MCW Consultants Ltd.

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207 Queen's Quay West, Suite 615
Toronto, Ontario
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MECHANICAL SPECIFICATIONS

FOR

REPAIR VAVS, AHU AND COMPRESSORS REPLACEMENT 135 ST. CLAIR AVE W

TO

COLLIERS

DATED

OCTOBER 25TH, 2023

ISSUED FOR TENDER

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MCW Project No. 23144

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END OF SECTION

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PART 1 - GENERAL

1.01 DESCRIPTION

.1 Submit Shop Drawings, Product Data and Samples as specified herein.

.2 Designate in the Construction Schedule, or in a separate coordination schedule, dates for submission and dates that reviewed Shop Drawings, Product Data and Sample will be required. Give due consideration for review time required by the Consultant, with a minimum of fifteen (15) working days required. The submission of Appendix 'B' will be considered an acceptable submittal schedule.

.3 All data and dimensions on shop drawings, product data and sample information to be based on units (Imperial or Metric) as shown on the contract documents.

.4 Shop Drawings with errors or omissions and deviations will be returned "Not Reviewed".

.5 The Contractor's responsibility for deviations in submission from the requirements of Contract Documents is not relieved by the Consultant's review of submittals, unless a deviation on the submittal is noted as such in writing and has been accepted by the Consultant.

.6 Keep one (1) reviewed copy of each submission on site.

1.02 SHOP DRAWINGS

.1 Review and stamp Shop Drawings, Product Data and Samples prior to submission to the Consultant. Confirm that necessary requirements have been determined and verified and that each submittal has been checked and co-ordinated with requirements of the Work and the Contract Documents. Submittals not stamped, signed, dated and identified as to the specific project, will be returned without being examined and shall be re-submitted when completed.

.2 Submit drawings in a clear and thorough manner:

.1 Identify details by reference to drawing No. and detail, schedule or room numbers as shown on Contract Documents.
.2 Minimum sheet size and larger sheets to be multiples of 8½" x 11".
.3 Indicate materials, methods of construction and attachment or anchorage, erection diagrams, connections, explanatory notes and other information necessary for completion of Work. Where articles or equipment attach or connect to other articles or equipment, indicate that such items have been co-ordinated. Indicate cross references to design drawings and specification.
.4 Adjustments to shop drawings by the Consultant do not change the cost of the work. If adjustments affect the cost of Work, advise through normal channels in writing prior to proceeding with the Work.
.5 Make changes in shop drawings as directed by the Consultant. Resubmit and note any revisions other than those requested.
.6 If only minor adjustments are made, shop drawings to be returned and fabrication and installation of work to proceed.

.3 Determine and verify:

.1 Field measurements.
.2 Field construction criteria.
.3 Catalogue numbers and similar data.
.4 Conformance with Specifications.

.4 Co-ordinate each submittal with requirements of the Contract documents.

.5 Each Shop Drawing will be stamped by the Consultant in the following format:

☐ NOT REVIEWED ☐ REVIEWED
☐ RESUBMIT ☐ REVIEWED AS MODIFIED
☐ NOT SPECIFIED BY MCW, REVIEWED FOR MEP ONLY

.6 This review by the Consultant is for the sole purpose of ascertaining conformance with the general design concept. This review shall not mean that the Consultant approved the detail design inherent in the shop drawings, responsibility for which shall remain with this Subcontractor submitting same, and such review shall not relieve this Subcontractor 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.

.7 Products not specified by MCW are reviewed to confirm compliance with services provided only. Any changes required between provided services and shop drawing requirements will be identified for coordination between trades.

.8 Shop drawings shall be accompanied by a complete copy of the attached “Shop Drawing Submittal Sheet” Section 20 05 01, Appendix ‘A’.

.9 Begin no fabrication or work which requires submittals until return of submittals reviewed by Consultant.

1.03 PRODUCT DATA

.1 Where specified, Manufacturer’s standard schematic drawings, catalogue sheets, diagrams, schedules, performance charts, illustrations and other standard descriptive data is acceptable provided there is conformance with the following:

.1 Clearly identify pertinent products or models.
.2 Show performance characteristics and capacities.
.3 Show dimensions and clearances required.
.4 Show wiring or piping diagrams and controls.

.2 Manufacturer’s standard schematic drawings and diagrams may require modifications to drawings and diagrams to provide information applicable to the Work.

.3 Provide information specifically applicable to the Work.

1.04 SAMPLES

.1 Samples are to be provided in accordance with Division 01.

.2 Samples to be labelled, of sufficient size and quantity to clearly illustrate:

.1 Functional characteristics integrally related parts and attachment devices.
.2 Full range of colour, texture and pattern.

.3 Field Samples and mock-ups:

.1 Erect, at the project site and in location acceptable to the Consultant.
.2 Fabricate each sample and mock-up complete and finished.
.3 Remove mock-ups at conclusion of Work or as specified by the Consultant.

1.05 SUBMISSION REQUIREMENTS

.1 Submit promptly to approved schedule and in sequence to prevent submission delay in the Work.

.2 Submission requirements:

.1 Shop Drawings: Acceptable submissions are: Submit shop drawings electronically as agreed to during the kick off meeting with the Consultant.
.2 Product Data: Submit a copy for each O & M Manual.
.3 Samples: Submit as specified, or as requested during the shop drawing review period.

1.06 RESUBMISSION REQUIREMENTS

.1 Make corrections or changes to the submittals noted by the Consultant and resubmit.

.2 Shop Drawings and Product Data:

.1 Revise drawings or data, and resubmit as noted on the initial submittal.
.2 Indicate any changes which have been made other than those noted by the Consultant.

.3 Samples: Submit new samples as required for initial submittal as soon as possible after notification of the rejection of the original submission and mark “resubmitted samples”.

1.07 DISTRIBUTION

.1 Distribute reproductions of Shop Drawings and copies of Product Data which carry the Consultant’s stamp to all parties as specified by Division 01 General Requirements.

.1 Job site file
.2 Project record document file
.3 Other affected contractors
.4 Subcontractors
.5 Supplier or fabricator (as applicable)
.6 Operations Manual

PART 2 - PRODUCTS

2.01 NIL

PART 3 - EXECUTION

3.01 NIL

END OF SECTION 20 05 01

SHOP DRAWING SUBMITTAL SHEET

Project:		Date:	
Project No.		Submittal No.	
Section:			
Equipment Description			
Contractor:			
Sub-Contractor:			
Suppliers Name:			
Manufacturer:			
Catalogue No.:			
Variations From Tender Documents			

Engineer: MCW Consultants Ltd.
207 Queen's Quay West, Suite 615
Toronto, Ontario
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MECHANICAL GENERAL REQUIREMENTS SECTION 20 05 01 – APPENDIX 'B' PROJECT: _____ _____ PROJECT No: _____		**SHOP DRAWING SUBMITTAL SCHEDULE** DIVISION 20, 21 22, 23 & 25							Date: _____
SECTION	DESCRIPTION (List Equipment Example only Edit to Suit)	MANUFACTURER	SHOP DRAWING				DELIVERY		COMMENTS
			SUBMITTED		RETURNED				
			SCHED	ACTUAL	SCHED	ACTUAL	SCHED	ACTUAL	
20 05 10	Valves Expansion Tanks Expansion Compensators Strainers Thermometers and Gauges Fire Stopping Products Air separators Specialties Access doors								
20 05 20	Bases, Isolators, Silencers								
20 05 25	Insulation								
20 05 30	Variable Frequency Drives								
23 21 23	Pumps								
23 51 00	Breeching Gas Vents and Stacks								
23 52 00	Heating Boilers								

CONTENTS

PART 1 - GENERAL

1.01 DESCRIPTION

.1 Comply with requirements of Division 01, General Requirements and all documents referred to therein.

1.02 APPLICATION

.1 This Section applies to and is part of all Sections of Division 20, 21, 22, 23 and 25.

.2 Perform All Work specified herein by experienced and licensed personnel.

1.03 DEFINITIONS

.1 Wherever the term "The Consultant" is used in the Division 20, 21, 22, 23 and 25 Drawings and Specifications it means MCW Consultants Limited, Queen's Quay Terminal, 207 Queen's Quay West, Suite 615, Toronto Ontario, Canada M5J 1A7 (Phone 416-598-2920).

.2 Wherever the term "install" (and tenses of "install") is used in the Division 20, 21, 22, 23 and 25 Drawings and Specifications it means install and connect complete.

.3 Wherever the term "supply" is used in the Division 20, 21, 22, 23 and 25 Drawings and Specifications it means supply only for installation by other subtrades or under separate contract.

.4 Wherever the terms "Provide" or "Provision of" are used in relationship to equipment, piping, other materials and systems specified for the Work of Divisions 20, 21, 22, 23 and 25, it means "Supply, Install and Connect and make operable to specified performance". Wherever the terms "Provide" or "Provision of" are used in connection with services such as testing, balancing, start-up, preparation of Drawings and commissioning for any part of the Work of Divisions 20, 21, 22, 23 and 25, it means procure, prepare, supervise, take responsibility and pay for these services.

.5 Wherever "Drawings and Specifications" are referred to, it means "the Contract Documents".

.6 Wherever the terms "Authorities" or "Authorities having jurisdiction" are used in the Division 20, 21, 22, 23 and 25 Drawings and Specifications it means any and all agencies that enforce the applicable laws, ordinances, rules, regulations or codes of the Place of the Work. Refer to Division One.

.7 Wherever the term "Work" is used in the Divisions 20, 21, 22, 23 and 25 Drawings and Specifications it means all equipment, permits, materials, labour and Services to provide a complete Mechanical installation as described and detailed on the Drawings and in the Specifications.

.8 Wherever the term "Performance" is used in the Divisions 20, 21, 22, 23 and 25 Drawings and Specifications in relation to specified equipment, it means the specified capacity of that equipment as it applies to provide air, steam or water flow, heating and/or cooling within the specified conditions of operation including air, steam and water pressures, physical space limitations and noise levels.

.9 Wherever the term "Acceptable" is used in the Divisions 20, 21, 22, 23 and 25 Drawings and Specifications it means acceptable to the Consultant.

1.04 WORK INCLUDED

.1 Sections of Divisions 20, 21, 22, 23 and 25 are not intended to delegate functions nor to delegate Work and supply to any specific trade. The Work of Divisions 20, 21, 22, 23 and 25 includes all labour, materials, equipment, permits and tools required for a complete and working installation as described in the Divisions 20, 21, 22, 23 and 25 Specifications and Drawings and is not necessarily limited to items in the following Sections:

20 05 01	Shop Drawings Product Data and Samples
20 05 05	Mechanical Work General Instructions
20 05 10	Basic Mechanical Materials and Methods
20 05 40	Demolition and Revision Work

HEATING, VENTILATION AND AIR CONDITIONING

23 05 00	Common Work Results for HVAC
23 36 00	Air Terminal Units
23 37 00	Louvres Intakes and Vents
23 52 00	Heating Boilers

INTEGRATED AUTOMATICS

25 01 01	Building Automation System BACNET

1.05 REGULATORY REQUIREMENTS

.1 Comply with requirements of all Municipal, Provincial and Federal Bylaws and Ordinances as well as requirements of Utilities such as Ontario Gas Utilization Code. The Ontario Electrical Safety Code.

.2 Do not reduce quality of any part of the Work specified and/or shown on the Drawings by following regulatory requirements.

.3 In general and as applicable, perform all Work of Divisions 20, 21, 22, 23 and 25 to comply with physical and chemical properties, characteristics and performance requirements of recognized associations and agencies as listed herein and in the following:

ACCGH	–	American Conference of Governmental Industrial Hygienists
AMCA	–	Air Moving & Conditioning Association
ADC	–	Air Diffusion Council
ANSI	–	American National Standards Institute
ARI	–	Air Conditioning & Refrigeration Institute
ASCII	–	American Standard Communication Information Interchange
ASHRAE	–	American Society of Heating, Refrigeration and Air Conditioning Engineers
ASME	–	American Society of Mechanical Engineers
ASTM	–	American Society for Testing and Materials
AWWA	–	American Water Works Association
CGA	–	Canadian Gas Association
CGSB	–	Canadian General Standards Board
CIRI	–	Canadian Industrial Risk Insurers
CSA	–	Canadian Standards Association
CTI	–	Cooling Tower Institute
EIA	–	Electronic Industry Association
FCC	–	Fire Commissioner of Canada
FM	–	Factory Mutual
ISA	–	Instrument Society of America

IAO	–	Insurers Advisory Organization
MMC	–	Marsh McLennan Insurance Protection Consultants
MTC	–	Ministry of Transportation and Communication
NBCC	–	National Building Code of Canada
NFPA	–	National Fire Protection Association
OBC	–	Provincial Ontario Building Code
OFM	–	Local Fire Codes or Standards Ontario Fire Marshall
MOEE	–	Ontario Ministry of Environment And Energy
OML	–	Ministry of Labour and Workmen's Compensation Requirements
OWRA	–	Ontario Plumbing Code
TSSA	–	Technical Standards & Safety Authority
UL	–	Underwriter's Laboratories Inc.
ULC	–	Underwriter's Laboratories of Canada

1.06 STANDARDS

.1 Provide new materials and equipment of proven design and quality. Provide current models of specified equipment manufactured in Canada or the United States of America, unless **specified** otherwise with published ratings certified by recognized North American testing and standards agencies.

.2 Provide Canadian made materials and equipment to maximize Canadian content in the Work.

.3 Comply with ASHRAE/IES 90.1 Standards in the supply and installation of all parts of the Work.

.4 Comply with Regulations Amending the Energy Efficiency Regulations P.C. 2004-965, 1 September 2004 for the following equipment:

.1 Water Chiller - To meet the requirements of CSA C743.
.2 Electric Water Heater - To meet the requirements of CAN/CSA C191-00.
.3 Gas Fired Water Heater - To meet the requirements of CSA – P.3-04.
.4 Large Air Conditioner, Heat Pumps and Condensing Units - To meet the requirements of CAN/CSA –C746 (current edition).

.5 Conform to the best modern practices of workmanship and installation methods and employ only skilled tradesmen working under the direction of fully qualified personnel.

.6 Materials and products provided and used must be in accordance with Division 01, to suit sustainable requirements.

1.07 PERMITS, FEES & INSPECTIONS

.1 Apply for, obtain, and pay for all permits, licenses, inspections, examinations and fees required for Work of Divisions 20, 21, 22, 23 and 25. Also submit, if required by the Authorities, information such as heat loss calculations, and other data that may be obtained from the Consultant. Should the Authorities require the information on specific forms, fill in these forms by transcribing thereto the information as provided by the Consultant.

.2 If the municipality is structured as a "single permit jurisdiction", the Contractor will apply, pay for and obtain the municipal building permit. In this case, the Divisions 20, 21, 22, 23 and 25 Subcontractor has no financial obligation for permit application except for permits not covered in the "single permit".

.3 Arrange for inspection of all Work by the Authorities having jurisdiction over the Work. On completion of the Work, present to the Consultant the final unconditional certificate of acceptance of the inspecting Authorities.

.4 Arrange and pay for inspection of all Work by TSSA for Gas Piping Systems On completion of the Work, present to the Consultant the final unconditional certificate of acceptance of the inspecting Authorities.

.5 In case of conflict, codes and regulations take precedence over the Contract Documents. In no instance reduce the standard or scope of work or intent established by the Drawings and Specifications by applying any of the codes referred to herein.

.6 Before starting any work, submit the required number of copies of Drawings and Specifications to the Authorities for their approval and comments. Comply with any changes requested as part of the contract, but notify the Consultant immediately of such changes. Prepare and submit any additional drawings, details or information as may be required.

1.08 CONTRACT DRAWINGS

.1 The Drawings for Mechanical Work are performance drawings, diagrammatic, intended to convey the scope of work and indicate general arrangement and approximate location of apparatus, fixtures and pipe runs. The Drawings do not intend to show Architectural and Structural details.

.2 Do not scale Drawings. Obtain information involving accurate dimensions from dimensions shown on Architectural and Structural Drawings, and by site measurement.

.3 Make, at no additional cost, any changes or additions to materials, and/or equipment necessary to accommodate structural conditions (pipes or ducts around beams and columns and other structural elements).

.4 Alter, at no additional cost, the locations of materials and/or equipment as directed that do not necessitate additional material.

.5 Install ceiling mounted or exposed components (e.g. diffusers, sprinkler heads, grilles) in accordance with reflected ceiling drawings or floor plans.

.6 Confirm on the site the exact location and mounting elevation of outlets and fixtures as related to existing Mechanical and Electrical components and Architectural and Structural details.

1.09 EXAMINATION OF THE PLACE OF THE WORK AND DOCUMENTATION

.1 Prior to submitting tender, carefully examine conditions at the Island Lake Public School which could affect the Work of this Division. Refer to and examine all Contract Documents.

.2 Verify that materials and equipment can be delivered to the Place of the Work and that sufficient space and access is available to permit installation thereof in locations shown on the Drawings.

.3 Verify location and elevation of existing services (water, electrical, sanitary, storm sewers, equipment, ductwork and piping) which may affect the Tender and Work of this Division. Repair any damage to existing underground services caused by neglect to determine and mark out the location of such services prior to excavation work commencing.

.4 Refer also to room finish schedules to determine finished, partially finished and unfinished areas of the building.

1.10 CO-ORDINATION DRAWINGS

.1 Prepare drawings in conjunction with all trades concerned, showing sleeves and openings for passage through structure, and all inserts, equipment bases, sumps, pits and supports, and relate these to suitable grid lines and elevation datum. Refer to requirements of Division 1

.2 The .2 Prepare interference and co-ordination drawings for all areas where the work of this Division could conflict with and/or obstruct the work of other trades and/or other Sections of this Division. Submit drawings for acceptance by the Consultant

1.11 SHOP DRAWINGS

.1 Conform to requirements of Section 20 05 01.

1.12 RECORD DRAWINGS

.1 The Contractor will supply marked up hard copy “Red Line” drawings to the consultant who will produce the CAD as-built drawings. The consultant will be paid directly by the Board to complete this work.

1.13 PRODUCT STANDARDS AND ALTERNATIVES

.1 Provide new material and equipment as specified and to acceptance of the Consultant. Manufacturers' names are listed to set a standard of quality, performance, capacity, appearance and serviceability. Acceptable alternative Manufacturers are also listed, and their products may be used in the Work subject to conditions stipulated in paragraph .3 of this Article.

.2 Where no other acceptable Manufacturers are indicated, provide only as specified. Requests for acceptance of manufacturers not listed must be submitted not less than seven working days prior to closing date of the tender. Submissions must bear proof of acceptance by the Consultant.

.3 Assume full responsibility for ensuring that when providing acceptable alternative Manufacturers, all performance, space, weight, connections (mechanical and electrical), power and wiring requirements, are within the scope of the item specified, and costs for any variances therefore are included in the tender. Equipment requiring greater than specified energy requirements and greater installation and service space requirements will not be accepted.

.4 All electrically operated equipment and electrical materials to bear the label of approval of CSA or be so stamped or have special approval of the Authorities. All material, wiring and devices to conform to the Canadian Electrical Code for the purpose for which they are to be used. All electrical equipment to be designed and manufactured in accordance with applicable EEMAC and ANSI specifications.

.5 All gas fired equipment to bear the label of the CGA or be so stamped.

.6 All plumbing products such as fixtures, faucets, flush valves and shower heads to bear the label of approval of the CSA or be so stamped.

1.14 TEMPORARY SERVICE

.1 Refer to Division 01 regarding temporary services, contractor's shop, storage and other such facilities. Temporary heat and ventilation is not included in the Work of Divisions 20, 21, 22, 23 and 25.

.2 Do not use any of the permanent Mechanical Systems during construction except as may be specified in Division 01 or unless specific written acceptance is obtained from the Consultant.

.3 The use of permanent facilities for temporary construction service such as for testing, commissioning and demonstration of operation will not affect in any way the commencement day of the warranty period. Refer to Division 01.

1.15 RIGHTS RESERVED

.1 Rights are reserved to issue any additional Detail Drawings, which in the judgement of the Consultant may be necessary to clarify the Work, and such Drawings shall form a part of the Contract.

1.16 EXPEDITING AND DELIVERIES

.1 Comply with requirements of **[Division 01]. [For equipment and materials purchased directly by the Owner, comply with requirements of Division 01.]**

.2 Continuously check and expedite delivery of equipment and materials. If necessary, inspect at the source of manufacture.

.3 Ensure that materials and equipment are delivered to the site at the proper time and in such assemblies and sizes so as to enter into the building and to be moved into the spaces where they are to be located without difficulty. Perform any cutting and patching involved in getting assemblies into place.

.4 Continuously check and expedite the flow of necessary information to and from all parties involved.

.5 Immediately inform the Consultant of any difficulties in delivery of equipment.

.6 Provide delivery records updated monthly.

1.17 WORK IN EXISTING BUILDING

.1 Perform work in existing areas to best suit available space and not interfere with or obstruct use of existing facilities.

.2 Cut, modify and extend, as shown in the Contract Documents **[or as directed]** by the Consultant, existing materials and equipment to be reused or relocated to suit the Work. Use new materials to match existing systems that are modified or extended.

.3 Scan and/or x-ray all concrete slabs to identify the appropriate location to cut, trench and/or core prior to commencing any work. Submit the results of the scan and/or x-ray in a report format to the structural engineer for review prior to cutting, trenching and/or coring. This contractor shall ensure that there are no interferences with other existing services prior to commencing any work.

.4 Refer to Section 20 05 40.

1.18 SUPERINTENDENCE

.1 Maintain at this job site, at all times, qualified personnel and supporting staff with proven experience in erecting, supervising, testing and adjusting projects of comparable nature and complexity.

1.19 TRIAL USAGE, TESTS AND COMMISSIONING

.1 Include, as part of the Work, trial usage of Mechanical Systems and equipment for the purpose of testing and commissioning and assisting Owner's staff in learning operational and maintenance procedures.

.2 Assist in trial usage over a length of time sufficient to confirm specified equipment capacities and operating characteristics. Maintain full responsibility for all mechanical equipment and systems required to temporarily operate during trial usage. Warranty period commencement for any equipment operated during trial usage will not occur until all Mechanical Work is substantially complete

.3 Provide all testing required on Mechanical System components and equipment where, in the opinion of the Consultant, specified performance is not being achieved.

.4 Integrated Systems Testing of Fire Protection and Life Safety Systems.

.1 With reference to Integrated Systems Testing (IST), please note that the 3rd party agent will be retained under a cash allowance and is not to be carried under this contract.
.2 This contractor shall include the cost to participate and function test the respective fire protection and life safety systems as per the Integrated Testing Plan (ITP).

1.20 COMPLETION

.1 After successful completion of tests and adjustments, remove temporary covers, and strainers, and obstructions to flow. Drain, flush and refill piping systems as often as required until all piping is clear of all debris.

.2 Provide new filter elements in pump seal filters.

.3 Leave Mechanical work in specified working order.

.4 Provide spare components as specified in Section 21 13 00 and Section 25 01 01.

1.21 WARRANTIES

.1 Comply with requirements of Division 01.

.2 Provide all required labour, parts and components required to service all installed items for a warranty period of at least one (1) year unless otherwise stated longer in individual specification sections.

.3 Include for all costs for cutting and patching, removal of equipment and restoration materials and work and repairs to other equipment affected in performance of warranty work.

.4 All warranties commence from the date of Substantial Performance of the Work, unless stated differently in individual specification sections.

.5 Provide warranty certificates showing the name of the firm giving the warranty, dated and acknowledged. Where a specific piece of equipment has an extended warranty or one differing from the base warranty requirements, provide a separate warranty certificate.

.6 Refer to individual specification sections in Divisions 20, 21, 22, 23, 25 for further warranty requirements.

1.22 INSTRUCTIONS TO OWNER'S STAFF

.1 Instruct the Owner's designated staff on all aspects of the operation of systems and equipment. Advise the Consultant at least one week in advance of the schedules of all instruction sessions.

.2 Obtain the services of Subtrade and Manufacturers' representatives to provide information and instructions on each part of the Mechanical Work and on items of equipment.

.3 Submit documentation of training to the Consultant immediately following final inspections, stating for each system or item of equipment:

.1 Date and time instructions commenced for each system.
.2 Duration (hours) instructions were given for each system.
.3 Names of Owner's staff receiving instructions.

.4 Other parties present (Manufacturer's representative, consultants, etc.).
.5 Signatures of each of the Owner's staff in attendance.

1.23 OPERATING AND MAINTENANCE MANUALS AND CLOSE-OUT DOCUMENTS

.1 Refer to Division 01 Close-Out Submittals and Close-Out Procedures.

.2 Secure and assemble all necessary literature describing the operation and maintenance of all equipment provided. Complete and submit documentation for review to Consultant eight (8) weeks prior to substantial completion.

.3 Provide 3 copies of Operating and Maintenance Manuals in hardcopy and Electronic PDF format copies on Optical media or USB storage device. Mount or connect digital copy to hard copy binders.

.4 Three manuals assembled in three ring binders with index tabs, each containing:

.1 This Subcontractor's name, address and telephone/fax numbers.
.2 Suppliers and Subtrades names and telephone numbers.
.3 Equipment data sheets (dimensions, capacities, electrical characteristics, wiring diagrams) along with equipment manufacturer’s recommended spare parts lists.
.4 Maintenance, operating and lubricating instructions and schedules for each item of equipment.
.5 As-built Wiring diagrams for each item of equipment.
.6 Copies of valve charts for the project.
.7 Shop Drawings and Product Data: provide final copies of complete sets of “Reviewed” or “Reviewed as Modified” Shop Drawings and other Submittals including Interference/ Coordination Model, Embedded Mechanical System’s Drawings, and Sleeving Drawings.
.8 Warranties: include one copy each of the Contractor’s warranty, Manufacturers’ warranties longer than one year, the bond, and any service contract provided by the contractor. Provide section index.
.9 Certifications by Inspection Agency: collect and include copies of the following inspection certification reports:
  .1 Plumbing and Gas Standards
  .2 Building Standards and Fire Prevention
  .3 Boilers and Pressure vessel
  .4 Utility Companies
  .5 Other Reports Required by Authorities
.10 Certificates for:
  .1 Boiler start up and commissioning
  .2 Chiller and refrigeration system start up and commissioning
  .3 Water treatment
  .4 Rooftop HVAC Equipment start-up and commissioning
  .5 Rooftop Heating and Ventilation Equipment start-up and commissioning
  .6 Control and Building Automation Systems commissioning
  .7 Fuel oil pumping systems commissioning
  .8 Variable speed electric drives commissioning
  .9 Piping pressure tests (domestic water, non-potable, fire protection heating/cooling piping) certifying system tested, pressure held, time of test and date and certification by the Consultant or commissioning agent.
  .10 Extended warranties.

1.24 CASH ALLOWANCES

.1 Cash allowance**s** are for water balancing and testing, and modification work related BAS.

1.25 CLEANING

.1 General

.1 Comply with General Conditions of the Contract, Supplementary Conditions and other Sections of Division 01.
.2 Conduct cleaning and disposal operations to comply with local ordinances and anti-pollution laws.
.3 Store volatile and toxic wastes in covered metal containers and remove from premises daily.
.4 Prevent accumulation of wastes which create hazardous conditions.
.5 Provide adequate ventilation during use of volatile or noxious substances.
.6 Use only cleaning materials and methods recommended by manufacturer of surface to be cleaned.

.2 Construction Cleaning

.1 Perform cleaning operations as specified in Division 01 and in accordance with manufacturer's recommendations.
.2 At all times, maintain the premises free from accumulation of waste material and waste caused by the Contractor’s work.
.3 In cases of disagreement or non-removal of waste material, the Owner may have waste removed from site at the Contractor’s own expense.
.4 Dumping of waste, debris, surplus materials, etc. on Owner’s property is strictly prohibited. Obtain permit and provide on-site dump containers for collection of waste materials and debris.
.5 Broom clean and keep dust free, daily, all rooms, surfaces and areas.
.6 Maintain roads and walks clean and free of dirt and mud due to work of this Contract. Provide ice and snow removal for walks which will be used exclusively by Contractor and/or Subcontractor's forces.

.3 Final Cleaning

.1 In preparation for Total Performance or occupancy, conduct final inspection of sight exposed surfaces and of accessible concealed spaces.
.2 Upon completion and verification of performance installation, remove all waste, equipment, tools, scaffolding, surplus materials, temporary protection, etc. and leave work in a clean and orderly condition.
.3 Remove grease, dust, dirt, stains, labels, fingerprints and other foreign materials from sight exposed interior and exterior finished surfaces.
.4 Upon completion of project or as required, remove all temporary buildings erected, all temporary construction aids, barriers and enclosures, all temporary utilities, hoists, access road sand walks, etc., leaving site in clear, tidy and satisfactory condition pending acceptance from the Owner.
.5 Brush clean all surfaces and areas of the Work.
.6 Vacuum clean and remove debris from the inside of air handling systems, fans, ducts, coils and terminal units.
.7 Clean exposed surfaces of Mechanical equipment, ductwork and piping. Polish plated work.
.8 Comb all bent fins to proper configuration on all coils in air handling units, fan coil units, entrance heaters and on finned radiation elements.
.9 Replace all temporary air filters with specified filters on all heating, cooling and ventilating equipment.
.10 Upon completion of work of each trade, thoroughly clean work and leave in a condition acceptable to Consultant and Owner.

PART 2 - PRODUCTS

2.01 NIL

PART 3 - EXECUTION

3.01 NIL

END OF SECTION 20 05 05

CONTENTS

PART 1 - GENERAL

1.01 DESCRIPTION

.1 Comply with Requirements of Division 01, General Requirements and all documents referred to therein.

.2 Comply with requirements of Section 20 05 05 Mechanical Work General Instructions.

1.02 SUBMITTALS

.1 Submit shop drawings on access doors, valves, strainers, expansion tanks, thermometers and gauges, expansion compensators, piping restraints, grooved end components, motor starters and motor control centers in accordance with Section 20 01 05.

PART 2 - PRODUCTS

2.01 ACCESS DOORS

.1 Provide rounded safety corners hinged access doors as constructed of primed 16 gauge steel as manufactured by William Brothers or Acudor equal to fire rating of wall or ceiling in which installed.

.2 Provide doors with minimum size of 300mm x 300mm (12" x 12"). Access doors to be sized of adequate size to permit service of equipment and/or resetting dampers. Provide minimum size of 600mm x 460mm (24" x 18") where personnel entry is required. Provide minimum size of 600mm x 750mm (24" x 30") where personnel entry is required for regular equipment maintenance.

.3 Provide for plaster surfaces recessed 16 ga. prime painted steel door and welded metal lath, ready to take plaster. Provide with concealed hinge and stainless steel studs with brass sleeves]

.4 Provide for tiled surfaces, recessed type 16 ga. primed steel (stainless steel for ceramic tile and shower areas) doors to suit type and dimension of tile used. Size door to be as close as possible to 300mm x 300mm (12” x 12”) by fitting to single or multiple tile dimensions. Provide with concealed hinges and stainless steel studs with brass sleeves.

.5 Provide, to suit wall surface or type of construction, other factory prime coated access doors of welded 16 gauge steel, flush type with concealed hinges, lock and anchor straps.

.6 Lay in type ceiling tiles, properly marked, may serve as access panels.

.7 Access doors in fire rated construction shall be ULC listed and labelled, meeting the requirements of Authorities having jurisdiction and rated to maintain the fire separation integrity.

2.02 PIPE AND FITTINGS

.1 Corrosion Prevention

.1 Provide V line insulating couplings as supplied by H & G Specialties Limited, or accepted alternative dielectric couplings, for prevention of galvanic corrosion at specific points where connections are required between copper, brass or bronze and black or galvanized steel piping.
.2 Other acceptable manufacturers EPCO, Watts.

.2 All fittings 50mm (2") and below connecting to equipment: Use unions, extra heavy duty pattern, having ground joints, brass seats and diagonal screws.

.3 Connections to equipment 65mm (2½") and above: Flanged, standard weight provided with ring gaskets.

.4 Cooling coil condensate: drainage grade copper tubing with copper drainage fittings with 50 50 solder.

.5 Heating:.

.1 Piping:

.1 Working Pressure up to and including 1035 kPa (150 psi): Schedule 40 ASTM specification A53 Grade A or B wrought steel black pipe with heavy cast iron **or** standard black malleable steel threaded fittings rated at 1380 kPa (200 psi WOG) for pipe sizes up to and including 50mm (2").

.2 Working Pressure of 1035 to 2070 kPa (150 to 300 psi): Schedule 80 ASTM specification A53 seamless Grade A or B wrought steel black pipe threaded fittings rated at 2070 kPa (300 psi WOG) for pipe sizes up to and including 50mm (2").

.3 Working Pressure of 2070 to 2760 kPa (300 to 400 psi): Schedule 160 ASTM specification A53 seamless Grade A or B wrought steel black pipe with heavy cast iron double extra strong threaded fittings rated at 2,760 kPa (400 psi) for pipe sizes up to and including 50mm (2").

.4 Working Pressure up to and including 1035 kPa (150 psi): Schedule 40 ASTM specification A53 [seamless] wrought steel black pipe with schedule 40 black steel welding fittings rated at 1380 kPa (200 psi WOG) for pipe sizes 65mm (2½") and over.

.5 Working Pressure of 1035 to 2070 kPa (150 to 300 psi): Schedule 40 ASTM specification A53 Grade A or B seamless or ASTM A106 Grade A or B wrought steel black pipe with schedule 40 black steel welding fittings rated at 2070 kPa (300 psi WOG) for pipe sizes 65mm (2½") and up to 600mm (24").

.6 [Working Pressure of 2070 to 2760 kPa (300 to 400 psi): Schedule 40 ASTM specification A53 Grade B seamless or ASTM A106 Grade B wrought steel black pipe with schedule 40 black steel welding fittings rated at 2,760 kPa (400 psi WOG) for pipe sizes 65mm (2½") and up to 600mm (24"). Use standard weight welding rings at pipe joints 150mm (6") and larger.

.7 Type L copper to ASTM B88 with 95/5 soldered wrought copper pressure fittings to ANSI B22.18 for piping system rated at 1035 kPa (150 psi WOG) for pipe sizes up to and including 50mm (2").

.2 Fittings:

.1 For pipe fittings up to and including 50mm (2"):

.1 Up to 862 kPa (125 psi WSP) Soldered: Wrought bronze or cast copper, ASTM B32, solder joint fittings, ANSI/ASME B16.18 or B16.22.

.2 Up to 862 kPa (125 psi WSP) Threaded: Banded black cast iron, ASTM A126, threaded, ANSI/ASME B16.4, Class 125, ASTM A126

.3 1035 kPa (150 psi WSP) Threaded: Galvanized malleable iron, threaded, ANSI/ASME B16.3, Class 150.

.4 1725 kPa (250 psi WSP) Threaded: Banded black cast iron, ASTM A126, threaded, ANSI/ASME B16.4, Class 250, and ANSI/ASME B1.20.1

.5 2070 kPa (300 psi WSP) Threaded: Galvanized malleable iron, threaded, ANSI/ASME B16.3, Class 300.

.2 For pipe fittings 65mm (2½") and up to 600mm (24"):

.1 Welded: Black steel, butted welded, ASTM A234/A234M, ANSI/ASME B16.9, each stamped by manufacturer for conformance and working pressure.

.2 Up to 862 kPa (125 psi WSP) Flanged: Cast iron flanged fittings, ANSI/ASME B16.1, Class 125.

.3 2070 kPa (300 psi WSP) Welded: Black steel, butt-welded, ASTM A234/A234M, ANSI/ASME B16.9, Class 300.

.3 Flanges: Provide either flat-face or raised-face flanges as required to match flange faces on valves and equipment.
- .1 Up to 862 kPa (125 psi WSP) Threaded: Threaded cast iron flanges, ANSI/ASME B16.1, Class 125.
- .2 1035 kPa (150 psi WSP): Weld neck or slip-on steel flanges, ASTM A181/A181M, Class 60, ANSI/ASME B16.5, Class 150.
- .3 1725 kPa (250 psi WSP) Threaded: Threaded cast iron flanges, ANSI/ASME B16.1, Class 250.
- .4 2070 kPa (300 psi WSP) Welded: Weld neck or slip-on steel flanges, ASTM A105/A105M, Grade 1, ANSI/ASME B16.5, Class 300.

.4 Flange Bolts:
- .1 Up to 862 kPa (125 psi WSP): ASTM A307, Grade B, square-head machine bolts with heavy hex-nuts.
- .2 Above 862 kPa (125 psi WSP): ASTM A193/A193M, Grade B7 bolts, with Grade 7 nuts.

.5 Unions for sizes up to 50mm (2”):
- .1 Up to 862 kPa (125 psi WSP) Soldered: Wrought bronze or copper, ground joint, solder end unions.
- .2 1035 kPa (150 psi WSP) Threaded: ASTM A197/A197M, ANSI/ASME B16.39, Galvanized malleable iron unions with ground joints, brass seat, threaded ends.
- .3 2070 kPa (300 psi WSP) Threaded: ASTM A197/A197M, ANSI/ASME B16.39, Galvanized malleable iron unions with ground joints, brass seat, threaded ends.]
  - .1 Butt welded fittings to ASTM A234 material and ANSI B16.9 dimensions
  - .2 Socket welded fittings to ASTM A105 materials and ANSI B16.11 dimensions.
  - .3 Use extra heavy fittings.
  - .

.4 Condensate Piping:
- .1 Piping:
  - .1 Steel pipe: to ASTM A53, Grade B ERW or ASTM A106, Grade B Seamless as follows:
  - .2 NPS 13mm to 50mm (½” to 2”) ; Schedule 80
  - .3 NPS 65mm to 300mm (2½” to 12”); Schedule 80
- .2 Fittings and Joints:
  - .1 Operating pressures over 15 psi: Class 300, screwed, ASTM A105 for pipe sizes up to and including NPS 2. For pipes over NPS 2, buttweld fittings shall be to ASTM A234 or Weld-o-let fittings to ASTM A105.
  - .2 Up to 50mm (2”) Screwed fittings M.I. to ASTM A47 materials and ANSI B16 dim.
  - .3 Above 50mm (2”) Welded fittings to ASTM A234 materials and ANSI B16.9 dim.
- .3 Flanges:
  - .1 Flanges: plain or raised face with flange gaskets to ANSI/AWWA C111/A21.11.
  - .2 Up to 63 mm (2½”): 300 lb RF screwed or socket weld; schedule 80.
  - .3 Over 63mm (2½”): 300 lb RF-welded neck or slip on back welded.
  - .4 Weld neck and slip on flanges shall be RF ASME/ANSI Class 300 forged steel and assembled with spiral wound gaskets.
  - .5 Gaskets in condensate systems with operating pressures over 15 psi: 3.2mm (⅛”) Comp-Flat ring type “Flexitallic”

.6 Bolts and nuts, alloy steel with semi-finished heavy Hex nuts and 2H7-8 studs to ANSI B18.2.1 and ANSI/ASME B18.2.2.
.7 Flange gaskets: 1.6 mm (1/16") non-asbestos composition flat ring gaskets suitable for mating surfaces; Durable Duron 8400 gold or equivalent.
.8 Plugs: to NPS solid C.S. barstock hex head screwed – minimum 75 mm (3") length.

.4 Nipples:
.1 Swage: seamless – C.S. thickness to suite pipe.
.2 Pipe schedule 80 seamless – C.S.]

.6 Generator exhaust: Refer to Section 23 51 00.

.7 Sanitary Drainage Internal:

.1 Buried:
.1 Cast iron pipe and fittings to CSA B70.
.2 Where buried and accepted by Authorities: PVC or ABS pipe and fittings to CSA CAN 3 B181.1 M85 (ABS) CAN 3 B181.2 M85 (PVC) B182.1, B182.2, (large diameter PSM PVC). B182.3, (large diameter IPS PVC).

.2 Suspended:
.1 Cast iron pipe and fittings to CSA B70.
.2 DWV copper to ASTM B306 with 50 50 soldered cast brass drainage fittings to CSA B158.1 or wrought copper fittings to ANSI B16 29.

.8 Sanitary Drainage External:

.1 Cast iron or approved ABS or PVC with solvent weld or ring gasket joints as specified for internal buried pipe.
.2 Concrete to CSA Standard A257.

.9 Vent Piping:

.1 DWV Grade copper to ASTM B306 76 with 50 50 soldered cast brass or wrought copper drainage fittings to CSA B158.1 and ANSI B16 29 respectively or cast iron pipe and fittings to CSA B70.

.10 Domestic Water:

.1 System pressure rated for [1380 kPa, 2070 kPa or XXX (200 psi, 300 psi or XXX)].
.2 Code and Standards:
.1 ASTM B88 Standard Specification for Seamless Copper Water Tube.
.2 ASME B16.15 Cast Bronze Threaded Fittings, Class 150 and 250
.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 B16.24 Cast Copper Alloy Pipe Flanges and Flanged fittings Class 150, 300, 400 and 600.
.6 CSA B242 Groove and Shouldered Type Mechanical Couplings
.7 AWS A5.8 Brazing Filler Material
.8 ASTM B32 Specification for Solder Metal
.9 ASTM B-312 Standard Specification for Stainless Steel Piping.

.3 Above Grade:
.1 Type L [K] copper, hard drawn, marked certified for compliance with ASTM B88 Standard, with 95/5 soldered, wrought copper or cast bronze pressure solder fittings to ANSI B16.22 and ANSI B16.18 respectively.
.2 Stainless Steel:

.1 304L stainless steel, Schedule 10 marked certified for compliance with ASTM A312/ASME SA-312 Standard for pipe sizes 75mm (3") and larger.
.2 Fittings: 304L stainless steel fittings to ASTM A-774 and A-403.

.3 Brass or bronze threaded fittings to ASME B16.15. Brass or bronze flanges or flanged fittings to ASME B16.24. Flanged joints to AWWA C111 and bolts to ASTM A307 and nuts to ASTM 563. Silver brazing alloy to AWS Classification BCuP-5.

.4 Method of joint connection:
.1 Soldered for pipes up to 65mm (2 ½").
.2 Brazed for pipes 75mm (3") or higher
.3 Grooved fittings may be used for exposed area.

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.11 Soldered Fittings in Potable Water Systems: Provide lead, antimony, cadmium and zinc free solders composed of tin/copper/silver or nickel components that are acceptable to Authorities having jurisdiction.

.12 Sewage and sump pump discharge piping: Schedule 40 ASTM A53 hot dipped galvanized steel pipe with hot dipped galvanized cast iron drainage fittings, or copper Type L to ASTM B88 83 with pressure fittings to ANSI B22.18 or ANSI B16.18 with 50 50 solder. Where buried, use PVC class 150 to CSA B137.3.

.13 Storm drainage piping:

.1 Cast iron pipe and fittings to CSA B70 where buried or suspended.
.2 Where buried and accepted by Authorities: PVC or ABS with solvent weld or ring gasket joints to CSA B182.1 and B182.2.
.3 Where external to the building, concrete to CSA Standard A257. Where acceptable to the Jurisdiction having authority, IPEX PVC Ultra Rib pipe and fittings to CSA Standard B182.4 with maximum long term deflection of 7.5%.

.14 Natural gas piping: Provide as required by the Authorities having jurisdiction as follows:

.1 ASTM A53 Schedule 40 seamless wrought steel with schedule 40 threaded 0malleable fittings to ANSI standard B16.3; welded in concealed areas and X rayed if required by Authorities having jurisdiction.
.2 ASTM A53 Schedule 40 wrought steel seamless with schedule 40 wrought steel butt welding fittings to ANSI B16.9. Welding procedures to comply with standards as required by the Authorities having jurisdiction.
.3 Connections to equipment: provide extra heavy duty pattern unions with ground joints, brass seats and threads to ANSI B1.20.1. Where flanges are required, provide standard weight type to ANSI B16.1 with neoprene gaskets.

.15 Victaulic couplings to CSA Standard B242 for fire protection, heating, chilled water and condenser water is acceptable provided that this application meets the approval of the Municipal Authorities who have jurisdiction at the place of the Work.

.1 Rigid Couplings: Ductile iron to specification A536. In mechanical rooms use grooved couplings to be designed with angle bolt pads to provide a rigid joint. Victaulic style 107N or 07. In mechanical rooms use grooved couplings to be designed with angle bolt pads to provide a rigid joint. Victaulic style 107 and 07.
.2 Flexible Couplings – Ductile iron to specification A536. Flexible grooved couplings shall be used where system flexibility is desired. Noise and vibration reduction at mechanical equipment connections is achieved by installing three flexible couplings near the vibrations source in lieu of braided flex connectors. Victaulic Style 77 or 177.

.3 AGS “W” Series Couplings (350mm (14”) and Larger): Victaulic Style W07 (rigid) and Style W77 (flexible) two housings cast with a wide key profile and flat bolt pads for metal-to-metal contact, wide-width FlushSeal® gasket, and plated steel bolts and nuts.

.4 Gaskets: Water Services EPDM Grade "E", with green colour code identification, conforming to ASTM D-200 for water services up to 110°C (230°F) or Grade “EHP” EPDM, with red colour code identification, conforming to ASTM D-2000 for water services up to 120°C (250°F).

.5 Fittings Victaulic full flow fittings manufactured of ductile iron to ASTM A 536 Grade 65 4 12 or steel to ASTM A-53, Grade B, with grooved ends designed to accept Victaulic couplings.

For pipe sizes 50mm (2") and smaller (for heating and cooling application only):

.1 Press fit fittings should only be used for system pressure up to 1031 kPa (150 psi).

.2 Press fittings by Viega Model Mega Press is acceptable for use in steel piping.

.3 Press fittings by Viega Model Pro Press is acceptable for use in copper piping.

.4 Material of press fit fittings to be same material as the piping.

.5 All products to be complete with CRN number and to be acceptable by the Authority Having Jurisdiction. Manufacturer to provide substantiation upon request by the Authorities.

.16 Victaulic products for domestic water services (hot and cold), to be rated for operating conditions of -34°C to +120°C (-29.2°F to 250°F) and 2067 kPa (300 psi).

.1 Couplings: ductile iron coated with copper alkyd enamel to ASTM A - 536. Flanges to be copper alkyd enamel coated to ANSI class 125 for cast iron and class 150 for steel. Couplings shall be “Installation Ready” stab-on couplings designed with angle bolt pads to provide a rigid joint, complete with EPDM gasket. Victaulic Style 607.

.2 Fittings: grooved copper to ASTM B-75 and grooved bronze castings to ASTM B-584 with copper tube dimensioned grooved ends (flaring of tube and fitting ends to IPS dimensions is not permitted).

.3 Gaskets: grade EHP EPDM to ASTM D-2000 (UL/ULC classified in accordance with ANSI/NSF-61 for hot (82°C) and cold (30°C) domestic water service).

.4 Acceptable Alternative: Gruvlok (Entire system by one manufacturer).

.17 Acid waste drainage and vent piping:

.1 Installation at sink: Provide Enfield flame retardant polypropylene pipe and fittings to ASTM F1412 with mechanical joints. Provide Enfield W501 universal 75mm (3”) deep trap with clear base (pencil trap).

.2 Where installed in walls and ceiling spaces: Provide Kimax tempered glass (available from Smillie McAdams Summelin Ltd.) as manufactured by Owens - Illinois complete with stainless steel compression couplings with Buna-N rubber liner and tetra-fluoro-ethylene gasket. Provide Kimax adaptors for joints to connections at sink drain and at acid interceptor. Provide tempered glass piping for all vents and drains for all lab sinks and fume hood sinks connected to the acid interceptor.

.3 Acceptable alternative to tempered glass: Duriron piping with MJ couplings consisting of sintered non porous teflon inner sleeve, neoprene outer sleeve and stainless steel clamp. Duriron to conform to ASTM A 518-80 and A-861-86.

.4 Provide Polypropylene acid resistant Fuseseal below grade up to the acid interceptor installed in accordance with manufacturers recommendations. Pipe to be certified in accordance with CSA B181.2. All joints to be thermally welded with the applicable adaptors to transition to tempered glass or duriron at floor level.

2.03 VALVES

.1 All valves to have minimum certified rating of 1380 kPa (200 psi) **[2070 kPa (300 psi)]** WOG. Refer to Section 23 05 05 for fire protection service valves.

.2 Conform to requirements of ANSI, ASTM, ASME, and applicable MSS standards.

.3 Manufacturer:

.1 Provide valves of same manufacturer throughout, where possible.
.2 Provide valves with manufacturer's name and pressure rating clearly marked on body (per MSS-SP-25).
.3 Product shall carry valid CRN (Canadian Registration Number) issued by respective Provinces.

.4 Valve Materials:

.1 Bronze: to ASTM B62 (406ºF/208ºC) or B61 (550ºF/288ºC) as applicable
.2 Brass: to ASTM B283 C3770
.3 Cast Iron: to ASTM A126, Class B (353ºF/178ºC) at 125 PSIG.
.4 Forge Steel: to ASTM A105N (800ºF/427ºC)
.5 Cast Steel: to ASTM A216WCB (800ºF/427ºC)

.5 Testing and Design:

.1 MSS-SP-80 - Bronze, Gate & Check Valves.
.2 MSS-SP-110 - Ball Valves.
.3 MSS –SP-70, 85, 71 - Cast Iron Gate, Globe & Check Valve.
.4 MSS-SP-72 - American Valve
.5 MSS-SP-67 – Kitz, Butterfly Valves.
.6 API 602 – Forge Steel Valves (Design)
.7 API 598 – Cast Steel Valves, Forge Steel Valves (Testing)
.8 API 609 – WKM High Performance BFV

.6 Gate valves:

.1 50mm (2") and smaller with bronze body and rising stem: Jenkins #810, Crane #428, Newman Hattersley #T607, Red and White #293.
.2 Valves for copper ends: Jenkins #813J, Crane #1334, Grinnell #3000, Toyo 299 or Newman Hattersley #T607, Kitz #44.
.3 Gate valves 65mm (2½") and up: Iron body, bronze trim, OS&Y, rising stem, Jenkins #454J, Crane #465 ½, Toyo #421A, Grinnell #6060A or Newman Hattersley #504, Kitz #72.
.4 For valves 150 mm (6") and greater where mounted overhead, provide O. S. & Y. valves with chain wheel operation - length of chain to be determined on site.
.5 For pressure higher than 1035 kPa (150 psig) and up to 1725 kPa (250 psig):
.1 Up to 50mm (2"):
.1 1034KPA (150psig) / 300 WOG Rating.
.2 Bronze Body to ASTM B62, Solid Wedge Disc, Bronze Trim.
.3 Kitz 64 or 46, Nibco T-133 or 134.
.4 65mm (2½") and Over:
.5 Class 150, Carbon Steel A216WCB Body, Bolted Bonnet, OS&Y, ½ Stellite Trim (Trim #8), Graphite Packing.
.6 Kitz 150 SCLS (Flanged), Kitz W150 SCLS (Butt Weld).]
.6 For pressure f higher than 1725 kPa (250 psig) and up to 2070 kPa (300 psig):
.1 Up to 50mm (2"):
.1 Class 800, Forge Steel A105N Body, OS &Y, Bolted Bonnet, ½ Stellite (Trim #8), Graphite packing.

.2 Bonney Forge: HL – 11 – T (Threaded), HL – 11 - SW (Socket Weld) or Beric: 501-T-(X)-8-A-08 (Threaded), 501-S-(X)-8-A-08 (Socket Weld).

.7 Ball valves:

.1 Up to 50 mm (2”):
.1 Brass and/or bronze body, full port, PTFE seats, double O-Ring design or PTFE packing, chrome plated solid bronze ball, lever handle.
.2 1034 kPa (150 psig) / 4137 kPa (600 psig) WOG rating.
.3 Kitz 58 (threaded) or 59 (solder), Crane 9201 (threaded) or 9202 (solder), Toyo 5044E (threaded) or 5049A (solder), Watts FBV-4 (threaded) or FBVS-4 (solder), Apollo 77F-100 (threaded) or 77F-200 (solder), Nibco T-FP600A (threaded) or S-FP600A (solder), [Victaulic Series 722].
.2 For pressure higher than1035 kPa (150 psig) and up to 1725 kPa (250 psig):
.1 Up to 50mm (2”):
.1 1724 kPa (250 psig) / 4137 kPa (600 psig) WOG Rating
.2 Forged brass body, full port, PTFE seats, PTFE packing, stainless steel ball and stem, lever handle
.3 Kitz 68PM or approved equal.
.3 It is preferable that ball valves be used in place of gates valves for sizes 12 to 50 mm (1/2” to 2”).

.8 Globe valves:

.1 50mm (2") and smaller: Grinnell #3240, Jenkins 106B, Crane #7, Toyo #221, or Newman Hattersley #13, Kitz #9.
.2 Valves 50mm (2") and smaller for copper ends: Grinnell #3240SJ, Jenkins #1068AP, Crane #1312, Red and White #212, Newman Hattersley Fig. 13 with adapters, Kitz #10.
.3 Valves 2½“ and greater, iron body, bronze seat and disc: Jenkins #234J, Crane #351, Red & White #400A, Newman Hattersley #731.
.4 For pressure higher than1035 kPa (150 psig) and up to 1725 kPa (250 psig:
.1 Up to 50mm (2”):
.1 1034KPA (150psig) / 300 WOG Rating.
.2 Bronze Body to ASTM B62, Solid Wedge Disc, Rising Stem.
.3 Kitz 09 or 10, Nibco T-235Y or S-235Y.
.2 65mm (2½”) and Over:
.1 Class 150, Carbon Steel A216WCB Body, Bolted Bonnet, OS&Y, ½ Stellite Trim (Trim #8), Graphite Packing.
.2 Kitz 150 SCOS (Flanged), Kitz W150SCOS (Butt Weld).]
.5 [For pressure higher than1725 kPa (250 psig) and up to 2415 kPa (350 psig:
.1 Up to 50mm (2”):
.1 Class 800, Forge Steel A105N Body, OS&Y, Bolted Bonnet, ½ Stellite (Trim #8), Graphite packing.
.2 Bonney Forge: HL – 31 – T (Threaded), HL – 31- SW (Socket Weld), Beric: 502-T-(X)-8-A-08 (Threaded), 502-S-(X)-8-A-08 (Socket Weld).

.9 Butterfly valves:

.1 Flanged:
.1 Enameled cast iron lug type body, stainless steel disc, blow-out proof stainless steel stem, EPDM seat
.2 Bi-directional tight shut-off to 1100 kPa (150 psi)
.3 Bi-directional dead-end service to 345 kPa (50 psi)
.2 Grooved end:
.1 65 – 300 mm (2 ½” – 12”):

.1 Enameled ductile iron body, stainless steel disc, blow-out proof stainless steel stem, EPDM seat
.2 Rated to 2068 kPa (300 psi) and bi-directional dead-end service capable to full rated pressure.
.3 Standard of acceptance: Victaulic Vic-300 MasterSeal

.2 350 – 600 mm (14" – 24"):
.1 PPS coated ductile iron body, PPS coated ductile iron disc, EPDM disc/seal, blow-out proof stainless steel stem, PPS coated
.2 Rated to 2068 kPa (300 psi) and bi-directional dead-end service capable to full rated pressure.
.3 Standard of acceptance: Victaulic Vic-300 AGS]

.3 Stainless steel 50 – 200 mm (2" – 8"):
.1 Stainless steel body and disc conforming to ASTM A351 Grade CF8M. Grade "E" EPDM seat, UL Classified in accordance with ANSI/NSF 61 for cold +73°F/+23°C and hot +180°F/+82°C potable water service and ANSI/NSF 372.
.2 Rated to 2068 kPa (300 psi) and dead-end service capable to full rated pressure.
.3 Standard of acceptance: Victaulic Series 461.

.4 Copper ends 65 – 150 mm (2-1/2" – 6"):
.1 Body material shall be bronze with copper tube dimensions, aluminum bronze disc with grade "CHP" fluoroelastomer seat. Suitable for water service with temperature range of -34C to +110C (-30F to 230F).
.2 UL Classified in accordance with ANSI/NSF 61 for cold +73°F/+23°C and hot +180°F/+82°C potable water service and ANSI/NSF 372.
.3 Rated to 2068 kPa (300 psi) and dead-end service capable to full rated pressure.
.4 Standard of acceptance: Victaulic Sesies 608N

.3 Handles and operators:
.1 Up to and including 100mm (4"): lever with infinite adjustment.
.2 150mm (6") and over: wheel/gear operated.
.3 Provide chain operator where mounted overhead.

.4 It is preferable, except for gas and steam services, that butterfly valves be used in place of gate valves for sizes 65 mm (2½") and greater.

.5 As manufactured by Challenger, Centerline, Keystone, DeZurick, Crane, Jenkins, Bray**,** Victaulic

.10 Swing check valves - other than at pump discharge:

.1 50mm (2") and smaller: Grinnell #3320, Jenkins #4092, Crane #37, Toyo #236, Newman Hattersley #47, Victaulic Series 712, Kitz #22.

.2 65mm (2½") and larger: Iron body, brass trim, flanged: Grinnell #6300A, Jenkins #587, Crane #373, Toyo #435JA, Newman Hattersley #651, Kitz #78.

.3 At pump discharge use wafer type check valve as manufactured by Grinnell #300, Victaulic Series 716H/716 or W715, Streamflo, Checkrite or M & G #1515WM5S with 316 stainless steel disc.

.4 For pressure higher than1035 kPa (150 psig) and up to 1725 kPa (250 psig):
.1 Up to 50mm (2"):
.2 1034KPA (150psig) / 300 WOG Rating
.3 Bronze Body to ASTM B62, Bronze Trim, Y-Pattern Swing Type.
.4 Kitz 29 or 30, Nibco S-433-B or T-433-B.
.5 65mm (2½") and Over:
.6 Class 150, Carbon Steel A216WCB Body, Bolted Cover, ½ Stellite Trim (Trim #8), Stainless Steel Inserted Flexible Graphite Gasket.
.7 Kitz 150 SCOS (Flanged) , Kitz W150SCOS (Butt Weld)

.8 Silent Check:
.9 Class 150, Cast Steel ASTM A216WCB Body, 316 S.S. Trim and Spring Loaded Center Guided Disc.
.10 Mueller Steam Specialty: 101 MDT, 105MDT (Globe Style).

.11 Domestic water valves:

.1 Gate valves 50mm (2") and under, soldered
.1 For pressure up to 150 psig, MSS SP-80, Class 150,bronze body, solid wedge bronze disc, rising stem, screw in, or union bonnet.
.2 Kitz 43, Crane 1334, Jenkins 813J, Newman Hattersley T608 and Nibco S-131
.2 Gate valves 50 mm (2") and under, threaded
.1 1000 kPa (150 psi), to MSS SP-80, Class 150, bronze body, solid wedge disc, rising stem, screw in, or union bonnet.
.2 Kitz 42, Crane 431, Jenkins 281OJ, Newman Hattersley T608 and Nibco T-131
.3 For pressure higher than1035 kPa (150 psig) and up to 2070 kPa (300 psig), MSS SP-80, Class 300, bronze body, solid wedge disc, rising stem, union or screw in bonnet.
.4 Kitz 37, Crane 634E, Jenkins 228OUJ, Newman Hattersley #C1174 and Nibco T-174A
.3 Gate valves 65mm (2½") and over flanged
.1 850 kPa (125 psi), to MSS SP-70, Class 125, cast iron body with flat faced flange, bronze or bronze faced solid wedge disc with bronze seat rings, rising stem, OS & Y, bolted bonnet.
.2 Kitz 72, Crane 465 ½, Jenkins 454J, Newman Hattersley #504 and Nibco F-617-O.
.3 1000 kPa (150 psi), to ASTM A216 grade WCB, Class 150, cast steel body with raised faced flange, flexible Type 416 stainless steel disc and hard faced seat rings, rising stem, OS & Y, bolted bonnet.
.4 Kitz 150 SCLS, Crane 47XUTand Jenkins J1009B8F
.5 For pressure higher than1035 kPa (150 psig) and up to 2070 kPa (300 psig), ASTM A216 grade WCB, Class 300, cast steel body with raised faced flange, flexible Type 416 stainless steel disc and hard faced seat rings, rising stem, OS & Y, bolted bonnet.
.6 Kitz 300 SCLS and Crane 33½ XU-F and Newman Hattersley #C1482.
.4 Globe valves 50mm (2") and under, soldered
.1 850 kPa (125 psi), to MSS SP-80, 300 CWP, bronze body, renewable composition PTFE disc, threaded over bonnet, lock shield handles as indicated.
.2 Kitz 10, Crane 1334/1320, Jenkins 813J and Nibco S-235-Y.
.5 Globe valves 50 mm (2") and under, threaded
.1 1000 kPa (150 psi), to MSS SP-80, Class 150, bronze body, renewable composition PTFE disc, union bonnet, lock shield handles as indicated.
.2 Kitz 09, Crane7TF, Jenkins 106BJ, Nibco T-235-Y and Newman Hattersley 13.
.6 Swing check valves 50 mm (2") and under, threaded
.1 850 kPa (125 psi), to MSS SP-80, Class 125, bronze body, bronze swing disc, regrindable seat, screw-in cap
.2 Kitz 22, Crane 37, Jenkins 4073J, Newman Hattersley 47 and Nibco T-413
.7 Swing checks 65mm (2½") and over, flanged
.1 850 kPa (125 psi), to MSS SP-71, Class 125, cast iron body with flat faced flange, renewable bronze seat rings, bronze faced iron or bronze disc, bolted cap.
.2 Kitz 78, Crane 373, Jenkins 587J, Newman Hattersley 651 and Nibco F-918
.8 Swing check valves 50 mm (2") and over, grooved:
.1 2065 kPa (300 psig), ductile iron body with spring-assisted disc.
.2 Victaulic series 719, NPS 2 ½ to 4 and Victaulic series 779, NPS 4 to 14
.9 Ball valves up to 50 mm (2"):

.1 1000 kPa (150 psi), two piece bronze body and chrome plated bronze ball, PTFE seat rings, solder joint or NPT to copper adapters, full port.
.2 Kitz 58 and 59, Crane 9302 and 9322, Jenkins 201J and 202J, Nibco S-FP-600 and T-FP-600 and Newman Hattersley 1969F and 1999.

.12 Balancing cocks:

.1 50mm (2") and smaller: DeZurick series 425. 65mm (2½") and larger: Flanged DeZurick Series 100. Both types to be complete with memory stops.

.13 Gas valves, CGA approved - lubricated plug type: 12 to 50 mm (½“ to 2”): Newman Hattersley 70M. 65 mm (2½“) and greater, flanged: Newman Hattersley #171M.

.14 Corporation stops and site service valves:

.1 Corporation Stops 2” to 12”: Cambridge Brass “Century” brass body ball valve with connections to suit piping. Ball to be stainless steel with teflon seats. Provide cast iron housing with threaded cover to suit depth of bury.
.2 Valves 2” to 12” FM, UL and ULC approved: Kennedy Valve mod. 4701 to AWWA standard C509. Flanged epoxy coated cast iron body, non-rising stem, 2” operating nut and post plate complete with Clow Canada Series 900-S/900-C adaptor flange/restrainer where connection to PVC pipe is required. Provide extension stem and cast iron housing complete with cover to suit depth of bury. Valves as manufactured by Clow are also acceptable.

.15 Balancing Valves: Where specified at items of equipment and where shown on schematic piping diagrams, provide S.A. Armstrong Ltd. Model CBV1 and CBV11 **or** Victaulic/Tour & Andersson Series 78K, 786, 787, 788 or 789 circuit balancing valves. Each valve to have features as follows:
.2 Screwed or flanged bronze or cast iron 1725 kPa (250 psi) bodies with maximum operating temperature of 121°C (249.8°F) with tamperproof balance setting, positive shut-off and drain.
.3 Other acceptable Manufacturers: Tour and Anderson, ITT and Newman-Hattersley.

.16 Pump Discharge Control Valves: Unless stated otherwise, provide S.A. Armstrong Ltd. Flo-Trex combinations check, balancing and shut-off valves at discharge of pumps. Newman Hattersley, Watts and Grinnell valves are also acceptable.

.17 Tri-Service Valve Assembly: Install Victaulic Tri-Service Valve Assembly at pump discharge for shutoff, throttling, and non-slam check service consisting of Vic®-300 MasterSeal™ butterfly valve and Series 779 venturi check valve with flow measurement capabilities, installed with Victaulic couplings (style to be determined by system requirements), 2065 kPa (300 psi) CWP rating**.**

2.04 HANGERS AND PIPING SUPPORTS

.1 Hangers:

.1 Provide adjustable Clevis type equal to Grinnell Fig. 65 for pipe sizes up to and including 65mm (2½"). For pipe sizes 75mm (3") and over, provide adjustable Clevis type equal to Grinnell Fig. 260. Use rod sizes as recommended by the manufacturer. Provide Grinnell FM approved Fig. 104 split swivel or Fig. 69 swivel type hangers on fire protection piping. On copper piping, provide copper plated type hanger or separate piping from hanger with an approved insulating tape or plastic coating. Grinnell adjustable ring type fig. 97 and fig. 97c (coated) are acceptable on copper piping up to 65 mm (2½”). Where insulation covers hanger, refer to Section 20 05 25.
.2 Provide oversized hangers to pass over insulation on all cold water piping. Refer to detail drawings and Section 20 05 25.
.3 For corrosive environments (pool areas) shall be stainless steel.

.2 Piping supports:

.1 For roof mounted piping, provide pipe roller supports with clamps as manufactured by Portable Pipe Hangers installed to Manufacturer's specifications. Use PPH model SS-8R or PP10 with roller for piping up to 65mm (2½") and use model PS-1-2 for pipes over 75mm (3") and up to 200mm (8"). For refrigeration piping and conduilts, use PPH model PS1-2. For pipes over 75mm (3"), use PPH-RB18 with clamps, base and all other applicable support. Supports to be aluminium with stainless steel clamps and rollers. Membrane pads to be close-cell extruded polystyrene insulation equal to Dow Chemical Roofmate.

.2 For roof mounted gas piping: On stable flatbed roof, use pipe supports by Quick Block with oversized stainless steel clamps for roof mounted gas piping up to 125mm (5"). **[Use PPH-RB18 with rollers and clamps for roof mounted gas piping up to 125mm (5").]** Supports for gas piping must be CGA certified & listed and meeting the requirement of gas code B149.1.

.3 For pipe risers, provide supports equal to Grinnell Fig. 40, black carbon steel, sized to carry the operating weight of the piping.

2.05 INSERTS

.1 Use only factory made, threaded or toggle type inserts as required for supports, and anchors, properly sized for the load to be carried.

.2 Use factory made expansion shields where inserts cannot be placed, but only as accepted by the Consultant and for light weights.

.3 Do not use explosive activated tools except with written acceptance of the Consultant.

2.06 SLEEVES

.1 Piping: Machine cut schedule 40 steel pipe, medium cast iron or 18 gauge galvanized steel; refer to detail drawings.

.2 Ductwork: At fire dampers refer to detail drawings: Other locations formed to accommodate duct size or access opening as required.

2.07 AIR VENTS

.1 Provide air vents as manufactured by Maid O Mist No. 7 series or Braukmann. Where system pressure exceeds 345 kPa (50 psig) provide air vents with 1035 kPa (150 psig) **[2070 kPa (300 psig)]**.rating.

2.08 EXPANSION TANKS

.1 Provide in sizes as shown 1380 kPa (200 psi) in equipment schedules**.** Expansion tanks meeting current ASME and CSA code requirements designed for a maximum working pressure of 1035 kPa (150 psi) constructed of mild steel with painted finish and complete with all necessary tappings in combination with Filtrol valve and automatic vent.

.2 Acceptable Manufacturers: O'Connor, Clemmer, Amtrol, Expanflex.

2.09 ANCHORS, GUIDES AND EXPANSION COMPENSATORS

.1 Provide hangers, supports, anchors, guides, expansion compensation and restraints for all vertical piping risers and horizontal piping for all services including but not limited to, heating, cooling, domestic water (all), drainage (all), fuel oil, gas, fire protection.

.2 Mechanical contractor is to review all structural drawings and in particular refer to the "structural Deformation" drawing for building movement and or shrinkage. If this drawing is not available the contractor must obtain this information direct from the structural consultant.

.3 Design Standards: Expansion Joint Manufacturer Association, ASTM B31.1, ASTM B31.9, ASHRAE and Manufacturers Standardization Society.

.4 All vertical risers for all services including but not limited to, heating, cooling, domestic water (all), drainage (all), fuel oil, gas, fire protection subjected to thermal expansion and/or contraction including building movement and building contraction shall be supported by spring isolators and central anchors designed to insure loading within design limits at structural support points. The riser design must be prepared and submitted for approval by the same isolation vendor supplying the HVAC mechanical equipment isolation and must include the initial load, initial deflection, change in deflection, final load and change in load at all spring support locations. In order to minimize load changes, the initial spring deflection must be at least 4 times the thermal movement. The isolation vendor shall provide and design all brackets at riser spring and anchor locations where standard clamps lack capacity or do not fit. The contractor must install and adjust all isolators under the supervision of the designing isolation vendor or his representative. The submittal must also include anchor loads when installed, cold filled, and at operating temperature. Include calculated pipe stress at end conditions and branch off locations as well as installation instruction. The support spring mounts to be Type SLF, anchors Type ADA, telescoping guides Type VSG, all as manufactured by Mason Industries, Inc.

.5 Hangers, supports, anchors, guides, expansion compensation, spring isolators and restraints to be designed and selected to withstand all static and dynamic loading conditions which act upon the piping system and associated equipment. The Mechanical Contractor is responsible to engage a Professional Engineer for the design of all hangers, supports, anchors, guides, expansion compensation, spring isolators and restraints systems based on piping material used and final layout of piping risers. The Mechanical Contractor is also responsible to provide detailed shop drawings showing calculations and equipment details of all anchors, guides and compensation for all systems with potential for thermal expansion/contraction and/or loads due to weight or thrust including heating and cooling mains, fan coil or heat pump risers and domestic water risers. These shop drawings to bear the signed seal of a Professional Engineer licensed to practice in the appropriate discipline and place of work. These shop drawings to include all details of construction including but not limited to the following:

.1 Static and dynamic forces at each anchor.
.2 Manufacturer's cut sheets for anchors.
.3 Thermal compensation calculations.
.4 Manufacturer's cut sheets for compensation equipment.
.5 Manufacturer's cut sheets for guides.
.6 Amount of expansion per floor and amount of expansion between each anchor based on Actual temperature of pipe when anchors were installed.
.7 Distance between floors.

.6 Make adjustments as necessary to satisfy the requirements of Structural Division.

.7 No anchors to be installed prior to shop drawings being reviewed and approved by Structural Division.

.8 Expansion compensation supplier to be responsible for site review/inspection of all devices and verification that all compensation devices are in the neutral position after anchoring and verification that any temporary spacing device, locking tabs, etc. have been removed prior to any heating or cooling system start up. Upon completion of review/inspection the mechanical contractor to issue a detailed report to the Consultant, including photos and including location of each device, signed by supplier confirming that each compensation device has been reviewed.

.9 Anchors, guides, expansion compensation shown on the drawings are for information only. Mechanical Contractor to be responsible to provide all elements of the system as described above.

.10 Selection of compensators to meet the pressure rating of each system. Compensators in domestic water application to meet the requirement of NSF 61. Bellows type expansion compensators not to be used for compensation on fan coil or heat pump risers. Provision to be made for seismic protection in seismic zones. Acceptable manufacturer: Mason Industries.

.11 Provide proper protection of all branch lines which are subject to the temperature difference and/or movement of vertical risers. Proper support, spring hangers and/or stainless steel braided hoses may be used for the protection of the piping systems.

.12 Professional engineering design services for detailed design of anchors, compensation and guides from the following companies will be accepted:

Tecoustics Ltd.
5036 South Service Road
Burlington, ON L7L 5Y7
(905) 681-6077

Pressure Vessel Engineering Ltd.
120 Randall Drive
Suite B
Waterloo, ON
(519) 880-9808

2.10 STRAINERS

.1 Provide where shown on the drawings, strainers as manufactured by Kitz, Mueller or Spirax Sarco:

- .1 50 mm (2“) and smaller:
  - .1 863 kPa (125 psig) / 1379 kPa (200psi) WOG rating
  - .2 Cast bronze body, screwed cap, Y-pattern, threaded or soldered ends.
  - .3 Kitz 15 (threaded)/16 (soldered), Mueller 351M (threaded)/353 1/2MM (soldered)
- .2 65 mm (2½“) and greater:
  - .1 Class 125
  - .2 Cast iron body, bolted cover, Y-pattern, flanged ends.
  - .3 Kitz 80, Mueller 758

.2 For pressure higher than 863 kPa (125 psig) and up to 1724 kPa (250 psig):

- .1 50mm (2”) and smaller:
  - .1 1724 kPa (250psig) / 2758 kPa (400 psig) WOG Rating
  - .2 Cast iron body, screwed cap, Y-pattern, threaded ends.
  - .3 Mueller 11M
- .2 65mm (2½”) and greater:
  - .1 Class 250
  - .2 Cast Iron body, bolted cover, Y-pattern, flanged ends.
  - .3 Mueller 752]

.3 Unless noted otherwise, provide an integral strainer for pressure relief valves, pressure regulating valves and backflow preventers.

.4 Strainer baskets:

- .1 Type 304 stainless steel or Monel,

.1 2" and smaller strainer size:
.1 20 mesh perforations for water [0.838mm (0.033") perforations for steam]
.2 2 ½" to 4" strainer size:
.1 1.57mm (0.062") perforations for water [1.14mm (0.045") perforations for steam]
.3 5"-10" strainer size
.1 3.17mm (0.125") perforations for water [1.14mm (0.045") perforations for steam]
.4 10" and larger size
.1 3.17mm (0.125") perforations for water [1.57mm (0.062") perforations for steam]
.5 For pump suction service, provide 3.175mm (0.125") perforations.

.5 Combination strainers and pump inlet diffusers, with screens as specified above, manufactured by S.A. Armstrong Ltd. (Suction Guide), Victaulic (Style 731) or Taco Model SDO are also acceptable.

2.11 THERMOMETERS AND GAUGES

.1 Pressure Gauges:

.1 Gauges where indicated on the drawings: Winters model P1S-100 Series to ANSI B40.100 grade "1A" level with SI and Imperial scales 115mm (4½") complete with ball valves and PSN B snubbers. Scale: To meet operating pressure ranges. **[0-700 kPa (0-100 psi)].**
.2 Provide brass, bronze or copper fittings only.

.2 Thermometers

.1 Provide bi-metal dial type thermometers complete with **brass** separable wells as shown on the Drawings and as manufactured by Trend (Winters). Model 32 adjustable angle 75mm (3") diameter with external reset. Range: 0°C to 50°C (32°F to 122°F) for chilled and condenser water and 10°C to 150°C (50°F to 302°F) for hot water with both Celsius and Fahrenheit scales.
.2 Provide liquid filled thermometers complete with brass separable wells as shown on the Drawings and as manufactured by Weis, vari-angle with 230 mm (9") scale. Range: 0°C to 50°C (32°F to 122°F) for chilled and condenser water and 10°C to 150°C (50°F to 302°F) for hot water with both Celsius and Fahrenheit scales.
.3 Gauges and thermometers as manufactured by Trerice and Ashcroft will also be accepted.
.4 Provide brass, bronze or copper fittings only.

2.12 WIRING

.1 Electric power wiring for equipment (connection of motors through starters and disconnects) provided by mechanical trades is specified in Division 26. Electrically operated equipment: to CSA Standard and bear Certification label.

.2 Provide motor control wiring (at any required voltage) between starter panels and control components to all requirements specified for similar wiring in Division 26.

.3 Provide wiring of items supplied by equipment manufacturers such as filter advance motors and control, high level alarms, low water cut offs, anti-vibration lock outs, flow switches, remote and local thermostats for unitary heating equipment and rooftop HVAC units, sump pump alternators, level controllers, water treatment equipment, and oil/grease interceptor alarms, and control wiring between starters and control panels (e.g. air cooled condensers, cooling towers and condensing units). Also provide wiring for communications interface panels, sensors, oil pumps, purge pumps and oil heaters supplied with water chillers. **[Refer also to Section 25 01 01]**.

2.13 ELECTRIC MOTORS

.1 CSA labelled, and except where specifically noted, all motors below 560 Watt (3/4 HP): 120 volt, single phase, 60 cycle. 560 Watt (3/4 HP) and over: 208 volt 3 phase, 60 cycle refer to Electrical Drawings and Mechanical Equipment Schedules for exact details. Motors to meet NEMA standards for maximum sound level ratings under full load. Service factor on all motors to be 1.15.

.2 Motor bearings: to be permanently lubricated ball type for motors up to and including 3725 W (5 hp). Bearings for all motors over 3725 W to be self-aligning greaseable ball bearings sized to provide life of at least 50,000 hours under belt driven service.

.3 Single Phase Motors: Provide permanent split capacitor type. Motors 14.9 kW (20 hp) and greater: Provide thermistor over temperature protection for each winding, wire in series, with leads terminated in the motor junction box.

.4 All motors over 186 W (1/4 HP) to be TEFC **[ODP]**. All motors over 1 HP to be high efficiency type with ratings based on statistically valid Quality Control procedures conforming to ANSI/IEEE 112 (Ref. 10), Test Method B (dynamometer), using NEMA MG1 (MG1-12.54 and MG1-12.55) (Ref.11), and conforming to efficiency ratings as defined in Table 10.4.1.A (a) under SB-10 of Ontario building Code. Motors to be approved under the Canadian Electrical Safety Code.

.5 For motors used with variable frequency drives, provide Class H motor winding insulation and be inverter duty type manufactured to NEMA Standard MG-1 part 31 “Definite purpose inverter-fed motors”. Ensure that drive Manufacturer reviews motor shop drawings prior to releasing order.

.6 Acceptable electric motor manufacturers: Westinghouse, CGE, Reliance, Brook-Crompton, Marathon, US Motors, WEG and Siemens.

2.14 MOTOR STARTERS – LOW VOLTAGE

.1 Electric motor starters for all motorized mechanical equipment are to be provided by Divisions 20, 21, 22, 23 and 25. Refer to Section 20 05 35 Motor Starters – Low Voltage for the requirements of motor starters.

2.15 MOTOR CONTROL CENTERS – LOW VOLTAGE

.1 Motor Control Centers for motorized mechanical equipment are to be provided by Divisions 20, 21, 22, 23 and 25. Refer to Section 20 05 35 Motor Control Centers – Low Voltage for the requirements of Motor Control Centers.

2.16 AIR SEPARATORS

.1 The Air Separator shall be designed, constructed, and stamped in accordance with Section VIII, Division I of the ASME Boiler and Pressure Vessel Code, and registered with the National Board of Boiler and Pressure Vessel Inspectors.

.2 The Air Separator shall be rated for 150 psi (1034 kPa) maximum working pressure.

.3 The Air Separator shall have a maximum temperature rating of 350°F (177°C).

.4 The Air Separator body shall be made of cast iron or carbon steel.

.5 The Air Separator body shall be three times the nominal inlet/outlet pipe diameter.

.6 The Air Separator shall include threaded blow down connection to allow for sediment to be regularly cleaned out of the unit.

.7 The Air Separator shall include a threaded air removal connection on top of the unit so an air vent or expansion/compression tank can be connected, allowing collected air to be removed from the unit. Provide automatic air vent at each air separator.

.8 The Air Separator shall be available with either NPT end connections (50mm thru 75mm sizes only), flanged end connections, or grooved end connections. Flange end connections should be designed according to ANSI Standards.

.9 Unless otherwise indicated, air separators are to be line sized.

.10 Acceptable manufacturers: Xylem Bell and Gossett, Armstrong, Taco, or equal.

2.17 MECHANICAL IDENTIFICATION

.1 Equipment Nameplates

.1 Provide apparatus (including electric motors) with proper nameplates affixed thereto, showing the size, name of equipment, serial number and all information usually provided, which also includes voltage, cycle, phase and horsepower of motors and the name and address of the Manufacturer.
.2 Nameplate wording shall also include equipment tag information, generally to be as per drawings (i.e. EF-1, AHU-1, etc.), and is to include equipment service and building area/zone served.
.3 Nameplates for equipment suspended above floor level or generally not within easy viewing from floor level are to be increased in size so as to be easily readable from floor level.

.2 Valve Tags

.1 Valve tags are to be coloured, 40 mm (1-½") square, 2-ply laminated plastic with bevelled edges, red-white, green-white, yellow-black, etc., to match piping identification colour, each complete with a 3.2 mm (1/8") diameter by 100 mm (4") long brass plated steel bead chain, and four lines of engraved maximum size identification wording, i.e.:
VALVE V12
200 mm (8")
CHILLED. WATER
NORMALLY OPEN

.3 Pipe Identification

.1 Standard pipe identification to be Smillie McAdams Summerlin Ltd., Brady or Primark Manufacturing Inc. vinyl plastic with indoor/outdoor type vinyl ink lettering and directional arrows, as follows:
.1 For pipe less than or equal to 150 mm (6") diameter, coiled type snap-on markers of a length to wrap completely around pipe or pipe insulation;
.2 For pipe larger than 150 mm (6") diameter, saddle type strap-on markers with 2 opposite identification locations and complete with nylon cable ties.
.2 Identification wording and colours for pipe identification materials are to be as follows:

PIPE SERVICE	IDENTIFICATION COLOUR	LEGEND
natural gas	to Code	to Code, c/w pressure
natural gas vent	to Code	to Code
heating water supply	Yellow	HTG. WTR. SUPPLY

PIPE SERVICE	IDENTIFICATION COLOUR	LEGEND
heating water return	Yellow	HTG. WTR. RETURN
heating water drain	Yellow	HTG. WTR. DRAIN
Pumped condensate	Yellow	PUMPED CONDENSATE
Steam vent	Yellow	STEAM VENT
Boiler feedwater	Yellow	BLR. FEEDWATER
Boiler blowdown	Yellow	BLR. BLOW-OFF

PART 3 - EXECUTION

3.01 INSTALLATION

.1 Install equipment, ductwork, conduit and piping in a workmanlike manner to present a neat appearance and to function properly to the acceptance of the Consultant. Install ducts and pipes parallel and perpendicular to building planes. Install piping and ductwork concealed in chases, behind furring, or above ceiling. Install exposed systems grouped to present a neat appearance. Comply with manufacturer's installation instructions.

.2 Install gauges and thermometers to permit easy observance from floor level.

.3 Install all equipment and apparatus with adequate space allowance for wiring, maintenance, adjustment and eventual replacement.

.4 Install control devices to guarantee proper sensing. Shield elements from direct radiation and avoid placing them behind obstructions.

.5 Include in the Work all requirements of Manufacturers shown on shop drawings.

.6 Install all ceiling mounted components (Diffusers, Grilles,) in accordance with reflected ceiling Drawings.

.7 Leave space clear and install all work to accommodate future materials and/or equipment and to accommodate equipment and/or materials supplied by other trades. Verify spaces in which work is to be installed. Install pipe and ductwork runs to maintain maximum headroom and clearances and to conserve space in shaft and ceiling spaces.

.8 Confirm on the site the exact location of equipment and fixtures. Confirm location of equipment supplied by other trades and mechanical requirements thereof.

.9 Where FMP “flow measurement port” is shown on the Drawings, make installation as described on the Detail Drawings and in a location as shown on the schematic piping drawings. Install the flow measurement port in straight run of pipe at least 3 m (10 ft. +/-) downstream from any valve, thermometer, tee, elbow or any other pipeline device.

3.02 EQUIPMENT CONNECTIONS

.1 Install piping connections to pumps and all other equipment without strain at the pipe connections. Remove, where requested by the Consultant, bolts in flanged connections or disconnect piping after the installation is complete to demonstrate that the piping has been so connected.

.2 Provide shut off valves on supply and return piping connections on all items of equipment.

.3 Provide flexible connectors on supply and return piping connections on all based mounted pumps.

.4 Corrosion Prevention: Install dielectric couplings as specified in Part I at:

.1 Connections to copper/aluminum perimeter convectors, radiant ceiling panels and coils with copper connections in steel piping systems.
.2 Connections between copper and steel pipe.
.3 Connections to cooling coil condensate drains.
.4 Steel Valves used in a copper or copper alloy piping system. In this case, use brass or bronze valves whenever possible.
.5 Connections to expansion tanks and domestic hot water tanks in copper piping systems.
.6 In either steel or copper piping systems, do not put short black steel nipples and individual black steel fittings between brass or bronze components such as valves use only copper, brass or bronze components. Use a minimum of eight times the mass of steel pipe or components between any two brass, bronze or copper fittings or components.
.7 Do not use copper alloy (brass and bronze) fittings and valves in place of specified dielectric couplings.
.8 Hot water and stream boilers: Connections to the boilers are to be swing joints. Provide a minimum of 600mm (24”) piping for swing joints.

.5 Pipe all discharge from relief valves and drains from equipment, outside air plenum/louvre, chemical pot feeders and tanks to nearest floor drain or suitable receptacle.

.6 Provide 20mm (¾") ball valves with hose ends, caps and chains at strainers, all piping system low points, pumps, coils and at each piece of equipment.

.7 Provide deep seal traps (150mm trap seal) on all air handling equipment condensate drains and on floor drains located within air handling unit plenums. Provide trap seal primers on all floor drain traps and gang traps.

3.03 PIPING SYSTEM INSTALLATION

.1 Install all piping in accordance with the best practices of the trade.

.2 The piping shown on the drawings is diagrammatic for clearness in indicating the general run and connections and may or may not be, in all instances, shown in its true position. Take responsibility for the proper erection of systems of piping in every respect suitable for the work intended and as described herein.

.3 Keep plugged or capped all openings in pipe or fittings during installation.

.4 Install piping to avoid any interference with the installation or removal of equipment, other piping and ducts.

.5 Install all valves, strainers and specialties to permit easy operation and access. On horizontal piping, install valves in an upright position. Where there are space constraints mount valves at a 45 deg. off vertical maximum. Install strainers to provide easy strainer basket removal.

.6 Install systems to provide thorough drainage and air elimination.

.7 During welding or soldering procedures, provide a fire retardant cloth, mat or blanket to protect the structure, and adequate fire protection equipment at all locations where work is being done. Close off shaft or confined areas with a fire retardant mat or cloth to prevent sparks or pieces of hot metal from falling down the shaft or area way.

.8 Provide long turn pipe fittings having not less than pipe wall thickness. Provide line size tees. Where branch lines are more than two sizes smaller than the main, weldolets may be used.

.9 Where steel piping is required to be buried, apply two coats of Densopaste (Denso of Canada Ltd.) primer to all buried surfaces after assembly and testing. Hot or cold applied tape as manufactured by Tapecoat, selected for the application and applied to manufacturer's instructions, is also acceptable.

.10 Where it is necessary to offset piping to avoid obstructions, use 45 degree rather than 90 degree elbows.

.11 Provide suitable cleanouts on every other change in direction and slope all condensate drip drains.

.12 Make all threaded pipe joints on water piping using a thread paste or teflon tape suitable for the service for which the pipe is to be used. Use of hemp or similar materials on threaded joints will not be permitted.

.13 For Grooved Couplings and Fittings: Comply with manufacturer's installation instructions for all products. Ensure that grooved pipes are in compliance with the current manufacturer's specifications and recommendations.

.1 Ensure that the "A" dimension, i.e. the area from the pipe end to the front edge of the groove is free from indentations, scores, seams, projections or roll marks.
.2 Use only lubricants which are nontoxic and non-injurious to the gasket material.
.3 Upon completion of assembly, the bolt pads of each coupling must be fully drawn together, except for HP 70 (Victaulic) couplings in sizes to 100mm (4").
.4 All grooved couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.
.5 The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified. .
.6 A factory-trained field representative shall provide on-site training for contractor's field personnel in the proper use of grooving tools and installation of grooved piping products. Factory-trained representative shall periodically review the product installation as requested by the Consultant. Contractor shall remove and replace any improperly installed products.

.14 Natural Gas Piping: Install in accordance to relevant Codes. Provide vents to atmosphere for all safety switches and regulators as required by Code. Provide approved type pipe supports under roof mounted piping and install all supports according to Code and manufacturer's instruction. Refer to the Gas Code for spacing requirements.

.15 Steam and Condensate Piping: Install steam piping level, or where possible, grade in direction of flow. On branch lines from mains feeding risers, pitch branch lines towards the horizontal mains to prevent water hammer. Grade all condensate piping in direction of flow.

.16 Compressed air piping: slope piping in direction of air flow. Provide drip points at all low points in the piping system consisting of a line size or 25 mm (1") minimum diameter 300 mm (12") long down leg with a reducer to a 12 mm (½") ball valve with nipple and cap.

.17 Install all piping requiring insulation with sufficient clearance to apply, seal and finish the insulation.

.18 Provide sufficient space between piping to install valves arranged in straight rows or equally spaced steps. Valve wheels, handles and operators to be easily accessible and operable.

.19 Do not install horizontal piping within masonry walls. Any piping installed in this manner will not be accepted.

.20 Use only non-ferrous metals in high humidity areas.

.21 Do not suspend any equipment, piping, ducting or any other mechanical components from formed hollow steel decking.

.22 Acid waste and vents: Vents to be taken directly to roof vents and installed separately from non-acid waste systems. Vents to be C.I. where they pass through building roof. Provide fibreglass protective packing at sleeves. Provide rigid fibreglass pads (sections of pipe covering) at all support points in accordance with manufacturer's instructions.

.23 Sanitary and storm piping: Provide all necessary restraining devices for all vertical and horizontal piping in major piping offsets or where turn of direction occurs. Restraining devices are to be an engineered product and designed solely for restraining application. Installation of restraining devices to be provided according to manufacturer's requirement.

.24 Underground sanitary and storm piping: Underground sanitary and storm piping required to be hung under structure slab are to be cast iron piping meeting the requirements of the Authorities having jurisdiction.

.25 Victaulic Piping:

.1 Victaulic Certified Contractor Training:

.1 The grooved coupling manufacturer's (the "manufacturer") factory trained representative shall provide on-site training for contractor's field personnel in the use of grooving tools, application of groove, and installation of grooved joint products. All contractor field personnel installing Victaulic couplings must have completed the Victaulic Certification Program. This shall be at the expense of the installing contractor

.2 Victaulic Inspection Services:

.1 A Victaulic factory trained representative shall periodically visit the job site and review the installation for best practices. Victaulic product that has been examined and has not met the visual inspection criteria for proper installation must be corrected and re-examined by Victaulic Inspection Services prior to the completion of the project. The installing Contractor shall correct any identified deficiencies.

.2 Victaulic product that has been examined and has not met the visual inspection criteria for proper installation must be corrected and re-examined by Victaulic Inspection Services prior to the completion of the project. Any Victaulic product that has not been corrected or was not examined will not be considered as part of the successful completion of Victaulic Inspection Services.

.3 Application:

.1 Upon completion of the manufacturer's inspection of the installation and any identified corrections, the manufacturer must provide the owner or purchaser with a warranty on manufacturer's products and their installation. The manufacturer shall provide a letter confirming that upon review, all products were adequately installed and the system meets their installation requirements. The manufacturer must determine the number of fittings that need to be reviewed in order to provide this sign-off documentation. This letter shall be included as part of the close-out documentation.

.26 Provide a stainless steel drip pan under all piping installed in: electrical, communications, security, CACF rooms or any room in which valuables can be damaged (ex. Locker Rooms). Drip pans to be sloped and piped to the nearest funnel floor drain.

3.04 CONTROL COMPONENTS

.1 Install all pipe line devices required by the Section 25 01 01 sub-contractor such as flow switches, valves and separable wells for temperature controllers and sensors.

3.05 DIRT ACCUMULATION IN CONTROL VALVES

.1 Remove any dirt accumulated under seats of automatic control valves during the first year's operation. Replace damaged valve parts at no additional cost to the Owner.

3.06 FIELD WELDING

.1 Included in the scope of work, make arrangements and pay for registration and inspection by TSSA, for the following pressure piping systems:

.1 Steam piping including condensate piping at pressure 100 kPa (15 psig) or higher
.2 Service water piping at design temperature above 121°C (250°F) or at design pressures at and above 1070 kPa (160 psig)
.3 Chilled water and cooling water at design temperatures above 65°C (150°F) or design pressures above 1725 kPa (250 psig)
.4 Fuel oil piping at pressure 690 kPa (100 psig) or higher
.5 Compressed air, greater than 19mm (¾”), at pressures and over 100 kPa (15 psig)
.6 Medical gas piping system
.7 Other piping system as required certification by the Authorities Having Jurisdiction.

.2 Piping standards to ASME B31.1 Code for Pressure Piping, for registered pressure piping system.

.3 Welding to be carried out using approved procedures by welders certified for pressure piping by TSSA.

.4 Arrange and pay for services of an Inspection Company specializing in making and interpreting x-rays of pipe welds. Examine a minimum of 10% of welds in piping carrying steam at 700 kPa (100 psi) or over using random selection procedure.

.5 Only persons holding current welding certificates for the applications required for the Work to be permitted to do any welding. Perform all welding to Standards specified by Authorities. Do not weld to structural members of the building.

3.07 HANGERS

.1 Hanger rods may be attached to beam or joist clamps, brackets, or concrete inserts. Explosive actuated tools are not permitted. Do not weld to structural steel unless accepted by the Consultant.

.2 Install hangers to the following table.

STEEL PIPE	
Nominal Pipe Size	Distance Between Supports
Up to 32mm (1¼")	2,400mm (8 ft.)
40mm (1½") - 65mm (2½")	3,000mm (10 ft.)
75mm (3") and over	3,600mm (12 ft.)

COPPER TUBING	
Nominal Pipe Size	Distance Between Supports
Up to 20mm (¾”)	1,800mm (6 ft.)
20mm (¾”) - 25mm (1”)	2,400mm (8 ft.)
32mm (1¼") - 50mm (2")	3,000mm (10 ft.)
65mm (2½") and over	3,600mm (12 ft.)

.3 Installation of Portable Pipe Hangers Inc. pipe supports:

.1 Verify that roofing system is complete, and roof surfaces are smooth and flat and are ready to receive Work.

.2 Verify that roof temperature is a minimum of 15.5°C (59.9°F) for proper adhesive performance.

.3 Use care in installation of portable pipe support systems not to damage roofing, flashing, equipment or related materials.

.4 Clean surfaces of roof to receive portable pipe support bases. Remove gravel from gravel surfaced roofs, remove dirt, dust, oils, and other foreign materials from all roofs. Prime existing membrane with a primer that is compatible with existing components in the roofing system.

.5 Locate bases and support framing as indicated on drawings and as specified herein.

.6 Ensure that pipe deflection does not exceed 1/240th of the span and in no case that spacing exceeds 3m (10 ft.).

.7 Set bases with adhesive in accordance with manufacturer's installation instructions. Accurately locate and align bases. Where applicable, replace gravel around bases after installation.

.8 Set framing posts into bases and assemble framing structure. Provide galvanized fasteners for galvanized framing, and stainless steel fasteners for stainless steel framing.]

3.08 AIR VENTS

.1 Provide air vents on water piping at all high points in the system and at each piece of equipment. Provide ball valves on automatic vents.

.2 Provide automatic air vents on piping mains except where a possibility from water damage would occur, in which case, use manual vents.

.3 Provide manual air vents at each piece of equipment.

.4 For all vents, except for screw driver operated type at convectors and unitary heating equipment, provide 9mm (⅜") copper drains to nearest floor drain.

3.09 EXPANSION JOINTS

.1 Install expansion loops, joints and compensators in accordance with the Drawings and manufacturer's instructions in regard to proper length, anchoring and guiding, pre compression, removal of spacers and testing.

3.10 ANCHORS, GUIDES AND EXPANSION COMPENSATORS

.1 Install all hangers, supports, anchors, guides, expansion compensators and restraints per manufacturer’s recommendations and per the requirements of the Professional Engineer responsible for the provision of the detailed shop drawings for hangers, supports, anchors, guides, expansion compensation and restraints.

.2 Manufacturers to provide field verification of the installation during construction phase and provide sign off letters upon completion of installation.

3.11 PROTECTION

.1 Cover openings in equipment and cover equipment where damage may occur from weather. Cover temporary openings in ducts and pipes with polyethylene sheets, until final connection is made. Cover all items cast into concrete floors or walls such as floor drains and cleanouts prior to pour, with heavy plastic tape or duct tape.

.2 Cover and seal, with polyethylene sheeting, all equipment, coils and motors in place during construction to prevent entry of dust, paint and debris.

3.12 RIGGING OF EQUIPMENT

.1 Provide all rigging, hoisting and handling of equipment as necessary in order to place the equipment in the designated area in the building.

.2 Direct this work by qualified personnel normally engaged in rigging, hoisting and handling of equipment.

3.13 CONCRETE

.1 Except as specifically indicated on the Mechanical Drawings or where indicated on the Architectural or Structural Drawings as provided by other Sections, provide all concrete work required for mechanical work (bases, curbs, anchors, thrust blocks, manholes, catch basins) in accordance with requirements of Division 3. Provide reinforced concrete housekeeping pads (equipment bases) at least 100 mm (4") high under all floor mounted equipment. Provide 150 mm (6”) high bases under equipment with cooling coils to provide sufficient clearance for deep seal condensate traps.

.2 Provide in good time, all inserts, sump frames, anchors etc., required to be built into forming for mechanical services.

.3 Equipment to be supported on concrete floors to have reinforced concrete housekeeping pad; pads solidly anchored to the structural slab to meet seismic requirements as follows:

.1 Reinforced concrete with bar or mesh reinforcing.
.2 Minimum 4 inches (100 mm) high with cambered edges.
.3 Seismically attracted to structural floor with 10 mm rebar dowels on 3 feet by 3 feet (900 mm x 900 mm) grid.
.4 Drill and epoxy grout dowels 3 inches (75 mm) into concrete floor.
.5 Provide minimum 8 inches (200 mm) edges to allow for equipment seismic restraint devices.
.6 Provide layout field shop drawings for all housekeeping pads to the Consultant for review.]

3.14 METALS

.1 Steel construction required solely for the work of Mechanical trades and not shown on Architectural or Structural Drawings: Provided by Divisions 20, 21, 22, 23 and 25 to the acceptance of the Consultant. Prepare and submit installation drawings on any steel construction for acceptance of the Consultant. Provide one coat of primer on all steel supports located outdoors.

3.15 CUTTING AND PATCHING

.1 Give timely notice concerning required openings. In work already finished the Contractor will perform all cutting and patching at the expense of Divisions 20, 21, 22, 23 and 25. Obtain the approval of the Consultant before doing any cutting.

.2 Provide all cutting and patching for mechanical services penetrating walls, floors and roofs as shown on the Drawings. Cut only to suit dimensions required and for minimum clearances.

.3 Seal around services passing through cut openings with materials commensurate with the fire rating of the wall, floor or roof. Ensure sealing is weatherproof for openings through exterior walls and roofs. Before sealing, provide prime coat of paint on all repaired surfaces..

3.16 INSERTS, SLEEVES AND ESCUTCHEONS

.1 Provide all sleeves required for ductwork, piping and access openings unless they are specifically shown on Architectural and Structural Drawings.

.2 Place inserts only in portion of the main structure and not in any finishing material.

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

.4 Provide the following for pipe sleeves:

.1 Through interior walls, exterior walls above grade, interior non waterproof floors: Machine cut schedule 40 steel pipe, medium cast iron or 18 gauge galvanized steel.
.2 Through walls below grade, waterproof floors, floors in janitor's closets, equipment rooms, and kitchens: machine cut medium cast iron, DWV copper or copper sheet extended 100mm (4") above the floor and cut flush with the underside.

.5 Seal all sleeves as follows:

.1 Through fire rated walls and floors and within mechanical assemblies (ducts): Stop insulation flush with all wall and floor surfaces and seal space between duct or pipe and sleeve with ULC approved and listed fire stopping material as manufactured by Double AD Distributors Ltd. (416) 292-2361 or M. W. McGill and Associates Ltd. “Fire Bloc” (416) 291-8393 or Dow RTV Silicon Foam or “Metacaulk” as distributed by EMCO Ltd. (416) 742-6220.

.2 Sealing of sleeves around piping and ductwork at fire separations is specified in Division 07. Make openings through fire rated assemblies with size or clearance limitations as specified in Section 07 27 00. Provide all fire stopping and smoke seals within mechanical assemblies (inside ducts). Seal openings with ULC approved and listed fire stopping material as manufactured by Double AD Distributors Ltd. (416) 292-2361 or M. W. McGill and Associates Ltd. “Fire-Bloc” (416) 291-8393 or Dow RTV Silicon Foam or “Metacaulk” as distributed by EMCO Ltd. (416) 742-6220.
.3 Approved and listed products from 3M and Hilti Fire Stop are acceptable.
.4 Through all non-fire rated walls and floors stop insulation, where applicable, at wall and floor surfaces. Ram pack ULC labelled mineral wool materials around piping and ductwork. Apply an approved caulking compound over the ram packed material on both sides.
.5 Through foundation walls: Use either of the two following methods:
.1 Cooperate with the Waterproofing trade and apply an approved caulking compound over ram packed mineral wool on both sides. Over this, on both sides, apply a layer of glassfab tape embedded in two coats of an approved mastic compound.
.2 Provide Link-Seal Model S mechanical seal mechanism with stainless steel bolting, EPDM seal element and composite pressure plates as supplied by Power Plant Supply Company (905) 845-7951. Follow Manufacturer's instructions in all aspects of installation procedure.
.6 Cover sleeves and openings around exposed piping in all finished areas with chrome plated escutcheons. Cover exposed duct sleeves in finished areas with an 18 gauge galvanized steel collar fixed to wall or floor.

3.17 ACCESS PANELS AND DOORS

.1 Install all concealed Mechanical equipment requiring adjustment or maintenance in locations easily accessible through access panels and doors. Install systems and components to result in a minimum number of access panels.

.2 Access doors are required in walls, ceilings and ductwork for the following:

.1 Fire dampers and motorized dampers (for inspection, repair and resetting). Provide access doors on both upstream and downstream sides of automatic dampers.
.2 Duct mounted coils (duct access upstream and downstream sides for cleaning).

.3 Fan inlets and outlets (for inspection of impellers and vanes).
.4 At VAV terminal inlets for access to air flow measurement devices and for cleaning and servicing.
.5 Unitary heating/cooling equipment, such as heat pumps and fan coils, in ceiling spaces.
.6 Duct mounted smoke detectors (for inspection of in-duct sensors).
.7 Control valves and temperature control components.
.8 Expansion compensators, guides and anchors.

.3 Indicate access panels on "As built" drawings and note at each location the items (i.e. equipment or valve no.) that access is being provided for.

.4 Prepare detail drawings showing location and type of all access doors in co-ordination with other trades before proceeding with installation and submit for review.

.5 Size access doors to provide adequate access and be commensurate with type of structure and architectural finish.

.6 Ensure proper rating of doors in fire separations.

.7 Provide lamacoid labels (white on black), screwed in place, on all access doors and access tiles listing items or equipment which access is being provided for.

3.18 PAINTING

.1 Provide all exposed ferrous metal work on equipment with at least one factory prime coat, or paint one prime coat on job. Clean up or wire brush all equipment before painting. Finish painting is specified in Division 09. This Division is not required to prime coat or paint ductwork or piping

.2 For factory applied finishes, repaint or refinish surfaces damaged during shipment, erection or construction work.

3.19 MECHANICAL WORK IDENTIFICATION

.1 Identify new exposed piping and ductwork in locations as follows:

.1 At every end of every piping or duct run;
.2 Adjacent to each valve, strainer, damper and similar accessory;
.3 At each piece of connecting equipment;
.4 On both sides of every pipe and duct passing through a floor, wall or partition, unless otherwise specified;
.5 At 6 m (20') intervals on pipe and duct runs exceeding 6 m (20') in length;
.6 At least once in each room, and at least once on pipe and duct runs less than 6 m (20') in length.

.2 Unless otherwise specified identify new concealed piping and ductwork in locations as follows:

.1 At points where pipes or ducts enter and leave rooms, shafts, pipe chases, furred spaces, and similar areas;
.2 At maximum 6 m (20') intervals on piping and ductwork above suspended accessible ceilings, and at least once in each room;
.3 At each access door location;
.4 At each piece of connected equipment, automatic valve, etc.

.3 Provide an identification nameplate for equipment provided as part of this project, including items such as control valves, motorized dampers, instruments, and similar products. Secure nameplates in place, approximately at eye level if possible, with stainless steel screws unless such a practice is prohibitive, in which case use epoxy cement applied to cleaned surfaces. Locate nameplates in the most conspicuous and readable location. Where equipment is locally switched (e.g. Room exhaust fans) provide identification plate at switch.

.4 Paint new natural and/or propane gas piping with primer and 2 coats of yellow paint in accordance with local governing code requirements and requirements of Division 09. Identify piping at intervals as specified above.

.5 Provide an identification nameplate for each motor starter or disconnect switch located in a motor control centre or on a motor starter panel, and on each individually mounted starter provided as part of mechanical work, and on each disconnect switch provided as part of the electrical work for motorized equipment provided as part of mechanical work.

.6 Co-ordinate with Section 25 01 01 Building Automation System subcontractor and obtain list of automatically operated equipment and provide warning identification on lamacoid plate for each item as follows:

"Warning: This equipment may start at any time. Do not service without disconnecting power."

.7 For electrically traced mechanical work, identification wording is to include "ELECTRICALLY TRACED".

.8 Tag valves and prepare a valve tag chart in accordance with following requirements:

.1 Attach a valve tag to each new valve, except for valves located immediately at equipment they control;
.2 Prepare a computer printed valve tag chart to list tagged valves, with, for each valve, the tag number, location, valve size, piping service, and valve attitude (normally open or normally closed);
.3 If an existing valve tag chart is available at site, valve tag numbering is to be an extension of existing numbering and new valve tag chart is to incorporate existing chart;
.4 Frame and glaze one copy of chart and, unless otherwise directed, affix to a wall in each main Mechanical and/or Equipment Room;
.5 Include a copy of valve tag chart in each copy of operating and maintenance instruction manuals;
.6 Hand an identified USB of valve tag chart to Owner at same time O&M Manuals are submitted.

.9 Where shut-off valves, control dampers, sensors, and similar items which will or may need maintenance and/or repair are located above accessible suspended ceilings, provide round coloured ceiling tacks in ceiling panel material, or stickers equal to Brady "Quick Dot" on ceiling grid material to indicate locations of items. Unless otherwise specified, ceiling tack or sticker colours are to be as follows:

.1	HVAC piping valves and equipment:	Yellow
.2	Fire protection valves and equipment:	Red
.3	Plumbing valves and equipment:	Green
.4	HVAC ductwork dampers and equipment:	Blue
.5	Control system hardware and equipment:	Orange

3.20 EXPOSED WORK

.1 Wherever any mechanical work (plumbing, heating and sprinkler piping, ductwork, and associated thermal insulation) is exposed in finished areas, co-ordinate the work with the Consultant prior to installation. If unsatisfactory installation results due to not following this procedure, perform remedial work to the Consultant's acceptance.

.2 For purposes of the foregoing, finished areas do not include parking garages and equipment rooms.

3.21 PIPING SYSTEM TESTS

.1 Do not insulate piping systems until completed, perfected, and proven tight.

.2 Should leaks develop in any part of the piping system, remove and replace defective sections, fittings and equipment.

.3 Test piping system in sections as required by the progress of work.

.4 Test all **heating** and piping hydraulically to a minimum pressure of 1100 kPa (150 psi) or 1.5 times the normal working pressure, whichever is the greater, and prove tight for a period of 8 hours. Testing with nitrogen is also acceptable provided a pressure of 1.25 times values specified previously is used. Test natural gas piping as required by codes and authorities.

.5 All plumbing, heating and cooling mains and branches are to be flushed and cleaned without fixtures and appliances connected.

.6 All tests must be recorded. Submit recorded data to the Consultant.

3.22 WATER BALANCING AND TESTING

.1 Wate**r** balancing and Testing is to be covered by a Cash Allowance.

.2 Water Balancing

.1 Perform hydronic system balancing by minor throttling for pumps that are less than 7.45 kW (10 HP) provided this results in a power draw of no greater than 10% of that required if the impeller were trimmed. For pumps greater than 7.45 kW (10 HP), the same limit applies but in no case is it to exceed 2.23 kW (3 HP). In either case where these limits are exceeded by throttling, the impeller is to be trimmed or replaced.
.2 Make adjustments to achieve specified [temperature drops across all finned radiation sections and] flows through [chillers and coils]. Also report all pump data such as suction, and discharge pressure, current draw at tested voltage and starter OL heater sizes and pump motor nameplate ratings.
.3 Provide pump curves indicating the operating point with superimposed power draw, RPM, impeller size, etc.
.4 Instruct piping system installers on proper locations of flow measurement ports.
.5 Report any required pump impeller adjustments to achieve specified performance.
.6 After adjustments, retest systems and issue final report confirming systems are operating in compliance with design.
.7 Provide flow measurement ports as shown on detail drawings and piping schematics in locations as directed by the water balancing specialist. Provide balancing valves where required as directed by the water balancing specialist.
.8 Provide any pump impeller modifications as recommended by the water balancing firm.]

.3 Acceptable Water Balancing Contractors:

.1 Air Audit.
.2 Clark Balancing.
.3 Air Velocities Control.

.4 Dynamic Flow Balancing Ltd.
.5 Flowset Balancing.

END OF SECTION 20 05 10

CONTENTS

PART 1 - GENERAL

1.01 DESCRIPTION

.1 Comply with Requirements of Division 01, General Requirements and all documents referred to therein.

.2 Comply with requirements of Mechanical Work General Instructions Section 20 05 05 and Basic Mechanical Materials and Methods Section 20 05 10.

1.02 WORK PERFORMED BY THIS SECTION

.1 This Section specifies requirements, criteria, methods and execution for mechanical demolition work that are common to one or more mechanical work Sections, and it is intended as a supplement to each Section and is to be read accordingly.

1.03 QUALITY ASSURANCE

.1 Qualifications: Execute work of this section only by skilled tradesmen regularly employed in the demolition of mechanical piping, equipment, ductwork, etc.

1.04 ASBESTOS AND HAZARDOUS MATERIALS

.1 If asbestos, PCBs or other hazardous materials are encountered in the course of the work, stop work in the vicinity of such materials and report their presence to the Owner and Consultant.

PART 2 - PRODUCTS

2.01 MATERIALS

.1 Materials used for patching and finishing shall be of the same quality and texture as the adjacent undisturbed areas. Refer to Section 20 05 10 – Basic Mechanical Materials and Methods for additional information regarding cutting and patching.

PART 3 - EXECUTION

3.01 DISCONNECTION AND REMOVAL OF EXISTING MECHANICAL WORK

.1 Where indicated on drawings, disconnect and remove existing mechanical work, including hangers, supports, insulation, etc. Disconnect at point of supply, remove obsolete connecting services and make system safe. Cut back obsolete piping behind finishes and cap water-tight, unless otherwise specified.

.2 Drain down existing piping prior to demolition. Safely dispose of fluids within piping, unless specified otherwise.

.3 Where existing mechanical services extend through, or are in an area to serve items which are to remain, maintain services in operation. Include for rerouting existing services concealed behind existing finishes and which become exposed during renovation work, so as to be concealed behind new or existing finishes.

.4 Unless otherwise specified, remove from site and dispose of existing materials which have been removed and are not to be relocated or reused.

.5 Unless otherwise specified, remove from site and dispose of existing materials which have been removed and are not to be relocated or reused, except for following which are to be handed over to Owner at site. Materials which are to be handed over to the Owner shall be transported by the contractor to a location within the project site designed by the Owner. The contractor shall be liable for damage to existing salvaged equipment during removal and transporting.

.6 Where existing mechanical equipment, ductwork, piping, etc. penetrating walls is removed, leaving an opening in the wall, the wall shall be sealed and patched by the mechanical contractor. The opening shall be sealed commensurate with the rating of the rest of the wall.

.7 Perform cutting and patching on fire rated surfaces to maintain the existing fire rating.

.8 Contractor shall pay for all fees for disposal of equipment.

.9 Remove existing piping, ductwork, equipment, etc. as far back and as close to walls as possible, to leave the maximum amount of space for new construction activities.

.10 Removed materials shall not be reused in the new construction work unless specifically noted or approved.

3.02 EXAMINATION

.1 Verify that abandoned or removed apparatus and equipment serve only abandoned facilities.

3.03 DEMOLITION AND EXTENSION OF EXISTING HVAC WORK

.1 Remove, relocate and extend existing installation to accommodate new construction.

.2 Remove abandoned piping and ductwork to source of supply.

.3 Disconnect and remove existing apparatus and equipment where noted.

.4 Extend existing installations using materials and methods compatible with existing HVAC installations, or as specified.

3.04 PIPING

.1 All welded piping shall be cut off square at the locations indicated on the demolition drawings.

.2 All threaded piping shall be disconnected at the location indicated on the demolition drawings.

.3 All openings of an remaining valves, piping or fittings shall be closed off with weld caps or blind flanges to prevent debris from entering the existing systems.

.4 All pipe hangers, supports and/or anchors shall be removed along with all piping shown to be removed.

3.05 INSULATION

.1 Insulation shall be removed from all ductwork, piping, fittings, valves and equipment designated for demolition.

.2 Comply with all safety precautions related to insulation removal.

.3 Be advised that items such as drainage sumps, catch basins, interceptors, and the like may contain unidentified hazardous waste and caution is to be taken when disconnecting and removing these items.

.4 If hazardous waste not listed in Specification is found, notify Owner and Consultant immediately and await directions.

3.06 INTERRUPTION TO AND SHUT-DOWN OF MECHANICAL SERVICES AND SYSTEMS

.1 Where disruptions of existing mechanical services are required, co-ordinate shut down with the [Consultant] [Owner] and do the work at a time and in a manner mutually acceptable.

.2 Perform work associated with shut-downs and interruptions as continuous operations to minimize shut-down time and to reinstate systems as soon as possible, and, prior to any shut-down, ensure materials and labour required to complete the work for which shut-down is required are available at site.

.3 Submit a written concise schedule of each disruption at least 72 (seventy two) hours in advance and obtain Owner's written consent prior to implementation. Do not shut-down or

.4 .

3.07 PROTECTIONS

.1 Contractor shall coordinate with all trades for all work specified in this project and shall provide the necessary barricades and dust control to protect Owner's personnel, the general public, etc. from injury, provide them safe passage to and from occupied portions of the building, and protect floors, walls, ceilings, furnishings, and equipment from damage or exposure to dust or debris.

3.08 CLEANING

.1 Do Cleaning in accordance with Section 20 05 05 - Mechanical Work General Instructions.

END OF SECTION 20 05 40

CONTENTS

PART 1 - GENERAL

1.01 DESCRIPTION

.1 Comply with Requirements of Division 01, General Requirements and all documents referred to therein.

.2 Comply with requirements of Mechanical Work General Instructions Section 20 05 05 and Basic Mechanical Materials and Methods Section 20 05 10.

.3 Comply with the requirements of Section 23 05 00 Common Work Results for HVAC.

1.02 WORK PERFORMED BY THIS SECTION

.1 Section Includes:

.1 Variable volume boxes, constant volume bypass and fan powered and electronic variable air volume boxes.

.2 Related Sections:

.1 Comply with requirements of Mechanical Vibration Control Section 20 05 20 and Starters and Wiring Section 20 05 35.

1.03 QUALITY ASSURANCE

.1 Materials in accordance with Section 20 05 05 and 20 05 10.

.2 Health and Safety Requirements:

.1 Do construction occupational health and safety in accordance with Division 01 and to suit Health and Safety Requirements.

.3 Certificates:

.1 Catalogue or published ratings those obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency.

.4 Catalogued or published ratings for manufactured items: Obtained from tests carried out by manufacturer or those ordered by manufacturer from certified ADC (Air Diffusion Council) testing agency signifying adherence to codes and standards.

.5 Terminal units of the same type to be product of one manufacturer.

.6 Acceptable Manufacturers: E.H. Price, Metal Aire, Tuttle & Bailey, Titus, Nailor or equal.

.7 Units to be CSA certified.

1.04 REFERENCES

.1 American National Standards Institute (ANSI)

.1 ANSI/AMCA 210, Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
.2 ANSI/NFPA 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.
.3 AHRI 410 - Standard for Forced-Circulation Air-Cooling and Air-Heating Coils.

.4 AHRI 880 - Performance Rating of Air Terminals.
.5 AHRI 885 - Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminals and Air Outlets.
.6 ASHRAE 130 - Methods of Testing for Rating Ducted Air Terminal Units.
.7 ASTM C1071 - Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
.8 ASTM C1338 Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings.
.9 ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
.10 ASTM E488/E488M - Standard Test Methods for Strength of Anchors in Concrete Elements.
.11 CSA C22.2 No. 236 – Heating and Cooling Equipment.
.12 UL 94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.
.13 UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; Underwriters Laboratories Inc.
.14 UL 1995 – Standards for Heating and Cooling Equipment.

.2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

.3 International Organization of Standardization (ISO)

.1 ISO 3741, Acoustics-Determination of Sound Power Levels of Noise Sources Using Sound Pressure - Precision Methods for Reverberation Rooms.

.4 Underwriter's Laboratories (UL)

.1 UL 181, Factory-Made Air Ducts and Air Connectors.

1.05 SUBMITTALS

.1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 20 05 01. Include product characteristics, performance criteria and limitations. Indicate Capacity, pressure drop, leakage, Provide sound data (NC levels) for both transmitted and radiated noise. All terminal units to be selected and attenuated as noted.

.2 Test data: To ANSI/AMCA 210.

.1 Submit published test data on DIN (Direct Internal Noise), in accordance with ISO 3741 made by independent testing agency for 0, 2.5 and 6 m/s branch velocity or inlet velocity.
.2 Sound power level with minimum inlet pressure of **[0.25] [0.5] [1] [1.5]** kPa in accordance with ISO 3741 for 2nd through 7th octave band, also made by independent testing agency.
.3 Pressure loss through silencer shall not exceed 60% of inlet velocity pressure maximum.

.3 Samples:

.1 Submit samples and mock-ups in accordance with Section 20 05 01.
.2 Submit mock-ups in accordance with Division 01**.**

.4 Certificates: Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.1 Instructions: Submit manufacturer's installation instructions.

.5 Close-out Submittals:

.1 In accordance with Section 20 05 05.

.6 Spares:

.1 Provide maintenance materials in accordance with Division 01 and Section 25 05 01.
.2 Furnish list of individual manufacturer's recommended spare parts for equipment include:
.1 Bearings and seals.
.2 Addresses of suppliers.
.3 List of specialized tools necessary for adjusting, repairing or replacing

1.06 DELIVERY, STORAGE, AND HANDLING

.1 Do Delivery, Storage and Handling in accordance with Section 20 05 05 - Mechanical Work General Instructions.

1.07 WARRANTY

.1 Provide warranties as outlined in Section 20 05 05.

PART 2 - PRODUCTS

2.01 VARIABLE VOLUME BOXES

.1 Pressure independent factory reset to air flow between minimum and maximum air volume.

.2 Sizes, capacities: as indicated on the drawings

.3 Differential pressure not to exceed 25 Pa at inlet air velocity of 10 m/s.

.4 Unit Casing:

.1 The unit casing shall be constructed of a minimum 22 gauge, 0.032 inch galvanized steel.
.2 The casing shall be assembled with longitudinal lock seam construction.
.3 Casing leakage shall be tested in accordance with ASHRAE 130.
.4 Casing leakage for the basic assembly shall not exceed 1.0 percent of the maximum rated airflow at 250Pa (1.0”w.g)
.5 Casing leakage for the basic assembly shall not exceed 2.0 percent of the maximum rated airflow at 750Pa (3.0”w.g).
.6 Units shall have a maximum casing height of 250mm (10”).

.5 Unit Discharge:

.1 Manufacturer shall provide rectangular unit discharges with slip-and-drive connections.

.6 Liners:

.1 Standard:
.1 Fiberglass Liner - FG.
.2 Insulation shall comply with the requirements of UL 181 (erosion), ASTM C1338 (fungi resistance), ASHRAE 62.1, and ASTM C1071, having a maximum flame/smoke spread of 25/50 for both the insulation and the adhesive when tested in accordance with ASTM E84.
.3 The insulation shall be secured with adhesive.

.4 Insulation edges exposed to the airstream shall be coated with NFPA 90A approved sealant.

.1 Insulation thickness shall be 25mm (1" thick), R-value of 4.1.

.2 Fiber-Free Foam Insulation - FF.

.1 Insulation shall comply with the requirements of UL 181 (erosion, mold growth and humidity) and ASHRAE 62.1, and shall have a maximum flame/smoke spread of 25/50 for both the insulation and the adhesive when tested in accordance with ASTM E84.

.2 The insulation shall be secured with adhesive.

.3 Insulation thickness shall be 25mm (1" thick), R-value of 4.0.

.3 Foil Board Liner - FB.

.1 Insulation shall comply with the requirements of UL 181 (erosion, mold growth and humidity) and ASHRAE 62.1, and shall have a maximum flame/smoke spread of 25/50 for both the insulation and the adhesive when tested in accordance with ASTM E84.

.2 The insulation shall be secured with adhesive.

.3 Insulation edges exposed to airstream shall be coated with NFPA 90A approved sealant.

.4 Insulation thickness shall be 25mm (1" thick), R-value of 4.2.

.7 Primary Air Damper Assembly:

.1 The damper assembly shall be heavy-gauge, galvanized steel with a solid shaft rotating in bearings.

.2 The damper shaft shall incorporate a visual position indicator etched into the end of the damper shaft to clearly indicate damper position over the full range of 90 degrees.

.3 The damper shaft shall be mounted on the side of the damper when looking in the direction of airflow, as indicated on the mechanical drawings.

.4 The 18 gauge damper assembly shall incorporate a peripheral gasket on the damper blades for tight airflow shutoff.

.5 Air leakage past the closed damper shall not exceed 2 percent of the unit maximum rated airflow at 750Pa (3.0 inch water gauge) inlet static pressure, tested in accordance with ASHRAE 130.

.8 Airflow Sensor:

.1 The airflow sensor shall be a differential pressure airflow device measuring total and static pressures, and mounted to the inlet valve.

.2 Plastic parts shall be fire-resistant, complying with UL 94.

.3 The airflow sensor shall be RoHS (Restriction of Hazardous Substances) compliant. Material containing polybrominated compounds shall not be acceptable.

.4 Control tubing shall be protected by grommets at the wall of the airflow sensor's housing.

.5 The airflow sensor shall be furnished with twelve total pressure sensing ports and four static pressure sensing ports, and shall include a center averaging chamber that amplifies the sensed airflow signal.

.6 After balancing, the airflow sensor signal accuracy shall be plus or minus five percent throughout terminal operating range.

.9 Inlet Valve:

.1 The inlet valve shall be a consistent diameter to retain flex duct and provide a stop for hard duct.

.2 The inlet valve shall include a raised single bead weld for added strength.

.3 The gasket seal shall be a low leakage continuous piece with a peripheral gasket for tight airflow shutoff.

.4 The inlet valve shall include two heavy duty stop pins to accurately position the damper in the closed and open positions.

.10 Sound Attenuator:

.1 The manufacturer shall supply sound attenuators to meet scheduled acoustical performance requirements of **[NC30**]. The unit shall be provided with 5ft integral discharge attenuator unless smaller attenuators can be demonstrated to meet acoustic requirements.

.2 With attenuators and a room attenuation of 8 db, the sound power level with reference to 10 to the –12 power watts shall be such that the sound pressure level in the room receiving air and in room in which the box is located, shall not exceed noise criterion as noted in at an inlet static pressure 0.37 kPa (1.5 in.wg.) with noise generated by diffusers excluded. Provide manufacturer's certified sound power ratings with an octave band analysis when tested in accordance with ASHRAE Standard 36B-63

.3 Where one attenuator fails to provide the sound attenuation required, utilize additional attenuators or lengths of duct lining. Where attenuators with outlets are used they shall be rated with the outlets and not as straight attenuators without outlets.

.11 Pressure drop for L/s (cfm) ranges shown for each box size shall be 0.07 kPa (0.3 in.wg.) maximum. Boxes shall be capable of modulating down to the minimum volume shown and shall shut-off tight where zero L/s (zero cfm) is shown.

.12 Controls:

.1 Provide a NEMA 1 Controls Enclosure.
.2 The terminal unit shall be supplied with a factory mounted 50 VA control transformer.
.3 Provide digital controller to operate damper operator between maximum or minimum air volume settings
.4 Sequence of operation as specified under Specification Section 25 00 00.

.13 Electrical Requirements:

.1 Single duct terminal units shall be provided with single-point power connection.
.2 The terminal unit equipment wiring shall comply with the requirements of NFPA 70.

2.02 CONTROLLERS

.1 Digital Controllers shall be responsible for monitoring and controlling directly connected VAV Terminals as required. Controllers shall include fully adjustable analog outputs and digital outputs as required utilizing a proportional plus integral control loop to control damper, electric heat and hot water coils for the purpose of maintaining user setpoints. Each controller shall be classified as a native BACnet device, conforming to the BACnet Advanced Specific Controllers (B-ASC) profile, ANSI/ASHRAE BACnet Standard 135.

.2 The VAV controller shall be available with integrated applications (based on model) for Single Duct and Fan Powered terminal units

.3 The controller shall be fully configurable via the Digital Display Sensor, including communication parameters (instance, MAC, baud) and application settings (K-factor, flow limits, box configuration, reheat or fan type, default user setpoints, etc.), without any specific PC-based software. VAV controllers shall not require the use of a personal computer and PC based software and/or any interface modules.

.4 The controller shall have integrated MS/TP communications. The communication port shall have network protection bulbs and integrated end-of-line (EOL) terminations.

.5 The controller shall have an integrated actuator rated at 40 in-lbs. Connection to the damper shall be with a v-bolt clamp, accepting 3/8" to 5/8" damper shaft sizes. The actuator shall travel 0 to 95 degrees with adjustable end stops at 45 and 60 degrees of rotation. The actuator shall have an integrated gear disengagement mechanism.

.6 The controller shall have an integrated transducer pressure sensor for airflow measurement. The sensor shall have a range or 0-2"wc, consuming and accurate to 4.5% of reading or 0.0008"wc, whichever is greater.

.7 The controller shall have screw terminal blocks that can accommodate wire sizes 14-22 AWG. Terminals shall be color coded: black terminals for power, green terminals for input and outputs, and grey terminals for twisted-shielded-pair communication.

.8 The power supply for the controller shall be 24 volts AC (-15%, +20%) power. Voltage below the operating range of the system shall be considered an outage.

PART 3 - EXECUTION

3.01 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: Comply with manufacturer's written recommendations or specifications including product technical bulletins, handling, storage and installation instructions and datasheet.

3.02 INSTALLATION

.1 Support independently of ductwork.

.2 Install with at least 1000 mm of flexible inlet ducting and minimum of four duct diameters of straight inlet duct same size as inlet. Install the inlets of the air terminal units with the air flow sensors a minimum of four duct diameters from elbows, transitions, and duct takeoffs.

.3 Locate controls, dampers and access panels for easy access.

.4 Connect the terminals to the ductwork.

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

.6 Provide access door at inlet for servicing air flow measurement devices.

3.03 CLEANING

.1 Do Cleaning in accordance with Section 20 05 05 - Mechanical Work General Instructions.

3.04 TRAINING

.1 Refer to Section 20 05 05 for training requirements.

END OF SECTION 23 36 00

CONTENTS

PART 1 - GENERAL

1.01 DESCRIPTION

.1 Comply with Requirements of Division 01, General Requirements and all documents referred to therein.

.2 Comply with requirements of Mechanical Work General Instructions Section 20 05 05 and Basic Mechanical Materials and Methods Section 20 05 10.

.3 Comply with the requirements of Section 23 05 00 Common Work Results for HVAC.

1.02 WORK PERFORMED BY THIS SECTION

.1 Section Includes:

.1 Mechanical louvres, intakes, vents and reinforcement and bracing for air vents, intakes and gooseneck hoods.
.2 Sustainable requirements for construction and verification.

1.03 QUALITY ASSURANCE

.1 Materials in accordance with Section 20 05 05 and 20 05 10.

.2 Health and Safety Requirements:

.1 Do construction occupational health and safety in accordance with Division 01 and to suit Health and Safety Requirements.

.3 Certificates:

.1 Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards.

1.04 REFERENCES

.1 American National Standards Institute (ANSI)/ National Fire Protection Association (NFPA)

.1 ANSI/NFPA 96, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.

.2 American Society for Testing and Materials International (ASTM)

.1 ASTM E90, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.

.3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

.4 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)

.5 Society of Automotive Engineers (SAE)

1.05 SUBMITTALS

.1 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 20 05 01. Include product characteristics, performance criteria, and limitations. Indicate pressure drop, face area, free area.

.2 Certificates: Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.3 Test Reports:

.1 Submit certified data from independent laboratory substantiating acoustic and aerodynamic performance to ASTM E90.

1.06 DELIVERY, STORAGE, AND HANDLING

.1 Do Delivery, Storage and Handling in accordance with Section 20 05 05 - Mechanical Work General Instructions.

1.07 WARRANTY

.1 Provide warranties as outlined in Section 20 05 05.

PART 2 - PRODUCTS

2.01 FIXED LOUVRES

.1 Stationary, extruded aluminum, site proof, weatherproof as manufactured by Airolite Type K 6776, 150mm (6") deep, 35º blades, complete with 12mm (2") mesh 16 ga. aluminum removable bird screen 50% minimum free area.

.2 Other acceptable manufacturers: Nlailor, Ruskin, Ventex, Construction Specialities.

2.02 ROOF MOUNTED LOUVRED ASSEMBLIES (EXHAUST AND INTAKE)

.1 As described on the Drawings, provide rainproof roof mounted louvred aluminium alloy exhaust and intake assemblies complete with bird screens as manufactured by Penn, Airolite or Greenheck.

2.03 WALL BOXES

.1 Provide where indicated on drawings single, double or triple weather proof wall boxes. Exhaust wallbox to be provided integral backdraft damper. A single coat of epoxy paint applied to the interior surface of the box and two coats of epoxy paint applied to the exterior. Tested to Static Test ASTM E331-00 and Cyclic Static Test ASTM E547-00 tested @ 700 Pa.

.2 Wall box to be provided with extruded aluminum grille.

.3 Insulate wall box on interior with closed cell polyurethane foam to achieve a R-value equal to that of the adjacent wall.

.4 Acceptable manufacturer Reversomatic model SWBW-8, DWBW-8, and TWBW-8 or equivalent.

.5 For combined intake and exhaust boxes provide Reversomatic model DV-200.

.6 For single intake and exhaust boxes serving ERV unit provide Reversomatic model SVI-50 and SVE-50 respectively.

.7 Coordinate on site for the required wall box height to suit the application.

PART 3 - EXECUTION

3.01 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: Comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions and datasheet.

3.02 INSTALLATION

.1 Install in accordance with manufacturer's recommendations.

.2 Reinforce and brace as indicated.

.3 Anchor securely into opening. Seal with caulking to ensure weather tightness.

3.03 OUTSIDE AIR AND EXHAUST LOUVRES

.1 Install to ULC requirements. Locate in fire walls, ceilings and partitions where indicated. Coordinate with and provide ULC installation details to drywall installer.

.2 Seal around fire damper assembly.

.3 After completion, have installation approved prior to concealment.

3.04 FIELD QUALITY CONTROL

.1 Verification requirements in accordance with Division 01 and include:

.1 Materials and resources.
.2 Storage and collection of recyclables.
.3 Construction waste management.
.4 Resource re-use.
.5 Recycled content.
.6 Local/regional materials.
.7 Low-emitting materials.

3.05 CLEANING

.1 Do Cleaning in accordance with Section 20 05 05 - Mechanical Work General Instructions.

END OF SECTION 23 37 20

CONTENTS

PART 1 - GENERAL

1.01 DESCRIPTION

.1 Comply with Requirements of Division 01, General Requirements and all documents referred to therein.

.2 Comply with requirements of Mechanical Work General Instructions Section 20 05 05 and Basic Mechanical Materials and Methods Section 20 05 10.

.3 Comply with the requirements of Section 23 05 00 Common Work Results for HVAC.

1.02 WORK PERFORMED BY THIS SECTION

.1 Centrifugal Water Chillers and associated parts and components.

1.03 REFERENCES

.1 The Air-Conditioning and Refrigeration Institute (ARI)

.1 ARI 550/590, Standard for Water-Chilling Packages Using the Vapour Compression Cycle.

.2 ASTM International Inc.

.1 ASTM C547, Standard Specification for Mineral Fibre Pipe Insulation.

.3 Canadian Standards Association (CSA International)

.1 CSA B52, Mechanical Refrigeration Code.

.4 Environment Canada/Environmental Protection Services (EPS)

.1 EPS 1/RA/2, Environmental Code of Practice for Elimination of Fluorocarbons Emissions from Refrigeration and Air Conditioning Systems.

1.04 QUALITY ASSURANCE

.1 Materials in accordance with Section 20 05 05 and 20 05 10.

.2 Health and Safety Requirements:

.1 Do construction occupational health and safety in accordance with Division 01 and to suit Health and Safety Requirements.

.3 Certificates:

.1 Catalogue or published ratings those obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency.

1.05 SUBMITTALS

.1 Provide manufacturer's printed product literature and datasheets for chillers and include product characteristics, performance criteria, physical size, finish and limitations in accordance with Section 20 05 01. Shop Drawings to include:

.1 Equipment including connections, piping and fittings, valves, strainers, control assemblies and ancillaries, identifying factory and field assembled.
.2 Wiring as assembled and schematically.
.3 Dimensions, construction details, recommended installation and support, mounting bolt hole sizes and locations and point loads.
.4 Space requirements for operation and maintenance.
.5 Type of refrigerant used.

.2 Test Reports: Submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.

.3 Certificates: Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.4 Closeout Submittals

.1 Refer to Section 20 05 05.
.2 Include:
.1 Description of equipment giving manufacturer's name, model type, capacity and serial numbers.
.2 Provide part load performance curves.
.3 Details on operation servicing and maintenance.
.4 Recommended spare parts list.

.5 Spares:

.1 Provide maintenance materials in accordance with Division 01 and Section 25 05 01.
.2 Furnish spare parts data for each different item of equipment specified, after approval of detail drawings.
.3 Include with data complete list of parts and supplies, with current unit prices, source of supply, recommended spare parts list for 1 year of operation and list of parts recommended by manufacturer to be replaced on routine basis.

1.06 DELIVERY, STORAGE AND HANDLING

.1 Do Delivery, Storage and Handling in accordance with Section 20 05 05 - Mechanical Work General Instructions.

1.07 WARRANTY.

.1 Warranty periods for chillers to start on the date of verification of acceptance issued in writing by the Consultant.

.2 The date of verification of acceptance is independent of Substantial Performance of the Work and may occur after certification of Substantial Performance.

.3 Chillers will be accepted after start up, a minimum of six hours of logged operation and submission of written verification of same by manufacturer's representative. The Consultant may also witness a portion of any of these this procedure.

.4 Include verification of acceptance certificates with the maintenance and operating manuals in the appropriate sections.

.5 Provide equipment manufacturer's qualified personnel to ensure proper start-up, including leak testing, evacuation, dehydration and charging, that condenser pressure controls are properly installed, to check out all operating and safety components as well as instruct the Owner's representative in safe and proper operation and maintenance.

.6 Provide warranties as outlined in Section 20 05 05.

PART 2 - PRODUCTS

2.01 GENERAL

.1 Provide outdoor packaged air-cooled liquid chiller with the capacity as scheduled on drawings at job site elevation listed in Section 15050.

.2 Chiller shall be designed to operate using R-410a Refrigerant.

.3 The liquid to be chilled will be water containing corrosion

.4 Inhibitors and antifreeze solution as required.

.5 Chiller shall be designed to operate using 480 volt, 3 phase, 60 Hz electrical power supply.

2.02 OUTDOOR PACKAGED AIR-COOLED CHILLER

.1 Approved manufacturer is AIRSTACK or approved equal. Note: There will be no deviation to system design or material choices. All manufacturers must comply with design criteria. Substitutions are not acceptable. In the event that submitted equipment is deemed non-compliant the contractor shall provide at no additional expense to the owner/client equipment that is compliant with specification.

.2 System Description: Chiller shall incorporate a Scroll type. Compressor(s) and consist of a single independent refrigerant circuit. Each refrigerant circuit shall consist of an individual compressor(s), evaporator, electronic expansion valve, liquid line solenoid valve, filter drier, fin and tube condenser, and control system. The entire system shall be mounted on a heavy steel base.

.3 General

.1 Chiller Modules shall be ETL listed in accordance with UL Standard 1995, CSA certified per Standard C22.2#236.
.2 System shall ship wired and charged with refrigerant and shall be factory run tested prior to shipment.
.3 Compressor, heat exchanger, piping and controls shall be mounted on a heavy gauge steel frame. Electrical controls, contactors, and relays for each system shall be mounted within the system cabinet.

.4 Evaporator: Each evaporator shall be a brazed plate heat exchangers constructed of 316 stainless steel; designed, tested, and stamped in accordance with ASME code for 400 psig water-side working pressure. Evaporator heat exchanger shall not be mounted above the compressor, to prevent the effect of migration of refrigerant to the cold evaporator with consequent liquid slugging on start-up.

.5 Compressor: Each chiller shall contain one (two) hermetic scroll compressors mounted to the chiller with rubber-in-shear isolators. Each system also includes high discharge pressure and low suction pressure safety cut-outs.

.6 Condenser: Each chiller shall contain a single fan. Blades are aluminum construction owlet design 7-blade axial fan with integral EC motor (direct drives with external VFD driven motors are not acceptable). Efficiency exceeds criteria set out in the ErP 2015 directive. Individual fans are factory tested. Encapsulation required. Encapsulation is a process of filling a complete electronic assembly with a solid compound for resistance to shock and vibration, and for exclusion of moisture and corrosive agents. Fan motors shall all be pressure controlled and suitable for outdoor use. Condenser coils shall be finned tube design. Coil shall be constructed using copper tubes and aluminum fins with integral subcooling.

.7 Central Control System.

.1 Chiller shall have microprocessor based controls. System shall include entering chilled water control and provide head pressure control for the condenser fan.
.2 Safeties shall include low leaving chilled water temperature safety for freeze protection.

.8 Refrigerant circuit shall include all refrigerant specialties to provide reliable operation down to 40□F Ambient.

.9 Chiller shall be provided with a single point power connection.

.10 PUMP

Provide integral chilled water Pump of size and capacity indicated on the drawings and schedules. Pump shall be a single centrifugal pump. Pump impeller shall be stainless steel. Pump housing shall be constructed of stainless steel. Pump starters and controls shall be provided. In addition, in the event of a loss-of-flow failure of the chilled water system, the system shall shut down and provide a failure output.
OPTIONAL: DUAL PUMPS
Dual pumps shall be provided for N+1 redundancy. In the event of a pump failure the back-up pump shall automatically be enabled.

.11 TANK

An integral 20 (40, 60, 100, 120) -gallon stainless steel chilled water tank shall be provided integral to the system piping. Tank shall be pressure rated at 125 psi minimum.

2.03 SAFETY AND OPERATING CONTROLS

.1 The chiller safety controls shall be provided (minimum) as follows:

.1 Low evaporator refrigerant pressure
.2 Loss of water flow through the evaporator
.3 High condenser refrigerant pressure
.4 High compressor motor temperature
.5 Low suction gas temperature
.6 Low leaving evaporator water temperature

2.04 CONTROL CENTRE

.1 Failure of chiller to start or chiller shutdown due to any of the above safety cutouts shall enable a fault output from the integral controls system.

.2 The chiller shall be furnished with a Master Controller as an integral portion of the chiller control circuitry to provide the following functions:

.1 Provide automatic chiller shutdown during periods when the load level decreases below the normal operating requirements of the chiller. Upon an increase in load, the chiller shall automatically restart.
.2 Provisions for connection to automatically enable the chiller from a remote energy management system.

.3 Normal Chiller Operation

.1 When chiller is enabled, the factory supplied Master Controller modulates the chiller capacity from minimum to maximum as required by building load.
.2 The Chiller control system shall respond to Entering Water Temperature and will have an integral reset based on entering water temperature to provide for efficient operation at part-load conditions.

2.05 ACCEPTABLE MANUFACTURERS

.1 Acceptable manufacturers: AIRSTACK, Trane, York, Carrier and McQuay.

PART 3 - EXCUTION

3.01 APPLICATION

.1 Manufacturer's Instructions: Comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.02 GENERAL

.1 Provide appropriate protection apparatus.

.2 Install unit as indicated, to manufacturer's recommendations and in accordance with EPS1/RA/2.

.3 Ensure adequate clearances for servicing and maintenance.

.4 Manufacturer to approve installation to supervise start-up and to instruct operators.

3.03 EQUIPMENT

.1 Chillers:

.1 Provide all necessary refrigerant relief lines, break away flanges, valves, pneumatic and electric control connections and piping for chiller oil cooler and purge unit as required by chiller manufacturer.
.2 Install pipeline thermometers and/or sensor wells as required on system side of break away flanges.
.3 Install in arrangements as shown on the drawings and when chiller installation consists of two units, or pairs of units, install each pair such that the control panel fronts face inward toward each other. If chiller installation is an odd number, i.e., 3 or 5, all control panel fronts to face each other as above. The odd unit panel to face the opposite side of the adjacent unit.
.4 Provide spacing minimum between chiller control panel fronts. Provide rear service space as required by the manufacturer but in no case less than 600mm from any component on the chiller.
.5 Refer to Section 20 05 10 for wiring requirements.
.6 Install units on a flat surface level within 1⁄8" and of sufficient strength to support concentrated loading with isolation spring assemblies under the units.

.7 Install components furnished by the manufacturer.
.8 Provide all water piping so unit and water circuits are serviceable without having to dismantle excessive lengths of pipe.
.9 Provide valves in water piping upstream and downstream of the evaporator and condenser water boxes connections for isolating the shells for maintenance.
.10 Provide drain valves and vent cocks to each water box.
.11 Install loose temperature sensors in accordance with the manufacturer's recommendations.
.12 Provide all necessary auxiliary water piping for oil cooler in accordance with the manufacturer's recommendations.
.13 Provide pressure relief piping from relief valve to outside in accordance with manufacturer's instructions and CSA-B52-1992.
.14 Provide certified wiring schematics to the electrical division for the chiller, associated equipment and controls.
.15 Provide all necessary control wiring as recommended by the manufacturer.
.16 Provide vapour proof flow switches in both chilled and condenser water piping interlocked to the control panel.

3.04 START UP SERVICE AND WARRANTY

.1 Manufacturer’s Warranty: Manufacturer shall provide full parts-only warranty coverage for entire chiller for a period of one year. All parts shall be warranted against defects in material and workmanship. Similar parts-only coverage shall be provided for the chillers compressors for a period of five years. The warranty period shall commence either on the equipment start-up date or six months after shipment, whichever is earlier.

.2 Manufacturer shall provide the services of a Factory Authorized Service Engineer to provide complete start-up supervision. Factory Authorized Service Engineer shall also be responsible for assembly of the chillers cabinetry package and electrical bus bar system. After start-up a Manufacturer’s Representative shall provide a minimum of 8-hours of operator training to the owner’s designated representative(s).

3.05 COMMISSIONING

.1 Supply the services of a factory trained representative to perform the field leak testing, dehydration, charging of refrigerant, and start-up of chiller.

.2 The mechanical contractor will notify the manufacturer at least two weeks in advance of required commissioning date.

.3 The manufacturer’s representative shall carry-out the following functions:

.1 Ensure that all chilled water systems are connected and that all pumps run and control valves open to provide maximum cooling load.
.2 Start up chiller and check refrigerant pressures, chilled water pull down, oil pressure, condenser operation and machine cycling. Check electric power, amps draw at start-up, running amps, voltage for each phase and kilowatt draw at 100% load.
.3 Verify that condenser pressure controls are properly installed.

3.06 PIPING SYSTEM FLUSHING PROCEDURE

.1 Prior to connecting the chiller to the building chilled water loop, the piping shall be flushed with a detergent and hot water (110-130° F) mixture to remove previously accumulated dirt and other organic residue. In old piping systems with heavy encrustation of inorganic materials consult a water treatment specialist for proper passivation and/or removal of these contaminants.

.2 During the flushing a 30 mesh (max.) Y-strainers (or acceptable equivalent) shall be in place in the system piping and examined periodically as necessary to remove collected residue. The use of on board chiller strainers shall not be acceptable. The flushing process shall take no less than 6 hours or until the strainers, when examined after each flushing, are clean. Old systems with heavy encrustation shall be flushed for a minimum of 24 hours and may take as long as 48 hours before the filters run clean. Detergent and acid concentrations shall be used in strict accordance with the respective chemical manufacturer`s instructions. After flushing with the detergent and/or dilute acid concentrations the system loop shall be purged with clean water for at least one hour to ensure that all residual cleaning chemicals have been flushed out.

.3 Prior to supplying water to the chiller the Water Treatment Specification shall be consulted for requirements regarding the water quality during chiller operation. The appropriate chiller manufacturer's service literature shall be available to the operator and/or service contractor and consulted for guidelines concerning preventative maintenance and off-season shutdown procedures.

3.07 WATER TREATMENT REQUIREMENTS

.1 Supply water for the chilled water circuit shall be analyzed and treated by a professional water treatment specialist who is familiar with the operating conditions and materials of construction specified for the chiller's heat exchangers, headers and associated piping. Cycles of concentration shall be controlled such that recirculated water quality for modular chillers using 316 stainless steel brazed plate heat exchangers and carbon steel headers is maintained within the following parameters:

.1	pH	Greater than 7 and less than 9
.2	Total Dissolved Solids (TDS)	Less than 1000 ppm
.3	Hardness as CaCO3	30 to 500 ppm
.4	Alkalinity as Ca CO3	30 to 500 ppm
.5	Chlorides	Less than 200 ppm
.6	Sulfates	Less than 200 ppm

3.08 FIELD QUALITY CONTROL

.1 Manufacturer's Field Services:

.1 Have manufacturer of products supplied under this Section review work involved in handling, installation/application, protection and cleaning of its product/s, and submit written reports, in acceptable format, to verify compliance of work with Contract.

.2 Provide manufacturer's field services, consisting of product use recommendations and periodic site visits for inspection of product installation, in accordance with manufacturer's instructions.

.3 Schedule site visits to review work at stages listed:

.1 After delivery and storage of products and when preparatory Work, or other Work, on which the Work of this Section depends, is complete but before installation begins.

.2 Twice during progress of Work at 25% and 60% complete.

.3 Upon completion of the Work, after cleaning is carried out.

.4 Obtain reports, within 3 days of review and submit, immediately, to the Consultant

.2 Upon completion of work, after cleaning is carried out.

.3 Performance Verification:

.1 General: Perform performance verification in accordance with Division and Sections 20 05 05 and 20 05 10 - General Commissioning (Cx) Requirements, supplemented as specified.

.4 Verification requirements in accordance with Division 01 and include:

.1 Materials and resources.
.2 Storage and collection of recyclables.
.3 Construction waste management.
.4 Resource re-use.
.5 Recycled content.
.6 Local/regional materials.
.7 Low-emitting materials.

3.09 DEMONSTRATION

.1 Training: Provide training in accordance with Division 01 and Sections 20 05 05 and 20 05 10 - General Commissioning (Cx) Requirements, supplemented as specified.

3.10 EQUIPMENT START UP

.1 Follow manufacturer's instructions and have manufacturer's representative present to certify the installation.

.2 Check each item of equipment to ensure proper electrical connections, etc., and to verify proper operation.

3.11 CLEANING

.1 Do Cleaning in accordance with Section 20 05 05 - Mechanical Work General Instructions.

END OF SECTION 23 64 30

CONTENTS

PART 1 - GENERAL

1.01 DESCRIPTION

.1 Division 01, General Requirements, is part of this Section and shall apply as if repeated here.

.2 Comply with requirements of Mechanical General Provisions Section 20 05 05 and Mechanical Basic Materials and Methods, Section 20 05 10.

.3 General: The control system shall consist of a high-speed, peer-to-peer network of DDC controllers and an operator workstation. The operator workstation shall be a personal computer (PC) with a LCD color monitor, mouse, keyboard, and printer. The DDC Application Software shall allow operators to interface with system via dynamic color graphics. Depict each mechanical system and building floor plan by a point-and-click graphic. Furnish a modem or network interface card for remote access to the network and for paging operators when an alarm occurs. Provide the latest versions of all controllers.

.4 The system shall directly control HVAC equipment as specified in Part 3 Sequences of Operation and as noted on the control drawings.

.5 The system shall use the BACnet protocol for communication to the operator workstation and for communication between control modules. Schedules, set points, trends, and alarms specified (Sequences of Operation) shall be BACnet objects.

1.02 WORK PERFORMED BY THIS SECTION

.1 Provide a complete direct digital control (DDC) Energy Management and Control System (EMCS) with all required software, host computer, monitor, keyboard, printers, field processing units, thermostats, controllers, dampers, valves, operators, switches, wiring and other accessory equipment, in accordance with the Drawings and as required by description of sequences of operation which shall include, but not be limited to:

.1 Air supply, return, exhaust and relief systems.
.2 Hot water heating and chilled water cooling and humidifying systems.
.3 VAV terminal units, fan coil units, perimeter **[finned]** convectors, reheat coils.
.4 Chillers, condensers, boilers, cooling towers, pumps.

.2 Electronic static pressure sensors and electric actuators for variable inlet guide vanes on Air Handlers, supply, return and exhaust fans.

.3 Electronic/electric actuators for all combustion air dampers.

.4 Electronic/electric control for smoke/fire dampers.

.5 Electronic control and actuation for VAV boxes.

.6 Wiring and installation of pressure differential switches and humidistats supplied with packaged humidifiers.

.7 Assistance in balancing of all hydronic systems, air systems and VAV boxes.

1.03 QUALITY ASSURANCE

.1 Qualifications: Execute work of this Section by bas building control contractor.

1.04 SUBMITTALS

.1 Submit control shop drawings and wiring diagrams with I/O points, written sequences of operation and components description.

.2 Submit catalogue cuts and specifications on all EMCS front end equipment, i.e. monitor/keyboard, printers, modem.

.3 Submit DDC data by systems, i.e. chilled water control, S1 air handling unit, etc., whereby schematics, panel terminal wiring, sequences of operation, hardware and component lists are grouped together without requiring cross reference to other parts of the data.

.4 Submit descriptions of the operating system and operator communication protocols and a complete list of point and controller names.

.5 Submit sample print-outs of all points (hardware only) listing, alarms, demand and energy logging.

.6 **[Submit proposed form of contract for service work.]**

.7 With reference to Architectural, Mechanical and Electrical Drawings, submit a layout of the Building Operator's room showing the most practical arrangement of the EMCS front end equipment. Show all dimensions and power requirements. Co-ordinate installation with other equipment i.e. fire alarm and security monitoring.

1.05 GUARANTEE

.1 Guarantee the control system and all components thereof free from defects in operating sequences, materials and workmanship for a period of **[one]** year of normal use and service from the date of certified acceptance by the Consultant - refer to warranties Section 20 05 05.

1.06 ACCEPTANCE

.1 Acceptance by the Consultant will be granted when:

.1 All components installed, operating and calibrated.
.2 DDC programming complete and operating personnel have received a minimum 4 hrs. of instructions.
.3 As-built drawings and operating instructions submitted.

1.07 INSTRUCTION, ADJUSTMENT AND "AS BUILT" DRAWINGS

.1 On completion of the Work, calibrate and adjust all components to operate as required. Provide three complete instruction manuals with "as constructed" control drawings and instruct the Owner's operating personnel in the operation and function of the system.

.2 Provide a minimum of 24 hrs. (6 - 4 Hr. sessions) instruction on EMCS operation to Owner's staff and 10 call-back sessions of 2 hrs. each during the first year of operation.

1.08 SERVICE CONTRACT

.1 Include in the tender price the cost for a "full service" contract on all base building control components, systems, and DDC system for 12 months commencing on the date of acceptance by the Consultant. This contract to include all required calibration, adjustments, and all other items required to keep the system in first class operating condition as would be recommended by the installer on an on-going year to year basis.

This contract is to be between the Owner directly and the installing Subtrade performing the Work of this Section. Present two copies of the form of contract for review on submission of shop drawings.

1.09 EMCS OPERATION SUMMARY

.1 The EMCS Operation Summary is a supplement to the drawings and the written sequence of operation.

.1 It is intended as a guide and clarification of requirements.
.2 It is not an I/O summary, but only a brief description of requirements for each type of system and unit component. The quantities of systems and components are shown on the drawings.
.3 It is the responsibility of this Section to determine quantities.

1.10 EMCS LIMITATIONS

.1 The use of Owner inaccessible software with **[proprietary]** EPROM or ROM CHIPS in field processing panels where EPROM burners are required **[and for which software agreements need be signed]** will not be accepted.

1.11 SHOP DRAWING

.1 Submit shop drawings for review in sufficient quantities to satisfy contractual requirements. Where shop drawings consist of printed catalogue sheets, submit at least ten (10) copies. Shop drawings pertain to each particular item as specified; show project and component name, item reference number, certified physical and performance data; and clearly indicate all applicable parts and accessories. Affix Contractor's "Approved" stamp on all copies of all shop drawings prior to their submittal to the Engineer for review. Approval stamp shows name of firm, date the approval was made and the checker's signature or initials. Should the above requirements not be adhered to, shop drawings submitted will be returned for proper re-submittal.

.2 Shop drawing review by the Engineer is for the sole purpose of ascertaining conformance with general design concept. This review means that the Engineer does not approve the detail design inherent in the shop drawings, responsibility for which remains with the Contractor submitting same, and such review shall not relieve the Contractor of his responsibility for errors or omission 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 co-ordination of the work of all subtrades.

.3 With reference to Architectural, Mechanical and Electrical Drawings, submit a layout showing the wiring system routing from EMCS front end equipment to all Field Processing Units (FPU), Local Control Units (LCU) and remote control devices of equipment supplied under Divisions 20, 21, 22, 23, and 25. Co-ordinate installation with other contractors to avoid interference of their equipment.

.4 Shop drawings (Adobe “PDF” format) shall show the following:

.1 Total Energy Management System communication diagram showing all EMCS components and layout of equipment.
.2 System Architectural schematics: Provide a complete drawing(s) which details all components of the monitoring and control system. Identify the individual type of controllers, communication buses and speeds, power sizes and distribution etc by location and name. Field devices need not be shown. Schematics must be integrated with the central operator’s computer for future reference.
.3 Schematic of Central Equipment showing sources of power, peripherals and connections, leased lines and connections, modems and connections, etc.
.4 Communication link diagram showing location of each FPU, LCU, power sources, systems connected, POT location, trunk conductors, modem location, etc.

.5 List of connected data points (input/output summaries) including FPU's to which they are connected and input/output devices (sensors, transducers, etc.).

.6 Drawings of each HVAC system showing all connected devices, all wiring connections between all components with terminal numbers, all data point addresses (connected and calculated) and operator notations. Wiring diagrams shall clearly designate between Divisions 23, 26 and Section 25 01 01 work. Provide a colour printed out of each graphic screen display for review and final written approval by the Owner.

.7 Documentation of all maintenance procedures for each system components including inspection, periodic preventive maintenance, fault diagnosis and repair or replacement of defective module. This shall include calibration, maintenance and repair of sensors, transmitters, transducers and panels plus diagnostics and repair or replacement of all system hardware.

.8 Damper schedules with construction details and dimensions. Identify dampers in accordance with specification and drawings.

.9 Specifications and data sheets for all control system components including relays, switches, thermostats, controllers, dampers, indicators, flow switches, sensors and similar components.

.10 Valve schedules with construction details, pressure drops and flows.

.11 Submit three (3) complete sequences of operation of the DDC systems in both program and written format.

.12 Data file assignments of each connected and calculated I/O point in both the ASC and PC work station.

.13 Energy management program parameters along with the I/O points assigned to each program.

.14 Technical specification data sheets of each system component and software module.

.15 Descriptive data, source codes and sequence of operation of all operating, user, and application software.

.16 Detail drawing showing dimensions and mounting techniques of both wall-mounted and free-standing versions of FPU's with built-in operator terminal pads.

.17 Detail drawings showing typical mounting methods for all sensors, transmitters and status indicators.

.18 Submit diskettes (including backup diskettes) containing up-to-date copies of the programs in each controller.

.5 Provide a copy of all “as-built” shop drawings in each of the Manuals specified. Provide an Operator’s manual consisting of instructions, program listings and control sequences.

.6 Shop Drawing must be approved before any materials are delivered or installed at site.”

1.12 RELATED WORK SPECIFIED ELSEWHERE

.1 Power wiring for all electric motors will be by Division 26 unless indicated otherwise.

.2 Electromagnetic starters with required number of ancillary contactors will be supplied and installed by Division 26 unless supplied as an integral part of equipment.

.3 [**Installation of control valves will be by Division 23, Heating, Ventilating and Air Conditioning. Supply will be by this Section unless supplied as an integral part of mechanical equipment i.e. humidistats.**]

.4 [**Installation of control dampers will be by Division 23. Supply will be by this Section. Note that some air handling equipment may have factory supplied motor operated dampers. Refer to Divisions 20, 21, 22, 23, 25 and Mechanical Equipment Schedules. Co-ordinate with Equipment suppliers of Divisions 20, 21, 22, 23, and 25.**]

.5 **[Supply and installation of combination smoke/fire dampers as detailed in Section 23 33 16 will be by Division 23, Heating Ventilation and Air Conditioning. Division 25 to provide actuators and controls for the combination dampers.]**

.6 **[Division 25 shall supply controllers and actuators of terminals to the manufactures for installation. Cost of factory installation of controller will be the terminal unit manufacturers. Refer to Division 23 for the requirement of unit controllers.]**

1.13 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 (server and browser for web-based systems).

.1 Graphic Display. A graphic with 20 dynamic points shall display with current data within 1 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 Configuration and Tuning Screens. Screens used for configuring, calibrating, or tuning points, PID loops, and similar control logic shall automatically refresh within 6 sec.
.4 Object Command. Devices shall react to command of a binary object within 2 sec. Devices shall begin reacting to command of an analog object within 2 sec.
.5 Alarm Response Time. An object that goes into alarm shall be annunciated at the workstation within 15 sec.
.6 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.
.7 Performance. Programmable controllers shall be able to completely execute DDC PID control loops at a frequency adjustable down to once per sec. Select execution times consistent with the mechanical process under control.
.8 Multiple Alarm Annunciations. Each workstation on the network (one only required initially) shall receive alarms within 5 sec of other workstations.
.9 Reporting Accuracy. System shall report values with minimum end-to-end accuracy listed in Table 1.
.10 Control Stability and Accuracy. Control loops shall maintain measured variable at setpoint within tolerances listed in Table 2.

1.14 AS BUILT DOCUMENTATION

.1 Prepare and submit five (5) copies of As Built and operating/maintenance manuals to the Engineer for review and approval.

.2 The BAS contractor shall provide a CD with each manual to include all of the As Built Documentation contained within the manual (fixture cuts, operating/maintenance procedures, warranties, letters, graphics, points lists, programming, sequences etc.) and shall also include As Built drawings in Autocad format.

1.15 WARRANTY

.1 Warrant labor and materials for specified control system free from defects for a period of 24 months after final acceptance. Control system failures during warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to Owner. Respond during normal business hours within 24 hours of Owner's warranty service request.

.2 Work shall have a single warranty date, even if Owner receives beneficial use due to early system start-up. If specified work is split into multiple contracts or a multi-phase contract, each contract or phase shall have a separate warranty start date and period.

.3 Provide updates to operator workstation or web server software, project-specific software, graphic software, database software, and firmware that resolve Contractor-identified software deficiencies at no charge during warranty period. If available, Owner can purchase in-warranty service agreement to receive upgrades for functional enhancements associated with above-mentioned items. Do not install updates or upgrades without Owner's written authorization.

.4 Exception: Contractor shall not be required to warrant reused devices except those that have been rebuilt or repaired. Installation labor and materials shall be warranted. Demonstrate operable condition of reused devices at time of Consultant's acceptance.

.5 Warranty periods for temperature controls and energy management systems (EMCS) to start on the date of verification of acceptance issued in writing by the [Consultant].

.6 The date of verification of acceptance is independent of Substantial Performance of the Work and may occur after certification of Substantial Performance.

.7 If the Consultant determines that equipment and systems operate satisfactorily at the end of final start-up, testing, and commissioning phase, Consultant will certify in writing that control system operation has been tested and accepted in accordance with the terms of this specification. Date of acceptance shall begin warranty period.

.8 Include verification of acceptance certificates with the maintenance and operating manuals in the appropriate sections.

PART 2 - PRODUCTS

2.01 DAMPERS

.1 Motorized Dampers are specified in Dampers, Section 23 33 10. Actuators are specified below.

2.02 ACTUATORS

.1 Sized to provide adequate power for opening, closing and modulating dampers or valves in specified time.

.2 Provide each actuator with a bracket for attaching to ductwork, building structure, or equipment. Do not install actuators in ducts or fresh air intakes.

.3 Provide electric low temperature protected actuators in unheated areas such as parking garages, ventilation shafts and transformer rooms and on any equipment located outdoors.

.4 Wherever possible, actuators to be provided to the original equipment manufacturer for factory installation (i.e. VAV terminal and fan manufacturers). Provide actuators to equipment manufacturer's specifications.

.5 All damper and valve actuators to be provided with spring return to normal position.

.6 For combination fire smoke dampers provide relays adjacent to the actuators for interface to fire alarm system by Division 26 Subcontractor. Wire relays to actuators. Co-ordinate with Division 26 subcontractor and provide instructions on wiring to achieve full open and full closed damper operation.

.7 Unless shown otherwise on drawings, actuators to be provided and set up such that all heating valves and return air dampers are normally open and cooling valves, exhaust and outdoor air dampers are normally closed.

.8 Actuators for Valves:

.1 Each automatic control valve shall be fitted with a “fail-safe” operator capable of tight shut-off against the differential imposed by the system.
.2 Valve actuators on valves 3 in. dia. and larger shall be provided with a manual position override.
.3 Floating point control of valves is not acceptable under any circumstances.
.4 **[The standard of acceptance shall be Belimo.]**

.9 Actuators for Dampers:

.1 All actuators for control dampers shall be electric type and be powered by a single phase AC 24V overload-proof synchronous motor.
.2 All actuators shall be direct-coupled type for both modulating and two position control dampers.
.3 All damper actuators shall be selected to operate maximum damper loads of 28 sq.ft. (2.6 sq.m.).
.4 Each actuator shall be “fail safe”, complete with external adjustable stops to limit the length of stroke in either direction and mounted on an adjustable bracket. Operating arms shall have double yoke linkages and double set of screws for fastening to the damper shaft.
.5 **[The standard of acceptance shall be Belimo.]**

2.03 WIRING

.1 Provide all electrical wiring and components required (of any voltage) within the temperature control system such as low limit protection, thermostats, alarms, refrigeration system components, relays and interlocks as required to achieve the control function specified in the schematic drawings and sequences of operation. This work to include wiring into prefabricated control circuits (as co-ordinated with the appropriate sub trade or supplier) of boilers, chillers, air cooled condensers, pump sets and fire alarm panels. Also provide suitably rated relays for single phase motors wired in series with manual starters where EMCS start/stop operation is required. Provide “Hand-Off-Auto” switch on relays.

2.04 VAV AIR HANDLING SYSTEMS

.1 Provide, for factory or field installation, all required actuators and controllers for the operation of variable volume components on supply and exhaust fans and factory assembled air handling units, and make all necessary field connections thereto. Provide in-factory co-ordination with VAV terminal and fan manufacturers.

.2 Provide actuators in the type, manufacture, and style as required by the equipment manufacturer's specifications.

.3 At the earliest opportunity during construction, test all actuators to ensure proper alignment and action.

.4 All VAV controllers for fan powered terminals to be connected to a 2 wire bus and provide outputs such as space temperature, air supply temperature, and actual measured air volume. Operator control over space temperature and minimum/maximum primary air volume set points to be achieved through head end equipment and portable command display device connected into an FPU and local sensor.

.1 For standard VAV terminals, provide identical features except air supply temperature may be deleted.

.5 Provide VAV controllers as follows:

.1 Non-volatile program and data storage utilizing EEPROM (volatile memory with battery back-up not acceptable).
.2 On-site reprogrammable (without use of special proprietary devices) through head end equipment and through portable command and display device via FPU and local sensor.
.3 With control power transformer and numbered terminals for connection to DDC 2 wire bus.
.4 All VAV unit primary air dampers to be fail in place.

2.05 NAMEPLATES

.1 Provide Lamicoid nameplates, 25mm x 550mm (1" x 22") at all control system devices to clearly indicate the service of a particular device. All manual switches, unless they come with standard nameplates, are labelled. All thermostats, thermometers and switches installed on all local panels shall be similarly labelled. Permanent painted stencil labels may be used on all controllers and relays mounted inside local panels, if so desired. Tape labels are not acceptable.

.2 All duct and pipe mounted sensors, ASC's, etc. are to be similarly labelled.

.3 Electronic-to-Pneumatic Transducers

.1 The device shall be sufficient to provide full scale operation of the pneumatic operator. The transducer shall provide linearity of 1% of full scale. Hysteresis and repeatability of 0.75% full scale or less. A 1-5V d.c. output feedback signal, proportional and linear to the 21-138 kPa output signal shall be provided. A gauge tap shall be provided to mount a pressure gauge for pressure output indication.
.2 Acceptable products:
.1 Kreuter manufacturing Company, Kreuter Marketing Canada E/I-P Transducer, with mounting hardware, and 0-20 psig pressure gauge.

.4 Control Relays

.1 Control relays are SPDT for control of electrical starters and equipment where shown on the control diagrams.
.2 Coil voltage matches the ASC. Contacts are rated a 5A to 120 VAC.
.3 Control relay contacts shall be rated for 150% of the loading application, Form C double pole contacts. The relay shall provide a minimum, one million operations and contain coil transient suppression devices and DDC output LED pilot. All relays shall be mounted on a separate relay base and in ventilated indoor locations.
.4 Acceptable products:
.1 CARLO GAVAZZI.
.2 FEME. Model Series M15, Pilot.
.3 Omron, HP rated, starter rated.

.5 Solid State Relays (SSR)

.1 SSR with opto-electronic coupler for 3-32 V d.c. turn on/off input control shall be provided. Relays shall be rated for the application and mounted on a properly sized heat sink in order to regulate relay temperatures below 25°C continuously.
.2 Acceptable products:
.1 Crydom.

PART 3 - EXECUTION

3.01 GENERAL

.1 The DDC controls project shall be performed in such a manner as to limit disruption of the normal daily operation of the building HVAC equipment. The work shall occur while the control system remains on-line in order to maintain a minimum level of comfort within the building. The Owner shall be notified about situations in which equipment will be off-line for extended periods of time during the project. The Contractor shall conduct all on-site work in conjunction with building operating staff to streamline the new system startup.

3.02 COMPONENTS

.1 Mount all controllers and relays within control panel cubicles. Mount exposed components for easy access and protect from damage.

.2 Cut-out mount switches and timers on control panel fronts.

.1 Identify all exposed components and equipment mounted on the control panel front with lamacoid nameplates screwed or pop-riveted in place. Identify instruments inside the cabinet with Dymo tape labels.

.2 Provide, on all equipment operated by EMCS, 50 x 100mm red lamacoid tags with white lettering held with screws or pop rivets, reading: "Warning This equipment may start at any time. Do not service without disconnecting power."

.3 Locate all local control panels as shown on the drawings or as directed by the Consultant.

.4 Provide electric freeze protection thermostats with averaging elements capable of sensitivity on any 300mm (12") portion. Mount element across coil face approximately 150mm (6") downstream of coil in rows 400mm (16") OC. Locate lowest row no higher than 1500 mm (6”) above bottom of coil. Mount thermostats side-by-side 1500mm (60") above floor on service side of unit.
Provide relay such that on low temperature shut-down, one button will reset control circuit. Label and locate button on service side of equipment.

.5 Mount CO detectors between 900 to 1200mm (3'- 0" to 4'- 0") above floor. Provide a lockable wire guard enclosure over unit. Provide field calibration by manufacturer's designated representative.

3.03 CO-ORDINATION

.1 Attend and assist in testing and commissioning the chiller, cooling tower, boiler and pumping systems.

.2 Attend and assist in testing and commissioning air handling and distribution systems.

.3 Set outdoor air dampers to minimum positions as verified by the air balancing specialist.

.4 Calibrate air volumes and temperatures at each VAV terminal as verified by the air balancing specialist.

.5 Attend and assist in commissioning, start-up and testing of fans and smoke/fire dampers.

3.04 WIRING

.1 Install all wiring in conduit and conform to CSA, ULC and local Code requirements as well as requirements as specified in Division 26 except as stipulated in following paragraph .2.

.2 EMCS 24 Volt Wiring:

.1 In ceiling spaces, approved plenum cable to be installed neatly clipped to structure in 8 foot intervals and run parallel and at right angles to building structural members. Plenum cable to be installed clear of any electrical or mechanical components requiring access or servicing.

.2 All EMCS wiring installed within walls and where exposed to be installed in conduit conforming to requirements of Division 26.

.3 All wiring in connection with the control system shall be furnished by the Contractor.

.4 All wiring shall conform to governing codes and shall be inspected by request of the Contractor for approval. The Contractor shall obtain and purchase all necessary permits as required.

3.05 LABELLING

.1 All control equipment is to be labelled with lamacoid plates with a designation corresponding to the specific system point description/label. All lamacoids shall be mechanically fastened to surfaces. Submit samples to the Owner for approval.

3.06 COMMISSIONING – DDC SYSTEMS

.1 Check the installation of each sensor, actuator and controlled device.

.2 Verify and record in as built OEM drawings the wiring of each I/O sensor and device as installed.

.3 Calibrate each sensor as required.

.4 Manually operate each output for every system with a portable Display Terminal supplied by the contractor for commissioning.

.5 Tune each control loop and print the response of trends for hard copy record. Identify correct PID parameters on all print outs.

.6 Verify all start/stop operations, e.g. “schedule control”, “Optimized control”, “unoccupied mode” setback.

.7 Verify all custom control programs and alarm functions.

.8 Perform end-to-end checks from an operator terminal to all sensors and actuators to verify system communications and control.

3.07 SEQUENCES OF OPERATION

.1 Room Temperature Set Points (adjustable):

Unless otherwise noted, the following are temperature set-points for conditioned spaces of general areas:

.1 “Occupied” heating: 22.2°C
.2 “Unoccupied” heating: 16.0°C
.3 “Occupied” cooling: 23.9°C
.4 “Unoccupied” cooling: 29.0°C

Unless otherwise noted, the following are temperature set-points for conditioned spaces of classroom areas with displacement diffusers and hot water piping:

.1 “Occupied” heating: 21.0°C
.2 “Unoccupied” heating: 18.3°C

.3 "Occupied" cooling: 25.0°C
.4 "Unoccupied" cooling: 26.6°C

3.08 CLEANING

.1 Do Cleaning in accordance with Section 20 05 05 - Mechanical Work General Instructions.

END OF SECTION 25 01 01