kw) input
.4 post purge
.5 interrupted pilot
.6 self check on start-up to make sure air proving and discharge air sensors are operating within design tolerances
.7 low fire start
.8 controlled burner start-up and shut down
.9 diagnostic lights for ease of set-up and service
.10 blower contactor that starts fan after burner pre-purge
.11 damper contact that allows fan to start after damper opens, damper to close after fan stops and damper to close on flame failure
.12 non-recycling auto by-pass low limit that has built-in sensor checking
.13 built-in alternate blower and damper functions and set back temperatures for unoccupied mode operation using a single room thermostat

.6 Heating control function shall be:

.1 Modulating discharge air complete with rest input terminals for 0-10 vdc signal from BMS.

2.7 FILTERS

.1 Filter sections shall be provided with adequately sized access doors to allow easy removal of filters. Filter removal shall be from one side as noted on the drawings.

.2 The filter modules shall be designed to slide out of the unit. Side removal 2" (50 mm) filters shall slide into a formed metal track, sealing against metal spacers at each end of the track. 2" (50 mm) Non-woven cotton and synthetic fabric media with a metal support grid and rigid heavy-duty board enclosing frame with diagonal support members bonded to the air entering and air exiting side of each pleat. Permanent re-usable metal enclosing frame. The filter media shall have an efficiency of 25-30% on ASHRAE Standard 52.1-92, and minimum MERV 6 per ASHRAE 52.2.-1999.

.3 Filter media shall meet U.L. Class 2 standards.

2.8 DAMPERS

.1 Damper frames shall be extruded aluminum sections securely screwed to the air handling unit chassis. Pivot rods of ½" (13 mm) aluminum, shall turn in nylon or bronze bushings. Rods shall be secured to the blade by means of straps and set screws.

.2 Blades shall be extruded aluminum airfoil blades. The damper shall included blade edge seals and perimeter frame seals The pivot rod shall "nest" in the centreline. Damper blade edge seals shall interlock. Maximum length of damper between supports shall be 42 inches (1070 mm).

.3 Dampers shall be standard construction for all dampers include blade ends sealed with an adhesive backed foam polyurethane gasketting. Outdoor air dampers also include an all weather PVC seal, fastened with a positive lock grip and pliable overlap edge on entering air side of interlocking edges. Dampers are interlocked from the centre.

.4 Two position inlet dampers shall be parallel blade type.

.5 Makeup Air Inlet Damper Control

.1 Provide a two position, normally closed electric damper operator. This damper operator shall be interlocked so that when the unit is shut down, or on a power failure, the damper shall return to the closed position.

3 Execution

3.1 AIR HANDLING UNITS

.1 Install air handling unit where indicated.

.2 Install unit flat and level and in accordance with manufacturers installation literature.

.3 Make all duct connections through flexible duct connectors.

.4 Level units while fans are in operation and align ductwork providing clearance in proportion to flexible duct connector length, ensuring that misalignment of ductwork when fan is not in operation does not strain or damage the connector.

.5 Power wiring under Division 16. All control wiring will be under Section 15900.

.6 Pipe all drain pan connections the nearest floor drain with appropriately sized trap.

.7 Field Testing of Units: do all field tests in the presence of the System Verification Agency and record all tests on forms acceptable to the Consultant. Issue the test report in triplicate to the Consultant.

3.2 FILTERS

.1 Air filters are to be provided with each air handling unit.

.2 Provide one set of filters for each filter bank at substantial completion and one spare set for each and every filter bank in accordance with 15010.

.3 Do not permit operation of air handling units during construction unless fully protected with filters in place. Replace all filters exposed during construction period in addition to those required above.

3.3 VARIABLE FREQUENCY DRIVES

.1 Provide variable frequency drives (VFD) for Air Handling Unit.
.2 Install VFD in strict accordance with manufacturers installation instructions.
.3 Provide wiring diagram to Division 16 for power supply and ground connections. Arrange and pay for connections from VFD to motor.
.4 Arrange for manufacturer to conduct start-up procedures and Owner's Instruction. Include VFD programming in Start-up.

End of Section

1 General

1.1 GENERAL

.1 Read and conform to:
- .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
- .2 Division 1 requirements and documents refered to therein.

1.2 SECTION INCLUDES

.1 Infrared heaters.
.2 Tubular infrared heaters.
.3 Fuel fired packaged air units.

1.3 REFERENCES

.1 ASHRAE 103 - Method of Testing for Annual Fuel Utilization Efficiency of Residential Central Furnaces and Boilers.
.2 NFPA 31 - Installation of Oil-Burning Equipment.
.3 NFPA 54 (AGA Z223.1) - National Fuel Gas Code.
.4 NFPA 90A - Installation of Air Conditioning and Ventilating Systems.
.5 NFPA 90B - Installation of Warm Air Heating and Air-Conditioning Systems.
.6 NFPA 211 - Chimneys, Fireplaces, Vents, and Solid Fuel Burning Appliances.
.7 UL 727 - Oil-Fired Central Furnaces.

1.4 SUBMITTALS FOR REVIEW

.1 Section 15010: Procedures for submittals.
.2 Product Data: Provide manufacturer's literature and data indicating rated capacities, weights, accessories, electrical nameplate data, and wiring diagrams.
.3 Shop Drawings: Indicate assembly, required clearances, and locations and sizes of field connections.

1.5 SUBMITTALS FOR INFORMATION

.1 Section 15010: Submittals for information.
.2 Manufacturer's Instructions: Indicate rigging, assembly, and installation instructions.

1.6 SUBMITTALS AT PROJECT CLOSEOUT

.1 Section 15010: Submittals for project closeout.
.2 Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts listing.
.3 Warranty: Submit manufacturers warranty and ensure forms have been filled out in Owners name and registered with manufacturer.

1.7 QUALITY ASSURANCE

.1 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1.8 REGULATORY REQUIREMENTS

.1 Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.9 WARRANTY

.1 Section 15010: Submittals for project closeout.
.2 Provide five year manufacturers warranty for heat exchangers.

1.10 EXTRA MATERIALS

.1 Section 15010: Submittals for project closeout.
.2 Provide two of each filter.

2 Products

2.1 TUBULAR INFRARED HEATERS

.1 Manufacturer: Reznor.
.2 Other acceptable manufacturers offering equivalent products.
  .1 Roberts Gorden.
  .2 Perfection.
  .3 Gas Fired Products Inc.
.3 Units: Packaged, partially factory assembled, pre-wired unit consisting of cabinet, burner, heat exchanger, radiant tube, reflector, controls; for natural gas.
.4 Heat Exchanger: Aluminized tubular steel combustion chamber with aluminized steel tube with aluminum reflector.
.5 Gas Burner:
  .1 Gas Burner: Forced draft type with adjustable combustion air supply.
  .2 Gas valve provides 100 percent safety gas shut-off; 24 volt combining pressure regulation, safety pilot, manual set (On-Off), pilot filtration, automatic electric valve.
  .3 Electronic pilot ignition, with electric spark igniter.
  .4 Non-corrosive burner air blower with permanently lubricated motor.
.6 Gas Burner Safety Controls: Thermo-couple sensor prevents opening of solenoid gas valve until pilot flame is proven and stops gas flow on ignition failure.
.7 Operating Controls: Low voltage room thermostat cycles burner to maintain room temperature setting.

3 Execution

3.1 EXAMINATION

.1 Verify that space is ready for installation of units and openings are as indicated on shop drawings.
.2 Verify that proper power supply is available.
.3 Verify that proper fuel supply is available for connection.

3.2 INSTALLATION

.1 Install to NFPA 90A.
.2 Install gas fired units to NFPA 54.
.3 Provide vent connections to NFPA 211.

.4 Provide operating controls; refer to Section 15900.
.5 Provide connection to electrical power systems; refer to Division 16.

End of Section

1 General

1.1 GENERAL

.1 Read and conform to:
- .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
- .2 Division 1 requirements and documents refered to therein.

1.2 REFERENCES

.1 AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
.2 AFBMA 11 - Load Ratings and Fatigue Life for Roller Bearings.
.3 AMCA 99 - Standards Handbook.
.4 AMCA 210 - Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
.5 AMCA 300 - Reverberant Room Method for Sound Testing of Fans.
.6 AMCA 301 - Method of Publishing Sound Ratings for Air Moving Devices.
.7 AMCA 500 - Method of Testing Louvres for Ratings.
.8 AMCA 5000 - Method of Testing Dampers for Ratings.
.9 ARI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils.
.10 ARI 430 - Fabrication of Central Station Air Handling Units.
.11 ARI 435 - Application of Central-Station Air-Handling Units.
.12 ARI 610 - Central System Humidifiers for Residential Applications.
.13 SMACNA - HVAC Duct Construction Standards - Metal and Flexible.
.14 UL 900 - Air Filter Units.

1.3 SUBMITTALS

.1 Section 15010: Procedures for submittals.
.2 Shop Drawings: Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, and electrical characteristics and connection requirements.
.3 Product Data:
- .1 Provide literature which indicates dimensions, operating weights, capacities, ratings, fan performance, gauges and finishes of materials, and electrical characteristics and connection requirements.
- .2 Provide data of filter media, filter performance data, filter assembly, and filter frames.
- .3 Provide fan curves with specified operating point clearly plotted.
- .4 Submit sound power level data for both fan outlet and casing radiation at rated capacity.
- .5 Submit electrical requirements for power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.

.4 Samples: Submit two of each type of replacement filter media with frame.
.5 Manufacturer's Installation Instructions.

1.4 OPERATION AND MAINTENANCE DATA

.1 Section 15010: Submittals for project closeout.
.2 Maintenance Data: Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.

1.5 QUALIFICATIONS

.1 Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum five years documented experience, who issues complete catalogue data on total product.

1.6 DELIVERY, STORAGE, AND HANDLING

.1 Section 15010: Transport, handle, store, and protect products.
.2 Accept products on site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs. Inspect for damage.
.3 Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

1.7 ENVIRONMENTAL REQUIREMENTS

.1 Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

1.8 EXTRA MATERIALS

.1 Section 15010: Submittals for project closeout.
.2 Provide one spare set for each unit of the following;
  .1 fan belts
  .2 filters

2 Products

2.1 MANUFACTURERS

.1 Captiveaire.
.2 Springair.
.3 Halton.

2.2 OUTDOOR UNITS

.1 Indirect-fired gas heating and ventilating unit(s). Orientation shall be Horizontal Down discharge. Unit shall be factory assembled, tested and shipped as a complete packaged assembly, for outdoor mounting, consisting of the following:
  .1 gas furnace;
  .2 centrifugal blower (forward-curved double width/double inlet);
  .3 motor starter with thermal overload protection;
  .4 motor and drive assembly;
  .5 fuel burning and safety equipment;
  .6 temperature control system, and
  .7 gas piping.
.2 Approvals: Unit assembly shall be tested in accordance with Standard, ANSI Z83.8-2006 and CSA 2.6-2006 and shall bear the ETL label. The duct furnace shall be certified by the American Gas Association and approved by the Canadian Gas Association.
.3 Housing:
  .1 Unit housing shall be constructed of 20 Gauge G-90 galvanized steel. The wall panels and roof panels shall be fabricated by forming double-standing, self-locking seams that require no additional support. The floor and wall panels shall be caulked air tight with a silicone caulk. All casing panels shall be attached with sheet-metal screws or rivets, which can be removed to field service large components. The unit base shall be suitable for curb mount. The base shall be constructed of galvanized steel. Base shall be structurally reinforced to accommodate the blower assembly and burner. Housing construction should be suitable for outdoor installation.
  .2 All doors and at least one side of every sheet metal surface of the unit separating two air-masses of different air temperatures shall be faced with properly secured 1" aluminum-faced insulation for condensation prevention. The discharge of the unit (Down) shall be internal to the heating module containing the furnaces.

.3 All electrical controls on the control board shall be mounted in an isolated, fully enclosed and insulated vestibule, completely separated from any combustion air, but accessible for servicing needs.

.4 All furnace exhaust flues shall be of double-wall construction. All furnace exhaust flue connections and roof penetration seams shall be sealed with High-Temp Fire-Barrier 2000+ type silicone caulking.

.5 All unit housings shall be equipped with Internal Air Distribution Screens on the upstream side of each furnace heat-exchanger.

.6 All gas valves and electrical safety-limits shall be mounted within the burner vestibule; wiring to these components shall be properly secured and away from all high temperature metal surfaces. The burner vestibule shall be an integral part of the unit and not extend outside the exterior casing of the unit and not exposed to the main air stream.

.7 High wind rain caps shall be installed at the termination of the furnace discharge flues.

.8 The vestibule full-size door shall provide easy access to controls and gas-train components. Blower door shall provide easy access to blower, motor and drives. Access doors shall be provided on both front and back side of unit providing full access to every part of the unit.

.4 Blower:

.1 Blower(s) shall be forward-curved, centrifugal, Class I or II, double width, double inlet, constructed G-90 galvanized steel. Unit shall have a heavy-duty, solid-steel shaft. Wheels shall be balanced in two planes and done in accordance with AMCA standard 204-96. The wheel blades shall be aerodynamically designed. The wheel blades shall be securely attached to the wheel inlet ring. The wheel shall be firmly attached to the fan shaft with set screws and keys. The blower assembly shall be isolated from the fan structure with vibration isolators.

.2 Blower capacity shall be as indicated.

.3 External Static: The sum of duct loss plus duct component static- Example: louvers, diffusers. All blowers shall be tested and set at rated speed after being installed in the factory-assembled unit.

.5 Motor & Motor Compartment: Motors shall be heavy duty ball bearing type. Motor mounting plate shall be constructed of heavy gauge galvanized steel and shall be designed to provide easy adjustment of belt tension. Blower motor shall be Open Drip Proof.

.6 Shaft & Bearings: Shafts shall be precision ground and polished. Heavy duty, pre-lubricated bearings shall be selected for a minimum (L50) life in excess of 200,000 hours of operation at maximum cataloged operating speed. They shall be designed for, and individually tested specifically for use in air handling applications.

.7 Belts & Drives: Belts shall be oil and heat resistant, non-static, grip-notch type. Drives shall be cast type, precision machined and keyed and secured attached to the fan and motor shafts. Fan operating speed shall be factory set using adjustable pitch motor pulleys. Blower drives shall be fully adjustable. All drives shall be a minimum of 2 groove above 2 HP.

.8 Burner & Heat Exchanger:

.1 The gas burner shall be an indirect-fired, push-through type, using natural gas at an inlet-supply pressure to the unit of 7 inches water column. Burner shall be a tubular in-shot fired design capable of using natural gas. Each burner ignition shall be of the direct-spark design with remote flame sensing at inlet of the last firing tube of the gas manifold. Each burner ignition module shall be pre-programmed with a ignition sequence comprised of a 1 minute pre-purge, 1 min inter-purge, 2 minute post-purge, 15 second ignition, 3 trials for ignition, and 60 min lockout.

.2 Direct-sparking sequence shall last through the complete during of the trial for ignition period for guaranteed lightoff.

.3 Burner shall always be lit at maximum gas flow and combustion airflow for guaranteed light-off. Each burner ignition module shall have LED indicators for troubleshooting and a set of exposed prongs for testing flame indication signal.

.4 All furnaces shall be controlled by an electronic vernier-type fully modulating control system capable of achieving 83% combustion efficiency over the entire gas firing range of the unit.

.5 Each furnace shall have a minimum turndown ratio of 6:1 for natural gas.

.6 Each furnace heat exchanger shall be a bent-tube style design made entirely of type 409 stainless steel.

.7 Each furnace shall include a blocked vent safety airflow switch with high temperature silicone tubing operating off of absolute pressure measured inside of the power-vent blower housing.
.8 Each furnace shall include a high temperature auto-recycling limit with a maximum non-adjustable setpoint of 200F.
.9 Each furnace shall include a manual reset high temperature flame roll out switch with a non-adjustable setpoint of 325F.
.10 Each Furnace shall be accessible from both sides of unit.
.11 Each Furnace shall include a power-vent assembly for exhausting flue gases with a ype PSC type motor that is securely mounted with rubber vibration isolators and easily accessible/removable for service.
.12 Every heat-exchanger shall have a manufacturer-backed 10-year pro-rated warranty.
.13 Every power-vent blower motor and housing shall have a standard 1-year manufacturer-backed warranty.
.14 Each furnace module gas inlet shall be equipped with a 0-35"w.c. gas pressure gauge. A 0-10"w.c. gas pressure gauge shall be installed on the gas manifold of each furnace.

.9 Gas Equipment: All gas equipment shall conform to local-Code requirements Components:
.1 modulating-gas valve
.2 on/off redundant gas valve
.3 burner
.4 main-gas shut-off valve
.5 main-gas regulator
.6 two solenoid valves
.7 All gas manifold components shall be piped and wired at the factory.

.10 Safety Controls:
.1 motor starter with adjustable overloads
.2 main air-flow safety switch
.3 electronic flame-safety relay
.4 high-temperature limit switch
.5 non-fused disconnect
.6 flame roll-out switch
.7 main-gas regulator
.8 two solenoid valves
.9 modulating-gas valve
.10 burner
.11 combustion air-proving switch.

.11 Accessories
.1 Inlet Dampers: Manufacturer shall provide and install on unit, a two-position, motor operated damper with internal end switch to energize the blower-starter circuit, when damper is 80% open. Blades shall be a maximum of 6" wide 16 Gauge G-90 galvanized steel shall be made to guarantee the absence of noticeable vibration at design air velocities. Damper blades to be mounted on friction-free synthetic bearings. Damper edges shall have PVC coated polyester fabric mechanically locked into blade edge. Jamb seals to be flexible metal, compression type.
.2 Filters: The filters shall be (2") thick, aluminum mesh, coated with super-filter adhesive. Aluminum-mesh filters shall have aluminum frames with media to be layers of slit and expanded aluminum, varying in pattern to obtain maximum depth loading. Washable 2" filters shall be enclosed in two-piece, die-cut frame with diagonal supports. Frame shall be constructed of heavy-duty beverage board. Filter media is supported on the air leaving side by a metal grid. Filter Section shall be insulated constructed of G-90 galvanized steel with filters supported by internal slides and with removable access panels. Filters shall be provided in a v-bank arrangement.
.3 Fresh-Air Inlet Hood: Shall be constructed of G-90 galvanized steel with birdscreen. Intake must be 30"clear above roof surface.
.4 Curb: 24" curb shall be constructed of 18 ga G-90 galvanized steel as a completed welded assembly.

.12 Temperature Control Systems
.1 BAS (Building Automation System) Control: For building exhaust-air replacement with

modulated temperature control based off of BAS supplied 0-10 Vdc or 4-20mA input signal. Auxiliary contacts and relays provided for contractor in the field.

.13 Other Options: Operating lights mounted in a remote-control panel to indicate: power, burner ON and blower ON.

.14 Wiring And Electrical
- .1 The control circuit voltage shall be 24 volts.
- .2 A control transformer shall be provided.
- .3 Unit shall have standing 120 Vac power.
- .4 The control wiring shall be carried in wire channel or conduit.
- .5 Wiring in control enclosures shall be in accordance with the Electrical Code and local codes.
- .6 Motor starter shall be provided.
- .7 Starter shall be line voltage, definite purpose type.
- .8 Unit shall be complete with all items such as relays, starters, switches, safety controls, conduit and wire as required for proper operation.
- .9 All factory-mounted controls shall be factory prewired to the unit control panel.
- .10 Optional
  - .1 Single point electrical connection shall be supplied.
  - .2 Blower-on delay timer to pre-heat the heat-exchanger prior to energizing the main blower.
  - .3 Convenience outlet shall be provided on the control board with 120 Vac service.
  - .4 Freeze-stat shall be provided with adjustable dials for time and temperature settings to shut down the main blower in case of burner failure.
  - .5 Dirty filter airflow switch with LED indicator light on remote panel.
  - .6 Cabinet heater strip with thermostat.

.15 Factory Tested: Unit shall be operated, tested and set at the factory using job-site conditions for electrical and gas input. All operating and safety controls shall be tested and set at the factory. Adjustable, or fixed sheaves shall be set for proper RPM at specified conditions. Gas-pressure regulator shall be set for specified burning rate at specified inlet pressure.

.16 Service and Parts: The supplier shall furnish gas piping schematics, as built wiring connection and control-circuit diagrams, dimension sheets and a full description of the unit. Service manuals, showing service and maintenance requirements, shall be provided with each unit.

.17 Acceptable Manufacturer Model: CaptiveAire A-IBT or approved equal.

2.3 FANS

.1 Fan Characteristics
- .1 Type: Backward inclined, type fan.
- .2 Performance Ratings: Conform to AMCA 210 and bear the AMCA Certified Rating Seal.
- .3 Sound Ratings: AMCA 301; tested to AMCA 300 and bear AMCA Certified Sound Rating Seal.
- .4 Bearings: Self-aligning, grease lubricated, ball or roller bearings with lubrication fittings extended to exterior of casing with plastic tube and grease fitting rigidly attached to casing.
- .5 Mounting: Locate fan and motor internally on welded steel base coated with corrosion resistant paint. Factory mount motor on slide rails. Provide access to motor, drive, and bearings through removable casing panels or hinged access doors. Provide built-in inertia base of welded steel with bottom sheet and reinforcing grid for concrete ballast. Mount base on vibration isolators ; refer to Section 15190 - Vibration Isolation
- .6 Flexible Connection: Separate fan and coil sections. refer to Section 15815 - Duct Work Accessories.
- .7 Perforated diffuser plate shall be provided on the fan discharge for uniform air distribution.
- .8 Fans shall be selected so that speed required for the operative duty is at least 10% less than the max. speed of the fan.
- .9 Fans shall be selected for extremely low noise levels.
- .10 Performance: as scheduled.

.2 Scrolled Centrifugal fans
- .1 Provide fan wheel diameter and class construction as scheduled. Fans must carry the

AMCA seal for AIRFLOW and SOUND.

.3 Fan Wheels and Shafts: Provide air foil blades and solid shafts keyed to the fan wheel.

.4 Motor shall be heavy duty, premium efficiency, TEFC type with permanently lubricated sealed ball bearings and furnished to suit the electrical characteristics indicated in Section15950 - Mechanical/Electrical Equipment Schedule

.5 Bearings are to be mounted on the integral fan scroll bracing.

.6 Fan and motor shall be mounted on an all welded, structural steel, prime coated, and internal isolation base with springs. The outlet of the fan shall be separated from the unit casing by means of a factory installed flexible connection. The internally mounted motor shall be provided on a slide rail base to allow proper adjustment of belt tension.

.7 Fans shall have inlet OSHA approved inlet screens.

.3 Plenum Type Fans

.1 Provide fan wheel diameter and class construction as scheduled. Fans must carry the AMCA seal for AIRFLOW and SOUND.

.2 Fans shall be centrifugal plenum type, designed without scroll type housing. Fans shall incorporate a wheel, heavy gauge reinforced steel inlet plate with removable spun inlet cone, structural steel frame, shaft and bearing in AMCA Arrangement 3 configuration as an entire assembly.

.3 All fan wheels shall have tapered spin wheel cones or shrouds providing stable flow and high rigidity, the wheels shall be non-overloading type.

.4 Provide plenum fan inlets on the fan wall and air outlets from the casing with a smooth 2" radius bell mouth fitting free of protruding structural members and flanges.

.5 The blades shall be continuously welded, die-formed Airfoil type, designed for maximum efficiency and quite operation. Partial welding will not be acceptable on airfoil Blades.

.6 Impellers shall be statically and dynamically balanced and the complete fan assembly shall be test balanced at the operating speed prior to shipment.

.7 Motor shall be heavy duty, premium efficiency, TEFC type with permanently lubricated sealed ball bearings and furnished to suit the electrical characteristics indicated in Section15950 - Mechanical/Electrical Equipment Schedule.

.1 The plenum fan assembly MUST have an enclosed safety screen as per OSHA standards. Provision of a door interlock is not an acceptable alternative to complete fan screening.

2.4 BEARINGS AND DRIVES

.1 Bearings: heavy duty regreasable AFBMA 9 ball or AFBMA 11 roller type in a cast iron pillow block housing, , minimum L10 life in excess of 200,000 hours at maximum cataloged operating speed, self-aligning. Copper tubes shall extend to allow regreasing of bearings.

.2 Shafts: Solid, hot rolled steel, ground and polished, with key-way, and protectively coated with lubricating oil.

.3 V-Belt Drive: precision machined cast iron or steel type, keyed and securely attached to the wheel and motor shafts, dynamically balanced. Variable and adjustable pitch sheaves for motors 1.5 kW and under selected so required rpm is obtained with sheaves set at mid-position; fixed sheave for larger motors. Belts shall be oil and heat resistant, non-static type, matched and drive rated as recommended by manufacturer. Drives shall be sized for 150% of the installed motor horsepower.

.4 Belt Guard: OSHA approved fully enclosed metal belt guard having sides of galvanized steel and 2.8 mm thick, 20 mm diamond mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation, with provision for adjustment of belt tension, lubrication, and use of tachometer with guard in place.The guard shall be sized as to allow an increase of two sizes of either sleeve.

2.5 VIBRATION ISOLATION

.1 An integral all weld steel vibration isolation base shall be provided for the fan and motor.

.2 Provide open spring mounts with iso stiff springs, sound deadening pads and leveling bolts
.3 Horizontal stiffness shall be equal to vertical stiffness
.4 Spring deflection shall be 50mm (2 inches)
.5 Isolators shall have siesmic (earthquake) restraints. Refer to Section15191 - Seismic Restraints

2.6 COILS

.1 Casing: Provide access to both sides of coils. Enclose coils with headers and return bends exposed outside casing. Slide coils into casing through removable end panel with blank off sheets and sealing collars at connection penetrations.
.2 Drain Pans: 600 mm (24 in.) downstream of coil and down spouts for cooling coil banks more than one coil high. Drain pans shall be of stainless steel and sloped to eliminate standing water.
.3 Eliminators: Three break of Type 304 stainless steel, mounted over drain pan.
.4 Air Coils: Certify capacities, pressure drops, and selection procedures to ARI 410.
.5 Fabrication:
  .1 Tubes: seamless copper expanded into fins, brazed joints.
  .2 Fins: Aluminum mechanically bonded to tubes.
  .3 Headers: Seamless copper tube with vent and drain connections.
  .4 Coil casing: 1.6mm (16 gauge), die formed, galvanized steel channels with center and end supports.
.6 Configuration:
  .1 Drainable, with threaded plugs for drain and vent, threaded plugs in return bends and in headers opposite each tube.
  .2 Maximum individual coil height not to exceed 1219mm (48 in.).
  .3 Intermediate drain pans where more than one coil is required.
  .4 Mounted on coil rack frames manufactured to allow coils to be individually removed.
.7 Glycol/Water Heating Coils:
  .1 Tubes: 16 mm (in.) OD, minimum wall thickness of **0.016 inches**.
  .2 Coil casing: 1.6mm (16 gauge), die formed, galvanized steel channels with center and end supports.
  .3 Coil racks: 1.6mm (16 gauge) satin coat steel, painted with red oxide primer.
.8 Chilled Water Cooling Coils:
  .1 Tubes: 16 mm (in.) OD, minimum wall thickness of **0.016 inches**.
  .2 Coil casing: 1.6mm (16 gauge), die formed, type 304 stainless steel channels with center and end supports.
  .3 Coating: Heresite
  .4 Coil racks: 2.8mm (12 gauge) 304 stainless steel
.9 Steam Coils:
  .1 Tubes: **16** mm (in.) OD, minimum wall thickness of **0.016 inches**.
  .2 Coil casing: 1.6mm (16 gauge), die formed, galvanized steel channels with center and end supports.
  .3 Coil racks: 1.6mm (16 gauge) satin coat steel, painted with red oxide primer.
.10 Coils shall be tested at _____ kPa (450 psig) air pressure.
.11 Coils shall be selected for a maximum velocity of ____ m/s (450 fpm) in cooling application and _____ m/s (600 fpm) in heating application.

2.7 FILTERS

.1 Filter Box: Section with filter guides, access doors from both sides, for side loading.
.2 Filter Frames: Holding frames shall be factory fabricated of 1.6mm (16 gauge) galvanized steel and shall be equipped with gaskets and 2 heavy duty positive sealing fasteners. Each fastener shall be capable of withstanding 0.9kg (25 lb.) pressure without deflection, capable of being attached or removed without the use of tools.
.2 Filter Media: high density microfine glass fibers laminated to a non-woven synthetic backing to form a lofted filter blanket, UL 900 listed Class I or Class II, approved by local authorities.
.3 Renewable Media: Section with vertical filters with manual control and auxiliary frame for extended surface retained media filters. Refer to Section 23 40 00.

.3 Pre-Filters: Filters shall be 50mm (2"). Arrangement: Flat, disposable, extended area panel filters, (MERV 8).
.5 Extended Surface: Filter box with holding frames and blank-off sheets, extended surface retained media filters with 30 percent dust spot efficiency. Refer to Section 23 40 00.
.6 Extended Surface Cartridge Filters: Final filters shall be high performance, AAF RigiFil II SH (MERV 13) deep pleated 300mm (12") long cartridge disposable type. Each filter shall consist of glass fibre media, media support grid, contour stabilizer and enclosing frame.
.7 Extended Surface Bag Filters: Final filters shall be high performance, AAF Dri-Pak (MERV 11) deep pleated 559mm (22") long bag disposable type. Each filter shall consist of glass fibre media, media support grid, contour stabilizer and enclosing frame.
.7 30% eff. pre-filters shall be 50 mm (2") thick, pleated media of disposable type. Filter media shall not be less than 2.5 sq.ft. per 1.0 sq. ft. of filler area.
.8 Secondary filters shall be 85-95% efficiency disposable types.
.9 Filter Media: Final filter media shall be of high density microfine glass fibers laminated to a non-woven synthetic backing to form a lofted filter blanket. The filter media shall be MERV 11. The filter shall be listed by Underwriters Laboratories as Class 2
.9 Final filters shall be high efficiency particle absolute (HEPA) with 99.97% on 0.3 micron particle size.
.10 Summer Filter Position: Provide an additional prefilter rack upstream of the snow melt coils for summer operation.
.11 Filter Gauges: Magnehelic gauges, 90 mm diameter diaphragm actuated dial in metal case, with static pressure tips, accurate to +/- 2% of full range. Provide one gauge flush mounted into the casing for each filter bank.

2.8 DAMPERS

.1 Mixing Boxes: Section with factory mounted outside and return air dampers of galvanized steel with vinyl bulb edging in galvanized frame, with galvanized steel axles in self-lubricating nylon bearings, in parallel blade arrangement with damper blades positioned across short air opening dimension.
.2 Damper Leakage: Maximum 2 percent at 1 kPa differential pressure when sized for 10 m/s face velocity.
.3 Face and Bypass Dampers: Factory mounted in casing with access doors, of galvanized steel blades, with vinyl bulb edging, galvanized steel frame, and axles in self-lubricating nylon bearings, arranged to match coil face with bottom bypass, blank-off and division sheets, internal linkage, access doors, and adjustable resistance plate.
.4 Multi zone Dampers: Factory mounted in casing with service door, of galvanized steel blades with vinyl bulb edging and frame with 13 mm(1/2") diameter stainless steel shaft in oil impregnated bronze bearings, with end stops in frame, arranged for parallel blade operation, with adjustable resistance plates, hand quadrants, and sheet metal clips for duct connections.
.5 Damper drives (make: BELIMO shall be provided as an optional quote. Shafts shall extend out sufficiently so as to mount the drives.

3 Execution

3.1 INSTALLATION

.1 Install to manufacturer's instructions.
.2 Install to ARI 435.
.3 Assemble high pressure units by bolting sections together. Isolate fan section with flexible duct connections.
.4 Install assembled unit on Mason Super `W' 0.1 Deflection Isolation.
.5 Exact thickness of concrete housekeeping pad to suit depth required for deep seal trap.

3.2 AIR HANDLING UNIT SCHEDULE

.1 Air Handling Unit Scheduled: As scheduled on drawings.

End of Section

1 General

1.1 GENERAL

.1 Read and conform to:
- .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
- .2 Division 1 requirements and documents refered to therein.

1.2 SECTION INCLUDES

.1 Metal duct work.
.2 Duct cleaning.
.3 Duct Leakage Testing

1.3 REFERENCES

.1 ASTM A90/A90M - Weight (Mass) of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.
.2 ASTM A653/A653M - Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
.3 ASTM A1011/A1011M - Standard Specification for Steel, Sheet, and Strip Hot-Rolled, Carbon, Structural, High-Strength, Low-Alloy with Improved Formability.
.4 AWS D9.1 - Sheet Metal Welding Code.
.5 NFPA 90A - Installation of Air Conditioning and Ventilating Systems.
.6 NFPA 90B - Installation of Warm Air Heating and Air-Conditioning Systems.
.7 NFPA 96 - Ventilation Control and Fire Protection of Commercial Cooking Operations.
.8 SMACNA - HVAC Air Duct Leakage Test Manual.
.9 SMACNA - HVAC Duct Construction Standards - Metal and Flexible.

1.4 PERFORMANCE REQUIREMENTS

.1 No variation of duct configuration or sizes permitted except by written permission. Size round ducts installed in place of rectangular ducts to ASHRAE table of equivalent rectangular and round ducts.

1.5 SUBMITTALS

.1 Section 15010: Procedures for submittals.
.2 Shop Drawings: Indicate duct fittings, particulars such as gauges, sizes, welds, and configuration prior to start of work for 1000 kPa pressure class and higher systems.
.3 Product Data: Provide data for duct materials.
.4 Samples: Submit two samples of typical shop fabricated duct fittings.
.5 Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA HVAC Air Duct Leakage Test Manual.
.6 Manufacturer's Installation Instructions: Indicate special procedures for glass fibre ducts.

1.6 PROJECT RECORD DOCUMENTS

.1 Section 15010: Submittals for project closeout.
.2 Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

1.7 QUALITY ASSURANCE

.1 Perform Work to SMACNA - HVAC Duct Construction Standards - Metal and Flexible.
.2 Perform Duct Leakage Tetsing to SMACNA "HVAC Air Duct Leakage Testing Manual"
.2 Maintain one copy of document on site.

1.8 QUALIFICATIONS

.1 Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
.2 Installer: Company specializing in performing the work of this section with minimum three years documented experience.

1.9 REGULATORY REQUIREMENTS

.1 Construct duct work to NFPA 90A standards.

1.10 ENVIRONMENTAL REQUIREMENTS

.1 Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.
.2 Maintain temperatures during and after installation of duct sealants.

2 Products

2.1 MATERIALS

.1 Galvanized Steel Ducts: ASTM A653 galvanized steel sheet, lock-forming quality, having G90 zinc coating of to ASTM A90.
.3 Hanger Rod: continuously threaded, galvanized steel in general, stainless steel for stainless steel ducts.
.4 Hight Transmission Loss (HTL) Ductwork: galvanized ductwork of same gauge as outer casing of adjacent duct silencer, minimum 16 gauge.
.5 Fasteners: RivIts, bolts, or sheet metal screws.
.6 Sealant: Non-hardening, water resistant, fire resitive, compatible with mating materials; liquid used alone or with tape, or heavy mastic.
.7 Hanger Rod: ASTM A36; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.

2.2 DUCT WORK FABRICATION

.1 Fabricate and support to SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated. Provide duct material, gauges, reinforcing, and sealing for operating pressures indicated.
.2 Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centreline. Where not possible and where rectangular elbows are used, provide air foil turning vanes. Where acoustical lining is indicated, provide turning vanes of perforated metal with glass fibre insulation.
.3 Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
.4 Fabricate continuously welded round and oval duct fittings two gauges heavier than duct gauges indicated in SMACNA Standard. Joints: minimum 100 mm cemented slip joint, brazed or electric welded. Prime coat welded joints.
.5 Provide standard 45 degree lateral wye takeoffs unless otherwise indicated where 90 degree

conical tee connections may be used.

.6 Flexible ducts shall be factory fabricated to CAN/ULC S110. Shall be sprial wound aluminum constrcution with average thickness of 0.15 mm and a minimum positive pressure rating of 3.0 K pascals for medium and high pressure ratings.

3 Execution

3.1 INSTALLATION

.1 Install to manufacturer's instructions.
.2 Install and seal ducts to SMACNA HVAC Duct Construction Standards - Metal and Flexible.
.3 Duct Sizes are inside clear dimensions. For lined ducts, maintain sizes inside lining.
.4 Provide openings in duct work where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated duct work, install insulation material inside a metal ring.
.5 Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
.6 Use crimp joints with or without bead for joining round duct sizes 200 mm and smaller with crimp in direction of air flow.
.7 Use double nuts and lock washers on threaded rod supports.
.8 Connect diffusers or light troffer boots to low pressure ducts directly or with 1.5 m maximum length of flexible duct held in place with strap or clamp.
.9 Connect flexible ducts to metal ducts with adhesive and metal or nylon straps.
.10 During construction provide temporary closures of metal or taped polyethylene on open duct work to prevent construction dust from entering duct work system.
.11 Install HTL ductwork between duct silencer and mechanical room wall.
.12 Balancing dampers shall be installed on branches as per locations shown on the drawings and as per the requirements of NEBB and AABC listing/measuring standards.
.13 Where ducts pass through walls, floors, openings requied to have a fire resistance rating the opening in the construction around the duct shall be filled with an approved fire stop material as per NFPA 90A and fire damper shall also be installed with access doors as per the code.
.14 Perform duct leakage testing for all ductwork installed ubnder this contract.

3.2 DUCTWORK SCHEDULE

Duct System	Material	Max. Velocity (FPM)	Pressure Class (in. w.g.)	Leakage Class (cfm/100sf @ 1" wg)
HVAC Supply - Rectangular	galvanized steel	2,000	2	6
HVAC Supply - Round	galvanized steel	2,000	2	3
HVAC Return/Exhaust-rectangular	galvanized steel	2,000	-2	6
HVAC Return/Exhaust - round	galvanized steel	2,000	-2	3
Fume Hood Exhaust	304 stainless steel	2,000	-2	0
Cage Wash Exhaust	304 stainless steel	2,000	-2	6
Glass Wash Exhaust	304 stainless steel	2,000	-2	6

End of Section

1 General

1.1 GENERAL

.1 Read and conform to:
- .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
- .2 Division 1 requirements and documents refered to therein.

1.2 SECTION INCLUDES

.1 Air turning devices/extractors.
.2 Backdraft dampers.
.3 Duct access doors.
.4 Duct test holes.
.5 Fire dampers.
.6 Flexible duct connections.
.7 Volume control dampers.

1.3 REFERENCES

.1 NFPA 90A - Installation of Air Conditioning and Ventilating Systems.
.2 SMACNA - HVAC Duct Construction Standards - Metal and Flexible.
.3 UL 33 - Heat Responsive Links for Fire-Protection Service.
.4 UL 555 - Fire Dampers.

1.4 SUBMITTALS

.1 Section 15010: Procedures for submittals.
.2 Shop Drawings: Indicate for shop fabricated assemblies including volume control dampers.
.3 Product Data: Provide for shop fabricated assemblies including volume control dampers. Include electrical characteristics and connection requirements.
.4 Manufacturer's Installation Instructions: Indicate for fire dampers.

1.5 PROJECT RECORD DOCUMENTS

.1 Section 15010: Submittals for project closeout.
.2 Record actual locations of access doors.

1.6 QUALIFICATIONS

.1 Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1.7 REGULATORY REQUIREMENTS

.1 Products Requiring Electrical Connection: Listed and classified by Underwriters' Laboratories Inc., as suitable for the purpose specified and indicated.

1.8 DELIVERY, STORAGE, AND HANDLING

.1 Section 15010: Transport, handle, store, and protect products.
.2 Protect dampers from damage to operating linkages and blades.

1.9 EXTRA MATERIALS

.1 Section 15010: Submittals for project closeout.
.2 Provide two of each size and type of fusible link.

2 Products

2.1 AIR TURNING DEVICES/EXTRACTORS

.1 Multi-blade device with blades aligned in short dimension; steel construction; with individually adjustable blades, mounting straps.

2.2 BACKDRAFT DAMPERS.

.1 Gravity Backdraft Dampers, Size 450 x 450 mm or Smaller, Provided with Air Moving Equipment: Air moving equipment manufacturers standard construction.
.2 Multi-Blade, Parallel Action Gravity Balanced Backdraft Dampers: 1.5 mm thick galvanized steel, or, with centre pivoted blades of maximum 150 mm width, with felt or flexible vinyl sealed edges, linked together in rattle-free manner with 90 degree stop, steel ball bearings, and plated steel pivot pin; adjustment device to permit setting for varying differential static pressure.

2.3 DUCT ACCESS DOORS

.1 Fabricate to SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.
.2 Fabrication: Rigid and close-fitting of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated duct work, install minimum 25 mm thick insulation with sheet metal cover.
  .1 Less Than 300 mm Square: Secure with sash locks.
  .2 Up to 450 mm Square: Provide two hinges and two sash locks.
  .3 Up to 600 x 1200 mm: Three hinges and two compression latches with outside and inside handles.
  .4 Larger Sizes: Provide an additional hinge.
.3 Access doors with sheet metal screw fasteners are not acceptable.

2.4 DUCT TEST HOLES

.1 Temporary Test Holes: Cut or drill in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.
.2 Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation;

2.5 FIRE DAMPERS

.1 Manufacturers:
  .1 Controlled Air
  .2 Ruskin
  .3 Nailor
  .4 Substitutions: Refer to Section 15010.
.2 Fabricate to NFPA 90A and UL 555, and as indicated.
.3 Ceiling Dampers: Galvanized steel, 0.76 mm frame and 1.5 mm flap, two layers 3.2 mm ceramic fibre on top side , and one layer on bottom side for round flaps, with locking clip.
.4 Horizontal Dampers: Galvanized steel, 0.76 mm frame, stainless steel closure spring, and lightweight, heat retardant non-asbestos fabric blanket.
.5 Curtain Type Dampers: Galvanized steel with interlocking blades. Provide stainless steel closure springs and latches for horizontal installations. Configure with blades out of air stream except for 250 Pa pressure class ducts up to 300 mm in height.
.6 Multiple Blade Dampers: 1.5 mm galvanized steel frame and blades, oil-impregnated bronze or

stainless steel sleeve bearings and plated steel axles, 3.2 x 12.7 mm plated steel concealed linkage, stainless steel closure spring, blade stops, and lock.

.7 Fusible Links: UL 33, separate at 71 degrees C with adjustable link straps for combination fire/balancing dampers.

2.6 FLEXIBLE DUCT CONNECTIONS

.1 Fabricate to SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.

.2 Connector: Fabric crimped into metal edging strip.

.1 Fabric: UL listed fire-retardant neoprene coated woven glass fibre fabric to NFPA 90A, minimum density 1.0 kg/sq m.

.2 Net Fabric Width: Approximately 50 mm wide.

.3 Metal: 75 mm wide, 0.6 mm thick.

2.7 VOLUME CONTROL DAMPERS.

.1 Fabricate to SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.

.2 Splitter Dampers:

.1 Material: Same gauge as duct to 600 mm size in either direction, and two gauges heavier for sizes over 600 mm.

.2 Blade: Fabricate of single thickness sheet metal to streamline shape, secured with continuous hinge or rod.

.3 Operator: Minimum 6 mm diameter rod in self aligning, universal joint action, flanged bushing with set screw.

.3 Single Blade Dampers: Fabricate for duct sizes up to 150 x 760 mm.

.4 Multi-Blade Damper: Fabricate of opposed blade pattern with maximum blade sizes 200 x 1825 mm. Assemble centre and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.

.5 End Bearings: Except in round duct work 300 mm and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon or sintered bronze bearings.

.6 Quadrants:

.1 Provide locking, indicating quadrant regulators on single and multi-blade dampers.

.2 On insulated ducts mount quadrant regulators on stand-off mounting brackets, bases, or adapters.

.3 Where rod lengths exceed 750 mm provide regulator at both ends.

2.8 FIRE PROTECTION DUCT WRAP

.1 Ductwork requird to be fire-rated shall be wrapped with 3M Fire Master Duct Wrap consisting of a 1-1/2" (38 mm) thick non-combustible, flexible fireproof blanket, fully encapsulated in a foil scrim and supplied in roll form. The wrap material shall be aplied directly onto the installed ductwork Guide No. 40 U21, 'Fire Resistant Ducts', as tested to ISO Standard 6944. Royal Quickstop and CL4 Fire Protection Thermal Insulation Quickwrap also acceptable.

2.9 DUCT HEATER

.1 Manufacturer: Neptronic

.2 Other acceptable manufacturer offering equivalent products:

.1 Thermolic.

.2 Wattco.

.3 Substitutions: Refer to Section 15010.

.3 Construction

.1 Supply and install electric heaters as manufactured by NEP (Neptronic) or approved equal, model DF, slip-in type, CSA-C and CSA-US certified according to CSA standard C22.2 No. 155 and UL 1996. Electric heaters shall be manufactured and approved for zero clearance for all combustible materials.

.2 Heater frames shall be galvanized, assembled with rivets - no welding allowed. The control panel shall have pre-punched flanges for easy field installation and rounded corners therefore preventing sharp edges.
.3 Heating elements shall be open coil, grade C nickel chrome alloy supported by ceramic bushings in an enclosed frame design.
.4 Electric heaters shall be provided with modulating control according to requirement and airflow.
.5 All heaters have: magnetic contactors; automatic thermal cutouts; manual thermal cutouts (when required by code); fixed airflow switch, transformer with secondary fuse, internal wiring for the number of stages indicated, disconnects etc.
.6 All the controls shall be integrated and pre-wired within a NEMA-1 control panel which will include a removable, hinged door to provide easy access
.7 Control of the duct heaters to be supplied via the Mitsubishi System.
.8 Controls: If scheduled, modulating electric heaters shall be supplied with an electronic sensor on each side of the heater to measure the temperature and the airflow, and a HEC controller to adjust the output temperature in accordance with the measured parameters. The HEC controller shall stop the electric heater when there is no airflow.

2.10 KITCHEN EXHAUST HOOD

.1 Exhaust only canopy hood rated for all types of cooking equipment. The hood shall have the size, shape and performance specified on drawings. Construction shall be type 430 stainless steel with a #4 polish where exposed. Individual component construction shall be determined by the manufacturer and ETL. Construction shall be dependent on the structural application to minimize distortion and other defects. All seams, joints and penetrations of the hood enclosure to the lower outermost perimeter that directs and captures grease-laden vapor and exhaust gases shall have a liquid-tight continuous external weld in accordance with NFPA 96. Hood shall be wall type with a minimum of four connections for hanger rods. Connectors shall have 9/16" holes pre-punched in 1 ½" x 1 ½" angle iron at the factory to allow for hanger rod connection by others.
.2 Ventilator shall be furnished with U.L. classified high efficiency stainless steel baffle filters, supplied in size and quantity as required by ventilator. The filters shall extend the full length of the hood and the filler panels shall not be more than 6" in width.
.3 The hood manufacturer shall supply complete submittal drawings including hood sections view(s) and hood plan view(s). These drawings must be available to the engineer, architect and owner for their use in construction, operation and maintenance.
.4 Exhaust duct collar to be 4" high with 1" flange. Duct sizes, CFM and static pressure requirements shall be as shown on drawings. Static pressure requirements shall be precise and accurate; air velocity and volume information shall be accurate within 1-ft increments along the length of the ventilator.
.5 U.L. incandescent light fixtures and globes shall be installed and pre-wired to a junction box. The light fixtures shall be installed with a maximum of 4'0" spacing on center and allow up to a 100 watt standard light bulb.
.6 The hood shall be ETL Listed as "Exhaust Hood Without Exhaust Damper", ETL Sanitation Listed and built in accordance with NFPA 96. The hood shall be listed for 450°F cooking surfaces at 150 CFM/ft, 600°F cooking surfaces at 200 CFM/ft, and 700°F cooking surfaces at 250 CFM/ft. The hood shall be ETL Listed as "Exhaust Hood Without Exhaust Damper".
.7 The hood shall have:
  .1 A double wall insulated front to eliminate condensation and increase rigidity. The insulation shall have a flexural modulus of 475 EI, meet UL 181 requirements and be in accordance with NFPA 90A and 90B.
  .2 An integral front baffle to direct grease laden vapors toward the exhaust filter bank.
  .3 A built-in wiring chase provided for outlets and electrical controls on the hood face and shall not penetrate the capture area or require an external chaseway.
  .4 Removable grease cup for easy cleaning.
.8 Additional Features
  .1 Utility Cabinet
  .2 Captrate Combo®, Captrate Solo®, stainless steel baffle, aluminum baffle, and high

velocity cartridge filters Enclosure Panels
.3 Back splash 304 stainless steel
.4 Side (left & right) splashes 304 stainless steel
.5 Field wrapper of same material as hood
.6 Front stainless steel perforated supply plenum with supply duct dampers and risers
.7 Complete fire suppression system (Ansul R102) or approved equal.
.8 Control Panel with light switch, fan switch, pilot lights, starters, overloads for exhaust supply fans and gas valve relay
.9 Acceptable Manufacture: Captive-Aire ND-2 or approved equal.

.9 Kitchen Hood Fire Protection System:
.1 Fire Suppression System capable of protecting all hazard areas associated with cooking equipment:
.1 The system shall be an automatic fire suppression system using a wet chemical agent for cooking grease related fires.
.2 The system shall be capable of suppressing fires in the areas associated with ventilating equipment including hoods, ducts, plenums, and filters as well as auxiliary grease extraction equipment. The system shall also be capable of suppressing fires in areas associated with cooking equipment, such as fryers; griddles and range tops; upright, natural charcoal, or chain-type broilers; electric, lava rock, mesquite or gas-radiant char-broilers; and woks.
.3 The system shall be the pre-engineered type having minimum and maximum guidelines established by the manufacturer and listed by Underwriters Laboratories (UL/ULC).
.4 The system shall be installed and serviced by personnel trained by the manufacturer.
.5 The system shall be capable of protecting cooking appliances by utilizing either dedicated appliance protection and/or overlapping appliance protection.
.2 Quality Control:
.1 Manufacturer: The System shall be manufactured by a company with at least ten years experience in the design and manufacture of pre-engineered fire suppression systems. The manufacturer shall be ISO 9001 registered.
.2 Certificates: The wet agent shall be a specially formulated, aqueous solution of organic salts with a pH range between 7.7 - 8.7, designed for flame knockdown and foam securement of grease-related fires.
.3 The pre-engineered restaurant fire suppression system components shall be warranted for five years from date of delivery against defects in workmanship and material.
.3 Components:
.1 The basic system shall consist of a regulated release assembly which includes a regulated release mechanism and a wet chemical storage tank housed within a single enclosure. Nozzles, blow-off caps, detectors, cartridges, agent, fusible links, and pulley elbows shall be supplied in separate packages in the quantities needed for fire suppression system arrangements. Additional equipment shall include remote manual pull station, mechanical and electrical gas valves, and electrical switches for automatic equipment and gas line shutoff, and building fire alarm control panel interface.
.2 Wet Chemical Agent: The extinguishing agent shall be a specially formulated, aqueous solution of organic salts with a pH range between 7.8 - 8.2, designed for flame knockdown and foam securement of grease related fires.
.3 Agent Tank: The agent tank shall be installed in a stainless steel enclosure. The tank shall be constructed of stainless steel. Tanks shall be available in two sizes; 1.5 gallon (5.7 L) and 3.0 gallon (11.4 L).The tank shall have a working pressure of 110 psi (7.6 bar), a test pressure of 330 psi (22.8 bar), and a minimum burst pressure of 660 psi (45.5 bar). The tank shall include an adaptor/tube assembly containing a burst disc union.
.4 Regulated Release Mechanism: The regulated release mechanism shall be a spring-loaded, mechanical/pneumatic type capable of providing the expellant gas supply to one or two agent tanks depending on the capacity of the gas cartridge

used or three 3.0 gallon (11.4 L) agent storage tanks in certain applications. It shall contain a factory installed regulator deadset at 110 psi (7.6 bar) with an external relief of approximately 180 psi (12.4 bar). It shall have the following actuation capabilities: automatic actuation by a fusible link detection system and remote manual actuation by a mechanical pull station. The regulated release mechanism shall contain a release assembly, regulator, expellant gas hose, and agent storage tank housed in a stainless steel enclosure with cover. The enclosure shall contain knockouts for 1/2 in. conduit. The cover shall contain an opening for a visual status indicator. It shall be compatible with mechanical gas shut-off devices; or electric gas line or appliance shut-off devices, and connections to a building fire alarm control panel.

.5 Regulated Actuator Assembly: When more than two or three agent tanks, the regulated actuator shall be available to provide expellant gas for additional tanks. It shall be connected to the cartridge receiver outlet of the regulated release mechanism providing simultaneous agent discharge. The regulator shall be deadset at 110 psi (7.6 bar) with an external relief of approximately 180 psi (12.4 bar).The regulated actuator assembly shall contain an actuator, regulator, expellant gas hose, and agent tank housed in a stainless steel enclosure with cover. The enclosure shall contain knockouts to permit installation of the expellant gas line.

.6 Discharge Nozzles: Each discharge nozzle shall be tested and listed with the system for a specific application. Nozzles tips shall be stamped with the flow number designation (1/2, 1, 2, or 3). Each nozzle shall have a metal or rubber blow-off cap to keep the nozzle tip orifice free of cooking grease build-up.

.7 Distribution Piping: Distribution piping shall be Schedule 40 black iron, chrome-plated, or stainless steel conforming to ASTM A120, A53, or A106.

.8 Detectors: The detectors shall be the fusible link style designed to separate at a specific temperature.

.9 Cartridges: The cartridge shall be a sealed steel pressure vessel containing either carbon dioxide or nitrogen gas. The cartridge seal shall be designed to be punctured by the releasing device supplying the required pressure to expel wet chemical agent from the storage tank.

.10 Agent Distribution Hose: An agent distribution hose shall be available for kitchen appliances manufactured with or resting on casters (wheels/rollers). This shall allow the appliance to be moved for cleaning purposes without disconnecting the appliance fire suppression protection. Hose assembly shall include a restraining cable kit to limit the appliance movement within the range (length) of the flexible hose.

.11 Flexible Conduit: The manufacturer supplying the Restaurant Fire Suppression System shall offer flexible conduit as an option to rigid EMT conduit for the installation of pull stations and/or mechanical gas valves. The flexible conduit shall be UL Listed and include all approved components for proper installation.

.12 Pull Station Assembly: The Fire Suppression System shall include a remote pull station for manual system actuation. The pull station shall be designed to include a built-in guard to protect the pull handle. The pull station shall also be designed with a pull handle to allow for three finger operation and shall be red in color for quick visibility.

.4 Acceptable Manufacture: Tyco Fire Suppression & Building Products ANSUL R-102 or approved equal.

3 Execution

3.1 PREPARATION

.1 Verify that electric power is available and of the correct characteristics.

3.2 INSTALLATION

.1 Install accessories to manufacturer's instructions, NFPA 90A, and follow SMACNA HVAC Duct Construction Standards - Metal and Flexible. Refer to Section 15810 for duct construction and pressure class.

.2 Provide backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.

.3 Provide duct access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, at fire dampers, and elsewhere as indicated. Provide minimum 200 x 200 mm size for hand access, 450 x 450 mm size for shoulder access, and as indicated. Provide 100 x 100 mm for balancing dampers only. Review locations prior to fabrication.

.4 Provide duct test holes where indicated and required for testing and balancing purposes.

.5 Provide fire dampers , combination fire and smoke dampers at locations indicated, where ducts and outlets pass through fire rated components , and where required by authorities having jurisdiction. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.

.6 Demonstrate re-setting of fire dampers to Owner's representative.

.7 Provide flexible connections immediately adjacent to equipment in ducts associated with fans and motorized equipment , and supported by vibration isolators. For fans developing static pressures of 1250 Pa and over, cover connections with leaded vinyl sheet, held in place with metal straps.

.8 Use splitter dampers only where indicated.

.9 Provide balancing dampers on duct take-off to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.

3.3 FIRE PROTECTION DUCT WRAP

.1 Supply and install fire protection duct wrap on ductwork as indicated on drawings in accordance with manufacturers recommendations.

End of Section

1 General

1.1 GENERAL

.1 Read and conform to:
- .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
- .2 Division 1 requirements and documents refered to therein.

1.2 SECTION INCLUDES

.1 Roof exhausters.

1.3 REFERENCES

.1 AMCA 99 - Standards Handbook.
.2 AMCA 210 - Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
.3 AMCA 261 - Directory of Products Licensed to Bear the AMCA Certified Ratings Seal.
.4 AMCA 300 - Reverberant Room Method for Sound Testing of Fans.
.5 AMCA 301 - Method of Publishing Sound Ratings for Air Moving Devices.
.6 UL 705 - Power Ventilators.

1.4 SUBMITTALS

.1 Section 15010: Procedures for submittals.
.2 Product Data: Provide data on fans and accessories including fan curves with specified operating point clearly plotted, sound power levels at rated capacity, and electrical characteristics and connection requirements.
.3 Manufacturer's Installation Instructions.

1.5 OPERATION AND MAINTENANCE DATA

.1 Section 15010: Submittals for project closeout.
.2 Maintenance Data: Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

1.6 EXTRA MATERIALS

.1 Section 15010: Submittals for project closeout.
.2 Provide two sets of belts for each fan.

2 Products

2.1 ROOF EXHAUST FANS

.1 Greenheck model GB or equivalent products by;
- .1 Penn.
- .2 Loren Cook.
- .3 Substitutions: Refer to Section 15010.

.2 Product Requirements:
- .1 Performance Ratings: Conform to AMCA 210 and bear the AMCA Certified Rating Seal.
- .2 Sound Ratings: AMCA 301, tested to AMCA 300 ,and bear AMCA Certified Sound Rating Seal.
- .3 Fabrication: Conform to AMCA 99.

.3 Performance: as scheduled on drawings
.4 Fan Unit: V-belt or direct driven as indicated, with spun aluminum housing; resilient mounted motor; 13 mm1/2 inch mesh, 2 mm16 gauge aluminum birdscreen; square base to suit roof curb with continuous curb gaskets.
.5 Roof Curb: 300 mm 12 inch high self flashing of aluminum with continuously welded seams, built in cant strips, and factory installed nailer strip.
.6 Electrical Characteristics and Components
.1 Electrical Characteristics: as scheduled
.2 Motor: Refer to Section 15120.
.3 Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to code.
.4 Disconnect Switch: Factory wired, non-fusible, in housing for thermal overload protected motor.
.7 Backdraft Damper: Gravity actuated, aluminum multiple blade construction, felt edged with nylon bearings.
.8 Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheave selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self aligning pre-lubricated ball bearings.

2.2 IN-LINE CENTRIFUGAL EXHAUST

.1 Greenheck model BSQ or equivalent products by;
.1 Penn.
.2 Loren Cook.
.2 Product Requirements:
.1 Performance Ratings: Conform to AMCA 210 and bear the AMCA Certified Rating Seal.
.2 Sound Ratings: AMCA 301, tested to AMCA 300 ,and bear AMCA Certified Sound Rating Seal.
.3 Fabrication: Conform to AMCA 99.
.3 Performance: as scheduled on drawings
.4 Fan Unit: duct mounted; belt driven; heavy gauge formed steel housing; fan construction shall include two removable access panels located perpendicular to the motor mounting panel and sufficient in size to permit easy access to all interior components; belt and pillow block ball bearings protected from the airstream by an enclosure; shaft keyed to both the wheel and pulley; isolators and brackets sized to match the weight of the fan; fan inlet spun venturi throat overlapped by backward inclined centrifugal wheel with spun cone for maximum performance; insulated fan housing spring hanging isolators; galvanized steel combination motor cover and belt guard.
.5 Electrical Characteristics and Components
.1 Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to code.
.6 Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheave selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self aligning pre-lubricated ball bearings.

2.3 ENERGY RECOVERY VENTILATOR (ERV)

.1 Lossnay model LGH or equivalent to be approved by engineer.
.2 General Description: The fresh air ventilation system(s) shall utilize ERV total heat exchanger with fresh bypass economizer and heat recovery ventilation. These units shall be as per mechanical equipment schedule drawing. The ERV equipment shall form part of the Mitsubishi Electric City Multi HVAC system and will supply fresh air to all indoor zones served by the City Multi HVAC system. The ERV will have M-Net data network control and will be directly connectable to the City Multi M-Net Data communication control network and will be able to be electronically interlocked with City Multi indoor units.
.3 Unit Construction: The units will require a 208-230V 60Hz power supply and have a running current of between 0.56 ~ 5.7 amps. Each unit shall have 2 centrifugal fans running simultaneously

supplying and extracting air at the same rate. The units shall be constructed of galvanized sheet metal gauge 0.5t ~ 0.8t and covered with polyurethane foam insulation. The internal construction shall be galvanized sheet metal and foamed polystyrene. The heat exchanger element shall be constructed of specially treated paper in corrugated layers to allow total heat (sensible and latent) recovery from the exhaust air to the supply air. The temperature recovery efficiency will be between 77~81% and Enthalpy recovery efficiency 64.5~77 %. The element shall have filters at both the supply and exhaust sides with an access cover to allow easy maintenance. The mechanism of opening and closing the bypass damper shall be a 208V-230V synchronous electric motor through an actuator. The motor will drive a steel cable connected to an economizer damper flap to allow fresh air to bypass the element. Supply and return air thermistors shall control the damper and be interlocked with a Mitsubishi LCD remote controller. The control will be either:

.1 A 30vdc fuzzy logic signal generated by a City Multi System via a 2 core non polar screened cable to PZ-52SF-E Mitsubishi LCD remote controller or interlocked with a City Multi indoor unit.

.2 A PZ-41SLB-E Mitsubishi LCD independent remote controller wired to TM2 on the internal PCB of the ERV via a 2 core non polar cable.

.4 Ductwork: The installer shall supply, install, test and commission all interconnecting ductwork of the ERV units. Ductwork sizing, layout, fittings, etc shall be in strict accordance with the design requirements. The two outdoor ducts must be covered with heat insulating material in order to prevent condensation from forming. The two outdoor ducts must be tilted at a gradient (1/30 or more) down toward the outdoor area from ERV unit. Ductwork installation shall be carried out by a licensed sheet metal technician (certificate of approval must be submitted prior to installation commencement) and the manufacturer's design and Installation instructions. The installation of all ERV units, duct work, all interconnecting control and power wiring, commissioning and testing shall be carried out by licensed installers.

.5 Pre-Heater & Re-Heater (For installation in cold climates): A suitable pre-heater will be supplied and installed to pre-heat the air entering the ERV to above -10 deg C. The heater shall be sized to raise the temperature of the incoming supply air based on the heating (winter) design condition of the applicable site. A re-heater shall be supplied and installed to provide a neutral air temperature when fresh air from the ERV is supplied directly into the occupied space. In the case that the fresh air is mixed into the return air of the City Multi indoor unit the pre-heater and re-heater will be sized so that the mixed temperature of return and fresh air is always between 19 deg C and 30 deg C. The pre-heater and re-heater shall be installed according to the manufacturer's recommendation.

.6 Equipment, Warranty & Maintenance: The manufacturer shall provide a one-year warranty on parts and a 10 year warranty on the energy recovery core. The Contractor shall supply all the specified equipment complete with one year warranty on both materials and labor commencing on satisfactory handover of the completed system. The Contractor shall include for a one-year maintenance contract on the complete installation (with optional costs for extension years). The maintenance contract shall include for all works necessary.

3 Execution

3.1 INSTALLATION

.1 Install to manufacturer's instructions.
.2 Secure roof exhausters with stainless steel lag screws to roof curb.
.3 Extend ducts to roof exhausters into roof curb. Counterflash duct to roof opening.
.4 Install flexible connections specified in Section 15815 between fan inlet and ductwork. Ensure metal bands of connectors are parallel with minimum 25 mm one inch flex between ductwork and fan while running.
.5 Provide sheaves required for final air balance.
.6 Install backdraft dampers on inlet to roof and wall exhausters.
.7 Provide backdraft dampers on outlet from cabinet and ceiling exhauster fans and as indicated.
.8 Do not operate fans for any purpose until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

End of Section

1 General

1.1 GENERAL

.1 Read and conform to:
- .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
- .2 Division 1 requirements and documents refered to therein.

1.2 SECTION INCLUDES

.1 Diffusers.
.2 Registers/grilles.
.3 Roof hoods.

1.3 REFERENCES

.1 ADC 1062 - Air Distribution and Control Device Test Code.
.2 AMCA 500 - Method of Testing Louvres for Ratings.
.3 AMCA 5000 - Method of Testing Dampers for Ratings.
.4 ARI 650 - Air Outlets and Inlets.
.5 ASHRAE 70 - Method of Testing for Rating the Performance of Outlets and Inlets.
.6 SMACNA - HVAC Duct Construction Standard - Metal and Flexible.
.7 NFPA 90A - Installation of Air Conditioning and Ventilating Systems.

1.4 SUBMITTALS

.1 Section 15010: Procedures for submittals.
.2 Product Data: Provide data for equipment required for this project. Review outlets and inlets as to size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.
.3 Samples: Submit two of each required air outlet and inlet type.

1.5 PROJECT RECORD DOCUMENTS

.1 Section 15010: Submittals for project closeout.
.2 Record actual locations of air outlets and inlets.

1.6 QUALITY ASSURANCE

.1 Test and rate air outlet and inlet performance to ADC Equipment Test Code 1062 and ASHRAE 70.
.2 Test and rate louvre performance to AMCA 500.

1.7 QUALIFICATIONS

.1 Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

2 Products

2.1 MANUFACTURERS

2.2 RECTANGULAR CEILING DIFFUSERS

.1 Manufacturer's Reference: E. H. Price Model SCD
.2 Type: Square, adjustable pattern, stamped, multi-core diffuser to discharge air in 360 degree pattern with sectorizing baffles where indicated.
.3 Frame: Surface mount type. In plaster ceilings, provide plaster frame and ceiling frame.
.4 Fabrication: Steel with baked enamel off-white finish.
.5 Accessories: Radial opposed blade damper and multi-louvred equalizing grid with damper adjustable from diffuser face.

2.3 CEILING SLOT DIFFUSER

.1 Model SDA50: extruded aluminum, 13 mm slot with vanes to provide 180 deg. pattern adjustment, left, right or vertical, type 7B concealed mounting flange frame, mitred end flanges, SDA linear slot plenums (non-insulated) to suite installation, and all alignment strips, spacers, joiner strips for continuous slots and metal blank off strips needed for complete installation. E.H. Price SDA50.

2.4 CEILING GRID CORE EXHAUST AND RETURN GRILLES

.1 Manufacturer's reference: E. H. Price 80DAL
.2 Type: Fixed grilles of 13 x 13 x 13 mm louvres.
.3 Frame: 32 mm margin with concealed mounting. Channel lay-in frame for suspended grid ceilings.
.4 Fabrication: Aluminum with factory off-white enamel finish.
.5 Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face.

2.5 SIDEWALL/DUCT SUPPLY GRILLES

.1 Manufacturer's Reference: E.H. Price, Model 520D.
.2 Type: steel supply grille, double deflection complete with two sets of fully adjustable deflection blades spaced 3/4" (19 mm) on center.

2.6 SIDEWALL RETURN GRILLE

.1 Sidewall Mounted Grilles: E.H. Price 530D - steel register with damper, narrow margin border, front blades parallel to long dimension, colour finish as selected by Architect.

2.7 SIDEWALL EXHAUST GRILLE

.1 Heavy Duty: E.H. Price 95D/L/A/B12. Flat face heavy duty 1 1/4" (32 mm) wide steel border, heavy duty steel core 13 mm blades on 3/4" (2 mm) centres, 0 degree deflection vertical louvre orientation, opposed blade volume controller, screw fastenings, baked enamel finish.

2.8 LOUVRES

.1 Design Requirements: Design louvre members for applicable loads established by the Manitoba Building Code for the locality. Deflection: Maximum 1/175 of span of this loading. Pressure and suction of wind as calculated in accordance with hourly wind pressure one in 30. Gust effect factor: Minimum 2.5.
.2 Designs for louvres shall be prepared by or under the supervision of and shop drawings shall be signed and sealed by a professional engineer licensed in the province of Manitoba.
.3 Design louvres for a minimum free area indicated on drawings.
.4 Design for expansion and contraction of materials as required.
.5 Performance requirements: AMCA 511 certified rating for water penetration and air performance, tested with mill finish and using 0.28 millilitre (0.01 oz) as the point of beginning water penetration.
.6 Materials

.1 All aluminum work: ASTM B209M.
.2 Aluminum: Extruded shapes of Alcon 6063 aluminum alloy T5, T52, or T54 temper Sheet aluminum: Alloy 1100-H14 anodizing quality.
.3 Butyl tape: Tremco 440 tape by Tremco Mfg. Co., Weatherban Ribbon Sealer by 3M Inc.
.4 Bird screen: 1/2" 1/2" x 18 ga. (13 x 13 mesh x 1.3 mm) thick flattened expanded aluminum screen in extruded aluminum frame. Screening to be replaceable with frame.
.5 Fastenings: stainless steel.
.6 Flashing and close-off panels: 24 ga. (1.2 mm) thick aluminum.
.7 Insulation: CSA A101 glass fibre 3 pcf (48 kg/m3), AF530 fibreglass board by FiberglasCanada Inc. OF1-48 by Ottawa Fibre Inc.
.8 Sealant: CAN/CGSB-19.24-M Dymeric 240 by Tremco Ltd. Colour as selected by Consultant.
.9 Joint backing: closed cell foam polyethylene or chemically compatible rod stock or butyl or neoprene; diameter 25% greater than joint width.
.10 Primers: As recommended by sealant manufacturer to various job conditions.
.11 Cleaning material: Xylol, Methyl-ethyl-ketone, Toluol or as recommended by sealant manufacturer.

.7 Fabrication
.1 Fabricate louvres of extruded alloy aluminum, complete with necessary accessories, reinforcement, flashings, fixing devices and integral wind-driven-rain baffle on blades.
.2 Fabricate extruded aluminum angles, channels and reinforcement as required to frame and support the louvre elements.
.3 Fabricate louvres with no intermediate mullions and reinforcement visible on the building exterior; finished appearance of continuous blades housed in a rectangular frame.
.4 Louvres: 4" (100 mm) deep, 18 ga. (2.06 mm) thick frame, storm blade and braces with reinforcing bosses and interlocking extruded aluminum blade braces. Sill and continuous closure angles around perimeter. Airolite model CB6776 all welded louvre assembly or equivalent by Construction Specialties Ltd., Arrow United Industries.
.5 Flashing Sill: 18 ga. (2.06 mm) thick aluminum, formed to shed water, profile indicated and designed for two-point anchorage installation (at front and back of sill).
.6 Blank-off panel: 1 1/2" (38 mm) thick glass fibre insulation 3 pcf (48 kg/m3), laminated on both sides with 20 ga. (1.0 mm) thick aluminum sheet. Finish exterior sheet: To match louvre finish, exterior sheet: Matte black mill finish. Wrap panel edges with face sheet.
.7 Finish for louvre assembly: Kynar 500 two-coat fluorocarbon system minimum 1.0 mil (0.025 mm) thick. Submit two 3" x 3" x 5" (75 x 75 x 125 mm) samples of colour.

3 Execution

3.1 INSTALLATION

.1 Install to manufacturer's instructions.
.2 Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement.
.3 Install diffusers to duct work with air tight connection.
.4 Provide balancing dampers on duct take-off to diffusers, and grilles and registers, despite whether dampers are specified as part of the diffuser, or grille and register assembly.
.5 Paint ductwork visible behind air outlets and inlets matte black.

End of Section

1 General

1.1 SECTION INCLUDES

.1 Rail Material.
.2 Top Mounting Suspension.
.3 Support Legs.
.4 Hydraulic Brake System.
.5 Rail Splicing Joint.
.6 Middle Rail Duct Connection.
.7 Trolley Assembly.
.8 Regulator Assembly.
.9 Uncoupling Valve Assembly.
.10 Upper Flexible Hose.
.11 Lower Hose Assembly.
.12 Safety Disconnect Coupling.
.13 Collection Nozzle Assembly.
.14 Manual Fill Valve.
.15 Compressed Air Features.
.16 Hose Saddle.
.17 Electrical Controllers.
.18 Electrical System.
.19 Air Moving Devices.
.20 Ductwork System.

1.2 REFERENCES

.1 ACGIH - Industrial Ventilation, A Manual of Recommended Practice.
.2 AMCA 99 - Standards Handbook.
.3 AMCA 210 - Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
.4 AMCA 300- Reverberant Room Method for Sound Testing of Fans.
.5 AMCA 301 - Method of Calculating Fan Sound Ratings from Laboratory Test Data.
.6 ASTM A90/A90M - Weight (Mass) of Coating on Iron and Sheel Articles with Zinc or Zinc-Alloy Coatings.
.7 ASTM A653/A653M - Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
.8 ASTM C14/C14M - Concrete Sewer, Storm Drain, and Culvert Pipe.
.9 ASTM C443 - Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
.10 AWS D9.1 - Sheet Metal Welding Code.
.11 NBS PS 15 - Voluntary Product Standard for Custom Contact-Moulded Reinforced-Polyester Chemical-Resistant Process Equipment.
.12 SMACNA - HVAC Duct Construction Standards - Metal and Flexible.
.13 SMACNA - Rectangular Industrial Duct Construction
.14 SMACNA - Round Industrial Duct Construction Standard.
.15 UL 214 - Tests for Flame-Propagation of Fabrics and Films.

1.3 SUBMITTALS

.1 Division 1: Procedures for submittals.
.2 Shop Drawings: Indicate dimensions, sizes, weights and point loadings, and locations and sizes of field connections.
.3 Submit shop drawings for the fabrication and installation of Self Storing, Underslab exhaust outlet. Indicate other project specific data not included in the fabrication and installation drawings and required for project to include, but not limited to:
  .1 Layout and arrangement to fit to the job site requirements.
  .2 Product installation drawings as required by job site conditions.
.4 Product Data: Provide manufacturers literature and data sheets indicating rated capacities,

dimensions, weights and point loadings, accessories, electrical characteristics and connection requirements, wiring diagrams, and location and sizes of field connections.
.5 Provide fan curves with specified operating point clearly plotted.
.6 Submit sound power levels for both fan inlet and outlet at rated capacity.
.7 Manufacturer's Installation Instructions: Indicate assembly and installation instructions.

1.4 OPERATION AND MAINTENANCE DATA

.1 Division 1: Submittals for project closeout.
.2 Operation and Maintenance Data: Include instructions for fan lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

1.5 QUALITY ASSURANCE

.1 Fans
  .1 Performance Ratings: Conform to AMCA 210 and bear the AMCA Certified Rating Seal.
  .2 Sound Ratings: AMCA 301, tested to AMCA 300.
  .3 Fabrication: Conform to AMCA 99.

1.6 QUALIFICATIONS

.1 Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
.2 Installer qualifications: The installer shall be a licensed contractor with proven experience in the fabrication and installation of ventilating systems. The contractor shall be accepatable to the manufacturer and shall have received factory training if required.

1.7 REGULATORY REQUIREMENTS

.1 Products Requiring Electrical Connection: Listed and classified by Underwriters' Laboratories Inc., as suitable for the purpose specified and indicated.

1.8 EXTRA MATERIALS

.1 Division 1: Submittals for project closeout.

2 Products

2.1 SYSTEMS MANUFACTURERS

.1 Gas Plymovent: Cash Allowance

2.2 RAIL MATERIAL

.1 One-piece continuous extruded aluminum rail in a minimum length of 19 feet (5791.2 mm) in an effort to reduce the points of leakage due to seams or connections. The construction profile shall be of a round profile type, diameter of 6.5 inches (165.1 mm) with a rail thickness of 0.175 inch (4.5 mm). The bottom portion of the rail shall have a continuous slot to accept a rubber seal. Rail Material: Aircraft aluminum alloy Type AA-6063 (ASTM B209/B209M). Aluminum Rail: Extruded as a one piece design unit to maximize the structural integrity of the rail and to minimize joints. Extruded into the rail profile shall be all necessary mounting guides, which will allow for support of the rail mounting hardware and airline support cable. Mounting Channels: Provided continuously along both sides of the rail extrusion in order the proper positioning of all required mounting supports in accordance with codes. The rail shall allow the trolley/hose assembly to glide to the

door threshold in a safe and effective manner. The extruded rail channel shall allow the whole rail to remain rigid and shall provide an area to attach bolts for splicing additional rails together for systems over 19 feet (5791.2 mm) long. The overall extruded rail lengths shall be 19 foot (5791.2 mm) standard. Rail System: Equipped with a hydraulic braking system that limits travel of flex hose as the vehicle exits the building. Hydraulic Brake: Incorporated into the end cap of the suction rail.

2.3 TOP MOUNTING SUSPENSION

.1 Top Mounting Suspension: Designed to attach with 2 mounting cleats to the mounting slots that were extruded into the rail profile. The top suspension mount support shall consist of 2 extruded Aircraft aluminum alloy Type AA-6063 (ASTM B209/B209M) and provided with 3 pre-punched holes for attaching the aluminum leg assembly to the rail.

.2 Support Legs: Manufactured and provided by the supplier of primary exhaust removal system (Equipment Manufacturer). Support Leg Material: Aircraft aluminum alloy Type AA-6063 (ASTM B209/B209M). Supports: Standard in 19 feet lengths. A minimum of one support with appropriate bracing shall be provided for every 10 lineal feet(3 m) to 12 linear feet (3.7 m) of rail profile. The support legs shall consist of a square outer profile with dimensions no less than 2 inch (50.8 mm) OD by 0.1 inch (2.54 mm) by with 0.4 inch (10 mm) fastening hardware provided. The vertical adjustable mounting foot shall be capable of attaching the leg assembly to a ceiling with a 30 degree pitch, complete with 3/8 inch (9.5 mm) hardware necessary for mounting the leg assembly to the top suspension mount. The support leg shall be equipped with round tubular zinc-plated steel knee brace with pressed ends in standard lengths of 20 inch (508 mm), 30 inch (762 mm) and 72 inch (1828.8 mm). The angle shall be completely adjustable to the leg support and mounted perpendicular and parallel to direction of the rail. The typical support angle shall be 45 degrees from the centerline of the factory provided support leg. The standard leg shall be capable of meeting a Seismic Zone 4 requirement. Vertical support and bracing shall be provided to safely secure the rail profile in accordance with building code and seismic standards which may apply. A minimum of one support with appropriate bracing shall be provided for every 10 lineal feet (3 m) to 12 linear feet (3.7 m)of rail profile.

2.4 HYDRAULIC BRAKE SYSTEM

.1 Incorporated into the end cap of the suction rail profile. The hydraulic brake system must incorporate a hydraulic shock capable of reducing the forward impact of 1 to 4 suction trolleys which may be installed now or in the future to the exhaust rail system. This hydraulic shock shall be secured to a steel end cap fabricated of 6.25 inch (158.8 mm) diameter steel tubing with a wall thickness of 0.156 inch (4 mm) welded to a 0.156 inch (4 mm) steel plate with formed 90 degree side rails for rigidity. The end cap shall have a removable circular end plate to facilitate an end feed duct connection and shall be a black powder coated finish. The hydraulic shock shall be capable of reducing to a full stop the trolleys in less than 4 inch (101.6 mm), without physical damage to either the rail profile or trolley that it is stopping.

2.5 RAIL SPLICING JOINT

.1 The splice joint shall be formed aluminum extrusion equal to the internal diameter of the suction rail profile. The splice shall have a wall thickness of no less than .190 inches (4.8 m) in thickness and a length of no less than 8 inches (203.2 mm) from end to end. The rail splicing shall be safely secured by no less than 12- 3/8 inch 314.3 mm) by 1-½ inch (38.1 mm) bolts, nuts and lock washers. Each bolt shall pass through the exterior of the rail profile and splicing joint and be secured on the inside by a lock washer and nut. Self tapping bolts or screws are not acceptable.

2.6 MIDDLE RAIL DUCT CONNECTION

.1 The rail duct connection shall be rectangular to an 8 inch diameter round transition fitting fabricated from 24 gauge galvanized steel (ASTM A653) with a double rubber U style lip seal. The rectangular slot shall be 19 inch (482.6 mm) long by 1-¾ inch (44.5 mm) high with a 3/8 inch (9.5 mm) external flange to slide into the rail profile.

2.7 TROLLEY ASSEMBLY

.1 Gantry type trolley with sealed bearing loaded wheels designed to roll inside the internal rail profile flange. The trolley chassis shall be galvanized steel (ASTM A653) epoxy coated with a black finish. The chassis shall be fitted with a tapered cone. Rubber Sealing Lips: Vulcanized Teflon strip covering 1-½ inch (38.1 mm) of the bottom edge of the sealing lip which shall contact with (5) five Teflon rollers on each side of the transition to minimize resistance between the cone and the rubber sealing lips. The exhaust cone transition shall be a tapered slot design which shall fit inside the suction rail profile. The tapered slot shall be equal or exceed in area the diameter of exhaust ventilation hose to which it is attached. Trolley Assembly: Equipped with rubber impact bumpers at both the front and rear of the trolley chassis to eliminate metal to metal contact which could damage the trolley assembly. There shall be a system balancer assembly provided to aid in the delivery of the hose to the exit door. Balancer Assembly: Self-adjusting weight spring tension balancer with a lifting capacity of no less than 31 pounds (31 KG). The balancer shall have a minimum diameter steel cable of .080 inch (2 mm) and have a safety link connection.

2.8 REGULATOR ASSEMBLY

.1 Safely operate with an input pressure of 0 psi (0 KG/m2)- 150 psi (140614 KG/m2) ; the output pressure shall be preset at 15 psi (10546 KG/m2). Regulator: Attached to each Riser Clamp Assembly/Hose Drop and to the Boxloc track to allow for independent adjustment of each pneumatic nozzle. The regulator shall also be provided with needle type adjustment gauge that is clearly marked with the proper operating range of the system and the gauge shall be visibly read from standing on the bay floor.

2.9 UNCOUPLING VALVE ASSEMBLY

.1 Activate the release of the pneumatic collection nozzle located on vehicle's exhaust pipe. It shall be a whisker type valve that shall provide a single direction action and affixed to a mounting bracket directly onto the trolley chassis. The valve shall be activated when the whisker switch comes in contact with a disconnect plate located on the side of the rail profile. Disconnect Plate: Provide activation of the uncoupling valve switch mounted on the suction trolley chassis. Disconnect Plate: Capable of being mounted anywhere along the outside of the rail in a manner that allows for easy adjustment. One disconnect plate shall be provided for each trolley that is provided to allow for independent adjustment of exit speeds.

2.10 UPPER FLEXIBLE HOSE

.1 Flexible exhaust hose manufactured for the sole purpose of venting high temperature exhaust gases. Flexible Hose: Designed strictly for the harsh environment of rapid response and auto-release of a vehicle exhaust tailpipe. Hose: Range from 4 inch (101.6 mm) to 5 inch (127 mm) diameters with length of 25 feet (7.6 m) without joining or splicing connections. Hose Material: High temperature synthetic rubber impregnated into a high temperature laminated fabric with a minimum overlapping thickness of 2-7/16 inches (61.9 mm). This construction of hose must be capable of operating at continuous temperatures of 400 degrees F (204 degrees C) and intermittent temperatures of 500 degrees F (260 degrees C) such as are experienced when pump checks are performed inside the station. Wire Helix: Bound and protected in laminations of hose winding. This shall be accomplished in a fashion, which eliminates any possibility of personnel coming in contact with an exposed hot metal helix. The hose shall further protect the internal wire helix from heat buildup and in turn add increased visibility to personnel. Wear Strip: 9/16 inch (14.28 mm)

wide and be provided as a safety yellow color. The bend radius of the high temperature hose shall be no less than 1.5 times the diameter of hose to ensure that hot gases are not restricted as they pass through the system. Hoses utilizing an exposed metal helix will not be acceptable due to potential burn hazard and/or shock hazard from being utilized as a grounded, grounding or current carrying conductor for electromagnet connections. No exceptions will be allowed.

2.11 LOWER HOSE ASSEMBLY

.1 Rigid 4 inch (101.6 mm) to 5 inch (127 mm) diameter by 2 foot (609.6 mm) long section of yellow and black hose identical in appearance to the upper hose assembly. Lower Hose: Support the pneumatic connection nozzle and chrome reducing elbow in a rigid fashion to allow for the operator to place hose collection nozzle onto the tailpipe without bending over. The lower hose is the only section of hose which shall disconnect from the upper hose assembly and act as a safety disconnect in the unlikely event the nozzle gets entangled. Hoses utilizing an exposed metal helix will not be acceptable due to potential burn hazard.

2.12 SAFETY DISCONNECT COUPLING

.1 4-part segmented coupling with removable wear strips to protect the vehicle and disconnect from wear shall be incorporated in the design of the system. Coupling: Consists of two high temperature composite collars connected by a reusable-segmented coupling band. The release tension of this device shall be preset at 130 pounds (59 KG). and adjustable from 20 pounds (9 KG). to 206 pounds (93 KG). of separating force to accommodate varying exit speeds of vehicles. Coupling shall be re-usable and easily reconnected.

2.13 COLLECTION NOZZLE ASSEMBLY

.1 Collection Nozzle Assembly: Provides a substantially air tight seal around exhaust tail pipe when connected thus allowing for virtually 100% source capture. The seal shall limit the escape of life threatening exhaust gases, which may be present during the following conditions:
   .1 In the event vehicle's engine is accelerated above normal idle resulting in an exhaust velocity greater than 5000 feet per minute (25.4 meters per second).
   .2 In the event that the output velocity or CFM of the exhaust exceeds the manufacturers normal capture velocity or CFM of exhaust system.

.2 Nozzle: Automatically adjust its internal orifice to accept any tailpipe ranging from one inch through six-inch (152.4 mm) diameter. Nozzle Pressure: Not to exceed 15 psi (10546 KG/m2). when connected to the vehicle's tailpipe. Nozzle Construction: High temperature synthetic rubber vulcanized to a high temperature synthetic fabric. A NOMEX inner liner shall be provided for the primary temperature source at the tailpipe and to act as a friction barrier. The chrome-reducing elbow that connects to the connection nozzle shall be fabricated using continuous welded construction. Angle of Transition: No less than or greater than 67 degrees from the centerline of the reducer. Chrome Reducer: Incorporate a primary expanded metal debris screen, which is permanently affixed by welded seams to the inside opening of exhaust fitting.

2.14 MANUAL FILL VALVE

.1 Manual Connection Fill Valve: Located 6 inches (152.4 mm) above safety release coupling approximately 4 feet (1219.2 mm) from floor, sliding/push button type for manual or automatic release. In its design this valve shall incorporate in its design a handle with a impact resistant coating, which the operator may easily operate in a standing position and provide protection for the attached air fittings. The attachment of the collection nozzle shall not position the operator's breathing zone closer than 36 inches (914.4 mm) from the exhaust tailpipe. The automatic release of the connection valve shall be no greater than 3 psi (2109 KG/m2). shift pressure to activate the automatic nozzle deflation. Primary Air Supply: Accomplished by means of a compression type

fitting. The regulated air supply line to collection nozzle shall be designed to safely release from the upper hose at a pressure no greater than 80 lbs. (362.8 KG)

2.15 COMPRESSED AIR FEATURES

.1 Airlines: ¼ inch (6mm) OD tubing capable of exposure of high temperature air stream inside the ventilation hose and duct. Airlines: Fed through the exterior of the hose through Teflon and brass grommets. Airlines: Fed through the exterior of the duct through high temperature rubber grommets to protect against abrasion. Unless a fire station air compressor is to be utilized the bidder shall provide a quiet operating compressor to be located proximate to the vehicle bays. It shall also be located so that preventative maintenance can be performed quickly and effectively. The operation of the compressor running inside station shall not generate sound decibels in excess of 82 dBA. The compressor shall be equipped with a filter/dryer regulator to ensure the conveyance of clean dry air to the pneumatic controls incorporated in the auto-release ventilation system.

2.16 HOSE SADDLE

.1 Hose Suspension Saddle: Fabricated of a rubber molded cushion specifically manufactured for the sole purpose of suspending high temperature exhaust ventilation hose in a rapid response and auto-release application. The design of the saddle shall smoothly transition the direction of the hose during its travel along the rail. Securing clamps shall be provided including a link fastener, for the purpose of mounting it to the balancer safety link.

2.17 ELECTRICAL CONTROLLERS

.1 Controller: Built and supplied by a UL recognized and listed exhaust system manufacturer. Controller shall carry the UL - CUL listing label as an "Enclosed Industrial Control Panel." Individual components listed by UL - CUL shall not satisfy the above requirement. Manufacturer shall undergo monthly inspections by UL to verify all requirements and standards are met as outlined by UL. The controller shall be delivered as an Operating System Three series controller or an approved equal to the specifications to follow.

.2 Electrical Controllers: Bear a visible UL listing label as proof of subscribership and shall be validated by UL www.ul.com/database/ as an "Enclosed Industrial Control Panel". Certification documents shall accompany bid documents.Electrical controller and manufacturer shall be recognized and listed by UL. Controller shall be manufactured in accordance with Underwriters Laboratories standard UL-508 for "Enclosed Industrial Control Panels". The electrical controller shall include a Class 1 limited energy control circuit. Enclosures shall be NEMA 12 rated and UL listed as Type 12. The electrical control components shall be provided and mounted in an electrical enclosure to restrict access to internal components of the controller by authorized personnel only.

.3 Controller Performance: Designed to sense the output pressure and/or temperature change inside the ductwork system, which is normally generated by any internal combustion engine designed to propel a motor vehicle. The operating logic shall be designed to complete this cycle. At any point in time when a collection device is connected to a motor vehicle's exhaust tailpipe, as the operator starts the vehicle, the controller shall automatically sense the engine's output pressure or temperature of the exhaust and in turn energize the electrical contactor which will supply power to the AMCA certified spark resistant fan motor. Through the use of an adjustable timer the controller shall keep the contactors energized for up to six minutes in accordance with the stations response requirement. If the responding vehicle does not disconnect from the exhaust ventilation system in less than the designated setting, the temperature override switch shall override the time delay to ensure continuous system operation. This automated function will work for as long as the exhaust gas temperature is in excess of the setting on the heat sensor located in the ductwork system. This cycle shall not allow the electrical contactor, which energizes the exhaust fan, to short cycle or stop the fan while the system is connected to an operating vehicle.

.4 Motor Control Contactor: Allen Bradley Industrial Electrical Contactor 100C series. The contactor shall be UL - CUL listed as an approved component.

.5 Motor Control Overload Relay: Allen Bradley 193 E1 Plus series. Overload relay shall have an adjustable trip range to meet the proper full load amperage of the blower motor.

.6 Soft Touch Controls: Incorporated on the face or the access door of the controller by the use of an adhesive backed Lexan membrane type label to prevent water infiltration, which would void the NEMA 12R rating. Label: Provided and secured permanently to the exterior of the electrical controller. Label: Include the name of the manufacturer, address, telephone number, user instructions and any warnings or cautions required by Underwriters Laboratories.

.1 Auto Start: This mode of operation shall be strictly for normal day to day use, as it would apply to receiving an emergency call and leaving the station. Any one or combination of the three devices listed below in Paragraph H shall activate the system. The system shall maintain itself in the Auto Start mode and always return there after the Stop sequence has been initiated. The controller shall not have a permanent off position due to the potential health hazards of diesel exhaust components.

.2 Stop: This mode of operation shall be a system override to shut down the system manually. Upon activating this mode of operation the exhaust system blower shall shut down. After a period not to exceed three seconds the controller shall automatically return to the Auto Start ready mode. This shall be a safety feature to prevent a potential health hazard from carcinogenic diesel exhaust leakage from systems having an undesirable open nozzle.

.3 Manual Run: This mode of operation shall be a system override to run the exhaust system blower continuously for the purpose of running the vehicles indoors for equipment checks during inclement weather. Upon activating this mode of operation the exhaust system blower shall start and run continuously until the Stop mode is activated at which point the system will automatically return to the Auto Start ready mode within a maximum three second time period.

.7 System Indicator LED's: Show system status at all times.

.1 Auto Start Indicator: Indicate the system is in the fully automatic mode of operation and that power is on to the controller.

.2 Fan On Indicator: Indicate that power is being applied to the system blower and the controller is operating normally.

.3 Filter Status Indicator: Indicates, if flashing, excessive pressure loss across the filter bank media. Consequently the filter must be serviced to maintain optimum efficiency of the system.

.4 Stop Indicator: Indicate the fan has been manually de-energized and will return to the Auto Start ready sequence in less than three seconds to prevent the system blower from being left in the Off mode.

.5 Manual Run Indicator: Indicate the fan is operating in a continuous run mode until interrupted by the stop mode activation.

.8 Controller Transformer: UL listed industrial control circuit transformer sized to properly supply all components so that only one transformer shall be required. Transformer shall be provided with multi-tap primary for 115, 208, 240, 277, 400, 480, and 600VAC, and 24, 120, 230VAC secondary operating on 50 or 60 hertz with a capacity of 90 volt amperes.

.9 Control Circuit Protection: By the use of primary and secondary fuses to meet UL requirements. The primary shall be protected by a pair of FLQ style fuses rated at 1.6 amps for voltages under 400V and a pair of .75 amp fuses for voltages over 400V. A single glass fuse rated at 3.15 amps at 250V shall protect the secondary side of the control circuit.

.10 Electronic Control Circuit Card: Solid state printed circuit board. The soft controls shall be an integral part of the control circuit card. The control circuit card shall utilize a potentiometer to adjust the length of the timing cycle from 7 to 360 seconds. It shall incorporate several different modes of operation and optional features.

.11 Activation Devices:

.1 Engine Start Switch: An engine pressure sensing type, capable of recognizing the output pressure of any type of motor vehicle exhaust. The electrical contact shall be dry type or not to exceed 24V ac. There shall be one sensor per vehicle.

.2 Thermal Start Switch: Temperature sensing switch of the snap disc type and adjustable from 90 degrees F (32 degrees C) to 130 degrees F (55 degrees C) to configure the system based on different exhaust temperatures. There shall be one sensor per vehicle.

.3 Wireless Transmitter and Receiver System: Shall be an optional feature operating on a 900 Mhz spread spectrum frequency and FCC part 15 compliant. The receiver shall utilize 4 independent programmable channels of control and capable of supporting up to 16 transmitters. The receiver shall operate on 24 VAC and enclosed in a non metallic

enclosure with a clear see through lid to view digital display for system supervisory functions. The transmitter shall be programmable and shall be powered by a 5 year 3 volt battery for ease of replacement and cost savings. The transmitter shall have an open field range of 2500 feet and shall be initiated by a NO contact closure such as from a pressure switch mounted on the exhaust system trolley/crab or a relay mounted on the vehicle.

.12 Clean Filter Indicator Alarm: Used in conjunction with the optional Unifilter for filtering diesel exhaust particulate before release to the atmosphere. The clean filter indicator shall monitor the pressure loss across the filter bank media. Once the useful life of the filter has been depleted the pressure differential switch will signal a high-pressure loss and flash the "Fan On" indicator while the exhaust blower is running.

.13 Electrical Wiring: Run in wire channel to allow for easier identification of the wiring circuits and for a neat appearance. All wiring circuitry shall meet National Electric Code and UL standards for proper size, bending radiuses (NEC code ref. 300-34) and terminations.

.14 Electrical Terminal Block: 600 V, UL rated and recognized. It shall provide individual connection points for remote controls, clean filter indicator and power connections. The primary and secondary control wiring fuses shall be incorporated into the terminal block as one unit.

.15 Product Manual: Shall be provided with each electrical control box supplied. The product manual shall include a description of components with part numbers inclusive to the controller. It shall include a wiring schematic showing all internal circuitry as well as all field installed wiring connections to the controller.

.16 Electrical Interference: To protect the apparatus and communications, designs that allow any possibility of electrical back-feed or induced current which may interfere with a central services communication or onboard vehicle computer logic or navigational equipment will not be accepted.

2.18 ELECTRICAL SYSTEM

.1 Station Electric Supply Panel: The power circuit for the "Emergency Response Vehicle Exhaust Removal System" shall originate in a circuit breaker panel board of the appropriate size to handle the load. Fan circuit shall be supplied by a UL listed, HACR rated circuit breaker (HACR rating is specifically for motor type loads) of the same type as indicated by the manufacturer of the circuit breaker panel or a dual element time delay fuse for fuse style panels. The circuit shall be clearly marked on an engraved ledger plate or in ink on the panel schedule as "Emergency Response Vehicle Exhaust Removal System".

.2 OS-3 Automatic Controller: Built and supplied by a UL recognized and listed exhaust system manufacturer. Controller shall carry the UL - CUL listing label as an "Enclosed Industrial Control Panel". Individual components listed by UL shall not satisfy the above requirement. Manufacturer must undergo monthly inspections by UL to verify all requirements and standards are met as outlined by UL. The controller shall be delivered as an Operating System Three series controller or an approved equal to the specifications in 2.17 Electrical Controllers. The controller shall be mounted 6 feet (1829 mm) to the top of the cabinet AFF (above finished floor). A safety disconnecting means must be within sight of the controller for servicing and for safety reasons. If the supply panel is not within sight, a separate disconnecting means is required beside the controller (per NEC Code 2008). Safety disconnect shall be capable of being locked in the off and on position to follow lockout, tag out procedures. See attached Table 1-1 for proper Square D part number of safety disconnect switch.

.3 Power Wiring Conduit: Minimum of EMT utilizing fittings for damp locations such as apparatus wash down areas (per NEC Code 2008). Conduit shall be supported with a conduit strap every 10 feet and within 3 feet of each box or termination, (per NEC 2008).

.4 Power Wiring from Supply Panel to OS-3: THHN stranded copper wire consisting of a flame retardant, heat-resistant thermoplastic insulation with a nylon jacket for abrasion, gas, and oil resistance and rated up to 600 volts.

.5 Low Voltage Control Wiring: Minimum of a 16/2 multi-conductor cable to meet UL standards for the controller's low voltage field wiring.

.6 Low Voltage Control: Encased in a minimum of ½ inch (12.7 mm) EMT from the OS-3 Controller to the attic or building steel where it shall terminate with a EMT connector with a threaded plastic bushing. Conduit: Supported with a conduit strap every 10 feet and within 3 feet of each box or termination (per NEC Code 2008). The 16/2 multi-conductor cable shall be supported by the

building structure and ran in a manner that the cable will not be damaged by normal building use (per NEC Code 2008), securely fastening it with nylon tie wraps every 24 inches (609.6 mm) to 36 inches (914.4 mm). Draping of the cable perpendicular to building steel or support members will be unacceptable.

.7 Power Wiring from OS-3 to Fan Motor: Minimum of EMT utilizing compression type fittings for damp locations such as apparatus wash down areas (per NEC Code 2008). Conduit shall be supported with a conduit strap every 10 feet (3048 mm) and within 3 feet 914.4 mm) of each box or termination (per NEC Code 2008). Conduit shall extend through the outside wall through a hole of the proper size and terminate directly into the back of the safety disconnect with the appropriate connector and sealed with a silicon sealer or cement mortar. (Using fan model number select appropriate wire and conduit size from Table 1-1).

.8 Fan Safety Disconnect: Square D, non-fusible, NEMA 3R rated for wet locations, mounted adjacent to the AMCA Certified blower. Safety disconnect shall be capable of being locked in the off and on position to follow lockout, tag out procedures. (Using fan model number select appropriate safety disconnect from attached Table 1-1).

.9 Liquid Tight Flexible Metal Conduit: UL listed liquidtight flexible metallic conduit (Sealtite). Conduit will encase the load wires and ground wire from the safety disconnect switch to the blower motor. Conduit length not to exceed 4 feet (1219.2 mm) from disconnect to blower motor. The appropriate listed terminal fittings shall be used (per NEC Code 2008). (Using fan model select appropriate conduit size from attached Table 1-1).

.10 Spark Resistant Blower: AMCA certified, designed and installed as a direct drive spark resistant blower (IMC code ref. 503.2) The motor shall meet current EPACT standards for energy savings. Fans utilizing steel impellers will not be accepted.

.11 Optional Temperature Switch: One for each apparatus connected to the system. The temperature switch shall be of the snap disc type and adjustable from 90 degrees F (32 degrees C) to 130 degrees F (54 degrees C). It shall be mounted on the ductwork 2 inches (50.8 mm) above the pressure switch by drilling a 1 inch (25.4 mm) hole, sealing the switch with silicon sealant and securing with 2 tek screws. Electrical connection shall be made with terminals provided or solder less type such as Thomas & Betts part no. 14RB-2577 or equivalent.

.12 Pressure Switch: One for each apparatus connected to the system. The pressure switch shall operate at a maximum of 24VAC, pre-calibrated at .18 in. of water column. Mounting shall be accomplished by drilling a 3/8 inch (9.5 mm) hole 3 inches 76.2 mm) above the riser bracket and to the left of the regulator and threading the switch into the duct. The electrical connections shall be made with a 0.020 inch (.5 mm) by 0.187 inch (4.8 mm) female quick disconnect terminals, such as Thomas & Betts part no. 14RBD-18277 or equivalent.

2.19 AIR MOVING DEVICES

.1 Centrifugal Fans: Direct drive centrifugal type, high pressure, single width, single inlet as required or indicated. Impeller Wheels: Radial design or backward incline for performance, spark resistant and made of a non ferrous material to prevent static electricity build up. The impeller shall be dynamically and statically balanced and of the non-overloading type to provide maximum efficiency while achieving quiet, vibration-free operation. The fan housing shall be manufactured from a epoxy powder coated galvanized steel or nonferrous material. The outlet configuration shall be top horizontal, bottom horizontal, or upblast. The housing shall be capable of field reconfiguration in the event the mounting position needs to be changed for unforeseen reasons. For aesthetic reasons the fan motor and assembly shall be mounted on a welded Type 304 stainless steel (ASTM A240/A240M) or epoxy powder coated steel mounting base to prevent rust stains on the exterior of the building. The fan housing and motor mounting hardware shall be Type 304 stainless steel (ASTM A240/A240M) for serviceability reasons.

.2 Fan Motor and Bearing: All 1 horsepower (746 watts) to 15 horsepower (11190 watts) motors shall be totally enclosed fan cooled (TEFC) continuous duty rated. The motors shall be dual voltage where applicable. Motors built after October 27th, 1997 shall comply with the government mandated "Energy Policy and Conservation Act" (EPACT) as outlined by the Department of Energy. The bearings shall be self-aligned, ball bearing type permanently sealed and lubricated. The exhaust discharge outlet shall be in compliance with International Mechanical Code and ACGIH recommendations (min. of 36" above roofline). Air intakes, windows, cascade systems, prevailing

currents, communication equipment and building aesthetics shall be considered in the final location of the fan.

.1 Teflon Shaft Seal: The fan shaft shall be steel and rotate in a non-sparking TEFLON seal to prevent leakage and to prevent hot exhaust gases from coming into contact with the motor bearings.

.2 Variable Speed Drive: The motor shall be compatible with a variable speed drive unit.

.3 Performance: The delivered volume shall take into account all the static regain of vehicle engine exhaust (based on an airtight connection at the tailpipe), lengths of ductwork, elbows, branches, shut off, wyes, etc. which accumulate the static pressure at the field inlet. The manufacturer's provided fan(s) shall be performance guaranteed.

.1 Fan Capacity: The Fan Capacity shall be sized as such as to deliver the required CFM at each hose drop to which the vehicle is attached.

.1 The 4 inch (101.6 mm) hose system shall be designed to deliver a minimum of 500 CFM (2.9 M/Second) at a velocity of 5800 FPM (33.6 M/Second) at the hose and nozzle connection.

.2 The 5 inch (127 mm) hose system shall be designed to deliver a minimum of 750 CFM (4.4 M/Second) at a velocity of 5800 FPM (33.6 M/Second) at the hose and nozzle connection.

.3 The 6 inch (152.4 mm) system shall be designed to deliver a minimum of 1100 CFM (6.4 M/Second) at a velocity of 5800 FPM (33.6 M/Second) at the hose and nozzle connection.

.4 Location: The preferable fan location shall be on the outside of the fire station as far away from any living quarters as possible so that firefighters would not be disturbed by the system activation. No blower fans shall be mounted inside the fire station. Silencers shall be provided when fan sound pressure level exceeds 64 dB.

2.20 DUCTWORK SYSTEM

.1 Ductwork Type and Materials: UMC Class 2 or SMACNA Class II product conveying duct, meet or exceed criteria for construction and performance as outlined in Round Industrial Duct Construction Standards, SMACNA. Materials of construction unless otherwise specified for all ductwork and fittings shall be a minimum G-90 galvanized sheet metal (ASTM A653/A653M). Only when specified, Type 304 stainless steel (ASTM A240/A240M) shall be provided.

.2 Ductwork Sizing and Gauges: Round pipe construction, with the range of available sizes not to exceed 10 inches (254 mm) in diameter. Duct gauge shall depend on diameter and a minimum operating pressure of 8 inches water gauge (1990 Pa). Acceptable Gauge and Reinforcement Requirements: Inner duct diameter 4 inches (101.6 mm) through 11 inches (279.4 mm) diameter shall be 22 gauge standard pipe (International Mechanical Code).

.3 Ductwork Fittings: Round and have a wall thickness 2 gauges (one even gauge number) heavier than the lightest allowable gauge of the downstream section of duct to which they are connected (International Mechanical Code). Air Duct Branch Entrances: Factory fabricated fittings or factory fabricated duct /tap assemblies. Fittings: Constructed so that air streams converge at angles no greater than 45 degree (International Mechanical Code). All Seams: Continuous stitch welded and if necessary internally sealed to ensure air tightness. Turning elbows shall be stitch-welded and used for all diameters and pressures. They shall be fabricated of 24 gauge galvanized steel and constructed as two piece with continuous welded seam construction fittings similar to those provided by Lindab Inc. Tapered Body Fittings: Used wherever particular fallout is anticipated and where air flow is introduced to the transport duct manifold.

.4 Ductwork Design Velocities: Minimum of 3500 FPM (20.3 M/Second) to 4000 FPM (23.2 M/Second) transport velocity. Capture Velocity: 5500 FPM (31.9 M/Second) to 6000 FPM (34.8 M/Second) to extract virtually 100 percent of the exhaust gases.

.5 External Ductwork: Sized for the exact inlet and outlet of the exhaust fan blower. An exhaust rain cap shall be supplied and manufactured in accordance with EPA standard for free draft rain cap requirements. Included as an integral part of this rain cap shall be a back draft damper to provide protection from rain and other inclement weather.

.6 Exhaust Penetrations: The core drilling shall be properly sized to reduce the diameter of the opening to the smallest possible size.

3 Excecution

3.1 INSTALLATION

.1 Install equipment to manufacturers instructions.
.2 Do not operate fans for any purpose until ductwork is clean, bearings lubricated, and fan has been test run under observation.
.3 Install fans with resilient mounting and flexible electrical leads. Refer to Division 15 and Division 16.
.4 Install flexible connections at fan inlet and discharge. Ensure metal bands of connectors are parallel with minimum 25 mm flex between ductwork and fan while running.
.5 Provide pitot tube openings where required for testing of systems, complete with metal cap with spring device or screw to ensure against air leakage.
.6 Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
.7 Slope underground ducts to plenums or low pump out points at l:500. Provide access doors for inspection.
.8 Paint buried metal ductwork with one coat and seams and joints with additional coat of asphalt base protective coating.
.9 Encase buried metal ductwork in 75 mm minimum of concrete. Provide adequate tie-down points to prevent ducts from floating during concrete placement.
.10 Tape joints of PVC coated metal ductwork with PVC tape. Backfill with sand.
.11 Manual Damper (LPD series), motorized damper (MOD-6) and remote switch.
.12 Engine running lab exhaust hose: metal unpacked interlock hose, st. steel type 302, -60deg.F. to 1800 deg.F. temperature rating.

3.2 CONNECTIONS

.1 Ground equipment accordign to Division 16 Section "Grounding and Bonding".
.2 Connect wiring according to Division 16 Section "Conductors and Cables".

3.3 ADJUSTING

.1 Refer to Division 15 for testing, adjusting, and balancing procedures.
.2 Replace fan and motor pulleys as required to achieve design airflow.
.3 Lubricate bearings.

End of Section

1 General

1.1 SECTION INCLUDES

.1 Fabricated breechings.
.2 Manufactured chimneys for gas fired equipment.
.3 Vent dampers.
.4 Manufactured double wall chimneys for fuel fired equipment.

1.2 REFERENCES

.1 ANSI Z21.66 - Automatic Vent Damper Devices for Use with Gas-Fired Appliances.
.2 ANSI Z21.67 - Mechanically Actuated Automatic Vent Damper Devices for Use with Gas-Fired Appliances.
.3 ANSI Z21.68 - Thermally Operated Automatic Vent Damper Devices for Use with Gas-Fired Appliances.
.4 ASTM A167 - Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
.5 ASTM A653/A653M - Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
.6 ASTM A1011/A1011M - Standard Specification for Steel, Sheet, and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
.7 ASTM C401 - Classification of Alumina and Alumina-Silicate Castable Refractories.
.8 NEMA MG1 - Motors and Generators.
.9 NFPA 31 (ANSI Z95.1) - Standard for the Installation.
.10 NFPA 54 (ANSI Z223.1) - The National Fuel Gas Code.
.11 NFPA 82 - Standard on Incinerators and Waste and Linen Handling Systems and Equipment.
.12 NFPA 211 - Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances.
.13 SMACNA - HVAC Duct Construction Standards - Metal and Flexible.
.14 UL 103 - Standard for Factory Built Chimneys for Residential Type and Building Heating Appliances.
.15 UL 127 - Standard for Factory-Built Fireplaces.
.16 UL 378 - Standard for Safety for Draft Equipment.
.17 UL 441 - Standard for Safety for Gas Vents.
.18 UL 641 - Type L Low-Temperature Venting Systems.
.19 UL 959 (ANSI Z181.1) - Medium Heat Appliance Factory Built Chimneys.

1.3 DEFINITIONS

.1 Breeching: Vent Connector.
.2 Chimney: Primarily vertical shaft enclosing at least one vent for conducting flue gases outdoors.
.3 Smoke Pipe: Round, single wall vent connector.
.4 Vent: That portion of a venting system designed to convey flue gases directly outdoors from a vent connector or from an appliance when a vent connector is not used.
.5 Vent Connector: That part of a venting system that conducts the flue gases from the flue collar of an appliance to a chimney or vent, and may include a draft control device.

1.4 DESIGN REQUIREMENTS

.1 Factory built vents and chimneys used for venting natural draft appliances to NFPA 211, UL listed and labeled.

1.5 SUBMITTALS FOR REVIEW

.1 Section 15010: Procedures for submittals.
.2 Shop Drawings: Indicate general construction, dimensions, weights, support and layout of breechings. Submit layout drawings indicating plan view and elevations where factory built units are used.
.3 Product Data: Provide data indicating factory built chimneys, including dimensional details of components and flue caps, dimensions and weights, electrical characteristics and connection requirements.
.4 Section 15010: Submittals for information.
.5 Submit manufacturer's installation instructions: Indicate assembly, support details, and connection requirements.
.6 Manufacturer's Certificate: Certify that refractory lined metal stacks meet or exceed specified requirements.

1.6 QUALITY ASSURANCE

.1 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
.2 Installer Qualifications: Company specializing in performing the work of this section with minimum two years documented experience.
.3 Design stacks under direct supervision of a Professional Structural Engineer experienced in design of this Work and licensed at the place where the Project is located.

1.7 REGULATORY REQUIREMENTS

.1 Conform to applicable code code for installation of natural gas burning appliances and equipment.
.2 Conform to applicable code for installation of oil burning appliances and equipment.
.3 Products Requiring Electrical Connection: Listed and classified by Underwriters' Laboratories, Inc., as suitable for the purpose specified and indicated.

2 Products

2.1 SPECIAL GAS VENT

.1 Product: Air-insulated double-wall for commercial applications, approved for use on individual or common vented.
.2 Use: Chimneys and Vents (Horizontal or Vertical) for ANSI Category I, II, III, and IV gas-burning appliances and Direct Vent and for Gas and Oil fired appliances listed for Type L, oil-fired appliances as approved by the appliance manufacturer.
.3 Fuels: Natural gas or propane fired, oil fired low temperature appliances
.4 Pressure: Positive up to 15" wc, negative, or neutral
.5 Standard Diameters: 4"-32"
.6 Seal: Factory adhered seal (4"-16"), RTV Sealant (18"-32")
.7 Testing & Listing: Tested and Listed by Underwriters Laboratories to UL 1738 /ULC S636 for use with Listed natural gas or propane burning equipment that produce continuous flue-gas temperatures not above 550°F. Tested and Listed by Underwriters Laboratories to UL 731 /ULC S609 for use with Listed oil and gas burning equipment that are suitable for venting with Type L vent which produce continuous flue-gas temperatures not above 570°F.
.8 Materials: flue-gas conduit fabricated from AL 29-4C® stainless steel, outer jacket is constructed of type 430 stainless steel with a space of approximately 1" between the flue-gas conduit and the jacket
.9 Joints: All joints fastened with a closure system that combines tapered ends, tabs and a locking band.
.10 Application: System may safely and securely be utilized in either interior or exterior installations. The system is capable of withstanding reasonable wind and incidental loads as required by UL

standards.

.11 Sizing: System is to be sized in accordance with appliance manufacturers' specifications, the most current edition of NFPA 211 Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances, the most current edition of NFPA 54 National Fuel Gas Code (ANSI Z223.1), ASHRAE recommendations, and all applicable local and regional codes.

.12 Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly. Termination: Round chimney top designed to exclude 98 percent of rainfall or Exit cone with drain section incorporated into riser as applicable.

.13 Installation: system is to be installed only in accordance with manufacturer's, "Installation and Maintenance Instructions" and with all applicable local, regional, and national codes. Install and seal per manufacturers' instructions so all joints are gas tight, preventing leakage of products of combustion into a building.

.14 Acceptable Manufacturer:
- .1 Heat Fab Saf-T Vent CI Plus
- .2 Metal-Fab, Inc.
- .3 Security Chimneys

2.2 GUYING AND BRACING MATERIALS

.1 Cable: Three galvanized, stranded wires of the following thickness:
- .1 Minimum Size: 1/4 inch (6 mm) in diameter.
- .2 For ID Sizes 4 to 15 Inches (100 to 381 mm): 5/16 inch (8 mm).
- .3 For ID Sizes 18 to 24 Inches (457 to 610 mm): 3/8 inch (9.5 mm).

.2 Pipe: Three galvanized steel, NPS 1-1/4 (DN 32).

.3 Angle Iron: Three galvanized steel, 2 by 2 by 0.25 inch (50 by 50 by 6 mm).

3 Execution

3.1 INSTALLATION

.1 Install to manufacturer's instructions.

.2 Install to NFPA 54 (ANSI Z223.1).

.3 Install breechings with minimum of joints. Align accurately at connections, with internal surfaces smooth.

.4 Support breechings from building structure, rigidly with suitable ties, braces, hangers and anchors to hold to shape and prevent buckling. Support vertical breechings, chimneys, and stacks at 4 m spacing, to adjacent structural surfaces, or at floor penetrations. Refer to SMACNA HVAC Duct Construction Standards - Metal and Flexible for equivalent duct support configuration and size.

.5 Install concrete inserts for support of breechings, chimneys, and stacks in coordination with formwork.

.6 Pitch breechings with positive slope up from fuel-fired equipment to chimney or stack.

.7 Coordinate installation of dampers.

.8 Install vent dampers, locating close to draft hood collar, and secured to breeching.

.9 Assemble and install stack sections to NFPA 82, industry practices, and in compliance with UL listing. Join sections with acid-resistant joint cement Connect base section to foundation using anchor lugs.

.10 Level and plumb chimney and stacks.

.11 Clean breechings, chimneys, and stacks during installation, removing dust and debris.

.12 At appliances, provide slip joints permitting removal of appliances without removal or dismantling of breechings, breeching insulation, chimneys, or stacks.

.13 Provide minimum length of breeching to connect appliance to chimney.

End of Section

1 General

1.1 GENERAL

.1 Read and conform to:
- .1 The General Conditions of the Contract
- .2 Comply with Division 1 requirements and documents referred to herein.
- .3 Comply with the General Requirements of Section 15010.

.2 Work Included:
- .1 General - Building Management System (BMS) Contractor shall provide and install:
  - .1 A fully integrated Building Automation System (BAS), incorporating direct digital control (DDC) for energy management, equipment monitoring and control, and subsystems with open communications capabilities as herein specified.
  - .2 Provide open communications system. The system shall be an open architecture with the capabilities to support a multi-vendor environment. To accomplish this effectively, system shall be capable of utilizing standard protocols as follows as well as be able to integrate third-party systems via existing vendor protocols. System shall be capable of LonWorks communication using the LonTalk protocol. System shall be capable of BACnet communication according to ASHRAE standard SPC-135A/95. System shall be capable of OPC server communications according to OPC Data Access 2.0 and Alarms and Events 1.0. The system shall not be limited to only use open communication protocols, but also be able to integrate a wide variety of third-party devices and applications via existing vendor protocols and through the latest software standards.
  - .3 Complete temperature control system to be DDC with electric actuation as specified herein.
  - .4 All wiring, conduit, panels, and accessories for a complete operational system.
  - .5 BMS Contractor shall be responsible for all electrical work associated with the BMS.
    - .1 Perform all wiring in accordance with all local and national codes.
    - .2 Install all line voltage wiring, concealed or exposed, in conduit in accordance with the division 16 specifications, NEC and local building code.
    - .3 Surge transient protection shall be incorporated in design of system to protect electrical components in all DDC Controllers and operator's workstations.
  - .6 The open protocol building automation system shall be as follows:
    - .1 Capable of high speed Ethernet communication using TCP/IP protocol.
    - .2 The system shall be capable of supporting both standard and vendor specific protocols to integrate a wide variety of third-party devices and legacy systems.
    - .3 The system shall be capable of supporting wireless secondary level networks and sensor communications using a mesh topology and IEEE 802.15.4 network.
    - .4 The intent is to either use the Operator Workstation provided under this contract to communicate with control systems provided by other vendors or to allow information about the system provided in this contract to be sent to another workstation. This allows the user to have a single seat from which to perform daily operation.
  - .7 Provide system graphics for each controlled device and/or integrated systems as required by the owner. Origin of information shall be transparent to the operator and shall be controlled, displayed, trended, etc. as if the points were hardwired to the BMS.
  - .8 One (1) Personal computer operator workstation, associated peripherals and equipment required to set up dynamic color graphic PC console at the Chief Engineer's Office.
  - .9 Primary DDC panels as follows:

.1 Minimum one (1) BMS system Primary DDC panel per floor. The application specific controllers installed for the terminal units on a floor will be connected to the BMS panel on the same floor.
.2 Minimum one (1) BMS system Primary DDC panel per each major mechanical system:
.1 Air Handling Unit
.3 It shall be acceptable to combine up to three (3) of the following mechanical equipment into one (1) Primary DDC panel:
.1 Exhaust Fans
.2 Standalone Supply Fans
.3 Package AC Units
.4 It is acceptable to wire the following systems into any of the Primary DDC panels:
.1 Miscellaneous alarm monitoring (i.e. ATS, leak, temperature, light …etc.)
.2 Miscellaneous equipment (i.e. Unit Heater, Domestic Water Heater, Standalone Dampers …etc.)
.5 Motors in motor control centers shall be controlled from the DDC controller associated with HVAC system. It shall not be acceptable to control all motors in a MCC from one DDC controller dedicated to the MCC. The intent of this specification is that the loss of any one DDC controller shall not affect the operation of other HVAC systems, only for the points connected to the DDC controller.
.10 Stand-alone Application Specific Controllers (ASCs) for terminal equipment (fan coil units).
.11 The BMS shall be powered by dedicated electrical circuits connected to building emergency power and furnished with UPS and redundant power arrangement.
.12 The controller and I/O distribution shall be designed such that all major HVAC equipment shall remain fully operational during network or communication interruption.

.3 General Product Description
.1 The installation of the control system shall be performed under the direct supervision of the BMS Contractor with the shop drawings, flow diagrams, bill of materials, component designation, or identification number and sequence of operation all bearing the name of the manufacturer. The BMS Contractor shall certify in writing, that the shop drawings have been prepared according to the equipment manufacturer's guidelines.
.2 All materials and equipment used shall be standard components, regularly manufactured for this and/or other systems and not custom designed specially for this project. All systems and components shall have been thoroughly tested and proven in actual use for at least two years.
.3 The system shall be scalable in nature and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, DDC Controllers, and operator devices.
.4 System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. Each DDC Controller shall operate independently by performing its own specified control, alarm management, operator I/O, and data collection. The failure of any single component or network connection shall not interrupt the execution of any control strategy, reporting, alarming and trending function, or any function at any operator interface device.
.5 DDC Controllers shall be able to access any data from, or send control commands and alarm reports directly to, any other DDC Controller or combination of controllers on the network without dependence upon a central or intermediate processing device. DDC Controllers shall also be able to send alarm to multiple operator workstations without dependence upon a central or intermediate processing device.
.6 DDC Controllers shall be able to assign password access and control priorities to each point individually. The logon password (at any PC workstation or portable operator terminal) shall enable the operator to monitor, adjust or control only the points that the operator is authorized for. All other points shall not be displayed at the PC workstation or portable

terminal. (e.g. all base building and all tenant points shall be accessible to any base building operators, but only certain base building and tenant points shall be accessible to tenant building operators). Passwords and priority levels for every point shall be fully programmable and adjustable.

.7 All DDC controllers shall be installed with 10% spare points (of each type) and 25% spare memory capacity for connection of floor work.

.8 Controls vendor must supply licensed copies of all software tools so customer can make all future Graphic and programming changes ay no additional costs. i.e Siemens PPCL, Honeywell CARE.

1.2 PRODUCTS FURNISHED BY NOT INSTALLED UNDER THIS SECTION

.1 Hydronic Piping:
- .1 Control Valves
- .2 Temperature Sensor Wells

.2 Duct-work Accessories:
- .1 Dampers
- .2 Terminal Unit Controls

1.3 RELATED SECTIONS

.1 The General Conditions of the Contract, Supplementary Conditions, and General Requirements are part of this specification and shall be used in conjunction with this section as part of the contract documents.

1.4 APPROVED CONTROL SYSTEM CONTRACTORS

.1 The following are the approved Control System Contractors and Manufacturers:
- .1 Johnson Controls Inc.
- .2 Reliabel Controls
- .3 Siemens Building Technologies, Ltd.
- .4 Honeywell International Ltd.
- .5 Delta Controls

1.5 QUALITY ASSURANCE

.1 The BAS system shall be designed and installed, commissioned and serviced by factory trained personnel. BMS contractor shall have an in-place support facility within 100 miles of the site with technical staff, spare parts inventory and necessary test and diagnostic equipment. The BMS contractor shall provide full time, on site, experienced project manager for this work, responsible for direct supervision of the design, installation, start up and commissioning of the B.M.S. The Bidder shall be regularly engaged in the installation and maintenance of BMS systems and shall have a minimum of ten (10) years of demonstrated technical expertise and experience in the installation and maintenance of B.M.S. systems similar in size and complexity to this project.

.2 The BMS contractor shall be the Manufacturer or an Authorized Manufacturers Contractor. No distributors are allowed.

.3 Materials and equipment shall be the catalogued products of manufacturers regularly engaged in production and installation of automatic temperature control systems and shall be manufacturer's latest standard design that complies with the specification requirements.

.4 The manufacturer of the building automation system shall provide documentation supporting compliance with ISO-9002 (Model for Quality Assurance in Production, Installation, and Servicing) and ISO-140001 (The application of well-accepted business management principles to the environment). The intent of this specification requirement is to ensure that the products from the manufacturer are delivered through a Quality System and Framework that will assure consistency in the products delivered for this project.

.5 This system shall have a documented history of compatibility by design for a minimum of 15 years.

Future compatibility shall be supported for no less than 10 years. Compatibility shall be defined as the ability to upgrade existing field panels to current level of technology, and extend new field panels on a previously installed network. Compatibility shall be defined as the ability for any existing field panel microprocessor to be connected and directly communicate with new field panels without bridges, routers or protocol converters.

1.6 SYSTEM PERFORMANCE

.1 Performance Standards. System shall conform to the following minimum standards over network connections. Systems shall be tested using manufacturer's recommended hardware and software for operator workstation.
- .1 Graphic Display. A graphic with 20 dynamic points shall display with current data within 10 sec.
- .2 Graphic Refresh. A graphic with 20 dynamic points shall update with current data within 8 sec. and shall automatically refresh every 15 sec.
- .3 Alarm Response Time. An object that goes into alarm shall be annunciated at the workstation within 15 sec.
- .4 Program Execution Frequency. Custom and standard applications shall be capable of running as often as once every 5 sec. Select execution times consistent with the mechanical process under control.
- .5 Performance. Programmable controllers shall be able to completely execute DDC control loops at a frequency adjustable down to once per sec. Select execution times consistent with the mechanical process under control.
- .6 Multiple Alarm Annunciations. Each workstation on the network shall receive alarms within 5 sec of other workstations.

1.7 SUBMITTALS

.1 Provide submittals within 6 weeks of contract award.

1.8 WARRANTY

.1 Provide submittals within 6 weeks of contract award including but not limited to hard & electronic copies of shop and "As Built" drawings (e.g. sequences of operation, points list, floor plans identifying all BMS equipment/points, network schematics, controller wiring details, valve & damper schedules, bill of materials with cut sheets, operating manuals, commissioning reports, warranty certificate including vendor contact information

1.9 OWNERSHIP OF PROPRIETARY MATERIAL

.1 Project specific software and documentation shall become Owner's property. This includes, but not limited to:
- .1 Graphics
- .2 Record drawings
- .3 Database
- .4 Application programming code

Response time shall be 2 hours during regular business hours and 4 hours for all after hours emergency call of all critical equipment failure (e.g. boiler or AHU failure) due to BMS hardware or software defects.

.2 Documentation
- .1 General
  - .1 Submit four (4) copies of owner's manuals upon completion of project.

2 Products

2.1 MATERIALS

.1 All products used in this project installation shall be new and currently manufactured and shall have been applied in similar installations. Do not use this installation as a product test site unless explicitly approved in writing by Owner or Owner's representative. Spare parts shall be available for at least five years after completion of this contract.

2.2 COMMUNICATIONS

.1 The design of the BMS shall support networking of operator workstations and Building Controllers. The network architecture shall consist of two levels, an Ethernet based primary network for all operator workstations, servers, and primary DDC controllers along with secondary Floor Level Networks (FLN) for terminal equipment application specific controllers.

.2 Access to system data shall not be restricted by the hardware configuration of the building management system. The hardware configuration of the BMS network shall be totally transparent to the user when accessing data or developing control programs.

.3 Thin Client access to client-server workstation configurations via Windows Terminal Services shall provide multiple, independent sessions of the workstations software. Terminal Services clients shall have full functionality, without the need to install the workstation software on the local hard drive.

.4 Operator Workstation Communication:

- .1 All color graphic operator workstations shall reside on the Ethernet network and the consoles shall be set up in a client/server configuration.
- .2 The servers will act as the central database for system graphics and databases to provide consistency throughout all system workstations.
- .3 The network shall allow concurrent use of multiple BMS software site licenses.
- .4 Communications to main server shall be via Terminal Services.

.5 Management Level Network Communication (MLN)

- .1 Operator Workstation shall be capable of simultaneous direct connection and communication with BACnet/IP, OPC and TCP/IP corporate level networks without the use of interposing devices.
- .2 Any controller residing on the primary building level networks shall connect to Ethernet network without the use of a PC or a gateway with a hard drive.
- .3 Any PC on the Management Level Network shall have transparent communication with controllers on the building level networks connected via Ethernet.
- .4 Any break in Ethernet communication from the PC to the controllers on the building level networks shall result in a notification at the Server PC.
- .5 The standard client and server workstations on the Management Level Network shall reside on industry standard Ethernet utilizing standard TCP/IP, IEEE 802.3.
- .6 System software applications will run as a service to allow communication with Primary Network Controllers without the need for user log in. Closing the application or logging off shall not prevent the processing of alarms, network status, panel failures, and trend information.
- .7 Access to the system database shall be available from any standard client workstation on the Management Level Network with Terminal Services Loaded on it.
- .8 Client access to client-server workstation configurations over the Internet network shall be available via Terminal Services Interface.

.6 Primary Network - Panel to Panel Communication:

- .1 All Building Controllers shall directly reside on the EIA-485 network such that communications may be executed directly between DDC Controllers.
- .2 Systems that operate via polled response or other types of protocols that rely on a central processor, file server, or similar device to manage panel-to-panel or device-to-device communications shall not be acceptable.
- .3 All operator interfaces shall have the ability to access all point status and application report data or execute control functions for any and all other devices. Access to data shall be based upon logical identification of building equipment. No hardware or software limits

shall be imposed on the number of devices with global access to the network data.

.4 The peer-to-peer panel-to-panel Building Level Network (BLN) shall use EIA-485, up to 76800 bps network speed:
  .1 Up to 115Kbps network speed.
  .2 Allow access using Telnet.

.5 The peer-to-peer panel-to-panel network shall provide the following minimum performance:
  .1 Provide sufficient data transfer rate for alarm reporting, report generation from multiple controllers, and upload/download between network devices. System performance shall insure that an alarm occurring at any Building Controller is displayed at any PC workstations, all Building controllers and other alarm printers within 15 seconds.
  .2 Message and alarm buffering to prevent information from being lost.
  .3 Error detection, correction and re-transmission to guarantee data integrity.
  .4 Synchronization of real-time clocks between Building Controllers, including automatic daylight savings time corrections.

.6 The primary network shall provide the following minimum performance:
  .1 Provide high-speed data transfer rates for alarm reporting, report generation from multiple controllers and upload/download efficiency between network devices. System performance shall insure that an alarm occurring at any Building Controller is displayed at any PC workstations, all Building controllers, and other alarm printers within 15 seconds.
  .2 Message and alarm buffering to prevent information from being lost.
  .3 Error detection, correction, and re-transmission to guarantee data integrity.
  .4 Synchronization of real-time clocks between Building Controllers, including automatic daylight savings time corrections.
  .5 The primary network shall allow the Building Controllers to access any data from, or send control commands and alarm reports directly to, any other Building Controller or combination of controllers on the network without dependence upon a central or intermediate processing device. Building Controllers shall send alarm reports to multiple operator workstations without dependence upon a central or intermediate processing device. The network shall also allow any Building controller to access, edit, modify, add, delete, back up, restore all system point database and all programs.
  .6 Devices containing custom programming must reside on the Primary Network

.7 Secondary Network - Application Specific Controller Communication:
  .1 Communication over the secondary network shall be the manufacturer's standard protocol.
  .2 This level communication shall support a family of application specific controllers for terminal equipment.
  .3 The Application Specific Controllers shall communicate bi-directionally with the primary network through Building Controllers for transmission of global data.
  .4 A maximum of 30 terminal equipment controllers may be configured on individual secondary network trunks to insure adequate global data and alarm response times.

.8 Remote Access to BMS: the BMS shall allow authorized remote access via dial-up or Internet.

2.3 OPERATOR INTERFACE

.1 Workstation hardware:
  .1 Personal computer operator workstations shall be provided for command entry, information management, system monitor, alarm management and database management functions. All real-time control functions shall be resident in the Building Controllers to facilitate greater distribution, fault tolerance and reliability of the building automation control. Workstation, LCD monitor and printer shall be as recommended by the Controls Manufacturer but in no case less than the following
    .1 Workstation shall consist of a personal computer with minimum 512MB RAM, hard drive with 80 GB available space, video card with 64 MB RAM capable of supporting a minimum of 1280 × 1024 resolution with a minimum of 32 Bit color, CD-RW, and DVD-ROM Drive, mouse and 101-key enhanced keyboard. Personal

computer shall be a Windows XP, 2000 or comparable operating system and shall include a minimum 3.0 GHz Pentium processor.

.2 The PC monitor shall be of flat panel type and shall support a minimum display resolution of no less than 1280 × 1024 pixels. The display shall have a minimum of 17" visible area in diagonal measurement. Separate controls shall be provided for color, contrasts and brightness. The screen shall be non-reflective.

.3 Provide an Epson FX-870 or equivalent printer at each workstation location or on the network (Ethernet) for recording alarms, operator transactions and systems reports.

.2 Server hardware:

.1 The Server hardware shall be of equal or better capability as that of Workstation and shall be equipped as follows:

.1 Locate server as located on plans.

.2 Provide a minimum 2GB RAM, with two hard drives of 160 GB available space each, with a RAID controller, a video card with 64 MB RAM capable of supporting a minimum of 1280 × 1024 resolution with a minimum of 32 Bit color, CD-RW, and DVD-ROM Drive, mouse and 101-key enhanced keyboard. Server shall be a Windows 2003 or comparable operating system, and shall include a minimum 3.0 GHz Pentium processor.

.3 Provide a monitor of flat panel type and shall support a minimum display resolution of no less than 1280 × 1024 pixels. The display shall have a minimum of 17" visible area in diagonal measurement. Separate controls shall be provided for color, contrasts and brightness. The screen shall be non-reflective.

.3 Operator Interface Software:

.1 Basic Interface Description

.1 Operator interface software shall minimize operator training through the use of user-friendly and interactive graphical applications, 30-character English language point identification, on-line help, and industry standard Windows application software. Interface software shall simultaneously communicate with and share data between Ethernet-connected building level networks.

.2 Provide a graphical user interface that shall minimize the use of keyboard through the use of a mouse or similar pointing device, with a "point and click" approach to menu selection and a "drag and drop" approach to inter-application navigation.

.3 The navigation shall be user friendly by utilizing "forward & back" capability between screens and embedded hyperlinks to open graphics, documents, drawings, etc.

.4 Selection of applications within the operator interface software shall be via a graphical toolbar menu - the application toolbar menu shall have the option to be located in a docked position on any of the four sides of the visible desktop space on the workstation display monitor, and the option to automatically hide itself from the visible monitor workspace when not being actively manipulated by the user.

.5 The software shall provide a multi-tasking type environment that allows the user to run several applications simultaneously. BMS software shall run on a Windows XP, or comparable 32 bit operating system. System database parameters shall be stored within an object-oriented database. Standard Windows applications shall run simultaneously with the BMS software. The mouse or Alt-Tab keys shall be used to quickly select and switch between multiple applications. The operator shall be able to work in Microsoft Word, Excel, and other Windows based software packages, while concurrently annunciating on-line BMS alarms and monitoring information

.6 The software shall provide, as a minimum, the following functionality:

.1 Real-time graphical viewing and control of the BMS environment

.2 Reporting

.3 Scheduling and override of building operations

.4 Collection and analysis of historical data

.5 Point database editing, storage and downloading of controller databases.

.6 Utility for combining points into logical Point Groups. The Point Groups shall then be manipulated in Graphics, trend graphs and reports in order to

streamline the navigation and usability of the system.

.7 Alarm reporting, routing, messaging, and acknowledgment

.8 "Collapsible tree," dynamic system architecture diagram application:

.1 Showing the real-time status and definition details of all workstations and devices on a management level network.

.1 Showing the real-time status and definition details of all Building Controllers at the Primary Network.

.2 Showing the definition details of all application specific controllers

.9 Definition and construction of dynamic color graphic displays.

.10 Online, context-sensitive help, including an index, glossary of terms, and the capability to search help via keyword or phrase.

.11 On-screen access to User Documentation, via online help or PDF-format electronic file.

.12 Automatic database backup at the operator interface for database changes initiated at Building Controllers.

.13 Display dynamic trend data graphical plot.

.1 Must be able to run multiple plots simultaneously

.2 Each plot must be capable of supporting 10 pts/plot minimum

.3 Must be able to command points directly off dynamic trend plot application.

.4 Must be able to plot both real-time and historical trend data

.14 Program editing

.15 Transfer trend data to 3rd party spreadsheet software

.1 Scheduling reports

.2 Operator Activity Log

.7 Enhanced Functionality:

.1 Provide functionality such that any of the following may be performed simultaneously on-line, and in any combination, via adjustable user-sized windows. Operator shall be able to drag and drop information between the following applications, reducing the number of steps to perform a desired function (e.g., Click on a point on the alarm screen and drag it to the dynamic trend graph application to initiate a dynamic trend on the desired point):

.1 Dynamic color graphics application

.2 Alarm management application

.3 Scheduling application

.4 Dynamic trend graph data plotter application

.5 Dynamic system architecture diagram application

.6 Control Program and Point database editing applications

.7 Reporting applications

.8 Plant Status showing the operating status of each BMS controlled/monitored equipment, floor plans identifying the location of each BMS & HVAC equipment/points, one graph for each major HVAC equipment showing all associated operating parameters, one graph for energy management showing the real time, monthly, and yearly accumulated consumption & demand (if applicable), one graph for lighting controls, one graph for all schedules (building, zone, special events...etc), one graph for all specified reports, one graph for administration (user logon history...etc)

.2 Report and alarm printing shall be accomplished via Windows Print Manager, allowing use of network printers.

.8 Security: Operator-specific password access protection shall be provided to allow the administrator/manager to limit users' workstation control, display and data base manipulation capabilities as deemed appropriate for each user, based upon an assigned password. Operator privileges shall "follow" the operator to any workstation logged onto (up to 999 user accounts shall be supported). The administrator or manager shall be able to grant discrete levels of access and privileges, per user, for each point, graphic, report, schedule, and BMS workstation

application. And each BMS workstation user account shall use a Windows Operating System user account as a foundation.

.9 The operator interface software shall also include an application to track the actions of each individual operator, such as alarm acknowledgement, point commanding, schedule overriding, database editing, and logon/logoff. The application shall list each of the actions in a tabular format, and shall have sorting capabilities based on parameters such as ascending or descending time of the action, or name of the object on which the action was performed. The application shall also allow querying based on object name, operator, action, or time range.

.10 Dynamic Color Graphics application shall include the following:

- .1 Must include graphic editing and modifying capabilities
- .2 A library of standard control application graphics and symbols must be included
- .3 Must be able to command points directly off graphics application
- .4 Graphic display shall include the ability to depict real-time point values dynamically with animation, picture/frame control, symbol association, or dynamic informational text-blocks
- .5 Navigation through various graphic screens shall be optionally achieved through a hierarchical "tree" structure
- .6 Graphics viewing shall include zoom capabilities
- .7 Graphics shall be capable of displaying the status of points that have been overridden by a field HAND switch, for points that have been designed to provide a field HAND override capability.
- .8 Advanced linking within the Graphics application shall provide the ability to navigate to outside documents (e.g., .doc, .pdf, .xls, etc.), Internet web addresses, e-mail, external programs, and other workstation applications, directly from the Graphics application window with a mouse-click on a customizable link symbol.

.11 Reports shall be generated on demand or via pre-defined schedule, and directed to CRT displays, printers or file. As a minimum, the system shall allow the user to easily obtain the following types of reports:

- .1 A general listing of all or selected points in the network
- .2 List of all points currently in alarm
- .3 List of all points currently in override status
- .4 List of all disabled points
- .5 List of all points currently locked out
- .6 List of user accounts and access levels
- .7 List all weekly schedules and events
- .8 List of holiday programming
- .9 List of control limits and deadbands
- .10 Custom reports from 3rd party software
- .11 System diagnostic reports including, list of Building panels on line and communicating, status of all Building terminal unit device points
- .12 List of programs
- .13 List of point definitions
- .14 List of logical point groups
- .15 List of alarm strategy definitions
- .16 List of Building Control panels
- .17 Point totalization report
- .18 Point Trend data listings
- .19 Initial Values report
- .20 User activity report

.12 Scheduling and override

- .1 Provide a calendar type format for simplification of time and date scheduling and overrides of building operations. Schedule definitions reside in the PC workstation and in the Building Controller to ensure time equipment scheduling when PC is off-line, PC is not required to execute time scheduling. Provide override access through menu selection,

graphical mouse action or function key. Provide the following capabilities as a minimum:

.1 Weekly schedules
.2 Zone schedules
.3 Event schedules - an event consists of logical combinations of equipment and/or zones
.4 Report schedules

.2 Additionally, the scheduling application shall:

.1 Provide filtering capabilities of schedules, based on name, time, frequency, and schedule type (event, zone, report)
.2 Provide sorting capabilities of schedules, based on name, time and type of schedule (zone, event, report)
.3 Provide searching capabilities of schedules based on name - with wildcarding options

.13 Collection and Analysis of Historical Data

.1 Provide trending capabilities that allow the user to easily monitor and preserve records of system activity over an extended period of time. Any system point may be trended automatically at time-based intervals (up to four time-based definitions per point) or change of value, both of which shall be user-definable. Trend data shall be collected stored on hard disk for future diagnostics and reporting. Automatic Trend collection may be scheduled at regular intervals through the same scheduling interface as used for scheduling of zones, events, and reports. Additionally, trend data may be archived to network drives or removable disk media for future retrieval.

.2 Trend data reports shall be provided to allow the user to view all trended point data. Reports may be customized to include individual points or predefined groups of selected points. Provide additional functionality to allow predefined groups of up to 250 trended points to be easily transferred on-line to Microsoft Excel. BMS contractor shall provide custom designed spreadsheet reports for use by the owner to track energy usage and cost, equipment run times, equipment efficiency, and/or building environmental conditions. BMS contractor shall provide setup of custom reports including creation of data format templates for monthly or weekly reports.

.3 Provide additional functionality that allows the user to view real-time trend data on trend graphical plot displays. A minimum of ten points may be plotted, of either real-time or historical data. The dynamic graphs shall continuously update point values. At any time the user may redefine sampling times or range scales for any point. In addition, the user may pause the display and take "snapshots" of plot screens to be stored on the workstation disk for future recall and analysis. Exact point values may be viewed and the graphs may be printed. A minimum of ten (10) dynamic graphs shall run simultaneously. Operator shall be able to command points directly on the trend plot by double clicking on the point. Operator shall be able to zoom in on a specific time range within a plot. The dynamic trend plotting application shall support the following types of graphs, with option to graph in 3D: line graph, area graph, curve graph, area-curve graph, step graph, and scatter graph. Each graph may be customized by the user, for graph type, graph text, titles, line styles and weight, colors, and configurable x- and y-axes.

.4 The time limitation of data trending shall be limited to the size of hard drive.

.14 Dynamic Color Graphic Displays

.1 Capability to create color graphic floor plan displays and system schematics for each piece of mechanical equipment, including, but not limited to, air handling units, chilled water systems, hot water boiler systems, and room level terminal units.

.2 The operator interface shall allow users to access the various system schematics and floor plans via a graphical penetration scheme, menu

selection, point alarm association, or text-based commands. Graphics software shall permit the importing of Autocad or scanned pictures for use in the system.

.3 Dynamic temperature values, humidity values, flow values and status indication shall be shown in their actual respective locations within the system schematics or graphic floor plan displays, and shall automatically update to represent current conditions without operator intervention and without pre-defined screen refresh rates.

.1 Provide the user the ability to display real-time point values by animated motion or custom picture control visual representation. Animation shall depict movement of mechanical equipment, or air or fluid flow. Picture Control shall depict various positions in relation to assigned point values or ranges. A library (set) of animation and picture control symbols shall be included within the operator interface software's graphics application. Animation shall reflect, ON or OFF conditions, and shall also be optionally configurable for up to five rates of animation speed.

.2 Sizable analog bars shall be available for monitor and control of analog values; high and low alarm limit settings shall be displayed on the analog scale. The user shall be able to "click and drag" the pointer to change the setpoint.

.3 Provide the user the ability to display blocks of point data by defined point groups; alarm conditions shall be displayed by flashing point blocks.

.4 Equipment state or values can be changed by clicking on the associated point block or graphic symbol and selecting the new state (on/off) or setpoint.

.5 State text for digital points can be user-defined up to eight characters.

.4 Colors shall be used to indicate status and change as the status of the equipment changes. The state colors shall be user definable.

.5 Advanced linking within the Graphics application shall provide the ability to navigate to outside documents (e.g., .doc, .pdf, .xls, etc.), Internet web addresses, e-mail, external programs, and other workstation applications, directly from the Graphics application window with a mouse-click on a customizable link symbol.

.6 The Windows environment of the PC operator workstation shall allow the user to simultaneously view several applications at a time to analyze total building operation or to allow the display of a graphic associated with an alarm to be viewed without interrupting work in progress.

.7 Off the shelf graphic software shall be provided to allow the user to add, modify or delete system graphic background displays.

.8 A clipart library of HVAC application and automation symbols shall be provided including fans, valves, motors, chillers, AHU systems, standard ductwork diagrams and laboratory symbols. The user shall have the ability to add custom symbols to the clipart library.

.9 The Graphics application shall include a set of standard Terminal Equipment controller application-specific background graphic templates. Templates shall provide the automatic display of a selected Terminal Equipment controller's control values and parameters, without the need to create separate and individual graphic files for each controller.

.10 The following features shall be provided so that the users can easily edit/revise graphics and manage graphics files.

.1 HTML programming shall not be required to display system graphics or data on a Web page. HTML editing of the Web page shall be allowed if the user desires a specific look or format.

.2 Storage of the graphical screens shall be in the Server, without requiring any graphics to be stored on the client machine. Systems

that require graphics storage on each client are not acceptable.

.15 System Configuration & Definition

.1 A "Collapsible tree," dynamic system architecture diagram/display application of the site-specific BMS architecture showing status of controllers, PC workstations and networks shall be provided. This application shall include the ability to add and configure workstations, Building Controllers, as well as 3rd-party integrated components. Symbols/Icons representing the system architecture components shall be user-configurable and customizable, and a library of customized icons representing 3rd-party integration solutions shall be included. This application shall also include the functionality for real-time display, configuration and diagnostics connections to Building Controllers.

.2 Network wide control strategies shall not be restricted to a single Building Controller, but shall be able to include data from any and all other network panels to allow the development of Global control strategies.

.3 Provide automatic backup and restore of all Building controller databases on the workstation hard disk. In addition, all database changes shall be performed while the workstation is on-line without disrupting other system operations. Changes shall be automatically recorded and downloaded to the appropriate Building Controller. Changes made at the user-interface of Building Controllers shall be automatically uploaded to the workstation, ensuring system continuity.

.4 System configuration, programming, editing, graphics generation shall be performed on-line.

.5 Point database configuration shall be available to the user within a dedicated point database editor application included in the operator interface software. The editor shall allow the user to create, view existing, modify, copy, and delete points from the database.

.6 The point editor shall have the capability to assign "informational text" to points as necessary to provide critical information about the equipment.

.7 The point editor shall also allow the user to configure the alarm management strategy for each point. The editor shall provide the option for editing the point database in an online or offline mode with the Building Controllers.

.8 The operator interface software shall also provide the capability to perform bulk modification of point definition attributes to a single or multiple user-selected points. This function shall allow the user to choose the properties to copy from a selected point to another point or set of points. The selectable attributes shall include, but are not limited to, Alarm management definitions and Trend definitions.

.9 Control program configuration shall be available to the user within a dedicated control program editor application included in the operator interface software. The editor shall allow for creation, modification and deletion of control programs. The editor shall include a programming assistance feature that interactively guides the user through parameters required to generate a control program. The editor shall also include the ability to automatically compile the program to ensure its compatibility with the Building Controllers. The editor shall provide the option for editing the control programs in an online or offline mode, and also the ability to selectively enable or disable the live program execution within the Building Controllers.

.16 Alarm Management

.1 Alarm Routing shall allow the user to send alarm notification to selected printers or workstation location(s) based on time of day, alarm severity, or point type.

.2 Alarm Notification shall be presented to each workstation in a tabular format application, and shall include the following information for each alarm point: name, value, alarm time & date, alarm status, priority,

acknowledgement information, and alarm count. Each alarm point or priority shall have the ability to sound a discrete audible notification.

.3 Alarm Display shall have the ability to list & sort the alarms based on alarm status, point name, ascending or descending alarm time.

.4 Directly from the Alarm Display, the user shall have the ability to acknowledge, silence the alarm sound, print. The user shall also have the ability to command, launch an associated graphic or trended graphical plot, or run a report on a selected alarm point directly on the Alarm Display.

.5 Each alarm point shall have a direct link from the Alarm Display to further user-defined point informational data. The user shall have the ability to also associate real-time electronic annotations or notes to each alarm.

.6 Alarm messages shall be customizable for each point, or each alarm priority level, to display detailed instructions to the user regarding actions to take in the event of an alarm. Alarm messages shall also have the optional ability to individually enunciate on the workstation display via a separate pop-up window, automatically being generated as the associated alarm condition occurs. The system shall have the ability to modify the priority text based on operator preference.

.7 Alarm Display application shall allow workstation operators to send and receive real-time messages to each other, for purposes of coordinating Alarm and BMS system management.

.4 Web based Operator Interface

.1 Internet connections, ISP services, as well as necessary firewalls or proxy servers shall be provided by the Owner as required to support the Terminal Services feature.

Human to Machine Interface (HMI), it is useful tool for users to operate the building, also display and manage building energy usage.

.1 A 7-inch diagonal, high resolution, wide-screen format, color LCD shall be provided for interfacing with the Building Automation System.

.2 BACnet communication over Ethernet with controllers on a local area network.

.3 User created graphics allows it to be completely customized for a given application.

.4 The touch screen interface allows operators to monitor and manage building HVAC systems by using custom real-time graphics, such as change occupancy schedules, adjust temperature setpoints and view floor layouts, display and acknowledge alarms.

.5 Allow multiple users and passwords for restricting access.

.6 Wall mounted in public spaces or panel mounted in mechanical rooms.

2.4 BUILDING CONTROLLER SOFTWARE

.1 General:

.1 Furnish the following applications software to form a complete operating system for building and energy management as described in this specification.

.2 The software programs specified in this Section shall be provided as an integral part of Building Controllers and shall not be dependent upon any higher level computer or another controller for execution.

.3 All points, panels and programs shall be identified by a 30 character name. All points shall also be identified by a 16 character point descriptor. The same names shall be displayed at both Building Controller and the Operator Interface.

.4 All digital points shall have a user defined two-state status indication with 8 characters minimum (e.g. Summer, Enabled, Disabled, Abnormal).

.5 Building Controllers shall have the ability to perform energy management routines including but not limited to time of day scheduling, calendar-based scheduling, holiday scheduling, temporary schedule overrides, start stop time optimization, automatic daylight savings time switch over, night setback control, enthalpy switch over, peak demand limiting, temperature-compensated duty cycling, heating / cooling interlock, supply temperature reset, priority load shedding, and power failure restart.

.6 The Building Controllers shall have the ability to perform the following pre tested control

algorithms:
.1 Two position control
.2 Proportional control
.3 Proportional plus integral control
.4 Proportional, integral, plus derivative control
.5 Automatic tuning of control loops
.6 Model-Free Adaptive Control

.7 Building Controllers shall not be susceptible to Microsoft Windows operating systems based viruses.

.2 System Security
.1 User access shall be secured using individual security passwords and user names.
.2 Passwords shall restrict the user to the objects, applications, and system functions as assigned by the system manager.
.3 User Log On / Log Off attempts shall be recorded.
.4 The system shall protect itself from unauthorized use by automatically logging off following the last keystroke. The delay time shall be user-definable.

.3 User Defined Control Applications:
.1 Controllers shall be able to execute custom, job-specific processes defined by the user, to automatically perform calculations and special control routines.
.2 It shall be possible to use any system measured point data or status, any system calculated data, a result from any process or any user-defined constant in any controller in the system.
.3 The system shall deny any unauthorized access and maintain records of such attempts. Three (3) levels of user profiles shall be programmed for Basic, Operator, and Administrator. The privileges of each level to be specified by owner during the training sessions.
.4 Each controller shall support plain language text comment lines in the operating program to allow for quick troubleshooting, documentation and historical summaries of program development.
.5 Controller shall provide a HELP function key, providing enhanced context sensitive on-line help with task orientated information from the user manual.

.4 Alarm Management:
.1 Alarm management shall be provided to monitor and direct alarm information to operator devices. Each Building Controller shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic and prevent alarms from being lost. At no time shall the Building Controllers ability to report alarms be affected by either operator or activity at a PC workstation, local I/O device or communications with other panels on the network.
.2 An Alarm "shelving" feature shall be provided to disable alarms during testing. (Pull the Plug, etc.).
.3 Conditional alarming shall allow generation of alarms based upon user defined multiple criteria.
.4 Binary Alarms. Each binary object shall be set to alarm based on the operator-specified state. Provide the capability to automatically and manually disable alarming.
.5 Analog Alarms. Each analog object shall have both high and low alarm limits. Alarming must be able to be automatically and manually disabled.
.6 All alarm or point change reports shall include the point's user defined language description and the time and date of occurrence.
.7 The user shall be able to define the specific system reaction for each point. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of six priority levels shall be provided for each point. Point priority levels shall be combined with user definable destination categories (PC, printer, Building Controller, etc.) to provide full flexibility in defining the handling of system alarms. Each Building Controller shall automatically inhibit the reporting of selected alarms during system shutdown and start-up. Users shall have the ability to manually inhibit alarm reporting for each point.
.8 Alarm reports and messages shall be routed to user-defined list of operator workstations, or other devices based on time and other conditions. An alarm shall be able to start programs, print, be logged in the event log, generate custom messages, and display graphics.

.9 In addition to the point's descriptor and the time and date, the user shall be able to print, display or store a 200 character alarm message to more fully describe the alarm condition or direct operator response.
.1 Each Building Controller shall be capable of storing a library of at least 50 alarm messages. Each message may be assignable to any number of points in the Controller.
.10 Operator-selected alarms shall be capable of initiating a call to a remote operator device.
.11 Remote Alarm Notification: the BMS shall be programmed to send critical alarm messages (operator specified) to CBS pagers, cell phones, PDA, and/or Blackberry. A minimum of 2 stage with delay shall be programmed.

.5 Scheduling:
.1 Provide a comprehensive menu driven program to automatically start and stop designated object or group of objects in the system according to a stored time.
.2 It shall be possible to define a group of objects as a custom event (i.e. meeting, athletic activity, etc.). Events can then be scheduled to operate all necessary equipment automatically.
.3 For points assigned to one common load group, it shall be possible to assign variable time delays between each successive start or stop within that group.
.4 The operator shall be able to define the following information:
.1 Time, day
.2 Commands such as on, off, auto, and so forth.
.3 Time delays between successive commands.
.4 There shall be provisions for manual overriding of each schedule by an appropriate operator.
.5 It shall be possible to schedule calendar-based events up to one year in advance based on the following:
.1 Weekly Schedule. Provide separate schedules for each day of the week. Each of these schedules should include the capability for start, stop, optimal start, optimal stop, and night economizer. When a group of objects are scheduled together as an Event, provide the capability to adjust the start and stop times for each member.
.2 Exception Schedules. Provide the ability for the operator to designate any day of the year as an exception schedule. Exception schedules may be defined up to a year in advance. Once an exception schedule is executed, it will be discarded and replaced by the standard schedule for that day of the week.
.3 Holiday Schedules. Provide the capability for the operator to define up to 99 special or holiday schedules. These schedules may be placed on the scheduling calendar and will be repeated each year. The operator shall be able to define the length of each holiday period.

.6 Night setback control. The system shall provide the ability to automatically adjust setpoints for night control.
.7 Loop Control. A PID (proportional-integral-derivative) closed-loop control algorithm with direct or reverse action and anti-windup shall be supplied. The algorithm shall calculate a time-varying analog value that is used to position an output or stage a series of outputs. The controlled variable, set point, and weighting parameters shall be user-selectable.
.8 Sequencing. Provide application software based upon the sequences of operation specified to properly sequence equipment.
.9 Staggered Start:
.1 This application shall prevent all controlled equipment from simultaneously restarting after a power outage. The order in which equipment (or groups of equipment) is started, along with the time delay between starts, shall be user definable.
.2 Upon the resumption of power, each Building Controller shall analyze the status of all controlled equipment, compare it with normal occupancy scheduling and turn equipment on or off as necessary to resume normal operations.
.10 Totalization:
.1 Run-Time Totalization. Building Controllers shall automatically accumulate and store run-time hours for all digital input and output points. A high runtime alarm shall be assigned, if required, by the operator.
.2 Consumption totalization. Building Controllers shall automatically sample, calculate and

store consumption totals on a daily, weekly or monthly basis for all analog and digital pulse input type points.

.3 Event totalization. Building Controllers shall have the ability to count events such as the number of times a pump or fan system is cycled on and off. Event totalization shall be performed on a daily, weekly or monthly basis for all points. The event totalization feature shall be able to store the records associated with events before reset.

.11 Data Collection:

.1 A variety of historical data collection utilities shall be provided to manually or automatically sample, store, and display system data for all points.

.2 Building Controllers shall store point history data for selected analog and digital inputs and outputs:

.1 Any point, physical or calculated may be designated for trending. Any point, regardless of physical location in the network, may be collected and stored in each Building Controllers point group.

.3 Trend data shall be stored at the Building Controllers and uploaded to the workstation when retrieval is desired. Uploads shall occur based upon either user-defined interval, manual command or when the trend buffers are full. All trend data shall be available for use in 3rd party personal computer applications.

.4 Loop Tuning. Building Controllers shall also provide high resolution sampling capability for verification of DDC control loop performance. Documented evidence of tuned control loop performance shall be provided on a <monthly, seasonal, quarterly, annual> period.

.1 For Model-Free Adaptive Control loops, evidence of tuned control loop performance shall be provided via graphical plots or trended data logs. Graphical plots shall minimally include depictions of setpoint, process variable (output), and control variable (e.g., temperature). Other parameters that may influence loop control shall also be included in the plot (e.g., fan on/off, mixed-air temp).

.2 For PID control loops, operator-initiated automatic and manual loop tuning algorithms shall be provided for all operator-selected PID control loops. Evidence of tuned control loop performance shall be provided via graphical plots or trended data logs for all loops.

.1 In automatic mode, the controller shall perform a step response test with a minimum one-second resolution, evaluate the trend data, calculate the new PID gains and input these values into the selected LOOP statement.

.2 Loop tuning shall be capable of being initiated either locally at the Building Controller, from a network workstation or remotely using dial-in modems. For all loop tuning functions, access shall be limited to authorized personnel through password protection.`

2.5 BUILDING CONTROLLERS

.1 Building Controllers shall be 32 bit, multi-tasking, multi-user, real-time 48 MHz digital control processors consisting of modular hardware with plug-in enclosed processors, communication controllers, power supplies and input/output point modules. Controller size shall be sufficient to fully meet the requirements of this specification and the attached point list.

.2 Each Building Controller shall support a minimum of 3 directly connected Secondary Networks.

.3 Each Building Controller shall have sufficient memory, a minimum of 72 megabyte, to support its own operating system and databases, including control processes, energy management applications, alarm management applications, historical/trend data for points specified, maintenance support applications, custom processes, operator I/O, and dial-up communications.

.4 Building Controller shall have an integral real-time clock.

.5 Each Building Controller shall support firmware upgrades without the need to change hardware.

.6 Spare Point Capacity. Each Building Controller shall have a minimum of 10 percent spare point capacity.

.1 The type of spares shall be in the same proportion as the implemented I/O functions of the panel, but in no case shall there be less than one spare of each implemented I/O type.

.2 Provide all processors, power supplies, and communication controllers so that the implementation of adding a point to the spare point location only requires the addition of the

appropriate:
.1 Expansion modules
.2 Sensor/actuator
.3 Field wiring/tubing.

.7 Serial Communication. Building Controllers shall provide at least two EIA-232C serial data communication ports for operation of operator I/O devices such as industry standard printers, operator terminals, and portable laptop operator's terminals. Building Controllers shall allow temporary use of portable devices without interrupting the normal operation of permanently connected printers or terminals.

.8 I/O Status and Indication. Building Controllers shall provide local LED status indication for each digital input and output for constant, up-to-date verification of all point conditions without the need for an operator I/O device. Graduated intensity LEDs or analog indication of value shall also be provided for each analog output. All wiring connections shall be made to field-removable terminals.

.9 Self Diagnostics. Each Building Controller shall continuously perform self diagnostics, communication diagnosis, and diagnosis of all panel components. The Building Controller shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication for any system.

.10 Power loss. In the event of the loss of power, there shall be an orderly shutdown of all Building Controllers to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 100 hours.

.11 Environment.
.1 Controller hardware shall be suitable for the anticipated ambient conditions.
.2 Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures and shall be rated for operation at 0°C to 49°C (32°F to 120°F).
.3 Controllers used in conditioned space shall be mounted in dust-proof enclosures and shall be rated for operation at 0°C to 49°C (32°F to 120°F).

.12 Immunity to power and noise.
.1 Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage.
.1 Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m (3 ft).
.2 Isolation shall be provided at all primary network terminations, as well as all field point terminations to suppress induced voltage transients consistent with:
.1 RF-Conducted Immunity (RFCI) per ENV 50141 (IEC 1000-4-6) at 3 V
.2 Electro Static Discharge (ESD) Immunity per EN 61000-4-2 (IEC 1000-4-2) at 8 kV air discharge, 4 kV contact
.3 Electrical Fast Transient (EFT) per EN 61000-4-4 (IEC 1000-4-4) at 500 V signal, 1 kV power
.4 Output Circuit Transients per UL 864 (2,400V, 10A, 1.2 Joule max)
.3 Isolation shall be provided at all Building Controller's AC input terminals to suppress induced voltage transients consistent with:
.1 IEEE Standard 587 1980
.2 UL 864 Supply Line Transients
.3 Voltage Sags, Surge, and Dropout per EN 61000-4-11 (EN 1000-4-11)

.13 Minimum Approved Building Controllers. BMS Contractors shall furnish Building Controllers as listed below. Providing an approved controller does not release the contractor from meeting all performance, software and hardware specifications for Building Controllers and system operations.

2.6 INPUT/OUTPUT INTERFACE

.1 Hardwired inputs and outputs may tie into the system through building or application specific controllers.

.2 All input points and output points shall be protected such that shorting of the point to itself, to another point, or to ground will cause no damage to the controller. All input and output points shall be protected from voltage up to 24 V of any duration, such that contact with this voltage will cause no damage to the controller.

.3 Binary inputs shall allow the monitoring of On/Off signals from remote devices. The binary inputs shall provide a wetting current of at least 12 mA to be compatible with commonly available control devices and shall be protected against the effects of contact bounce and noise. Binary inputs shall sense "dry contact" closure without external power (other than that provided by the controller) being applied.

.4 Pulse accumulation input objects. This type of object shall conform to all the requirements of binary input objects and also accept up to 10 pulses per second for pulse accumulation.

.5 Analog inputs shall allow the monitoring of low-voltage (0 to 10 VDC), current (4 to 20 mA), or resistance signals (thermistor, RTD). Analog inputs shall be compatible with-and field configurable to- commonly available sensing devices.

.6 Binary outputs shall provide for On/Off operation or a pulsed low-voltage signal for pulse width modulation control. Binary outputs on building and custom application controllers shall have three-position (On/Off/Auto) override switches and status lights. Outputs shall be selectable for either normally open or normally closed operation.

.7 Analog outputs shall provide a modulating signal for the control of end devices. Outputs shall provide either a 0 to 10 VDC, 4 to 20 mA or 0-20 PSI signal as required to provide proper control of the output device. Analog outputs on building or custom application controllers shall have status lights and a two-position (AUTO/MANUAL) switch and manually adjustable potentiometer for manual override. Analog outputs shall not exhibit a drift of greater than 0.4% of range per year.

.8 Tri-State Outputs. Provide tri-state outputs (two coordinated binary outputs) for control of three-point floating type electronic actuators without feedback. Use of three-point floating devices shall be limited to zone control and terminal unit control applications (VAV terminal units, duct-mounted heating coils, zone dampers, radiation, etc.). Control algorithms shall run the zone actuator to one end of its stroke once every 24 hours for verification of operator tracking.

.9 System Object Capacity. The system size shall be expandable to at least twice the number of input/ output objects required for this project. Additional controllers (along with associated devices and wiring) shall be all that is necessary to achieve this capacity requirement. The operator interfaces installed for this project shall not require any hardware additions or software revisions in order to expand the system.

2.7 POWER SUPPLIES AND LINE FILTERING

.1 Control transformers shall be UL listed. Furnish Class 2 current-limiting type or furnish over-current protection in both primary and secondary circuits for Class 2 service in accordance with NEC requirements. Limit connected loads to 80% of rated capacity.

.2 DC power supply output shall match output current and voltage requirements. Unit shall be full-wave rectifier type with output ripple of 5.0 mV maximum peak-to-peak. Regulation shall be 1.0% line and load combined, with 100-microsecond response time for 50% load changes. Unit shall have built-in over-voltage and over-current protection and shall be able to withstand a 150% current overload for at least three seconds without trip-out or failure.

.1 Unit shall operate between 0°C and 50°C (32°F and 120°F). EM/RF shall meet FCC Class B and VDE 0871 for Class B and MILSTD 810C for shock and vibration.

.2 Line voltage units shall be UL recognized and CSA approved.

.3 Power line filtering.

.1 Provide transient voltage and surge suppression for all workstations and controllers either internally or as an external component. Surge protection shall have the following at a minimum:

.1 Dielectric strength of 1000 volts minimum

.2 Response time of 10 nanoseconds or less

.3 Transverse mode noise attenuation of 65 dB or greater

.4 Common mode noise attenuation of 150 dB or better at 40 Hz to 100 Hz.

2.8 AUXILIARY CONTROL DEVICES

.1 General
- .1 Specified in this section are the following hard wired input/output devices connected to the Building Controller or ASC.
  - .1 Automatic Dampers
  - .2 Electric Damper Actuators
  - .3 Automatic Control Valves
  - .4 Binary Temperature Devices
  - .5 Temperature Sensors
  - .6 Humidity Sensors
  - .7 Indoor Air Quality (CO2/NO2, Refrigerant) Space Sensors
  - .8 Relays
  - .9 Current Switches
  - .10 Local Control panels

.2 Electric Damper Actuators
- .1 General
  - .1 The actuator shall have mechanical or electronic stall protection to prevent damage to the actuator throughout the rotation of the actuator.
  - .2 Where shown, for power-failure/safety applications, an internal mechanical, spring-return mechanism shall be built into the actuator housing. Alternatively, an uninterruptible power supply (UPS) may be provided. On terminal unit valves actuators capacitor driven fail action is permitted.
  - .3 Proportional actuators shall accept a 0 to 10 VDC or 0 to 20 mA control signal and provide a 2 to 10 VDC or 4 to 20 mA operating range.
  - .4 All 24 VAC/VDC actuators shall operate on Class 2 wiring.
  - .5 All actuators shall have an external manual gear release to allow manual positioning of the damper when the actuator is not powered. Spring-return actuators with more than 7 Nm (60 in.-lb) torque capacity shall have a manual crank for this purpose.
  - .6 Electric actuators for emergency generator damper control shall be rated for 350 degree F. maximum operating temperature and capable to drive fully open and close within 15 seconds.
  - .7 Acceptable manufacturer Siemens Building Technologies, Johnson Controls, Honeywell & Belimo.

.3 Automatic Control Valves
- .1 General:
  - .1 Control valves shall be two-way or three-way type single seated globe type for two-position or modulating service as shown. Valves shall meet ANSI Class IV leakage rating.
  - .2 Body pressure rating and connection type construction shall conform to pipe, fitting and valve schedules. Where pressure and flow combinations exceed ratings for commercial valves and operators, industrial class valves and operators shall be provided.
  - .3 Valve operators shall be of electric type.
  - .4 The valves shall be quiet in operation and fail-safe in either normally open or normally closed position in the event of power failure.
  - .5 Control valve operators shall be sized to close against a differential pressure equal to the design pump head plus 10 percent.
  - .6 Furnish differential pressure control valves for all water systems as shown on plans and/or specified in the sequence of operations.
  - .7 Provide valves 2" and smaller with screwed end bronze bodies and stainless steel trim. Provide valves 2-1/2" and larger with flanged ends, cast iron body and stainless steel trim.
  - .8 For modulating service that require large valve size (above 6"), such as cooling tower temperature bypass, chiller head pressure ,etc. where proper control with globe type control valve cannot be achieved or the application is not economical butterfly or v-port ball valves are allowed.

.9 Acceptable manufacturer Siemens Building Technologies, Johnson Controls, Honeywell and Belimo.

.2 Water Valves:

.1 Control valves shall be of equal percentage flow characteristics for modulating service.

.4 Binary Temperature Devices

.1 Line-voltage space thermostat:

.1 Line-voltage thermostats shall be bimetal-actuated, snap acting SPDT contact, enclosed, UL listed for electrical rating. The thermostat cover shall provide exposed set point adjustment knob. The thermostat shall operate within the 55°F to 85°F setpoint range, with 2°F maximum differential.

.2 Low-temperature safety thermostat:

.1 Low-limit air stream thermostats shall be UL listed, vapor pressure type, with a sensing element of 20 ft. minimum length. Element shall respond to the lowest temperature sensed by any 1 ft. section. The low-limit thermostat shall be automatic reset, SPDT type.

.5 Temperature Sensors

.1 Provide the following instrumentation as required by the monitoring, control and optimization functions. All temperature sensor shall use platinum RTD elements only, nickel or silicon are not acceptable. All control signals shall be via a 4-20 mA loop.

.2 Room Temperature:

.1	Temperature monitoring range	+40/+90 F (+40/120 F for high temp alarms)
.2	Output signal	4-20 mA
.3	Installation adjustments	none required
.4	Calibration adjustments	zero & span
.5	Factory calibration point	70 deg F
.6	Accuracy at calibration point	+0.5 F

.3 Liquid Immersion Temperature

.1	Temperature monitoring range	+20/+120 F or +70/+220 F
.2	Output signal	4-20 mA
.3	Installation adjustment	none required
.4	Calibration adjustments	zero & span
.5	Factory calibration point	70 deg F
.6	Accuracy at calibration point	+0.5 F

.4 Duct (Single Point) Temperature

.1	Temperature monitoring range	+20/+120 F
.2	Output signal	4-20 mA
.3	Installation adjustments	none required
.4	Calibration adjustments	zero & span
.5	Factory calibration point	70 deg F
.6	Accuracy at calibration point	+0.5 F

.5 Duct (Averaging) Temperature

.1	Temperature monitoring range	+20/+120 F
.2	Output signal	4 - 20 mA
.3	Installation adjustments	none required
.4	Calibration adjustments	zero & span
.5	Factory calibration point	70 deg F
.6	Accuracy at calibration point	+0.5 F

.6 Outside Air Temperature

.1	Temperature monitoring range	-50/+122
.2	Output signal	4-20 mA
.3	Installation adjustments	none required
.4	Calibration adjustments	zero & span
.5	Factory calibration point	70 deg F
.6	Accuracy at calibration point	+0.5 F

.6 Dew Point/Humidity Sensors

.1 Outside Air Dew Point Temperature

.1	Dew point monitoring range	-40/+115 F DP, 12% to 99% RH

.2 Output signal 4-20 mA
.3 Calibration adjustments zero & span
.4 Factory calibration point 70 F
.5 Accuracy at calibration point +2.0 Fdp

.2 Room/duct Relative Humidity
.1 Sensor Humidity range 0 to 100%
.2 Operating temperature 15 F to +170 F
.3 Accuracy +2% RH
.4 Sensing element Capacitive sensor
.5 Output signal 4-20 mA DC
.6 Installation adjustments zero & span
.7 Operating temperature 15 F to +170 F
.8 Voltage requirement 12-36 VDC

.7 Pressure Sensors
.1 Air Static Pressure Sensor
.1 Duct Static range -.5 to + 7.5"wg
.2 Accuracy + .05" w.g.
.3 Output signal 4 - 20 mA

.8 Indoor Air quality (CO2/NO2, Refrigerant) Sensors
.1 Provide all labor, materials, products, equipment and service to supply and install a gas detection and control system as indicated on the drawings and specified in this section.
.2 Products: VA301EM-Expansion Module, VA S301 D2 CO Toxic gas detector Carbon Monoxide, VA S301 D2 NO2 Toxic gas detector Nitrogen Dioxide (Diesel), VA301IRFSR R410a Infrared Refrigerant Gas Sensor, VA201TA 100 Power Transformer.
.1 VA301EM Controller Expansion Module: The VA 301 EM expansion module must be capable of communicating digitally with the networked sensors through RS-485 Modbus communication. Up to twenty sensors can be connected at a maximum distance of 200 feet. Power supply (bringing either 17-27 Vac or 24-38 Vdc) will be required to power the system and additional detectors shall be powered by 24-38 Vdc power supply. The expansion module will manage four internal DPDT relays at fully programmable alarm levels. The relay rating will be no lower than 5 A, 30 Vdc or 250 Vac (resistive load). The VA 301 EM shall include panel mounted selector for manual fan start/ stop operation, a silence key to acknowledge RFSA 105db horn (optional - audible alarm operation). The VA 301 EM shall be available with an optional "RFSA" unit mounted Strobe /Horn on top of the unit as an audible/ visual alarm. The expansion module will indicate the exact concentration of gas and the gas detected. The VA 301 EM panel shall be complete with standard LCD display which will indicate multiple alarm levels for each sensing point. The LED will also provide visual feedback in the following manner: Normal Operation - Green LED, Alarm Level A - Red LED, Alarm Level B - Red LED, Alarm Level C - Red LED, Failure - Yellow LED, TX - Yellow LED. The standard three high/low alarm levels will be complemented with a fault relay. The expansion module must provide an individual 4-20mA output per toxic/combustible gas sensors for BAS compatibility. The unit will be certified to UL and CSA standards. The controller must be manufactured within an ISO 9001 production environment.
.2 VA S301 D2 Toxic Gas Detectors: The sensor(s) will be powered by the VA-301EM expansion module. Targeted gas will enter the gas detection chamber according to the diffusion principle. The power requirements for the transmitters are 17-24Vac, 24-38Vdc, 290Ma@24Vdc, 10Va. The gas transmitter shall incorporate gas specific sensing technologies.
.1 Toxic: Electrochemical, Operating temperature range of -20degC to + 40degC
.2 Combustible: Catalytic, Operating temperature range of - 40degC to + 50degC **OR** Infrared, Operating temperature range of -40degC to + 50degC
.3 Oxygen: Diffusion Fuel Cell, Operating temperature range of -20degC to + 40degC
.4 Transmitter housing shall be a rugged explosion-proof enclosure rated as

suitable for Class 1, Div.1 Groups B,C,D locations. Sensor assemblies shall be field interchangeable plug in type allowing gas detection by convection or diffusion through a sintered stainless steel or wire mesh screened opening. The transmitters 'smart sensing' technology will be capable of recognizing the interchangeable sensor type and adjust, test and reset to a new or replacement sensor. Sensors shall be suitable for operation within RH ranges of 15-90% non condensing for Nitrogen Dioxide (NO2); 0-90% non condensing for Carbon Monoxide (CO).

.3 VA301IRFSR Infrared Refrigerant Gas Sensor: The refrigerant sensor will be powered by the VA-301EM Main Controller/ expansion module. The detector shall be of diffusion type with no internal sample pump or filter maintenance required. Refrigerant gas will enter the infrared gas detection chamber according to the diffusion principle. The exclusive Honeywell Analytics/Vulcain ABC logic infrared sensing technology will detect the refrigerant gas by sensing the absorption rate of a specific bandwidth of light. ABC logic prevents the unit from drifting over time. The gas sensor will have resolution levels of 1 ppm with a standard range of 0-1000 ppm. Temperature and relative humidity variations will have no effect on the unit's accuracy. The sensor will be capable of operating within relative humidity ranges of 5-95% and temperature ranges of 32oF-100oF (0oC-40oC). The Unit will be equipped with a NEMA 4X Polycarbonate-ABS impact-resistant enclosure. The system must provide a menu driven method of checking both zero and span calibrations of the detector; adjustments must be made through the controllers' front panel keyboard. The detectors shall require no periodic maintenance other than yearly zero and span checking with calibrated zero and span gas. Periodic checking or adjustments of the unit shall be capable of being accomplished by one person at the unit location. Stability- the 30 day zero and span drift shall be less than 1% F.S. without the aid of automatic or manual recalibration. The system shall not require any type of auto-zero techniques in order to maintain stability. The unit will be manufactured to UL and CSA standards. Units shall be manufactured in an ISO 9001-2000 production environment to conform to UL 1244, CSA. The sensor alarm levels and unit are to be installed in accordance with the following parameters:

TARGETTED GASES	FIRST ALARM RECOMMENDED SET POINT	SECOND ALARM RECOMMENDED SET POINT	TRANSMITTER LOCATION	RADIUS OF COVERAGE
Carbon Monoxide (CO)	25 PPM	100PPM	900mm – 1500mm (3ft – 5 ft) Above Finished Floor	15 Meters (50 ft)
Nitrogen Dioxide (NO2)	0.72PPM	2.0PPM	300mm (1ft) Below the Ceiling	15 Meters (50 ft)
R-410a (CH2F2/CHF2CF3)	250 PPM	500 PPM	300mm (1ft) Above the floor	6 Meters (20 feet)

.9 Relays
- .1 Control relays shall be UL listed plug-in type with dust cover and LED "energized" indicator. Contact rating, configuration, and coil voltage shall be suitable for application.

.10 Current Switches / Sensors
- .1 Current-operated switches shall be self-powered, solid-state with adjustable trip current.
- .2 Use current sensor to measure the real time amperage.
- .3 The switches and sensors shall be selected to match the current of the application and

output requirements of the DDC system.

2.9 COMMUNICATION AND CONTROL WIRING

.1 General:
- .1 Provide copper wiring, plenum cable, and raceways as specified in the applicable sections of Division 16 unless otherwise noted herein.
- .2 All insulated wire to be copper conductors, UL labeled for 90°C minimum service.

.2 Wire Sizing and Insulation
- .1 Wiring shall comply with minimum wire size and insulation based on services listed below:
  - .1

Service	Minimum Gage/Type	Insulation Class
AC 24V Power	12 Ga Solid	600 Volt
DC 24V Power	10 Ga Solid	600 Volt
Class 1	14 Ga Stranded	600 Volt
Class 2	18 Ga Stranded	300 Volt
Class 3	18 Ga Stranded	300 Volt

- .2 Provide plenum-rated cable when open cable is permitted in supply or return air plenum where allowed per execution specifications defined in Paragraph 3.07

.3 Power Wiring:
- .1 115V power circuit wiring above 100 feet distance shall use minimum 10 gage.
- .2 24V control power wiring above 200 feet distance shall use minimum 12 gage.

.4 Control Wiring:
- .1 Digital Input/Output wiring shall use Class 2 twisted pair, insulated.
- .2 Analog inputs shall use Class 2 twisted shielded pair, insulated and jacketed and require a grounded shield.
- .3 Actuators with tri-state control shall use 3 conductor with same characteristics

.5 Communication Wiring
- .1 Ethernet Cable shall be minimum CAT5
- .2 Secondary level network shall be 24 gage, TSP, low capacitance cable

.6 Approved Cable Manufacturers:
- .1 Wiring from the following manufacturers which meet the above criteria shall be acceptable:
  - .1 Anixter
  - .2 Belden
  - .3 Cerco

2.10 MOTORIZED CONTROL DAMPERS

.1 Acceptable Manufacturers:
- .1 Air Balance, Inc.
- .2 American Warming and Ventilating.
- .3 Greenheck.
- .4 Nailor Industries Inc.
- .5 Penn Ventilation Company, Inc.
- .6 Ruskin Company.

.2 General Description: AMCA-rated, parallel or opposed-blade design; minimum of 0.1084-inch (2.8-mm) thick, galvanized-steel frames with holes for duct mounting; minimum of 0.0635-inch (1.61-mm) thick, galvanized-steel damper blades with maximum blade width of 8 inches (203 mm).
- .1 Secure blades to 1/2-inch (13-mm) diameter, zinc-plated axles using zinc-plated hardware, with nylon blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
- .2 Operating Temperature Range: From minus 40 to plus 200 deg F (minus 40 to plus 93 deg C).
- .3 Provide closed-cell neoprene edging with replaceable rubber seals, rated for leakage at

less than 10 cfm per sq. ft. (51 L/s per sq. m) of damper area, at differential pressure of 4-inch wg (995 Pa) when damper is being held by torque of 50 in. x lbf (5.6 N x m); when tested according to AMCA 500D.

.4 Provide insulated dampers at fresh air intakes and exhaust air discharges.

2.11 LIQUID (VORTEX) FLOW METERS

.1 Manufacturer: Yokogawa. Model YF100 Yewflo, Fisher Rosemount.

.2 Features;

.1 universal amplifier
.2 integral or remote converter
.3 6 digit, 7 segment LCD display with backlighting
.4 choice of engineering units
.5 field set-up of parameters
.6 adjustable display orientation
.7 self-diagnostics
.8 full measurement - error/correction functions
.9 loop check test output
.10 data backup in EE PROM
.11 Size and capacity as required.
.12 Weather Station: Weather station with sensors for temperature, humidity, wind speed, rain, atmospheric pressure, CO2 levels, light levels for building management, energy management & lighting controls

3 Execution

3.1 EXAMINATION

.1 The project plans shall be thoroughly examined for control device and equipment locations. Any discrepancies, conflicts, or omissions shall be reported to the architect/engineer for resolution before rough-in work is started.

.2 The contractor shall inspect the site to verify that equipment may be installed as shown. Any discrepancies, conflicts, or omissions shall be reported to the engineer for resolution before rough-in work is started.

.3 The contractor shall examine the drawings and specifications for other parts of the work. If head room or space conditions appear inadequate-or if any discrepancies occur between the plans and the contractor's work and the plans and the work of others-the contractor shall report these discrepancies to the engineer and shall obtain written instructions for any changes necessary to accommodate the contractor's work with the work of others.

3.2 PROTECTION

.1 The contractor shall protect all work and material from damage by its employees and/or subcontractors and shall be liable for all damage thus caused.

.2 The contractor shall be responsible for its work and equipment until finally inspected, tested, and accepted.

3.3 COORDINATION

.1 Site

.1 The project coordination between trades is the responsibility of the prime contractor who is the one tier higher contractual partner such as mechanical contractor, general contractor, construction manager, owner or owner's representative as applicable.

.2 The controls contractor shall follow prime contractor's job schedule and coordinate all project related activities through the prime contactor except otherwise agreed or in minor

job site issues. Reasonable judgment shall be applied.

.3 Where the work will be installed in close proximity to, or will interfere with, work of other trades, the contractor shall assist in working out space conditions to make a satisfactory adjustment.

.4 If the contractor deviates form the job schedule and installs work without coordinating with other trades, so as to cause interference with work of other trades, the contractor shall make the necessary changes to correct the condition without extra charge.

.5 Coordinate and schedule work with all other work in the same area, or with work that is dependent upon other work, to facilitate mutual progress.

.2 Submittals.

.1 Refer to the "Submittals" article in Part 1 of this specification for requirements.

.3 Test and Balance

.1 The contractor shall furnish a single set of all tools necessary to interface to the control system for test and balance purposes.

.2 In addition, the contractor shall provide a qualified technician for assistance throughout the test & balance period as required.

3.4 GENERAL WORKMANSHIP

.1 Install equipment, piping, and wiring/raceway parallel to building lines (i.e., horizontal, vertical, and parallel to walls) wherever possible.

.2 Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.

.3 Install all equipment in readily accessible locations as defined by Chapter 1, Article 100, Part A of the National Electrical Code (NEC).

.4 Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.

.5 All equipment, installation, and wiring shall comply with acceptable industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.

3.5 FIELD QUALITY CONTROL

.1 All work, materials, and equipment shall comply with the rules and regulations of applicable local, state, and federal codes and ordinances as identified in Part 1 of this specification.

.2 Contractor shall continually monitor the field installation for code compliance and quality of workmanship.

3.6 WIRING

.1 All control and interlock wiring shall comply with national and local electrical codes and Division 16 of this specification. Where the requirements of this section differ from those in Division 16, the requirements of this section shall take precedence.

.2 All NEC Class 1 (line voltage) wiring shall be UL Listed in approved conduit according to NEC and Division 16 requirements.

.3 All low-voltage wiring shall meet NEC Class 2 requirements. (Low-voltage power circuits shall be sub fused when required to meet Class 2 current limit.)

.4 Where NEC Class 2 (current-limited) wires are in concealed and accessible locations, including ceiling return air plenums, approved cables not in conduit may be used provided that cables are UL Listed for the intended application. For example, cables used in ceiling plenums shall be UL Listed specifically for that purpose.

.5 All wiring in mechanical, electrical, or service rooms-or where subject to mechanical damage- shall be installed in conduit.

.6 Do not install Class 2 wiring in conduit containing Class 1 wiring. Boxes and panels containing high voltage wiring and equipment may not be used for low-voltage wiring except for the purpose of interfacing the two (e.g., relays and transformers).

.7 Do not install wiring in conduit containing tubing.

.8 Where plenum rated cable is run exposed, wiring is to be run parallel along a surface or perpendicular to it and neatly tied at 3 m (10 ft) intervals.

.9 Where plenum rated cable is used without conduit, it shall be supported from or anchored to structural members. Cables shall not be supported by or anchored to ductwork, electrical conduits, piping, or ceiling suspension systems.
.10 All wire-to-device connections shall be made at a terminal block or wire nut. All wire-to-wire connections shall be at a terminal strip or wire nut.
.11 All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.
.12 Maximum allowable voltage for control wiring shall be 120 V. If only higher voltages are available, the contractor shall provide step-down transformers or interposing relays.
.13 All plenum rated wiring shall be installed as continuous lengths, with no splices permitted between termination points
.14 All wiring in conduit shall be installed as continuous lengths, with no splices permitted between termination points or junction boxes.
.15 Maintain fire rating at all penetrations. Install plenum wiring in sleeves where it passes through walls and floors.
.16 Size and type of conduit and size and type of wire shall be the responsibility of the contractor, in keeping with the manufacturer's recommendations and NEC requirements, except as noted elsewhere.
.17 Include one pull string in each conduit 3/4 in. or larger.
.18 Control and status relays are to be located in designated enclosures only. These enclosures can include packaged equipment control panel enclosures unless they also contain Class 1 starters.
.19 Conceal all conduit, except within mechanical, electrical, or service rooms. Install conduit to maintain a minimum clearance of 15 cm (6 in.) from high-temperature equipment (e.g., steam pipes or flues).
.20 Secure conduit with conduit clamps fastened to the structure and spaced according to code requirements. Conduit and pull boxes may not be hung on flexible duct strap or tie rods. Conduits may not be run on or attached to ductwork.
.21 Adhere to this specification's Division 16 requirements where conduit crosses building expansion joints.
.22 The Contractor shall terminate all control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site.
.23 Flexible metal conduits and liquid-tight, flexible metal conduits shall not exceed 1 m (3 ft) in length and shall be supported at each end. Flexible metal conduit less than ½ in. electrical trade size shall not be used. In areas exposed to moisture, including chiller and boiler rooms, liquid-tight, flexible metal conduits shall be used.

.24 Conduit must be adequately supported, properly reamed at both ends, and left clean and free of obstructions. Conduit sections shall be joined with couplings (according to code). Terminations must be made with fittings at boxes, and ends not terminating in boxes shall have bushings installed.

3.7 COMMUNICATION WIRING

.1 The contractor shall adhere to the items listed in the "Wiring" article in Part 3 of the specification.
.2 All cabling shall be installed in a neat and workmanlike manner. Follow manufacturer's installation recommendations for all communication cabling.
.3 Do not install communication wiring in raceway and enclosures containing Class 1 or other Class 2 wiring.
.4 Maximum pulling, tension, and bend radius for cable installation, as specified by the cable manufacturer, shall not be exceeded during installation.
.5 Contractor shall verify the integrity of the entire network following the cable installation. Use appropriate test measures for each particular cable.
.6 When a cable enters or exits a building, a lightning arrestor must be installed between the lines and ground. The lighting arrestor shall be installed according to the manufacturer's instructions.
.7 All runs of communication wiring shall be unspliced length when that length is commercially

available.

.8 All communication wiring shall be labeled to indicate origination and destination data.

.9 Grounding of coaxial cable shall be in accordance with NEC regulations article on "Communications Circuits, Cable, and Protector Grounding."

3.8 INSTALLATION OF SENSORS

.1 General:
- .1 Install sensors in accordance with the manufacturer's recommendations.
- .2 Mount sensors rigidly and adequately for the environment within which the sensor operates.
- .3 Room temperature sensors shall be installed on concealed junction boxes properly supported by the wall framing.
- .4 All wires attached to sensors shall be air sealed in their raceways or in the wall to stop air transmitted from other areas affecting sensor readings.
- .5 Sensors used in mixing plenums and hot and cold decks shall be of the averaging type.
- .6 Low-limit sensors used in mixing plenums shall be installed in a serpentine manner horizontally across the full face of the coil.
- .7 All pipe-mounted temperature sensors shall be installed in wells. Install all liquid temperature sensors with heat-conducting fluid in thermal wells.
- .8 Install outdoor air temperature sensors on north wall, complete with sun shield at designated location.

.2 Room Instrument Mounting
- .1 Room instruments, including but not limited to wall mounted thermostats and sensors located in occupied spaces shall be mounted 53 inches above the finished floor unless otherwise shown.

.3 Instrumentation Installed in Piping Systems
- .1 Thermometers and temperature sensing elements installed in liquid systems shall be installed in thermowells.
- .2 Gauges in piping systems subject to pulsation shall have snubbers.
- .3 Gauges for steam service shall have pigtail fittings with isolation valve.

.4 Duct Smoke Detectors
- .1 Duct smoke detectors will be provided by the Fire Alarm System Contractor in supply and return air ducts in accordance with Division 16
- .2 Contractor shall connect the DDC System to the auxiliary contacts provided on the Smoke Detector as required for system safeties and to provide alarms to the DDC system.

.5 Averaging Temperature Sensing Elements
- .1 Sensing elements shall be installed in a serpentine pattern.
- .2 Averaging sensors shall be installed in a serpentine manner vertically across the duct. Each bend shall be supported with a capillary clip.

.6 Relative Humidity Sensors
- .1 Relative humidity sensors in supply air ducts shall be installed at least 3m (10 feet) downstream of humidity injection elements.

3.9 ACTUATORS

.1 Mount and link control damper actuators according to manufacturer's instructions.
- .1 To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately 5° open position, manually close the damper, and then tighten the linkage.
- .2 Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.
- .3 Provide all mounting hardware and linkages for actuator installation.

.2 Electric/Electronic
- .1 Dampers: Actuators shall be direct-mounted on damper shaft or jackshaft unless shown as a linkage installation. For low-leakage dampers with seals, the actuator shall be mounted with a minimum 5° available for tightening the damper seals. Actuators shall be mounted following manufacturer's recommendations.

.2 Valves: Actuators shall be connected to valves with adapters approved by the actuator manufacturer. Actuators and adapters shall be mounted following the actuator manufacturer's recommendations.

.3 Identification of Tubing and Wiring

.1 All wiring and cabling including that within factory-fabricated panels shall be labeled at each end within 5 cm (2 in.) of termination with the DDC address or termination number.

.2 Permanently label or code each point of field terminal strips to show the instrument or item served.

3.10 IDENTIFICATION OF HARDWARE AND WIRING

.1 All wiring and cabling, including that within factory-fabricated panels shall be labeled at each end within 5 cm (2 in.) of termination with the DDC address or termination number.

.2 Permanently label or code each point of field terminal strips to show the instrument or item served.

.3 Identify control panels with minimum 1 cm (½ in.) letters on laminated plastic nameplates.

.4 Identify all other control components with permanent labels. All plug-in components shall be labeled such that removal of the component does not remove the label.

.5 Identify room sensors relating to terminal box or valves with nameplates.

.6 Manufacturers' nameplates and UL or CSA labels are to be visible and legible after equipment is installed.

.7 Identifiers shall match record documents.

.8 Provide unique point name/address plastic label for all end devices. Controller Namplates to have Controller Name & Controller Network ID. Enclosure to have plastic nameplates with unique ID and associated electrical circuit breaker number. All input/output wires at the controller terminal shall be labelled with point name. There shall be laminated points list of each controller attached to the associated enclosure.

3.11 PROGRAMMING

.1 Provide sufficient internal memory for the specified sequences of operation and trend logging. There shall be a minimum of 25% of available memory free within the primary controller for future use.

.2 Point Naming: System point names shall be modular in design, allowing easy operator interface without the use of a written point index. Point Naming standard shall be agreed upon between owner and BAS contractor. Refer to Submittals section in the General Section.

.3 Software Programming

.1 Provide programming for the system and adhere to the sequences of operation provided. The contractor also shall provide all other system programming necessary for the operation of the system, but not specified in this document. Imbed into the control program sufficient comment statements to clearly describe each section of the program. The comment statements shall reflect the language used in the sequences of operation and be of different font and color in text editor. Use the appropriate technique based on one of the following programming types:

.1 Text-based:

.1 Must provide actions for all possible situations

.2 Must be modular and structured

.3 Must be commented

.4 Must provide line by line programing and compilation wizard to allow for ease of editing.

.2 Graphic-based:

.1 Must provide actions for all possible situations

.2 Must provide programing and compilation wizard to allow for ease of editing.

.3 Must be documented

.4 Operator Interface

.1 Standard graphics-Provide graphics for all mechanical systems and floor plans of the building. This includes each refrigeration system, hot water system, boiler, air handler,

geothermal pump, heat exchanger and all terminal equipment. Point information on the graphic displays shall dynamically update. Show on each graphic all input and output points for the system. Also show relevant calculated points such as set points.

.2 Show terminal equipment information on a "graphic" summary table. Provide dynamic information for each point shown.

.3 The contractor shall provide all the labor necessary to install, initialize, start up, and troubleshoot all operator interface software and its functions as described in this section. This includes any operating system software, the operator interface database, and any third-party software installation and integration required for successful operation of the operator interface.

.4 Contractor shall provide necessary programming to create all reports refered to in Part 2 Operator Interface Software

3.12 CONTROL SYSTEM CHECKOUT AND TESTING

.1 Phase I - Field I/O Commissioning

.1 Verify that each control panel has been installed according to plans, specifications and approved shop drawings. Calibrate, test, and have signed off each control sensor and device.

3.13 CONTROL SYSTEM DEMONSTRATION AND ACCEPTANCE

.1 Demonstration

.1 Prior to acceptance, the control system shall undergo a series of performance tests to verify operation and compliance with this specification. These tests shall occur after the Contractor has completed the installation, started up the system, and performed his/her own tests.'

.2 The tests described in this section are to be performed in addition to the tests that the contractor performs as a necessary part of the installation, start-up, and debugging process and as specified in the "Control System Checkout and Testing" article in Part 3 of this specification. The engineer will be present to observe and review these tests. The engineer shall be notified at least 10 days in advance of the start of the testing procedures.

.3 The demonstration process shall follow that approved in Part 1, "Submittals." The approved checklists and forms shall be completed for all systems as part of the demonstration.

.4 The contractor shall provide at least two persons equipped with two-way communication and shall demonstrate actual field operation of each control and sensing point for all modes of operation including day, night, occupied, unoccupied, fire/smoke alarm, seasonal changeover, and power failure modes. The purpose is to demonstrate the calibration, response, and action of every point and system. Any test equipment required to prove the proper operation shall be provided by and operated by the contractor.

.5 As each control input and output is checked, a log shall be completed showing the date, technician's initials, and any corrective action taken or needed.

.6 Demonstrate compliance with Part 1, "System Performance."

.7 Demonstrate compliance with sequences of operation through all modes of operation.

.8 Demonstrate complete operation of operator interface.

.2 Acceptance

.1 All tests described in this specification shall have been performed to the satisfaction of both the engineer and owner prior to the acceptance of the control system as meeting the requirements of completion. Any tests that cannot be performed due to circumstances beyond the control of the contractor may be exempt from the completion requirements if stated as such in writing by the engineer. Such tests shall then be performed as part of the warranty.

.2 The system shall not be accepted until all forms and checklists completed as part of the demonstration are submitted and approved as required in Part 1, "Submittals."

3.14 CLEANING

.1 The contractor shall clean up all debris resulting from their activities daily. The contractor shall remove all cartons, containers, crates, etc., under his/her control as soon as their contents have been removed. Waste shall be collected and placed in a designated location.

.2 At the completion of work in any area, the contractor shall clean all work, equipment, etc., keeping it free from dust, dirt, and debris, etc.

.3 At the completion of work, all equipment furnished under this section shall be checked for paint damage, and any factory-finished paint that has been damaged shall be repaired to match the adjacent areas. Any cabinet or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent areas.

3.15 TRAINING

.1 The Contractor shall provide competent instructors to give full instruction to designated personnel in the adjustment, operation and maintenance of the system installed. Factory employed/certified instructors shall be thoroughly familiar with all aspects of the subject matter they are to teach. All training shall be held during normal work hours of 8:00 a.m. to 4:30 p.m. weekdays.

.2 Provide a minimum of 8 hours on-site, on-line, training session.

.3 Training materials to be submitted for engineer/owner review 2 weeks prior to the training.

3.16 SYSTEM TUNING & ADJUSTMENT

.1 The BMS contractor shall allow 2 site visits for the 1st year. One before the winter season and one before the summer season to tune and adjust the system operating parameter to achieve optimum operating efficiency. Report shall be submitted to owner for review after each visit.

End of Section

1 General

1.1 GENERAL

.1 Read and conform to:
- .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
- .2 Division 1 requirements and documents refered to therein.

1.2 SECTION INCLUDES

.1 Sequence of operation:
- .1 VRF System and ERV
- .2 Geothermal/Heat Exchanger Loop
- .3 Make-up unit

1.3 SYSTEM DESCRIPTION

.1 This section defines the manner and method by which controls function.
.2 Requirements for each type of control system operation are specified.
.3 Equipment, devices, and system components required for control systems are specified in other Sections.

1.4 SUBMITTALS FOR REVIEW

.1 Section 15010: Procedures for submittals.
.2 Shop Drawings: Indicate mechanical system controlled and control system components.
- .1 Label with settings, adjustable range of control and limits. Include written description of control sequence.
- .2 Include flow diagrams for each control system, graphically depicting control logic.
- .3 Include draft copies of graphic displays indicating mechanical system components, control system components, and controlled function status and value.

1.5 SUBMITTALS AT PROJECT CLOSEOUT

.1 Section 15010: Submittals for project closeout.
.2 Project Record Documents: Record actual locations of components and set points of controls, including changes to sequences made after submission of shop drawings.

1.6 QUALITY ASSURANCE

.1 Design system under direct supervision of a Professional Engineer experienced in design of this Work and licensed in the Province of Manitoba.

2 Products

2.1 SEQUENCE OF OPERATIONS

.1 Outside Air Conditions
- .1 The system shall monitor the outside air temperature and humidity. These values shall be made available to the system at all times.
- .2 The controller shall monitor and record the high and low OSA temperature and RH readings. These readings shall be recorded on a daily, month-to-date, and year-to-date basis.

.2 Electric Force Flow Heaters
.1 The unit shall maintain a heating set point of 21°C (adj.) by cycling fan and electric heater on/off via wall mounted line voltage thermostat. The fan shall run when zone temperature drops below heating set point.
.3 Laundry Dryer Exhaust
.1 Fans are interlocked with their respective dryers. Dryers cannot operate without their respective fans operating. A spring loaded timer switch selected to match maximum dryer operating time, mounted adjacent to dryer, shall turn exhaust fan on/off. When the set time is reached, timer switch shall shut off the exhaust fan and corresponding dryer(s).
.4 Ground Source Heat Pump System
.1 System Components: The system consists of the following:
.1 Ground source system
.2 Back Up Boiler
.3 Heat Exchanger
.4 Pumps
.5 Heat Pump
.2 Ground Source System Operation: System shall be enabled when commanded by BMS based on heating/cooling demand.
.1 Ground Source Pump (P-1 & 2) (Lead/Lag) Constant Speed Operation: When heating or cooling is needed as signified by the operation of condensing units (CU-1 and 2), lead ground source pump starts. Pump runs continuously at constant speed anytime the ground source system is needed. Lead pump starts prior to condensing units start and stops after the condensing units stop. Pumps have a user adjustable delay on start and stop appropriately set to allow for orderly system start-up, shutdown and sequencing. Pumps operate in a lead/lag fashion. Lead pump runs first. On failure of lead pump, lag pump runs and the lead pump turns off. Designated lead pump rotates as follows (user selectable): manually by software switch, pump runtime (adj.) is exceeded, or weekly. Lag pump starts when additional condensing units start.
.2 Ground Source Bypass Valve V-1: Valve V-1 shall be normally open to the ground source system rejecting/extracting heat to/from the ground under normal conditions. When ground source supply water temperature as sensed by T-6 falls below required set point of -1°C (adj.) with a heating demand and the outside air temperature below 10°C (adj.), the back up heating system is started. Once started, valve V-1 closes to minimum position of 1% (adj.) to bypass the ground source loop. T-6 continues to monitor water temperature from the ground source. During back up heating operation, the temperature setpoint at T-2 shall be 15°C (adj). When ground source water temperature at T-6 exceeds set point of -1°C (adj.), the system reverts to normal operation. The back up heating system turns off and the bypass valve opens. To prevent short cycling, there shall be a user definable (adj.) delay and minimum runtime for the back up heating system.
.3 Condensing Units: Condensing units modulate capacity in unison to meet demand. Below modulation range, units cycle to meet demand. To prevent short cycling, there shall be a user definable (adj.) delay and minimum runtime.
.3 Back Up Heating System Operation: Backup heating system is enabled when commanded by BMS when ground source cannot maintain supply water temperature set point of -1°C (adj.). as sensed by T-1. To prevent short cycling, there shall be a user definable (adj.) minimum runtime.
.1 Boiler Pump (P-3) Constant Speed Operation: When back up heating system is started, control system starts boiler pump P-3. Pump runs continuously at constant speed anytime the back up heating system is running. Pump starts prior to boiler start and stops after the boiler stops. Pumps have a user adjustable delay on start and stop appropriately set to allow for orderly system start-up, shutdown and sequencing.
.2 Boiler is enabled after a user adjustable time after hot water flows are proven via flow switch. Boiler shall have a user adjustable delay on start appropriately set to allow for orderly system start-up, shutdown and sequencing. Boiler runs subject to its own internal safeties and controls via it's internal control panel. Boiler shall be

monitored by BMS for operating conditions, statuses and alarms via BMS interface in boiler control panel. Boilers will be provided complete with control panels and OEM open protocol panels for communication of BMS network. Review specification and/or shop drawings and supplement the OEM Controls to include for:

.1 BMS network interface for open protocol communications.
.2 Interlock with circulating pumps as required to manufacturer's instructions.
.3 Replicating all alarms, adjust points, temperature readings at BMS.
.4 Supply and install all hardware and software required to connect boiler control panel to the BMS Network.

.3 Hot Water Supply Temperature: Hot water supply temperature set point at sensor T-2 shall be -1°C (adj.). Boiler shall modulate capacity from 20% to 100% to maintain set point. Below it's modulation range, boiler shall cycle on/off. To prevent short cycling, there shall be a user definable (adj.) minimum runtime.

.4 Monitoring: The following shall be monitored:
.1 Boiler hot water supply and return temperatures
.2 Boiler operating conditions, statuses and alarms
.3 Status of all pumps from current sensing relays
.4 Status of all VFDs

.5 Alarms: Alarms shall be provided as follows:
.1 All Water Pumps
.1 Failure: Commanded on, but the status is off
.2 Runtime Exceeded: Status runtime exceeds a user definable limit
.2 Boilers
.1 Boiler Alarms
.2 Failure: Commanded on, but the status is off
.3 VFDs
.1 VFD Alarms
.4 High /Low Boiler Hot Water Supply Temp: temperature greater than 82°C (adj.) / less than 21°C (adj.).
.5 High /Low Boiler Hot Water Return Temp: temperature greater than 80°C (adj.) / less than 21°C (adj.).
.6 High /Low Ground Source Water Supply Temp: temperature greater than 30°C (adj.) / less than -4°C (adj.).
.7 High /Low Ground Source Water Return Temp: temperature greater than 30°C (adj.) / less than -4°C (adj.).

.6 Shutdown: Back up Heating system shuts down under the following conditions:
.1 Emergency shutdown signal
.2 Hot water no longer required

.5 VRF Heating & Cooling System

.1 VRF System and ERV: The VRF control system will be supplied with independent controls, controlling the VRF system and the ERV unit. See the control system in section 15655. The VRF control system will tie in and communicate with the BMS system. The system shall operate based on a preset (adj.) occupancy schedule. The system shall cycle on/off to maintain space setback set points (18°C (adj.) heating and 27°C (adj.) cooling) in the unoccupied mode. In occupied mode, system shall run continuously and modulate heating and cooling capacities to meet space heating and cooling demand as determined by space temperature variation from set point of 21°C (adj.) heating and 24°C (adj.) cooling. When the system is required to operate, a signal is sent to the BMS to start the ground source system for proper heat rejection or reclaim. The ERV is interlocked with the VRF fan coil units and operate together. When outdoor air temperature drops below set point, the controller for the electric duct heater mounted on the ERV supply will turn on and modulate capacity to maintain an entering air set-point.

.2 Fan Coil Units: Fan coil units shall operate based on a preset occupancy schedule. Units provide heating and cooling as required to meet space temperature set point. On an increase in space temperature, fan speeds up and refrigerant valve modulates open to provide more cooling. On a drop in space temperature, in floor heating is activated as the first stage of heating. On further drop in temperature, fan speeds up and refrigerant valve

modulates open up to provide more heating. BC controller monitors which fan coil units need heating and cooling and sends hot or cold refrigerant accordingly.

.6 Radiant Floor Heating System

.1 Radiant Floor Heating: When space temperature drops below space set point and outside air temperature is below set-point of 10°C (adj.), the first stage of heating (radiant floor) is activated. Upon activation, radiant loop pump starts and runs continuously at constant speed to circulate water in the system. Radiant floor heating bypass valve V-2 shall modulate open on a rise in differential pressure and modulate closed on a drop in differential pressure. Space thermostats monitor space temperature and open/close in floor heating valves based on demand for heat. The in-floor heating zones work with the respective fan coil unit of the zone; the in-floor shall be the first stage of heating and the fan coils will be the second stage. The system shall ensure the fan-coils are not in cooling mode while the in-floor of that zone is in operation.

.2 Heat exchanger AU-1/2: Once pump operation is confirmed, heat exchanges are enabled. AU-1 & AU-2 will modulate capacity in unison to meet in floor heating temperature set point of 35°C (adj.). until maximum capacity is reached. In floor heating set point shall be reset up/down based on the percentage of valves requiring in floor heat.

.3 Monitoring: The following shall be monitored:

.1 Radiant floor hot water supply and return temperatures

.2 Heat Exchanger operating conditions, statuses and alarms

.3 Status of all pumps from current sensing relays

.4 Alarms: Alarms shall be provided as follows:

.1 Water Pump

.1 Failure: Commanded on, but the status is off

.2 Runtime Exceeded: Status runtime exceeds a user definable limit

.2 Heat Exchanger

.1 Heat Exchanger Alarms

.2 Failure: Commanded on, but the status is off

.3 High /Low Hot Water Supply Temp: temperature greater than 43°C (adj.) / less than 21°C (adj.). Slab temperature is not to exceed 35°C (adj.).

.5 Shutdown: Heating system shuts down under the following conditions:

.1 Emergency shutdown signal

.2 Hot water no longer required

.7 Exhaust Fan Control

.1 Exhaust fan EF-3: The turnout room exhaust fan will run continuously at minimum speed and be staged to high speed according to temperature and humidity set-points of 26°C (adj.) and 55% (adj.).

.2 Exhaust Fan EF-4: The maintenance shop exhaust fan will cycle on/off according to the temperature set-point of 26°C (adj.).

.3 Exhaust Fan EF-2: The apparatus floor exhaust fans will operate based on zone CO and NO2 concentrations and the operation of other supply/exhaust fans. The control system will monitor their operation and control EF-2 accordingly. If other exhaust fans are on, the apparatus floor exhaust fan will slow down accordingly to compensate for the increased exhaust. When the CO and NO2 level rise above set-point (CO level below 60 ppm and NOX level below 2.0 ppm), the apparatus floor exhaust fan will speed up until the levels are below their set points.

.4 Exhaust Fan EF-6: .1 Exhaust fan shall be continuously enabled to maintain space temperature set point of 27C (adj.). Fan starts on temperature rise in room above set point and turn off below set point. Fan cycles to maintain set point temperature. Exhaust air and supply air dampers shall be interlocked with their respective fan. Dampers open when fan is started and close when fan turns off.

.8 Radiant Heater

.1 The unit shall maintain a heating set point of 70°F (adj.) by cycling fan and gas heater on/off via wall mounted line voltage thermostat. The fan shall run when zone temperature drops below heating set point.

.9 Make Up Air Unit

.1 AHU Components: system consists of the following:

.1 Outside Air Dampers

.2 Prefilter
.3 Gas heat
.4 Supply Fan
.5 Supply fan VFD

.2 Dedicated controller: AHU shall be controlled by a dedicated controller mounted adjacent to the unit/system.

.3 Indication & adjustments: All settings shall be operator adjustable via password protected access.

.4 Start/Stop: The unit shall be started and stopped by the BMS and shall run based upon an operator adjustable schedule at the OWS.

.5 Outside Air Damper: On start up, damper shall fully open and close damper end switches to allow fan to start. On shut down, dampers shall close after a 60 sec. (adj.) time delay after the fan is stopped.

.6 Supply Fan: The supply fan shall run anytime the unit is commanded to run. To prevent short cycling, the supply fan shall have a user definable (adj.) minimum runtime.

.7 Space Pressure: Space pressure sensor shall modulate the supply fan VFD speed to maintain space pressure set point of 60 Pa (adj.).

.8 Exhaust Fans: The exhaust fans shall be interlocked with supply fan and run whenever the supply fan runs.

.9 Supply Air Temperature: The controller shall monitor the supply air temperature and maintain supply air temperature set point of 21°C (adj.). The supply air temperature set point shall be reset lower/higher based on zone cooling and heating requirements. Zone thermostat resets of the supply air temperature.

.10 Heating: Heating shall be enabled whenever required by the zone to maintain temperature set point and the supply fan is on. Supply air temperature sensor shall modulate the heating system to maintain supply air set point.

.11 Monitoring: The controller shall monitor:
.1 Equipment Status: supply fan (thru CSR),
.2 Temperature: supply air
.3 Alarm Condition: VFD

.12 Alarms: Alarms shall be provided as follows:
.1 Supply Fan Failure: Commanded on, but the status is off after 15 second delay
.2 Supply Fan VFD Fault
.3 High / Low Supply Air Temp: supply air temperature greater / less than 35°C / 10°C (adj.)

.13 Shut Down: On shutdown, the fans stop, the inlet damper, heating system shuts. The unit shall shut down and generate an alarm under the following conditions:
.1 Emergency shutdown
.2 High / Low Supply Air Temp
.3 Fire alarm

End of Section

1 General

1.1 GENERAL

.1 Read and conform to:
- .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended in the Contract Documents;
- .2 Division 1 requirements and documents refered to therein.

1.2 MECHANICAL/ELECTRICAL EQUIPMENT SCHEDULE

1. The following Mechanical/Electrical Equipment Schedule is provided to assist the Contractor in coordinating the efforts of sub-trades responsible for Divisions 15 and 16. The assignment of work among subcontractors is the Contractor's responsibility and the Contractor is free to amend the schedule as he sees fit.
2. The Mechanical/Electrical Equipment Schedule also describes work that is required and may or may not be described elsewhere. All work indicated in the Mechanical/Electrical Equipment Schedule shall be included in the Bid Price.
3. The Mechanical/Electrical Equipment Schedule shall not limit the extent of the Contract in any way. Work indicated elsewhere or otherwise needed for a complete and functioning installation shall be provided whether or not shown in the Mechanical/Electrical Equipment Schedule.

1.3 RESPONSIBILITY CODES

1. Responsibility Codes in the Electrical Equipment Schedule shall be interpreted as follows:

   .1 "Supplied by Div." means that the equipment is to be supplied to the site under the Division described by number.

   .2 "Installed by Div." means that the equipment is to be received from the supplier, handled, set in place and installed at the site under the Division described by number.

   .3 "Wired and connected by Div." means that the equipment and its associated devices are to be wired and connected to the various electrical systems in accordance with the equipment manufacturer's installation instructions and wiring diagrams under the Division described by number.

End of Section

No.	Equipment				Controls			Responsibility		
	Item	Characteristics (FKW = Fractional KW)		Location	Type	Location	Manufacturer's Reference	Supplied by Div.	Installed By Div.	Wired & Connected by Div.
1	LAVATORY & WASH BASIN	KW	FKW	HC WASHROOM 102	Disconnect	At Transformer	HBL#13R92MD	16	16	16
		Voltage	120		Junction Box	See drawings	See Elec Spec	16	16	16
		Phase	1		Transformer	See drawings	See Mech Spec	15	15	16
		Freq.	60		Low Voltage wiring	See Mech Spec	See Mech Spec	15	15	15
	Division 16 to provide 120volt feed to transformer. Division 15 to locate transformer, wiring in conduit between controller & transformer.									
2	GAS FIRED DOMESTIC HOT WATER HEATERS (Quantity 2)	KW	FKW	MECHANICAL ROOM 105	Disconnect (2)	At Door	HBL#13R92MD	16	16	16
		Voltage	120		Other Controls	See Mech Spec	See Mech Spec	15	15	15
		Phase	1							
		Freq.	60							
	Connect hot water heaters to Building Management System									
3	DOMESTIC HW RE-CIRC PUMP	Watts	90	MECHANICAL ROOM 105	Disconnect	See Starter	See Starter	16	16	16
		Voltage	120		Starter	by unit	AB# 512 Series	16	16	16
		Phase	1		Other Controls	See Mech Spec	See Mech Spec	15	15	15
		Freq.	60							
	Starter complete with HOA and red pilot light in cover. Before final connection to pump, Division 16 to notify Division 15 Control Contractor and provide junction box as required for Division 15 to install relay for control of pump. Connect pump to Building Management System.									
4	HYDRATION STATION	Watts	370	EXERCISE ROOM 125	Disconnect	At Unit	See Elec Spec	16	16	16
		Voltage	120		Starter	In Unit	See Mech Spec	15	15	15
		Phase	1							
		Freq.	60							
5	AIR COMPRESSOR	KW	3.75	MAINTENANCE SHOP 126	Disconnect	See Starter	See Starter	16	16	16
		Voltage	208		Starter	By Unit	AB# 512 Series	16	16	16
		Phase	1							
		Freq.	60							
6	EXHAUST EF-1A	KW	2.25	APPARATUS FLOOR 124	Disconnect	At Unit	See Mech Spec	15	15	16
		Voltage	208		Starter	See Elec Dwgs	AB 509 Series	16	16	16
		Phase	3		Other Controls	See Mech Spec	See Mech Spec	15	15	15
		Freq.	60							
	Connect exhaust fan to Building Management System.									
7	EXHAUST EF-1B	KW	2.25	APPARATUS FLOOR 124	Disconnect	At Unit	See Mech Spec	15	15	16
		Voltage	208		Starter	See Elec Dwgs	AB 509 Series	16	16	16
		Phase	3		Other Controls	See Mech Spec	See Mech Spec	15	15	15
		Freq.	60							
	Connect exhaust fan to Building Management System. Starter to be complete H-O-A & red pilot light in cover.									
8	APPARATUS FLOOR EXHAUST EF-2	KW	0.56	APPARATUS FLOOR 124	Disconnect	In VFD	See Mech Spec	15	15	15
		Voltage	208		VFD	See drawings	See Mech Spec	15	15	16
		Phase	3		Other Controls	See Mech Spec	See Mech Spec	15	15	15
		Freq.	60							
	Connect exhaust fan to Building Management System. Exhaust fan interlocked with Make Up Air Unit. Division 16 to provide (special) wiring from VFD to unit as per VFD manufacturers recommendations.									
9	TURN-OUT ROOM EXHAUST EF-3	KW	0.38	TURN-OUT ROOM ROOF	Disconnect (WP)	At Unit	See Mech Spec	15	15	16
		Voltage	208		Starter	See Elec Dwgs	AB 509 Series	16	16	16
		Phase	1		Other Controls	See Mech Spec	See Mech Spec	15	15	15
		Freq.	60							
	Connect exhaust fan to Building Management System. Starter to be complete H-O-A & red pilot light in cover.									

No.	Equipment				Controls			Responsibility		
	Item	Characteristics (FKW = Fractional KW)		Location	Type	Location	Manufacturer's Reference	Supplied by Div.	Installed By Div.	Wired & Connected by Div.
10	MAINTENANCE SHOP EF-4	KW	0.13	MAINTENANCE SHOP ROOF	Disconnect (WP)	At Unit	See Mech Spec	15	15	16
		Voltage	120		Starter	See Elec Dwgs	AB 509 Series	16	16	16
		Phase	1		Other Controls	See Mech Spec	See Mech Spec	15	15	15
		Freq.	60							
	Connect exhaust fan to Building Management System. Starter to be complete H-O-A & red pilot light in cover.									
11	EXERCISE ROOM EXHAUST EF-5	KW	FKW	EXERCISE ROOM ROOF	Disconnect (WP)	At Unit	See Mech Spec	15	15	16
		Voltage	120		Starter	See Elec Dwgs	See Elec Spec	16	16	16
		Phase	1		Other Controls	See Mech Spec	See Mech Spec	15	15	15
		Freq.	60							
	Connect exhaust fan to Lighting Occupancy Sensor & Building Management System.									
12	MECHANICAL ROOM EXHAUST EF-6	KW	0.19	MECHANICAL ROOM 105	Disconnect	At Unit	HBL#13R92MD	16	16	16
		Voltage	120		Starter	See Elec Dwgs	AB 509 Series	16	16	16
		Phase	1		Other Controls	See Mech Spec	See Mech Spec	15	15	15
		Freq.	60		Motorized Dampers	See drawings	See Mech Spec	15	15	15
					RA Thermostat	See drawings	See Mech Spec	15	15	15
	Connect exhaust fan to Building Management System.									
13	KITCHEN HOOD EXHAUST EF-7	KW	1/4	ROOF	Disconnect	In Unit	By Manufacturer	15	15	16
		Voltage	120		Starter	By Unit	AB 509 Series	16	16	16
		Phase	1		Other Controls	See Mech Spec	See Mech Spec	15	15	15
		Freq.	60							
	Division 16 to provide H-O-A switch complete with pilot light in starter cover. Fan shuts down upon activation of hood extinguishing system.									
13	MAINTENANCE SHOP DRYER EXHAUST EF-8	KW	FKW	MAINTENANCE SHOP 126	Disconnect	In Unit	By Manufacturer	15	15	16
		Voltage	120		Starter	At Unit	See Mech Spec	15	15	15
		Phase	1		Other Controls	See Mech Spec	See Mech Spec	15	15	15
		Freq.	60							
	Connect exhaust fan to Building Management System. Divison 16 shall interlock exhaust fan to dryer, refer to details on electrical drawings.									
14	CONDENSING UNIT CU-1	MCA	30	MECHANICAL ROOM 105	Disconnect	At Unit	See Mech Spec	15	15	16
		Voltage	208		Starter	At Unit	See Mech Spec	15	15	16
		Phases	3		Other Controls	See Mech Spec	See Mech Spec	15	15	15
		Freq.	60							
	Connect condensing unit to Building Management System.									
15	CONDENSING UNIT CU-2	MCA	30	MECHANICAL ROOM 105	Disconnect	At Unit	See Mech Spec	15	15	16
		Voltage	208		Starter	At Unit	See Mech Spec	15	15	16
		Phases	3		Other Controls	See Mech Spec	See Mech Spec	15	15	15
		Freq.	60							
	Connect condensing unit to Building Management System.									
16	RADIANT HEAT TUBE RHT-1	FLA	1.1	APPARATUS FLOOR 124	Disconnect	At Unit	HBL#13R92MD	16	16	16
		Voltage	115		Thermostat	See drawings	See Mech Spec	15	15	15
		Phases	1		Starter	See Elec Dwgs	AB 509 Series	16	16	16
		Freq.	60		Other Controls	See Mech Spec	See Mech Spec	15	15	15
	Connect radiant heat tube to Building Management System. Division 16 shall provide outlet box & 1/2" conduit complete with pullwire to accessible ceiling for control wiring.									

No.	Equipment				Controls			Responsibility		
	Item	Characteristics (FKW = Fractional KW)		Location	Type	Location	Manufacturer's Reference	Supplied by Div.	Installed By Div.	Wired & Connected by Div.
17	RADIANT HEAT TUBE RHT-2	FLA	1.1	APPARATUS FLOOR 124	Disconnect	At Unit	HBL#13R92MD	16	16	16
		Voltage	115		Thermostat	See drawings	See Mech Spec	15	15	15
		Phases	1		Starter	See Elec Dwgs	AB 509 Series	16	16	16
		Freq.	60		Other Controls	See Mech Spec	See Mech Spec	15	15	15
	Connect radiant heat tube to Building Management System. Division 16 shall provide outlet box & 1/2" conduit complete with pullwire to accessible ceiling for control wiring.									
18	MAKE-UP UNIT MUA-1	kW	3.75	APPARATUS FLOOR 124	Disconnect	At Unit	See Mech Spec	15	15	16
		Voltage	208		Thermostat	See drawings	See Mech Spec	15	15	15
		Phases	3		VFD	At Unit	See Mech Spec	15	15	16
		Freq.	60		Control Panel	See drawings	See Mech Spec	15	15	15
					Sensors	See drawings	See Mech Spec	15	15	15
					Other Controls	See Mech Spec	See Mech Spec	15	15	15
	Connect make-up air unit to Building Management System. Division 16 to provide wiring from disconnect switch to VFD. Division 16 to provide (special) wiring from VFD to unit as per VFD manufacturers recommendations. Division 15 shall interlock MUA-1 to EF-2, EF-3 & EF-4. Division 16 shall provide 1/2" conduit from Control Panel to Unit & from Sensors to Unit.									
18	MAKE-UP UNIT MUA-2	kW	3.75	ROOF	Disconnect (WP)	At Unit	See Mech Spec	15	15	16
		Voltage	120		Starter	See drawings	See Mech Spec	15	15	16
		Phases	1		Other Controls	See Mech Spec	See Mech Spec	15	15	15
		Freq.	60							
	Fan shuts down upon activation of hood extinguishing system.									
19	BOILER B-1	KW	FKW	MECHANICAL ROOM	Disconnect	At Door	HBL#13R92MD	16	16	16
		Voltage	120		Other Controls	See Mech Spec	See Mech Spec	15	15	15
		Phases	1							
		Freq.	60							
	Division 16 to provide lamacoid label over each disconnect switch reading "Boiler Disconnect". Do not gang with lighting switch. Boiler controlled by Building Management System.									
20	ENERGY RECOVERY UNIT ERV-1	kW	0.60	MECHANICAL ROOM 105	Disconnect	At Unit	FPL#C1332SN/F	16	16	16
		Voltage	208		Starter	See Elec Dwgs	AB 509 Series	16	16	16
		Phases	1		Other Controls	See Mech Spec	See Mech Spec	15	15	15
		Freq.	60							
	Connect energy recover unit to Building Management System.									
21	DUCT HEATER DH-1	kW	12	MECHANICAL ROOM 105	Disconnect	At Unit	FPL#C5636	16	16	16
		Voltage	208		Starter	See Elec Dwgs	AB 509 Series	16	16	16
		Phases	3		Other Controls	See Mech Spec	See Mech Spec	15	15	15
		Freq.	60							
	Connect duct heater to Building Management System.									
22	REFRIGERANT HEAT EXCHANGER AU-1 & AU-2	kW	0.015	MECHANICAL ROOM 105	Disconnect (2)	See Starter	See Starter	16	16	16
		Voltage	208		Starter (2)	See Elec Dwgs	AB 512 Series	16	16	16
		Phases	1		Other Controls	See Mech Spec	See Mech Spec	15	15	15
		Freq.	60							
	Connect refrigerant heat exchangers to Building Management System.									
23	BRANCH CONTROLLER BC-1	kW	0.314	CORRIDOR 109	Disconnect	At Unit	HBL#13R92MD	16	16	16
		Voltage	208		Starter	See Mech Spec	See Mech Spec	15	15	15
		Phases	1		Other Controls	See Mech Spec	See Mech Spec	15	15	15
		Freq.	60							
	Division 16 shall provide 1/2" conduit complete with pullwire from BC-1 to Fan Coil Units for controls connection by Division 15.									

No.	Equipment				Controls			Responsibility		
	Item	Characteristics (FKW = Fractional KW)		Location	Type	Location	Manufacturer's Reference	Supplied by Div.	Installed By Div.	Wired & Connected by Div.
24	FAN COIL UNIT FC-1	kW	0.060	COMPUTER STUDY 108	Disconnect	At Unit	HBL#13R92MD	16	16	16
		Voltage	208		Starter	At Unit	See Mech Spec	15	15	16
		Phases	1		Thermostat	See drawings	See Mech Spec	15	15	15
		Freq.	60		Other Controls	See Mech Spec	See Mech Spec	15	15	15
	Division 16 shall provide 1/2" conduit complete with pullwire from each fan coil unit to BC Controller Unit for controls connection by Division 15.									
	Division 16 shall provide outlet box & 1/2" conduit complete with pullwire to accessible ceiling for control wiring.									
25	FAN COIL UNIT FC-2	kW	0.110	STATION OFFICER /DISPATCH 107	Disconnect	At Unit	HBL#13R92MD	16	16	16
		Voltage	208		Starter	At Unit	See Mech Spec	15	15	16
		Phases	1		Thermostat	See drawings	See Mech Spec	15	15	15
		Freq.	60		Other Controls	See Mech Spec	See Mech Spec	15	15	15
	Division 16 shall provide 1/2" conduit complete with pullwire from each fan coil unit to BC Controller Unit for controls connection by Division 15.									
	Division 16 shall provide outlet box & 1/2" conduit complete with pullwire to accessible ceiling for control wiring.									
26	FAN COIL UNIT FC-3	kW	0.110	CORRIDOR 109 (SUPPLYING W/R AND SHOWERS)	Disconnect	At Unit	HBL#13R92MD	16	16	16
		Voltage	208		Starter	At Unit	See Mech Spec	15	15	16
		Phases	1		Thermostat	See drawings	See Mech Spec	15	15	15
		Freq.	60		Other Controls	See Mech Spec	See Mech Spec	15	15	15
	Division 16 shall provide 1/2" conduit complete with pullwire from each fan coil unit to BC Controller Unit for controls connection by Division 15.									
	Division 16 shall provide outlet box & 1/2" conduit complete with pullwire to accessible ceiling for control wiring.									
27	FAN COIL UNIT FC-4	kW	0.120	LOUNGE/DAY ROOM 115	Disconnect	At Unit	HBL#13R92MD	16	16	16
		Voltage	208		Starter	At Unit	See Mech Spec	15	15	16
		Phases	1		Thermostat	See drawings	See Mech Spec	15	15	15
		Freq.	60		Other Controls	See Mech Spec	See Mech Spec	15	15	15
	Division 16 shall provide 1/2" conduit complete with pullwire from each fan coil unit to BC Controller Unit for controls connection by Division 15.									
	Division 16 shall provide outlet box & 1/2" conduit complete with pullwire to accessible ceiling for control wiring.									
28	FAN COIL UNIT FC-5	kW	0.120	KITCHEN 116	Disconnect	At Unit	HBL#13R92MD	16	16	16
		Voltage	208		Starter	At Unit	See Mech Spec	15	15	16
		Phases	1		Thermostat	See drawings	See Mech Spec	15	15	15
		Freq.	60		Other Controls	See Mech Spec	See Mech Spec	15	15	15
	Division 16 shall provide 1/2" conduit complete with pullwire from each fan coil unit to BC Controller Unit for controls connection by Division 15.									
	Division 16 shall provide outlet box & 1/2" conduit complete with pullwire to accessible ceiling for control wiring.									
29	FAN COIL UNIT FC-6	kW	0.110	CORRIDOR 117	Disconnect	At Unit	HBL#13R92MD	16	16	16
		Voltage	208		Starter	At Unit	See Mech Spec	15	15	16
		Phases	1		Thermostat	See drawings	See Mech Spec	15	15	15
		Freq.	60		Other Controls	See Mech Spec	See Mech Spec	15	15	15
	Division 16 shall provide 1/2" conduit complete with pullwire from each fan coil unit to BC Controller Unit for controls connection by Division 15.									
	Division 16 shall provide outlet box & 1/2" conduit complete with pullwire to accessible ceiling for control wiring.									
30	FAN COIL UNIT FC-7	kW	0.050	EXERCISE ROOM	Disconnect	At Unit	HBL#13R92MD	16	16	16
		Voltage	208		Starter	At Unit	See Mech Spec	15	15	16
		Phases	1		Thermostat	See drawings	See Mech Spec	15	15	15
		Freq.	60		Other Controls	See Mech Spec	See Mech Spec	15	15	15
	Division 16 shall provide 1/2" conduit complete with pullwire from each fan coil unit to BC Controller Unit for controls connection by Division 15.									
	Division 16 shall provide outlet box & 1/2" conduit complete with pullwire to accessible ceiling for control wiring.									
31	GEOTHERMAL PUMP P-1	kW	2.250	MECHANICAL ROOM 105	Disconnect	See Starter	See Starter	16	16	16
		Voltage	208		Starter	At Unit	AB 512 Series	16	16	16
		Phase	3		Other Controls	See Mech Spec	See Mech Spec	15	15	15
		Freq.	60							
	Connect geothermal pump to Building Management System.									

No.	Equipment				Controls			Responsibility		
	Item	Characteristics (FKW = Fractional KW)		Location	Type	Location	Manufacturer's Reference	Supplied by Div.	Installed By Div.	Wired & Connected by Div.
32	GEOTHERMAL PUMP P-2	kW	2.250	MECHANICAL ROOM 105	Disconnect	See Starter	See Starter	16	16	16
		Voltage	208		Starter	At Unit	AB 512 Series	16	16	16
		Phase	3		Other Controls	See Mech Spec	See Mech Spec	15	15	15
		Freq.	60							
	Connect geothermal pump to Building Management System.									
34	BOILER PUMP P-3	kW	0.750	MECHANICAL ROOM 105	Disconnect	See Starter	See Starter	16	16	16
		Voltage	208		Starter	At Unit	AB 512 Series	16	16	16
		Phase	3		Other Controls	See Mech Spec	See Mech Spec	15	15	15
		Freq.	60							
	Connect boiler pump to Building Management System.									
35	INFLOOR PUMP P-4	kW	0.375	MECHANICAL ROOM 105	Disconnect	See Starter	See Starter	16	16	16
		Voltage	208		Starter	At Unit	AB 512 Series	16	16	16
		Phase	3		Other Controls	See Mech Spec	See Mech Spec	15	15	15
		Freq.	60							
	Connect infloor pump to Building Management System.									
36	GLYCOL FILLING PUMP GLP-1	KW	FKW	MECHANICAL ROOM 105	Disconnect	See Starter	See Starter	16	16	16
		Voltage	115		Starter	At Unit	AB 512 Series	16	16	16
		Phase	1		Other Controls	See Mech Spec	See Mech Spec	15	15	15
		Freq.	60							
	Connect glycol filling pump to Building Management System.									
37	MANIFOLD PUMPS (4)	KW	FKW	APPARATUS FLOOR 124, FOYER 101, W/R 114	Disconnect (4)	See drawings	See Elec Spec	16	16	16
		Voltage	115		Other Controls	See Mech Spec	See Mech Spec	15	15	15
		Phase	1							
		Freq.	60							
	Connect manifold pumps to Building Management System.									