DIVISION 1 ()

DIVISION 21 (MECHANICAL – FIRE SUPPRESSION)

DIVISION 23 (MECHANICAL – HEATING, VENTILATING AND AIR CONDITIONING)

DIVISION 25 (CONTROLS)

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 All Sections

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 - Submittal Procedures.

.2 Special procedure submittals:

.1 Submit schedule of shutdowns or closure of active service or facility, including power and communications services.

1.3 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 - Closeout Submittals.

.2 Operation and maintenance data:

.1 Include, in the operation and maintenance manual, manufacturer's operating and maintenance instructions and recommended cleaning materials and methods.

.1 Submit operating and maintenance instructions for pre-bid or pre-purchased products or equipment.

1.4 WORK COVERED BY CONTRACT DOCUMENTS

.1 Work of this Contract comprises renovation of Archbishop Denis O' Connor, located at 80 Mandrake St, Ajax, ON L1S 5H4; and further identified as school.

1.5 CONTRACT METHOD

.1 Construct work under one stipulated price contract.

1.6 WORK BY OTHERS

.1 Cooperate with other Contractors carrying out their respective work.

.2 Coordinate work with other Contractors. If any part of the work of this Contract depends on work of another Contractor for its proper execution or result, promptly report, in writing, defects which may interfere with proper execution of the work to the Consultant.

1.7 CONTRACTOR USE OF PREMISES

.1 Access to the work site: Unrestricted use during summer vacation.

.2 Access to the work site: Limited access during school year

.1 Coordinate use of premises with the school board.

.2 Obtain and pay for additional storage or work areas needed for the work.

1.8 OWNER OCCUPANCY

.1 The Owner will occupy the premises during construction.

.2 Cooperate with Owner's requirements to schedule operations to minimize conflict and facilitate Owner's occupancy.

1.9 ASSIGNED CONTRACTS

.1 The Owner has issued Letter of Intent for pre-ordered products.

.2 Take responsibility for purchasing, handling, and installing pre-ordered products as if for other Contractor-supplied products.

.1 Install products in accordance with the appropriate technical sections.

.3 Execute contracts with assigned suppliers to require them to perform their work in accordance with the Contract Document.

.4 Include assigned contract values and costs of related work in the costs for purchase, delivery, installation, adjusting and finishing of pre-ordered materials in the Contract Amount.

.5 Schedule of Pre-Ordered Products:

.1 Refer to the Appendix for Intent to Award Letter complete with Schedule of Pre-Order Products

.6 Obtain necessary shop drawings from the HTS and coordinate installation. Expedite, receive, unload, install, connect, and test specified equipment. Warrant such work.

.7 Receive equipment free on board (F.O.B.), store, and maintain equipment until installation

1.10 ALTERATIONS, ADDITIONS OR REPAIRS TO EXISTING BUILDING

.1 Take responsibility for the care, custody, and control of property which is assigned to the Contractor for performance of the work.

.2 Take responsibility for the premises assigned to the Contractor for performance of the work.

.3 Make good damage to existing property caused by work of this Contract.

1.15 EXISTING SERVICES

.1 Notify the Consultant and utility companies of intended service interruptions and obtain required permissions.

.2 Provide the Consultant minimum 48 hours' notice when work involves breaking into, or connecting to, existing services. Provide the Consultant minimum 48 hours' notice for necessary interruption of mechanical or electrical services. Minimize duration of interruptions. Carry out work, at times as directed by governing authorities, with minimum disturbance to Owner]'s operations.

.3 Comply with reviewed schedule and provide notice to affected parties. Provide temporary services to maintain critical building services.

.4 Provide adequate bridging over trenches which cross sidewalks or roads to permit normal traffic.

.5 Protect, relocate, or maintain existing active services. When inactive services are encountered, cap off in manner approved by authorities having jurisdiction.

1.16 DOCUMENTS REQUIRED

.1 Maintain at project site, one copy of each document:

.1 Drawings.

.2 Specifications.

.3 Addenda.

.4 Site-specific health and safety plan and other related documents.

.5 WHMIS safety data sheets in accordance with Section 01 35 29 - Health, Safety, and Emergency Response Procedures.

.6 Reviewed construction progress Schedule.

.7 Reviewed shop drawings.

.8 Manufacturer's instructions.

.9 List of outstanding shop drawings.

.10 Change Orders.

.11 Change Directives.

.12 Other modifications to the Contract.

.13 Site inspection and test reports.

.14 Other specified documents.

PART 2 - PRODUCTS

2.1 NOT USED

.1 Not used.

PART 3 - EXECUTION

3.1 NOT USED

.1 Not used.

END OF SECTION 01 11 00

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 All Sections

1.2 ACCESS AND EGRESS

.1 Design, construct and maintain temporary "access to" and "egress from" work areas, including stairs, runways, ramps or ladders and scaffolding, independent of finished surfaces and in accordance with relevant municipal, provincial and other regulations.

1.3 USE OF SITE AND FACILITIES

.1 Execute work with least possible interference or disturbance to normal use of premises. Make arrangements with School Board to facilitate work as stated.

.2 Maintain existing services to building and provide for personnel and vehicle access.

.3 School Board will assign sanitary facilities for use by Contractor's personnel. Keep facilities clean.

.4 Use only elevators existing in building for moving workers and material.

.1 Protect walls of passenger elevators, to approval of School Board prior to use.

.2 Accept liability for damage, safety of equipment and overloading of existing equipment.

.5 Closures: protect work temporarily until permanent enclosures are completed.

1.4 ALTERATIONS, ADDITIONS OR REPAIRS TO EXISTING BUILDING

.1 Execute work with least possible interference or disturbance to building operations and normal use of premises. Arrange with School Board to facilitate execution of work.

1.5 EXISTING SERVICES

.1 Provide for personnel, pedestrian and vehicular traffic.

.2 Construct barriers in accordance with Section 01 56 00 - Temporary Barriers and Enclosures.

1.6 SPECIAL REQUIREMENTS

.1 Carry out noise generating Work Monday to Friday from [9:00] to [17:00] hours.

.2 Submit schedule in accordance with Section 01 32 16.19 - Construction Progress Schedule - Bar (Gantt) Chart.

.3 Ensure Contractor's personnel employed on site become familiar with and obey regulations including safety, fire, traffic and security regulations.

.4 Keep within limits of work and avenues of ingress and egress.

1.7 SECURITY

.1 Where security has been reduced by Work of Contract, provide temporary means to maintain security.

.2 Security clearances:

.1 Personnel employed on this project will be subject to security check. Obtain clearance, as instructed, for each individual who will require to enter premises.

.2 Obtain requisite clearance, as instructed, for each individual required to enter premises.

.3 Personnel will be checked daily at start of work shift and provided with pass which must be worn at all times. Pass must be returned at end of work shift and personnel checked out.

1.8 BUILDING SMOKING ENVIRONMENT

.1 Comply with smoking restrictions. Smoking is not permitted.

PART 2 - PRODUCTS

2.1 NOT USED

.1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED

.1 Not Used.

END OF SECTION 01 14 00

PART 1 - GENERAL

1.1 REFERENCE STANDARDS

.1 Owner/Contractor Agreement.

.2 Canadian Construction Documents Committee (CCDC)

.1 CCDC 2-2020, Stipulated Price Contract.

1.2 APPLICATIONS FOR PROGRESS PAYMENT

.1 Refer to CCDC 2

.2 Make applications for payment on account as monthly as Work progresses.

.3 Date applications for payment last day of agreed monthly payment period and ensure amount claimed is for value, proportionate to amount of Contract, of Work performed and Products delivered to Place of Work at that date.

.4 Submit to Consultant, at least 28 days before first application for payment. Schedule of values for parts of Work, aggregating total amount of Contract Price, to facilitate evaluation of applications for payment.

1.3 SCHEDULE OF VALUES

.1 Refer to CCDC 2.

.2 Provide schedule of values supported by evidence as Consultant may reasonably direct and when accepted by Consultant, be used as basis for applications for payment.

.3 Include statement based on schedule of values with each application for payment.

.4 Support claims for products delivered to Place of Work but not yet incorporated into Work by such evidence as Consultant may reasonably require to establish value and delivery of products.

1.4 PREPARING SCHEDULE OF UNIT PRICE TABLE ITEMS

.1 Make form of submittal parallel to Schedule of Values, with each line item identified same as line item in Schedule of Values. Include in unit prices only:

.1 Cost of material.

.2 Delivery and unloading at site.

.3 Sales taxes.

.4 Installation, overhead and profit.

.2 Ensure unit prices multiplied by quantities given equal material cost of that item in Schedule of Values.

1.5 PROGRESS PAYMENT

.1 Refer to CCDC 2.

.2 Consultant will issue to Owner, no later than 10 days after receipt of an application for payment, certificate for payment in amount applied for or in such other amount as Consultant determines to be due. If Consultant amends application, Consultant will give notification in writing giving reasons for amendment.

1.6 SUBSTANTIAL PERFORMANCE OF WORK

.1 Refer to CCDC 2.

.2 Prepare and submit to Consultant comprehensive list of items to be completed or corrected and apply for a review by Consultant to establish Substantial Performance or substantial performance of designated portion of Work when Work is substantially performed if permitted by lien legislation applicable to Place of Work designated portion which Owner agrees to accept separately is substantially performed. Failure to include items on list does not alter responsibility to complete Contract.

.3 No later than 10 days after receipt of list and application, Consultant will review Work to verify validity of application, and no later than 7 days after completing review, will notify Contractor if Work or designated portion of Work is substantially performed.

.4 Consultant: state date of Substantial Performance of Work or designated portion of Work in certificate.

.5 Immediately following issuance of certificate of Substantial Performance of Work, in consultation with Consultant, establish reasonable date for finishing Work.

1.7 PAYMENT OF HOLDBACK UPON SUBSTANTIAL PERFORMANCE OF WORK

.1 Refer to CCDC 2.

.2 After issuance of certificate of Substantial Performance of Work:

.1 Submit application for payment of holdback amount.

.3 After receipt of application for payment and sworn statement, Consultant will issue certificate for payment of holdback amount.

.4 Where holdback amount has not been placed in a separate holdback account, Owner will, 10 days prior to expiry of holdback period stipulated in lien legislation applicable to Place of Work, place holdback amount in bank account in joint names of Owner and Contractor.

.5 Amount authorized by certificate for payment of holdback amount is due and payable on day following expiration of holdback period stipulated in lien legislation applicable to Place of Work. Where lien legislation does not exist or apply, holdback amount is due and payable in accordance with other legislation, industry practice, or provisions which may be agreed to between parties. Owner may retain out of holdback amount sums required by law to satisfy liens against Work or, if permitted by lien legislation applicable to Place of Work, other third party monetary claims against Contractor which are enforceable against Owner.

1.8 PROGRESSIVE RELEASE OF HOLDBACK

.1 [Refer to CCDC 2].

.2 Where legislation permits, if Consultant has certified that Work of subcontractor or supplier has been performed prior to Substantial Performance of Work, Owner will pay holdback amount retained for such subcontract Work, or products supplied by such supplier, on day following expiration of holdback period for such Work stipulated in lien legislation applicable to Place of Work.

.3 In addition to provisions of preceding paragraph, and certificate wording, ensure that such subcontract Work or products is protected pending issuance of final certificate for payment and be responsible for correction of defects or Work not performed regardless of whether or not such was apparent when such certificates were issued.

1.9 FINAL PAYMENT

.1 Refer to CCDC 2.

.2 Submit application for final payment when Work is completed.

.3 Consultant will, no later than 10 days after receipt of application for final payment, review Work to verify validity of application. Consultant will give notification that application is valid or give reasons why it is not valid, no later than 7 days after reviewing Work.

.4 Consultant will issue final certificate for payment when application for final payment is found valid.

PART 2 - PRODUCTS

2.1 NOT USED

.1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED

.1 Not Used.

END OF SECTION 01 29 00

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 All Sections.

1.2 ADMINISTRATIVE

.1 Schedule and administer project meetings throughout the progress of the work at the call of Consultant.

.2 Prepare agenda for meetings.

.3 Distribute written notice of each meeting four days in advance of meeting date to School Board and Consultant.

.4 Provide physical space and make arrangements for meetings.

.5 Preside at meetings.

.6 Record the meeting minutes. Include significant proceedings and decisions. Identify actions by parties.

.7 Reproduce and distribute copies of minutes within two days after meetings and transmit to meeting participants and, affected parties not in attendance.

.8 Representative of Contractor, Subcontractor and suppliers attending meetings will be qualified and authorized to act on behalf of party each represents.

1.3 PRECONSTRUCTION MEETING

.1 Within 15 days after award of Contract, request a meeting of parties in contract to discuss and resolve administrative procedures and responsibilities.

.2 School Board, Consultant, Contractor, major Subcontractors, field inspectors and supervisors will be in attendance.

.3 Establish time and location of meeting and notify parties concerned minimum 10 days before meeting.

.4 Incorporate mutually agreed variations to Contract Documents into Agreement, prior to signing.

.5 Agenda to include:

.1 Appointment of official representative of participants in the Work.

.2 Schedule of submission of shop drawings, samples, colour chips. Submit submittals in accordance with Section 01 33 00 - Submittal Procedures.

.3 Requirements for temporary facilities, site sign, offices, storage sheds, utilities, fences in accordance with Section 01 52 00 - Construction Facilities.

.4 Delivery schedule of specified equipment.

.5 Site security in accordance with Section 01 56 00 - Temporary Barriers and Enclosures.

.6 Proposed changes, change orders, procedures, approvals required, mark-up percentages permitted, time extensions, overtime, administrative requirements.

.7 Owner provided products.

.8 Record drawings in accordance with Section 01 33 00 - Submittal Procedures.

.9 Maintenance manuals in accordance with Section 01 78 00 - Closeout Submittals.

.10 Take-over procedures, acceptance, warranties in accordance with Section 01 78 00 - Closeout Submittals.

.11 Monthly progress claims, administrative procedures, photographs, hold backs.

.12 Appointment of inspection and testing agencies or firms.

.13 Insurances, transcript of policies.

1.4 PROGRESS MEETINGS

.1 During course of Work and 2 weeks prior to project completion, schedule progress meetings monthly.

.2 Contractor, major Subcontractors involved in Work and Consultant and Owner are to be in attendance.

.3 Notify parties minimum 5 days prior to meetings.

.4 Record minutes of meetings and circulate to attending parties and affected parties not in attendance within 2 days after meeting.

.5 Agenda to include the following:

.1 Review, approval of minutes of previous meeting.

.2 Review of Work progress since previous meeting.

.3 Field observations, problems, conflicts.

.4 Problems which impede construction schedule.

.5 Review of off-site fabrication delivery schedules.

.6 Corrective measures and procedures to regain projected schedule.

.7 Revision to construction schedule.

.8 Progress schedule, during succeeding work period.

.9 Review submittal schedules: expedite as required.

.10 Maintenance of quality standards.

.11 Review proposed changes for affect on construction schedule and on completion date.

.12 Other business.

PART 2 - PRODUCTS

2.1 NOT USED

.1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED

.1 Not Used.

END OF SECTION 01 31 19

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 All Sections

1.3 ADMINISTRATIVE REQUIREMENTS

.1 Submit to Consultant submittals listed for review. Submit promptly and in orderly sequence to not cause delay in Work. Failure to submit in ample time is not considered sufficient reason for extension of Contract Time and no claim for extension by reason of such default will be allowed.

.2 Do not proceed with Work affected by submittal until review is complete.

.3 Present shop drawings, product data, samples and mock-ups in SI Metric units.

.4 Where items or information is not produced in SI Metric units converted values are acceptable.

.5 Review submittals before submission to Consultant. This review represents that necessary requirements have been determined and verified, or will be, and that each submittal has been checked and coordinated with requirements of Work and Contract Documents. Submittals not stamped, signed, dated and identified as to specific project will be returned without being examined and considered rejected.

.6 Notify Consultant, in writing at time of submission, identifying deviations from requirements of Contract Documents stating reasons for deviations.

.7 Verify site measurements and affected adjacent Work are coordinated.

.8 Contractor's responsibility for errors and omissions in submission is not relieved by Consultant's review of submittals.

.9 Contractor's responsibility for deviations in submission from requirements of Contract Documents is not relieved by Consultant review.

.10 Keep one reviewed copy of each submission on site.

1.4 SHOP DRAWINGS AND PRODUCT DATA

.1 [Refer to CCDC 2.

.2 The term "shop drawings" means drawings, diagrams, illustrations, schedules, performance charts, brochures and other data which are to be provided by Contractor to illustrate details of a portion of Work.

.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 coordinated, regardless of Section under which adjacent items will be supplied and installed. Indicate cross references to Contract drawings and specifications.

.4 Allow 5 days for Consultant's review of each submission.

.5 Adjustments made on shop drawings by Consultant are not intended to change Contract Price. If adjustments affect value of Work, state such in writing to Consultant before to proceeding with Work.

.6 Make changes in shop drawings as Consultant may require, consistent with Contract Documents. When resubmitting, notify Consultant in writing of revisions other than those requested.

.7 Accompany submissions with transmittal letter containing:

.1 Date.

.2 Project title and number.

.3 Contractor's name and address.

.4 Identification and quantity of each shop drawing, product data, and sample.

.5 Other pertinent data.

.8 Submissions to include:

.1 Date and revision dates.

.2 Project title and number.

.3 Name and address of:

.1 Subcontractor.

.2 Supplier.

.3 Manufacturer.

.4 Contractor's stamp, signed by Contractor's authorized representative certifying approval of submissions, verification of site measurements and compliance with Contract Documents.

.5 Details of appropriate portions of Work as applicable:

.1 Fabrication.

.2 Layout, showing dimensions, including identified site dimensions and clearances.

.3 Setting or erection details.

.4 Capacities.

.5 Performance characteristics.

.6 Standards.

.7 Operating weight.

.8 Wiring diagrams.

.9 Single line and schematic diagrams.

.10 Relationship to adjacent work.

.9 After Consultant's review, distribute copies.

.10 Submit electronic copy of shop drawings for each requirement requested in specification Sections and as Consultant may reasonably request.

.11 Submit electronic copies of product data sheets or brochures for requirements requested in specification Sections and as requested by Consultant where shop drawings will not be prepared due to standardized manufacture of product.

.12 Submit electronic copies of test reports for requirements requested in specification Sections and as requested by Consultant.

.1 Report signed by authorized official of testing laboratory that material, product or system identical to material, product or system to be provided has been tested in accord with specified requirements.

.2 Testing must have been within 3 years of date of Contract award for project.

.13 Submit electronic copies of certificates for requirements requested in specification Sections and as requested by Consultant.

.1 Statements printed on manufacturer's letterhead and signed by responsible officials of manufacturer of product, system or material attesting that product, system or material meets specification requirements.

.2 Certificates must be dated after award of Contract complete with project name.

.14 Submit electronic copies of manufacturers instructions for requirements requested in specification Sections and as requested by Consultant.

.1 Pre-printed material describing installation of product, system or material, including special notices and Safety Data Sheets concerning impedances, hazards and safety precautions.

.15 Documentation of the testing and verification actions taken by manufacturer's representative to confirm compliance with manufacturer's standards or instructions.

.16 Submit electronic copies of Operation and Maintenance Data for requirements requested in specification Sections and as requested Consultant.

.17 Delete information not applicable to project.

.18 Supplement standard information to provide details applicable to project.

.19 If upon review by Consultant, no errors or omissions are discovered or if only minor corrections are made, copies will be returned and fabrication and installation of Work may proceed. If shop drawings are rejected, noted copy will be returned and resubmission of corrected shop drawings, through same procedure indicated above, must be performed before fabrication and installation of Work may proceed.

1.8 CERTIFICATES AND TRANSCRIPTS

.1 Immediately after award of Contract, submit Workers' Compensation Board status.

.2 Submit transcription of insurance immediately after award of Contract.

PART 2 - PRODUCTS

2.1 NOT USED

.1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED

.1 Not Used.

END OF SECTION 01 33 00

PART 1 - GENERAL

1.1 DEFINITIONS

.1 Hot works: Work involving open flames or producing heat or sparks, including cutting, welding, soldering, brazing, grinding, adhesive bonding, roofing operations, thermal spraying and thawing pipes, and other similar operations.

.2 Regulatory authority: Governmental agency or other authority which has jurisdiction over the matters in question.

1.2 REFERENCE STANDARDS

.1 CSA Group (CSA):

.1 CSA Z1002:12, Occupational health and safety — Hazard identification and elimination and risk assessment and control

.2 Employment and Social Development Canada (ESDC):

.1 R.S.C., 1985, c. L 2, Canada Labour Code

.3 Government of Ontario:

.1 R.S.O. 1990, C. 01 Occupational Health and Safety Act

.4 Health Canada (HC):

.1 R.S.C. 1985, c. H-3, Hazardous Products Act

.2 SOR/2015 17, Hazardous Products Regulations

1.3 ADMINISTRATIVE REQUIREMENTS

.1 File notice of the project with regulatory authorities prior to beginning work.

.2 Pre-construction safety meeting: Conduct a site meeting in accordance with Section 01 31 19 - Project Meetings and attended by the Consultant and Subcontractors to:

.1 Verify project health and safety requirements.

.2 Review known or foreseeable health or safety hazards.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 - Submittal Procedures.

.2 Site-specific health and safety plan:

.1 Include, at minimum:

.1 Documentation requirements in accordance with CSA Z1002.

.2 On-site contingency and emergency response plans: Address standard operating procedures to be implemented during emergency situations.

.2 Submit minimum 10 Working Days before beginning work at the work site.

.1 The School Board may respond if concerns are noted.

.2 Resubmit, with noted corrections, of deficiencies or concerns before beginning work at the work site.

.3 Submit electronic copies of health and safety inspection reports submitted to regulatory authorities.

.4 Submit electronic copies of reports or directions issued by regulatory authorities.

.5 Submit electronic copies of incident and accident reports.

.6 Submit electronic copies of Workplace Hazardous Materials Information System (WHMIS) Safety Data Sheets (SDSs) in accordance with WORKPLACE HAZARDOUS MATERIAL INFORMATION SYSTEM in this section.

1.5 REGULATORY REQUIREMENTS

.1 Comply with Section 01 41 00 - Regulatory Requirements.

.2 Comply with the Canada Labour Code and related regulations.

.3 Comply with the Government of Ontario's Occupational Health and Safety Act and related regulations.

1.6 HEALTH AND SAFETY COORDINATOR

.1 Appoint a competent and authorized representative as health and safety coordinator to:

.1 Conduct health and safety training sessions; prevent people or persons without required training from entering the work site.

.2 Develop, enforce, and monitor the site-specific health and safety plan.

.3 Be on site during execution of the work.

.2 Qualifications:

.1 Individual with working knowledge of occupational safety and health regulatory requirements and known or foreseeable hazards related to the work.

1.7 SAFETY ASSESSMENT

.1 Perform site-specific safety hazard assessment in accordance with CSA Z1002.

.2 Work at site is expected to involve:

.1 General construction hazards.

.2 Working at heights.

.3 Working in enclosed spaces.

.4 Contact with asbestos-containing materials.

.5 Contact with lead-based paints.

.6 Contact with polychlorinated biphenyl (PCB).

.7 Contact with mould.

.3 Develop written site-specific health and safety plan, referencing the project specifications and based on hazard assessment, before beginning work at the work site.

1.8 GENERAL REQUIREMENTS

.1 Prioritize safety and health of the public and site personnel and protection of environment over cost and schedule considerations for the work.

.2 Protect health and safety of people or persons on site or adjacent to the site, safety of property on site or adjacent to the site, people or persons adjacent to site and environment to extent that they may be affected by the work.

.3 Assume the role of the constructor in accordance with the Government of Ontario's Occupational Health and Safety Act and related regulations.

.4 Comply with and enforce compliance by employees with safety requirements of the Contract Documents, regulatory requirements, and the site-specific health and safety plan.

.5 Provide proper site separation and identification in accordance with Section 01 56 00 - Temporary Barriers and Enclosures.

.6 Post applicable documents, articles, notices, and orders in conspicuous location on site in accordance with regulatory requirements.

.7 Provide first aid facilities and an accident prevention program in accordance with regulatory requirement.

.8 Provide appropriate emergency facilities, as specified in SDSs, where workers might be exposed to contact with chemicals, including eye-wash facilities and emergency showers.

.1 Train workers in use of emergency equipment.

.9 Provide appropriate personal protective equipment as specified in SDSs.

.1 Properly fit workers for personal protective equipment.

.2 Train workers in care, use, and maintenance of personal protective equipment.

1.9 FIRE SAFETY REQUIREMENTS

.1 Comply with National Fire Code of Canada (NFC), Section 5.2., Hot Works, and Section 5.6., Construction and Demolition Sites.

.2 Comply with the Owner's hot work management program; obtain hot work permits as required.

.3 Ventilate areas of hot work by use of suitable portable supply and exhaust fans.

.4 Ventilate hot work in enclosed spaces in accordance with Section 01 51 00 - Temporary Utilities.

.5 Provide continuous fire watch during hot work and for minimum 1 hour after. Perform final visual inspection after fire watch completion or 4 hours after completion of the work.

.1 Use thermal scanners or infrared thermometers to take temperature readings if visual inspection is impeded by obstructions.

.6 Burning rubbish or construction waste materials: In accordance with Section 01 35 43 - Environmental Procedures.

1.10 UNFORSEEN HAZARDS

.1 When unforeseen or peculiar safety-related factors, hazards, or conditions occur during the work, follow procedures in place in accordance with employees' rights to refuse work and other regulatory requirements. Advise the health and safety coordinator, School Board and Consultant verbally and in writing.

1.11 WORKPLACE HAZARDOUS MATERIAL INFORMATION SYSTEM

.1 Provide products that comply with Hazardous Products Regulations and other regulatory requirements regarding use, handling, labelling, storage, and disposal of hazardous materials.

.2 Deliver copies of applicable SDSs to the work site. Provide SDSs in compliance with Hazardous Products Regulations for hazardous products that will be used in the work. Locate SDSs in accessible locations for workers and visitors throughout the site, bound and organized in binders.

.1 Maintain access to current SDSs on site at all times.

.3 Deliver hazardous products to site only after delivery of acceptable SDSs.

.4 Train workers required to use or work in close proximity to hazardous products in accordance with regulatory requirements.

.5 Label controlled products at work site in accordance with Hazardous Products Regulations and other regulatory requirements.

1.12 OVERLOADING

.1 Prevent loading any part of the structure during the construction with a load greater than it is calculated to bear safely when complete. Ensure temporary supports are as strong as permanent supports. Prevent placing loads on concrete floors and roofs until they have attained their permanent set.

1.15 POWDER ACTUATED DEVICES

.1 Obtain written authorization from the School Board before using powder actuated devices.

1.16 CORRECTION OF NON-COMPLIANCE

.1 Immediately address health and safety non-compliance issues identified by regulatory authorities or by the School Board and Consultant.

.2 Submit written reports of actions taken to correct non-compliance.

.3 The School Board Consultant may stop work if non-compliance is not corrected.

PART 2 - PRODUCTS

2.1 NOT USED

.1 Not used.

PART 3 - EXECUTION

3.1 NOT USED

.1 Not used.

END OF SECTION 01 35 29

PART 1 - GENERAL

1.1 SUMMARY

.1 This Section references laws, bylaws, ordinances, rules, regulations, codes, orders of Authority Having Jurisdiction (AHJ), and other legally enforceable requirements applicable to the Work and that are or become enforced during performance of the Work.

1.2 RELATED REQUIREMENTS

.1 List other Sections that are referenced in this Section that contain specific information that the reader might expect to find in this Section, but is specified elsewhere. Typically, this list does not include Division 00 or Division 01 Sections.

1.3 DEFINITIONS

.1 Reference Standards: Means consensus standards, trade association standards, guides, and other publications expressly referenced in the Contract Documents.

1.4 REFERENCE STANDARDS AND REFERENCE DOCUMENTS

.1 If specified referenced standards do not indicate an edition or version, the latest edition or revision issued by the publisher at the time of bid closing shall apply, except as follows:

.1 If a particular edition or revision date of a specified standard is referenced in an applicable code or other regulatory requirement, the edition or version in the regulatory reference shall apply.

.2 The specified reference standards establish minimum requirements. If Contract Documents indicate requirements that conflict with a reference standard, the more stringent requirements shall apply.

.3 If multiple reference standards are specified and the standards establish different requirements, the most stringent requirement shall apply.

.4 In case of discrepancy or uncertainties, refer to Consultant for interpretation or clarification.

1.5 CODES

.1 Building Code: Perform Work in accordance with the Ontario Building Code 2024 including amendments up to the time of bid closing and other codes of provincial or local application.

.2 If there is a conflict or discrepancy between codes, the most stringent requirements shall apply.

.3 Specific design and performance requirements listed in Specifications and indicated on Drawings may exceed minimum requirements established by referenced Codes; these requirements will govern over the minimum requirements listed in the referenced Codes.

1.6 FEES

.1 Regulatory Requirements: Except as otherwise specified, Contractor shall apply for, obtain, and pay fees associated with permits, licenses, certificates, and approvals required by regulatory requirements and Contract Documents, based on General Conditions of Contract and the following:

.1 Regulatory requirements and fees in force at the time of bid closing, and

.2 A change in regulatory requirements or fees scheduled to become effective after the time of bid closing and of which public notice has been given before the time of bid closing.

PART 2 - PRODUCTS

2.1 PERMIT REQUIREMENTS

.1 Development Permit: Owner has applied for, obtained, and paid for development permit.

.2 Building Permit:

.1 Owner has applied for and will be paying for building permit. [Contractor] is responsible for obtaining or coordinating other permits required for Work and its various parts.

.2 Contractor shall display building permit and other permits in a conspicuous location at the Place of the Work.

.3 Occupancy Permits:

.1 Contractor shall apply for, obtain, and pay for occupancy permits, including partial occupancy permits where required by AHJ.

.2 Contractor shall correct deficiencies in accordance with Consultant's instructions. If a deficiency is not corrected, the Owner reserves the right to make correction and charge Contractor for costs incurred.

.3 Contractor shall turn occupancy permits over to Owner.

PART 3 - EXECUTION

3.1 NOT USED

.1 Not Used.

END OF SECTION 01 41 00

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 All Sections

1.2 DEFINITIONS

.1 Quality Assurance: Procedures for preventing defects and deficiencies before and during execution of the Work.

.2 Quality Audit: Systematic and independent examination to determine whether quality requirements have been fulfilled as planned. A quality audit will examine processes, products and services to determine if they have been implemented effectively to achieve their specified objective.

1.3 REFERENCE STANDARDS

.1 ASTM International (ASTM):

.1 ASTM E329-20, Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection

.2 International Organization for Standardization (ISO):

.1 ISO 9001:2015, Quality Management Systems – Requirements

1.4 SECTION INCLUDES

.1 This Section describes administrative and procedural requirements for proactive Contractor activities to assure the quality of construction before and during execution of the Work.

1.5 ADMINISTRATIVE REQUIREMENTS

.1 Contractor is responsible for self-performed testing and inspections and submittal of test reports to Owner.

1.6 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 – Submittal Procedures.

1.7 QUALIFICATIONS

.1 Manufacturers' Qualifications:

.1 Specializes in manufacturing the products specified in the technical Section of the Project's construction specification.

.2 minimum 3 years documented experience with a record of successful performance

.2 Suppliers' Qualifications:

.1 authorized to distribute manufacturer's products

.2 has capacity to supply required products without delaying the Project

.3 Fabricators' Qualifications:

.1 experienced in producing products required for this Project

.2 successful record of in-service performance

.3 sufficient production capacity to fabricate required products without delaying the Project

.4 Installer Qualifications:

.1 firm or individual experienced in design and installation, application, and erection of materials to the extent required for this Project

.2 successful record of in-service performance

.5 Testing and Inspecting Agency Qualifications:

.1 accredited organizations by the Standards Council of Canada for testing and inspection

.2 capable of reliably performing testing of building products and inspections of construction activities in accordance with ISO 9001 and ASTM E329.

.6 Licensed Professionals Qualifications:

.1 individual registered or licensed to practice their respective design profession as defined by the statutory requirements of the professional registration laws of the state or jurisdiction in which the project is to be constructed.

1.8 CERTIFICATIONS

.1 Ensure that certification of products, processes, and systems includes physical and examination testing as specified in ASTM E329 and ISO 9001 to confirm compliance with Specifications requirements.

1.9 COORDINATION

.1 Coordinate and schedule tests and inspections with accredited testing inspection agencies as indicated in Contract Documents.

.2 Coordinate testing and inspections schedule with Subcontractor, testing agencies, and other affected parties.

PART 2 - PRODUCTS

2.1 NOT USED

.1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED

.1 Not Used.

END OF SECTION 01 43 00

PART 1 - GENERAL

1.1 SUMMARY

.1 This Section describes administrative and procedural requirements for reactive activities to verify that completed Work conforms to Contract Documents requirements.

.2 Having inspection and testing agencies by Contractor [or Owner] does not relieve the Contractor of their responsibility to perform Work in accordance with Contract Documents.

1.2 RELATED REQUIREMENTS

.1 All Sections

1.3 ADMINISTRATIVE REQUIREMENTS

.1 Allow and coordinate access to Work on site, manufacturing off site, and fabrication off site with inspection and testing agencies.

.2 Retain and pay for inspection and testing that are designated for Contractor's own quality control plan, and when testing and inspection are required by AHJ.

.3 Give advanced notice to Consultant and to each inspection/testing agency for inspection and testing required by Contract Documents or by AHJ.

.4 In advance of each test, notify appropriate agency Consultant in the order that attendance arrangements can be made.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 – Submittal Procedures.

.2 Submit schedule of testing and inspection activities to Consultant, applicable Subcontractors, testing agencies, and other affected parties. Include the following:

.1 List each testing and inspection agency

.2 Identify types of tests and inspections for each agency, and cross reference to applicable specification Section number-title in Contract Documents

.3 Description of test and inspection

.4 Identify applicable reference standard

.5 Identify test and inspection method

.6 Indicate number of each test and inspection required

.3 Submit one digital copy of each quality assurance inspection and test report to Consultant, except where a technical specification Section indicates otherwise.

.4 Submit reports for inspection and testing required by Contract Documents or by AHJ and performed by Contractor-retained inspection and testing agencies within 10 days after inspection or test is completed, except where a technical specification Section indicates a different time period.

.5 Submit one digital copy of each quality control inspection and test report to Consultant, except where a technical specification Section indicates otherwise.

.6 Deliver copies of quality control reports to Subcontractor of work being inspected or tested.

1.5 TESTING AND INSPECTION SERVICES

.1 Owner will retain and pay for independent inspection and testing agencies to inspect, test, or perform other quality control reviews of parts of the work, except where indicated otherwise.

.2 Provide equipment required for executing inspection and testing by appointed agencies.

.3 Correct defects and deficiencies when they are revealed during inspection or testing as advised by Consultant at no change to Contract Price or Contract Time. Pay costs for retesting and re-inspection. Appointed agency will request additional inspections or tests to ensure full degree of defects or deficiencies are revealed and corrected.

.4 Quality control testing and inspection reports to include the following:

- .1 Project name and number
- .2 Testing/Inspection agency's name, address, telephone number, and website
- .3 Date of issuing report
- .4 Dates and locations of tests, inspections, or samples
- .5 Description of the Work and test and inspection method
- .6 Numbers and titles of associated specification Sections
- .7 Test and inspection data and interpretation of test results (e.g., pass or fail)
- .8 Ambient conditions at time of test, inspection, or sampling
- .9 Recommendations on re-testing and re-inspecting, if applicable

PART 2 - PRODUCTS

2.1 NOT USED

.1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED

.1 Not Used.

END OF SECTION 01 45 00

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 All Sections

1.2 REFERENCE STANDARDS

.1 ULC Standards (ULC):

.1 CAN/ULC-S1001, Standard for Integrated Systems Testing of Fire Protection and Life Safety Systems

1.3 ADMINISTRATIVE REQUIREMENTS

.1 Acceptance of Work Procedures:

.1 Contractor's inspection: Conduct inspection of Work, identify deficiencies and defects, and repair as required to conform to Contract Documents.

.1 Notify the Consultant in writing of satisfactory completion of Contractor's inspection and submit verification that corrections have been made.

.2 Request Consultant's review.

.2 Consultant's review:

.1 Consultant and Contractor to review Work and identify deficiencies and defects.

.2 Contractor to correct Work as directed.

.3 Completion tasks: Submit written certificates in English that tasks have been performed as follows:

.1 Work: Completed and inspected for compliance with Contract Documents.

.2 Defects: Corrected.

.3 Deficiencies: Completed.

.4 Equipment and systems: Tested, adjusted and balanced and fully operational.

.5 Verification letter required to confirm integrated systems testing for fire protection and life safety systems has been successfully completed in accordance with CAN/ULC-S1001.

.6 Operation of systems: Demonstrated to Owner's

.7 Work: Complete and ready for final review.

.4 Final review:

.1 When completion tasks are done, request final review of Work by the Consultant, and Contractor.

.2 When Work is incomplete according to the Consultant, and authorized agencies, complete outstanding items and request an additional review.

.5 Declaration of Substantial Performance: When the Consultant considers deficiencies and defects corrected and requirements of Contract substantially performed, make application for Certificate of Substantial Performance.

.6 Commencement of lien and warranty periods: The date of Owner's acceptance of submitted declaration of Substantial Performance will be the date for commencement of warranty period and commencement of lien period, unless otherwise required by the lien statute at the Place of the Work.

.7 Final payment:

.1 When the Consultant considers final deficiencies and defects corrected and requirements of Contract met, make application for final payment.

.2 When the Work is deemed incomplete by the Consultant, complete outstanding items and request an additional review.

.8 Payment of holdback: After issuance of Certificate of Substantial Performance of Work, submit application for payment of holdback amount in accordance with the contractual agreement.

PART 2 - PRODUCTS

2.1 NOT USED

.1 Not used.

PART 3 - EXECUTION

3.1 NOT USED

.1 Not used.

END OF SECTION 01 77 00

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 All Sections

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Two weeks before Substantial Performance of the Work, submit to the Consultant final copies of operating and maintenance manuals in English.

.3 Provide spare parts, maintenance materials and special tools of same quality and manufacture as products provided in Work.

.4 Provide evidence, if requested, for type, source and quality of products supplied.

1.3 FORMAT

.1 Organize data as instructional manual.

.2 Binders: Vinyl, hard covered, 3 'D' ring, loose leaf [219 x 279] mm with spine and face pockets.

.3 When multiple binders are used correlate data into related consistent groupings.

.1 Identify contents of each binder on spine.

.4 Cover: Identify each binder with type or printed title 'Project Record Documents'; list title of project and identify subject matter of contents.

.5 Arrange content by systems, process flow, under Section numbers and sequence of Table of Contents.

.6 Provide tabbed fly leaf for each separate product and system, with typed description of product and major component parts of equipment.

.7 Text: manufacturer's printed data, or typewritten data.

.8 Drawings: Provide with reinforced punched binder tab.

.1 Bind in with text; fold larger drawings to size of text pages.

.9 Provide scaled CAD files in dwg format on [CD].

1.4 CONTENTS - PROJECT RECORD DOCUMENTS

.1 Table of Contents for Each Volume: provide title of project;

.1 Date of submission; names.

.2 Addresses, and telephone numbers of Consultant and Contractor with name of responsible parties.

.3 Schedule of products and systems, indexed to content of volume.

.2 For each product or system:

.1 List names, addresses and telephone numbers of subcontractors and suppliers, including local source of supplies and replacement parts.

.3 Product Data: mark each sheet to identify specific products and component parts, and data applicable to installation; delete inapplicable information.

.4 Drawings: supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams.

.5 Typewritten Text: As required to supplement product data.

.1 Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions specified in Section 01 45 00 - Quality Control.

.6 Training: Refer to Section 01 79 00 - Demonstration and Training.

1.5 AS-BUILT DOCUMENTS AND SAMPLES

.1 Maintain, in addition to requirements in General Conditions, at site for Consultant one record copy of:

.1 Contract Drawings.

.2 Specifications.

.3 Addenda.

.4 Change Orders and other modifications to Contract.

.5 Reviewed shop drawings, product data, and samples.

.6 Site test records.

.7 Inspection certificates.

.8 Manufacturer's certificates.

.2 Store record documents and samples in site office apart from documents used for construction.

.1 Provide files, racks, and secure storage.

.3 Label record documents and file in accordance with Section number listings in List of Contents of this Project Manual.

.1 Label each document "PROJECT RECORD" in neat, large, printed letters.

.4 Maintain record documents in clean, dry and legible condition.

.1 Do not use record documents for construction purposes.

.5 Keep record documents and samples available for inspection by Consultant.

1.6 RECORDING INFORMATION ON PROJECT RECORD DOCUMENTS

.1 Record information on set of black line opaque drawings, and in copy of Project Manual, provided by Consultant.

.2 Use felt tip marking pens, maintaining separate colours for each major system, for recording information.

.3 Record information concurrently with construction progress.

.1 Do not conceal Work until required information is recorded.

.4 Contract Drawings and shop drawings: mark each item to record actual construction, including:

.1 Measured depths of elements of foundation in relation to finish first floor datum.

.2 Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.

.3 Measured locations of internal utilities and appurtenances, referenced to visible and accessible features of construction.

.4 Site changes of dimension and detail.

.5 Changes made by change orders.

.6 Details not on original Contract Drawings.

.7 Referenced Standards to related shop drawings and modifications.

.5 Specifications: mark each item to record actual construction, including:

.1 Manufacturer, trade name, and catalogue number of each product actually installed, particularly optional items and substitute items.

.2 Changes made by Addenda and change orders.

.6 Other Documents: Maintain manufacturer's certifications, and inspection certifications, required by individual specifications Sections.

.7 Provide digital photos, if requested, for site records.

1.7 EQUIPMENT AND SYSTEMS

.1 For each item of equipment and each system include description of unit or system, and component parts.

.1 Give function, normal operation characteristics and limiting conditions.

.2 Include performance curves, with engineering data and tests, and complete nomenclature and commercial number of replaceable parts.

.2 Panel board circuit directories: provide electrical service characteristics, controls, and communications.

.3 Include installed colour coded wiring diagrams.

.4 Operating Procedures: include start-up, break-in, and routine normal operating instructions and sequences.

.1 Include regulation, control, stopping, shut-down, and emergency instructions.

.2 Include summer, winter, and any special operating instructions.

.5 Maintenance Requirements: include routine procedures and guide for trouble-shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.

.6 Provide servicing and lubrication schedule, and list of lubricants required.

.7 Include manufacturer's printed operation and maintenance instructions.

.8 Include sequence of operation by controls manufacturer.

.9 Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.

.10 Provide installed control diagrams by controls manufacturer.

.11 Provide Contractor's coordination drawings, with installed colour coded piping diagrams.

.12 Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.

.13 Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.

.14 Include test and balancing reports as specified in Section 01 45 00 - Quality Control.

.15 Additional requirements: As specified in individual specification Sections.

1.8 MAINTENANCE MATERIALS

.1 Spare Parts:

.1 Provide spare parts, in quantities specified in individual specification Sections.

.2 Provide items of same manufacture and quality as items in Work.

.3 Deliver to site; place and store.

.4 Receive and catalogue items.

.1 Submit inventory listing to Consultant.

.2 Include approved listings in Maintenance Manual.

.5 Obtain receipt for delivered products and submit before final payment.

.2 Extra Stock Materials:

.1 Provide maintenance and extra materials, in quantities specified in individual specification Sections.

.2 Provide items of same manufacture and quality as items in Work.

.3 Deliver to site; place and store.

.4 Receive and catalogue items.

.1 Submit inventory listing to Consultant.

.2 Include approved listings in Maintenance Manual.

.5 Obtain receipt for delivered products and submit before to final payment.

.3 Special Tools:

.1 Provide special tools, in quantities specified in individual specification Section.

.2 Provide items with tags identifying their associated function and equipment.

.3 Deliver to site; place and store.

.4 Receive and catalogue items.

.1 Submit inventory listing to Consultant.

.2 Include approved listings in Maintenance Manual.

1.9 DELIVERY, STORAGE, AND HANDLING

.1 Store spare parts, maintenance materials, and special tools in manner to prevent damage or deterioration.

.2 Store in original and undamaged condition with manufacturer's seal and labels intact.

.3 Store components subject to damage from weather in weatherproof enclosures.

.4 Store paints and freezable materials in a heated and ventilated room.

.5 Remove and replace damaged products at own expense and for review by Consultant.

1.10 WARRANTIES AND BONDS

.1 Provide plan in narrative form and contain sufficient detail to make it suitable for use by future maintenance and repair personnel.

.2 Assemble approved information in binder, submit upon acceptance of work and organize binder as follows:

.1 Separate each warranty or bond with index tab sheets keyed to Table of Contents listing.

.2 List Subcontractor, supplier, and manufacturer, with name, address, and telephone number of responsible principal.

.3 Obtain warranties and bonds, executed in duplicate by Subcontractors, suppliers, and manufacturers, within ten days after completion of applicable item of work.

.4 Verify that documents are in proper form, contain full information, and are notarized.

.5 Co-execute submittals when required.

.6 Retain warranties and bonds until time specified for submittal.

.3 Except for items put into use with Owner's permission, leave date of beginning of time of warranty until Date of Substantial Performance is determined.

.4 Include information contained in warranty management plan as follows:

.1 Roles and responsibilities of personnel associated with warranty process, including points of contact and telephone numbers within the organizations of Contractors, Subcontractors, manufacturers, or suppliers involved.

.2 Listing and status of delivery of Certificates of Warranty for extended warranty items.

.3 Provide list for each warranted equipment, item, feature of construction or system indicating:

.1 Name of item.

.2 Model and serial numbers.

.3 Location where installed.

.4 Name and phone numbers of manufacturers or suppliers.

.5 Names, addresses and telephone numbers of sources of spare parts.

.6 Warranties and terms of warranty: include one-year overall warranty of construction. Indicate items that have extended warranties and show separate warranty expiration dates.

.7 Cross-reference to warranty certificates as applicable.

.8 Starting point and duration of warranty period.

.9 Summary of maintenance procedures required to continue warranty in force.

.10 Cross-Reference to specific pertinent Operation and Maintenance manuals.

.11 Organization, names and phone numbers of persons to call for warranty service.

.12 Typical response time and repair time expected for various warranted equipment.

.4 Contractor's plans for attendance at [4] and [9] month post-construction warranty inspections.

.5 Procedure and status of tagging of equipment covered by extended warranties.

.6 Post copies of instructions near selected pieces of equipment where operation is critical for warranty and/or safety reasons.

.5 Respond in timely manner to oral or written notification of required construction warranty repair work.

.6 Written verification to follow oral instructions.

.1 Failure to respond will be cause for the School Board to proceed with action against Contractor.

1.11 WARRANTY TAGS

.1 Tag, at time of installation, each warranted item. Provide durable, oil-and water-resistant tag approved by Consultant.

.2 Attach tags with copper wire and spray with waterproof silicone coating.

.3 Leave date of acceptance until project is accepted for occupancy.

.4 Indicate the following information on tag:

.1 Type of product/material.

.2 Model number.

.3 Serial number.

.4 Contract number.

.5 Warranty period.

.6 Inspector's signature.

.7 Construction Contractor.

PART 2 - PRODUCTS

2.1 NOT USED

.1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED

.1 Not Used.

END OF SECTION 01 78 00

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 All Sections

1.2 ADMINISTRATIVE REQUIREMENTS

.1 Demonstrate scheduled operation and maintenance of equipment and systems to Owner's personnel two weeks before date of substantial performance.

.2 Owner: Provide list of personnel to receive instructions, and coordinate their attendance at agreed-upon times.

.3 Preparation:

- .1 Verify conditions for demonstration and instructions comply with requirements.
- .2 Verify designated personnel are present.
- .3 Ensure equipment has been inspected and put into operation.
- .4 Ensure testing, adjusting, and balancing has been performed and equipment and systems are fully operational.

.4 Demonstration and Instructions:

- .1 Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, and maintenance of each item of equipment at scheduled times, at the equipment location.
- .2 Instruct personnel in phases of operation and maintenance using operation and maintenance manuals as basis of instruction.
- .3 Review contents of manual in detail to explain aspects of operation and maintenance.
- .4 Prepare and insert additional data in operations and maintenance manuals when needed during instructions.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Submit schedule of time and date for demonstration of each item of equipment and each system two weeks before designated dates, for Consultant's approval.

.3 Submit reports within one week after completion of demonstration, that demonstration and instructions have been satisfactorily completed.

.4 Give time and date of each demonstration, with list of persons present.

.5 Provide copies of completed operation and maintenance manuals for use in demonstrations and instructions.

1.4 QUALITY ASSURANCE

.1 When specified in individual Sections requiring manufacturer to provide authorized representative to demonstrate operation of equipment and systems:

- .1 Instruct Owner's personnel.
- .2 Submit written report that demonstration and instructions have been completed.

PART 2 - PRODUCTS

2.1 NOT USED

.1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED

.1 Not Used.

END OF SECTION

I N D E X

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

.1 Work of this Section shall form part of Mechanical Contract. Section 23 00 01 (Mechanical Supplementary Information Form) and Section 23 00 10 (Mechanical General Requirements), shall form an integral part of this Section of the specification.

1.2 SCOPE OF WORK

.1 Visit the site to review existing conditions prior to submitting a tender price.

.2 The design, supply and installation of all materials and equipment required for complete Sprinkler Protection systems as hereinafter described and shown on the drawings including all permits and fees.

.3 All necessary water flow tests for bidding and new water flow tests after award of contract and prior to system design.

.4 General Sprinkler System: preparation of sprinkler shop drawings and systems hydraulic calculations.
Note: The sprinkler system shop drawings and associated hydraulic calculations must be signed and sealed by a Professional Engineer, licensed to practice in the Province. Submit printed copy (to scale) and electronic copy of drawings and specifications.

.5 Obtaining approvals from local Authority having jurisdiction and the Insurance Review Authority.

.6 Preparation of scaled floor plans including sectional views through the building.

.7 Preparation of a scaled site plan showing relevant municipal and project underground watermains, fire hydrants, valves and fire department connections. Include project buildings and exposures within 60 ft. of property.

.8 Site review of the sprinkler system installation and letter of compliance by the Sprinkler Contractor's Design Engineer, and certification of installation.

.9 Preparation of "As-Built" drawings indicating installed location of sprinkler heads, piping systems and system devices. Refer to Section 23 00 10, Article 1.5 for "As-Built" Drawing requirements. Submit printed copy (to scale) and electronic copy of drawings and specification.

.10 Any charges to the sprinkler system shown on the drawings and/or described hereinafter must be identified in the Tender Form.

1.3 CODES AND STANDARDS

.1 Systems shall be designed and installed in accordance with the Provincial Building Code; latest editions of NFPA standards, requirements of the Authorities having jurisdiction and the requirements, standards and interpretive guides of the Insurance Authority. Sprinkler Contractor must also conform to the manufacturer's recommendations.

.2 Where conflicts occur, the most stringent requirement shall apply.

.3 The systems shall conform to the applicable requirements of the following standards:

.1 NFPA-13, Installation of Sprinkler Systems.
.2 Factory Mutual (FM) and the Insurance Authority Interpretive Guides.
.3 Applicable Provincial and Local Codes and requirements.

.4 All other NFPA Standards which are referenced by the standards designated in 1.3 must be complied with. This applies whether reference occurs in the NFPA main body or appendices.

.5 If there is any conflict between the requirements of referenced Codes, Standards and Regulations, then that requirement which is most restrictive or requires additional cost shall take precedence over all others. The Consultant is the final authority in cases requiring Code interpretation.

1.4 APPROVALS

.1 Prepare not less than seven (7) sets of sprinkler system installation drawings (sprinkler shop drawings) and associated detailed system hydraulic calculations and submit directly to the Insurance Review Authority for review and approval. After obtaining the Insurance Review Authority approval submit the approved drawings and hydraulic calculations to the local Building and Fire Departments for their review and approval. The fully approved sprinkler shop drawings and hydraulic calculations shall then be submitted to the Consultant for review.
Note: No fabrication or installation shall proceed on the sprinkler systems until all approvals have been obtained.

.2 This Contractor is to apply for a separate sprinkler permit and pay all costs associated with the permit and including costs for all other fees and inspections. Contact the Town of Richmond Hill for the cost of the sprinkler permit and all other fees and inspections.

.3 Include in the Tender Price all costs associated with the review and approval by the Insurance Authority.

.4 All materials, equipment, valves and devices installed and furnished under this Section shall be listed and approved for use in the Sprinkler Systems installation by the Authorities, Agencies, Codes and Standards named in this Section of the Specification.

.5 Refer to: Underwriters Laboratories and Factory Mutual for approved Fire Protection Equipment List: (ULC), (ULI), and (FM).

1.5 INSURANCE REVIEW AUTHORITY & STANDARDS

.1 The Insurance Review Authority to be used for all approvals, standards, interpretations, etc., is the offices of AON Insurance Brokers Risk Consultants, as directed by the Board and Consultant.

.2 Obtain Insurance Review Authority standards and interpretive guides prior to submitting a Tender Price.

1.6 SHOP DRAWINGS

.1 Shop drawings are required for the following items.

.1 Sprinkler heads, each type (include sample of each if requested).
.2 Alarm control valves, complete with all accessories and trim.
.3 Fire Department connection.
.4 Excess pressure pump, including starter and accessories.
.5 Approved and listed control valves.
.6 Approved and listed flow, pressure and tamper switches.
.7 New water flow test results.
.8 Hydraulic calculations and drawings, including node diagrams.

.2 The installation is to be per the approved shop drawings.

1.7 CONTRACTOR QUALIFICATIONS

.1 Work of this Section shall be performed by a Sprinkler Contractor fully qualified and experienced in performing this type of work. Submit certifications of qualifications and satisfactory performance.

.2 Sprinkler Contractor shall be a paid member and in good standing, at time of tender, of the Canadian Automatic Sprinkler Association. Attach membership certificate to "Sprinkler Work Supplementary Information Form".

PART 2 - PRODUCTS

2.1 COMPONENT LISTING AND RATINGS

.1 All fire suppression components furnished under this Section shall be Underwriter's Laboratories, UL, ULC listed in the "Fire Equipment List"; and Factory Mutual, "FM", approved for fire suppression use or as provided by the appropriate National Fire Protection Association (NFPA) Fire Code. All accessory equipment shall also be so "listed" or "approved". Assemblies shall include trim and accessories manufactured or normally supplied by the basic equipment Manufacturer (for example: a Tyco dry valve shall be equipped with Tyco trim). All components shall be new and rated for a working pressure of 175 psi unless required to be higher.

2.2 ALARM VALVES

.1 New alarm check control valve assemblies shall be approved, listed and complete with: approved control valves; water motor gong connections and gong; drainage and test connections; flow or pressure switches as applicable; low pressure switches; fire department pumper connections; excess pressure pump and accessories; starters; piping, gauges, auxiliary valves and fittings; inside electric bell; and all necessary attachments, fittings, trim, quick opening devices and accessories as required.

2.3 SWITCHES (New)

.1 All flow switches, pressure switches and valve tamper switches shall be UL, ULC listed and F.M. approved, and shall have two (2) sets of electrical contacts.

.2 All switches must be Insurance Authority approved. Obtain Insurance Authority approval prior to installation of switches.

.3 Co-ordinate with Division 16 to ensure that all switches are compatible with the building fire alarm system, and assist in wiring.

.4 Co-ordinate with the Owner's Security Company to ensure that all switches are compatible with the security system.

.5 Shut-off valve supervisory switches shall be designed for use with the intended control valve and must be provided on all control valves. They shall have tamperproof covers.

.6 Flow switch to be Potter, VSR-F or approved substitute (2PDT), with cover tamper switch.

.7 Low air pressure switch to be Potter PS40-2 or approved substitute (2PDT).

.8 Pressure flow alarms switch to be Potter PS10-2 or approved substitute (2PDT) with cover tamper switch.

2.4 SPARE SPRINKLER AND CABINET

.1 Provide enamelled steel, wall mounted cabinets with hinged front panels, containing special sprinkler wrenches and a stock of spare sprinkler heads for each alarm valve. An equal stock (numerically in accordance with NFPA 13) of each type of sprinkler head shall be included. Cabinets shall be located at each alarm valve. A laminated list of all sprinklers installed in the School shall be provided.

2.5 FIRE DEPARTMENT CONNECTION

.1 Fire Department connection is existing to remain.

2.6 SPRINKLER PIPING

.1 Pipe or tube used in sprinkler systems shall meet or exceed the standards in NFPA 13. Copper pipe shall be type 'L'.

.2 Fittings used in sprinkler systems shall meet or exceed the standards in NFPA 13, and shall have a minimum pressure rating of 175 PSI.

.3 Make reductions in pipe sizes with one piece reducing fittings. Bushings not acceptable, except that when one-piece reducing fittings of proper size are not obtainable, single bushings of the face type will be permitted up to 5% of total number of reducing fittings in the system. Where face bushings are used, install with outer face flush with the face of fitting opening being reduced.

.4 Couplings are not to be used except where length of pipe between fittings exceeds 20 feet.

2.7 SPRINKLER HEADS

.1 Provide listed and Insurance authority approved sprinkler heads of types, makes and models as noted on the Drawing.

.2 Where located close to heating coils, unit heaters and other similar sources of heat, heads shall be of high temperature type.

.3 Where located near light fixtures, ductwork, beams and other such obstructions, heads shall be installed and located to meet NFPA 13 requirements. Install additional sprinkler heads, at no extra cost to the Owner, as required to meet NFPA 13 requirements.

.4 Where located in electrical rooms, heads shall be high temperature type to meet authority requirements and NFPA 13.

.5 In unfinished stairwells, elevator machine rooms, below ductwork, all areas with ceilings less than 8'-0", and all areas so noted on the drawings, install approved wire guards on the sprinkler heads. Guards shall be painted white.

2.8 VALVES

.1 Small bore (50mm (2") and less) accessory valves are to be bronze, 175 psi working pressure and listed for service with fire sprinkler systems. Trim check valves shall be of a companion series.

.2 Control and check valves shall be flanged, lugged, mechanical joint, or grooved (small bore to be threaded) and "listed" for "Fire Protection Service". Common valve types are further specified as follows:

.1 Above ground shut-off valves shall be approved type control valves, each equipped with tamper switches.
.2 Check valves to be swing check type with rubber gaskets.
.3 Wet alarm riser assemblies to be as shown with grid relief valves. Relief valves shall be not less than 1/4" size set to operate at pressure not greater than 175 psi. Pressure relief valves are to be piped to outside or to floor drains in sprinkler area.

2.9 PENETRATIONS AND FIRE BARRIERS

.1 Penetrations of smoke and fire walls must be firestopped with approved products and methods. Acceptable manufacturers are as follows:

.1 Dow-Corning "Fire Sealant"
.2 Metaline Company "Metacaulk"
.3 3M Company "CP-25 Fire Barrier"

2.10 ACCESSORIES

.1 Water Motor Alarm Gong is existing to remain.

.2 Water Flow Detectors: Equip sprinkler alarm valve assembly with FM approved pressure switches as manufactured by Potter Electric.

.3 Control Valve Supervisory Switches: FM approved, equipped with tamper switches, Model No. OSYS-U-1 manufactured by Potter Electric.

.4 Hangers and Supports: Provide approved and listed hangers and supports as required by NFPA-13 and by governing authorities. Provide approved seismic restraints as required by the Code and local practice. Attach piping to structural joists with support clips at edge of joist angles. Attach piping over 2.1/2 inches diameter at structural joist panel points only. Obtain approval of support method from the Structural Engineer prior to beginning any pipe installation.

2.11 SLEEVES AND ESCUTCHEONS

.1 Sleeves through structural concrete members and sleeves for walls below grade and floors on grade shall be standard weight galvanized Schedule 40 steel pipe. Sleeves through other than structural components of the building shall be 20 gauge galvanized sheet metal with lock seam joints. Top of sleeve shall be two inches above floor minimum. USG Thermafiber safing insulation shall be installed between sleeve and pipe and finished with approved fire stop. Submit detail and product literature if requested.

.2 Escutcheon plates to be installed where exposed piping passes through walls, ceilings, and floors of building shall be minimum 20 gauge steel, chrome plated. Exposed hanger rods in finished spaces with ceiling shall have escutcheon set screw. Split type escutcheon plates are not acceptable.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Installation of fire protection systems and components shall be in accordance with applicable NFPA Standards, Insurance Authority's Interpretive Guides, and Manufacturer's recommendations. The systems shall be installed by an experienced firm licensed in the Province and regularly engaged in the installation of fire sprinkler system per NFPA-13. The site sprinkler foreman shall have at least 6 years fulltime sprinkler experience with an aggregate crew experience average of 4 years.

.2 Verification Dimensions: The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and shall confer with the Consultant about any discrepancy before performing the work. The Consultant's approval will not relieve the Sprinkler Contractor from his responsibilities to perform all work in accordance with specification and contract terms, as the Sprinkler Contractor will be the Engineer of Record.

.3 Co-ordination and Fit: The contract drawings are conceptual, representing system design intent. It is the Sprinkler Contractor's responsibility to co-ordinate his work with that of other trades, provide offsets and additional sprinklers as necessary and at no additional cost to the Owner to insure "fitting" of all components within the available space while maintaining code compliance, sprinkler head coverage and design intent. Note: Include an additional ten (10) sprinkler heads in the tender price for additional coverage. Do not cut building structural members, beams, joists, etc, for routing of sprinkler piping. Deviations from the contract drawings are to be made only with the Consultant's written authorization.

.4 Route piping and locate sprinkler heads as required to avoid building structure equipment, plumbing piping, heating and air conditioning piping, ductwork, lighting fixtures, electrical conduits and bus ducts, and similar work. These obstructions will not be relocated to accommodate the sprinklers or sprinkler piping requirements. No extras will be provided for this.

.5 Provide pipe offsets as required to complete the installation. Modify shop prefabricated piping, pipe hangers, and other components as required to fit the job site conditions.

.6 Conceal piping in pipe chases, walls, furred spaces and above ceiling in areas with dropped ceilings.

.7 Test Valves: Install test valves as close to eye-level as is practical. In finished areas test valves shall be in the ceiling space.

.8 Welding of materials shall conform to NFPA requirements and no welding within the Project Structure itself is authorized. Each weld must bear the welder's identifying mark. Shop drill and Weld-O-Lets on piping.

.9 All equipment pipe and fittings exposed to weather or corrosion shall be galvanized, plated, or otherwise protected.

.10 Temporary impairment of an "in-service" fire protection system (all or part) must be minimized and co-ordinated with the Owner and the Local Fire Department. If unavoidable, then a fire watch must be maintained at the Sprinkler Contractor's expense.

.11 The Sprinkler Contractor is responsible for the proper placement of his equipment and the openings and supports for same. This includes pipe connections, sleeves through floors and walls, and attachments to the structure. Penetrations of foundation walls and floors shall be sleeved and packed with water-tight mastic. Wall plates are to be provided at all exposed wall penetrations. They shall be metallic of the split type with chrome finish. Wall and ceiling penetrations shall be sealed as appropriate for fire and exterior walls, and smoke partitions.

.12 Do not connect the sprinkler system header to the incoming fire service piping until the incoming fire service piping has been satisfactorily tested, flushed and certified. Obtain a copy of the test and flushing certificate and include it in the maintenance manuals. Upon completion of the sprinkler piping installation and prior to commissioning of the sprinkler system flush the entire system, under pressure, as required by NFPA-13. Continue flushing until water is clear, and check to ensure that debris has not clogged sprinklers.

3.2 PROTECTION OF WORK

.1 The Sprinkler Contractor shall protect his work at all times from danger by freezing, breakage, dirt, foreign materials, etc., and shall replace all work so damaged. The Sprinkler Contractor shall use every precaution to protect the work of others, and will be held responsible for all damage to other work caused by his work or through the negligence of his workers.

3.3 IDENTIFICATION

.1 Apply signs to controls, and drain, test and alarm valves to identify their purposes and functions. Provide lettering sizes and styles selected by the Consultant from NFPA's suggested styles. Provide hydraulic placard for each sprinkler system in accordance with NFPA 13 and mount the placard at the alarm valve.

3.4 SEQUENCE OF CONSTRUCTION

.1 The Sprinkler Contractor shall diligently pursue the installation according to the general Project Schedule until the system is complete and operational.

3.5 WIRING

.1 Division 16 will provide wiring of building flow switches pressure switches, low pressure and tamper switches, etc. to the building fire alarm and supervisory systems. Sprinkler Contractor to assist the electrician in performing this work.

.2 Division 16 will mount all starters and will provide and install power wiring into all starters and into all controllers.

.3 This Section shall provide all power wiring, in conduit, from starters to pumps and controllers to pumps.

.4 This Section shall provide all necessary pilot circuit wiring and control wiring that is required for the automatic operation of excess pressure pump.

.5 All wiring provided by this Section shall conform to the requirements of Division 26.

.6 Installation of alarm valve, switches, and control valve monitoring switches shall be in compliance with the requirements of NFPA-13, the Insurance Authority, the Code, and recommendations of Owner's Security Company. Obtain and submit a written verification from the Owner's Security Company that the system is acceptable.

3.6 DRAINS

.1 Provide zone sprinkler test connections at the end of each system. Pipe grided system pressure relief valves to test connections discharging over floor drains or mop sinks, as shown on drawings.

.2 Piping is to be installed to allow complete draining, exceptions only as acceptable to the Consultant. Drains and tests shall spill over mop sinks or floor drains, all at Consultant's approved locations. Small auxiliary drains not piped outside shall be readily accessible and fitted with 20mm (3/4") domestic hose connections and removable cap and tags.

.3 Piping penetrating any exterior wall shall be copper, complete with di-electric couplings at connections

to dissimilar metals.

.4 Identify all system drains, auxiliary drains and inspection test connections. Provide access doors for concealed control valves, drain valves and test connections, as required.

3.7 REFLECTED CEILING PLANS

.1 Where installed in suspended ceilings, heads shall be in a symmetrical pattern in accordance with the Architectural reflected ceiling plans. Co-ordinate sprinkler head locations with all lights, ceilings and diffusers/grilles.

.2 Co-ordinate the sprinkler work with the work of other trades, prior to beginning any work.

3.8 FIRE DEPARTMENT CONNECTION

.1 Provide Fire Department connection is existing to remain.

3.9 TESTING AND VERIFICATION

.1 The Sprinkler Contractor shall co-ordinate each test and provide at least two weeks advance notice, in writing, to the Consultant and other inspection authorities. They shall inform the Consultant at least two weeks before testing, in writing, of special arrangements, and coordination efforts necessary but not under his control.

.2 Acceptance Testing of the Fire Protection System shall be in accordance with Authority requirements. The applicable Test Certificate(s) shall be completed at the time of testing and submitted to the Consultant.

.3 Perform all tests in accordance with the Authorities requirements, with N.F.P.A. standards, and Insurance Authority recommendations.

.4 All piping shall be hydrostatic tested after being flushed and cleaned. Hydrostatic test shall be, at minimum, 1379 kPa (200 psi) for a minimum of 2 h. Repair all leaks. Furnish a standard certificate indicating that the hydrostatic test has been satisfactorily carried out.

.5 Flush the main connections until foreign materials have been freed and the water is clear.

.6 Provide a standard certificate that flushing has been properly carried out for presentation to the Consultant.

.7 Prepare a complete checklist with a detailed description clearly stating which devices will be tested and how they will be tested and submit the checklist to the Consultant. This checklist shall be part of the conditions of accepting the installed system.

.8 At the completion of the installation of all system equipment and devices and when the system is fully operable, test and verify the entire system.

.9 Notification to the Consultant and a demonstration of the proper functioning of the entire system shall

be carried out only after the testing and verification task has been completed and all deficiencies are rectified.

.10 The purpose of a verification procedure is to confirm that all equipment operates as intended. Upon completion of the verification procedures, a certificate of verification shall be given to the Consultant. A copy shall be kept with the system documentation. An equipment schedule listing each device and showing confirmation that it was verified, shall also be provided.

.11 This certificate of verification shall be signed and sealed by a qualified representative of the Contractor who has witnessed the entire testing and verification procedure.

.12 The test and verification shall follow these guidelines:

.1 The wiring to every device (existing and new) shall be inspected and tested to verify that removal of the device or breaking a wire will initiate the trouble signals in the control panel.

.2 Trouble signals (existing and new) shall be verified to operate on open circuit, short circuit, ground fault or the removal of any plug-in component or devices. Wiring shall be inspected to ensure that individual terminations have been provided for all conductors and that, where applicable, correct polarities have been observed.

.3 All equipment connected to the fire alarm control unit (existing and new) shall be inspected for visible damage or tampering which might interfere with its intended operation.

.4 Any device (existing and new) which is field adjustable shall be tested to ensure that its setting is acceptable under ambient conditions at the location of the installation.

.5 All lamps and indicators (existing and new) shall be tested for acceptable operation. All control functions shall be operated to verify correct response.

.6 On completion of testing and verification, the supplier/ manufacturer's representative shall be made available to the Contractor to carry out final testing in the presence of the Consultant, and designated representative of the Owner.

.7 Final testing shall demonstrate the satisfactory operation of the complete system by operating devices and checking the performance of the components.

.8 If deficiencies are found, these shall be corrected and testing resumed. Additional testing shall be done at the Sprinkler Contractor's expense.

3.10 DECLARATION OF COMPLETION

.1 Sprinkler Protection Section shall submit a declaration signed by a responsible officer of the Company stating that the following procedures and tests have been performed in accordance with the Specifications.

.1 Insurance Review Authority and Building/Fire Departments approved and stamped shop drawings, submitted and reviewed by the Consultant.

.2 Spare sprinklers, wrench and cabinets provided.

.3 Pumps tested, after power and control wiring installation. Test certificates submitted to the

Consultant.

.4 On site operating instructions given to Owner's representative as follows:-

Name: _____ Date:_____

.5 Water motor alarms tested.

.6 Flow test made, as required by Authorities and Insurance Authority requirements. Sprinkler system flushed.

.7 Building flow, tamper, pressure and low pressure switches tested, after wiring by Electrical Section.

.8 As-Built drawings submitted to the Consultant.

.9 Alarm control valves and systems identified, valves tagged and system schematic chart in glass frame mounted on wall near alarm valves.

.10 Letter of compliance signed by the Sprinkler Contractor's Design Engineer, and sealed by their Professional Engineer.

.11 All piping, risers, etc. fully pressure tested as per NFPA, Insurance Authority and Fire Department requirements.

.12 All pipes, valves, alarm valves and devices identified.

.2 Sprinkler Protection system will not be accepted by the Consultant until the above declaration has been provided and signed in duplicate.

3.11 DESIGN REQUIREMENTS

.1 Water supply that is to be used for both bidding and basic design requirements shall be as determined by water supply Article 3.12 herein, and as accepted by all Authorities and including the Insurance Authority.

.2 For building and site elevations refer to the Architectural Drawings.

.3 Sprinkler and piping layouts for all portions of the building area shall be maintained; all pipe sizes shall be hydraulically calculated for each respective area and zone.

.1 Building sprinkler systems shall be hydraulically designed to N.F.P.A. 13 and Insurance Authority requirements. Design criteria shall be as specified below. Water densities, areas of application and occupancies shall be based on these minimum requirements or higher requirements as directed by Authorities and the Insurance Authority. Note: Confirm design requirements with the Authorities and the Insurance Authority prior to submitting Bid Price.

.2 General School Building Area: Shall be hydraulically designed to NFPA-13 requirements for light hazard occupancy and designed to deliver a minimum water density of 0.1 U.S.G.P.M./sq.ft. over most hydraulically remote operating area of 1500 sq.ft., allowing 250 U.S.G.P.M. for combined inside and outside hose streams.

.3 Library, Science Rooms and Art Rooms: Shall be hydraulically designed to NFPA-13

requirements for ordinary hazard Group 1 occupancy and designed to deliver a minimum water density of 0.15 U.S.G.P.M./sq.ft. over most hydraulically remote operating area of 1500 sq.ft., allowing 250 U.S.G.P.M. for combined inside and outside hose streams.

.4 General Purpose/Gymnasium and Stage Area: Shall be hydraulically designed to NFPA-13 requirements for ordinary hazard Group 1 occupancy and designed to deliver a minimum water density of 0.15 U.S.G.P.M./sq.ft. over most hydraulically remote operating area of 1500 sq.ft., allowing 250 U.S.G.P.M. for combined inside and outside hose streams.

.5 Mechanical Rooms, Electrical Rooms, Storage Rooms and Kitchen Areas: Shall be hydraulically designed to NFPA-13 requirements for ordinary hazard Group 2 occupancy and designed to deliver a minimum water density of 0.20 U.S.G.P.M./sq.ft. over most hydraulically remote operating area of 1500 sq.ft., allowing 250 U.S.G.P.M. for combined inside and outside hose streams.

.4 An allowance for inside and outside fire hose stream, (as noted in .2, .3, .4 and .5), or an adjusted figure as required by the Insurance Authority shall be included in the design calculations for each design area.

.5 Design calculations shall allow for a reasonable "buffer zone" (minimum of 8 psi drop) within the design requirements to allow for future deterioration in the water supply condition.

.6 Provide calculations necessary to determine the required hydraulic pipe sizes at all points within the systems. Hydraulic calculations shall be produced in a standard format as suggested by NFPA, and shall be submitted for approval to all Authorities as part of the shop drawing procedure.

.7 Pipe routing restrictions apply to this project as shown and as follows:

.1 Piping shown on the drawings is a schematic arrangement. Pipe support methods are critical to the structural system. Comply with support and bracing specifications and details. Alternative piping arrangements may be considered, provided the design intent is maintained and the criteria, space allocations and functions of the sprinkler system are not altered.

.2 Alternative piping systems and proposals shall be summarized on the Bidder's Company letterhead and shall be attached to the Tender Form for review by the Consultant. Cost savings, if any, shall also be indicated. All changes to location of sprinkler mains shall be to the approval of the Structural Engineer. Any costs associated with these changes shall be paid by the Sprinkler Contractor.

.3 Piping serving areas with suspended ceilings shall be concealed.

3.12 WATER SUPPLY

.1 This Section shall be fully responsible for consulting with all Authorities, obtaining pertinent water flow and pressure test information together with any other additional information prior to submitting his bid. The bidding Sub-Contractor shall arrange with the local Authority and do all necessary flow tests prior to submitting a tender bid, and shall do another flow test prior to doing system pipe sizing (see .3.1 below). All costs involved in obtaining this information shall be at the expense of the bidding Sprinkler Contractor.

.2 Drawings showing the development of the exterior yard watermain distribution, etc. are available upon request for review at the offices of the Contractor.

.3 Water Flow Test:

.1 A water flow test was conducted by Disano Sprinkler Design on September 13, 2024, utilizing Municipal fire hydrants near 36 Regatta Avenue, Richmond Hill, Ontario. The test results are as follows:

Static Pressure	76 psi
Residual Pressure	68 psi @ 1075 US gpm
Residual Pressure	64 psi @ 1718 US gpm

.2 Water flow test results are given for information only. Under all circumstances, the successful tenderer shall be required to make all necessary arrangements and conduct new water flow tests prior to finalization of all designs and pipe sizing. The costs of all such tests shall be included in the Tender Price. Copies of all new test results shall be submitted along with the shop drawing and hydraulic calculations.

.4 No change to the contract price will be accepted due to a different water condition after a Contract has been awarded.

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3.13 TAMPER SWITCHES

.1 Provide each shut-off and control valve on sprinkler systems with tamper switches. Switches will be wired by Division 26 to the building fire alarm system.

.2 Co-ordinate requirements of switches with Division 26. Switches shall be arranged to monitor all valves in the "normally open" position, and to generate a "trouble alarm" signal when the valves are closed.

3.14 INTEGRATED LIFE SAFETY SYSTEMS TESTING

.1 Integrated fire protection and life safety systems testing will be provided by an independent company selected by the Owner. The work will be tendered and administered by the Commissioning Agent. A representative of this Section shall be present at the time of the systems' testing procedure.

END OF SECTION 21 00 00

INSTRUCTIONS TO BIDDERS

Complete the Mechanical Supplementary Information Form in its entirety for perusal and acceptance by the Owner. Submit completed Form to the Engineer named hereunder within twenty-four (24) hours of Mechanical Tender closing. Failure of the Bidders to complete all of the information called for in this Form may result in the rejection of their Tender.

PROJECT:

ARCHBISHOP DENIS O'CONNOR

MECHANICAL UPGRADES

80 MANDRAKE ST.

AJAX, ONTARIO

DURAM CATHOLIC DISTRICT SCHOOL BOARD

ENGINEER:

Rybka Ellard Willson Limited
23 Lesmill Road,
unit 410
Toronto, Ontario
M3B 3P6
Tel: (905) 940-3100
Fax: (905) 940-2139

FROM: (Contractor's Name, Phone & Fax)

Further to our Bid dated _____, 20_____.

1. MANUFACTURERS AND SUPPLIERS:

(Refer to Section 23 00 10, Article 2.1 "Standards of Materials".)

I/We enclose herewith a list of Manufacturers and Suppliers to the Mechanical Building Services which is an integral part of the Bid. We hereby agree that the Owner may select from any substitutes that we have offered in our Bid. Our Bid Price is based on the equipment/manufacturers indicated hereunder and we hereby agree that we will not alter the indicated equipment/manufacturers unless specifically authorized by the Owner.

ITEM	BASE BID BASIS OF DESIGN	ACCEPTABLE ALTERNATE
Pipe Hangers	Grinnell	Crane, Flamco, Unistrut
Unions	Crane	Grinnell, Dart
Expansion Joints	Flexonics	Amtrol, Hydroflex, Tube Turn
Gate, Globe & Ball Valves	Crane	Jenkins, Kitz, Toyo/R+W, Nibco

Check Valves	Crane Kitz, Mueller, Nibco	Jenkins, Toyo/R+W,
Plug Valves	DeZurik	
Circuit Balancing Valves	Tour and Andersson	-
Butterfly Valves	Crane	Jenkins, Centerline, Nibco, Challenger, Kitz, Mueller, Apollo, Toyo/R+W
Thermal Insulation	Fiberglas Canada	Manson, Knauf, Johns-Manville
Expansion Tanks	S.A. Armstrong	Amtrol
Pumps & Circulators (except as noted)	ITT Fluids	S.A. Armstrong
Extended Shaft Coupling VIL Pumps	ITT Fluids	S.A. Armstrong
Suction Guides	ITT Fluids	S.A. Armstrong
Strainers	Sarco	Crane, McAvity, Morrison Brass, Braukmann, Mueller

2. MANUFACTURERS AND SUPPLIERS (CONT'D)

ITEM	BASE BID BASIS OF DESIGN	ACCEPTABLE ALTERNATE
Automatic Air Vents	Sarco	Amtrol, S.A. Armstrong, Braukmann, Trerice
Backflow Preventors	Watts	Braukmann, Zurn-Wilkins
Make-up Assemblies	Watts Mueller, Singer	S.A. Armstrong, Bell & Gossett,
Gauges, Thermometers	Trerice	Ashcroft, Weiss, Weksler, Winters, Wika
Hot Water Reheat Coils	Eng. Air	Aerofin, Daikin, Trane, Dunham-Bush
Hot Water Unit Heaters and Cabinet Heaters	Eng. Air	Dunham-Bush, Trane, Sterling, Sigma, Airtherm, Rittling
Finned Tube Radiation And Convectors	Eng. Air	Dunham-Bush, Trane, Sterling, Sigma, Slantfin, Rittling
Radiant Ceiling Panels	Airtex	Frenger, Sigma, Sun-El
Electric Pipe Tracing	Raychem	Serge-Baril
Water Treatment	Ashland	(No Alternates)
VAV, Fan-Powered VAV And By-Pass Boxes	Nailor	Titus, E.H. Price, Carnes, Krueger, Tuttle & Bailey
Hot Water Boilers	Riello	(No Alternates)
Prefabricated Chimneys	Schebler	Metal-Fab, ICC, Van-Packer, Selkirk, Chiminee
Combination Fire/Smoke, Fire and Smoke Dampers	Nailor	Air Balance, Ruskin, Canadian Advanced Air, Controlled Air, E.H. Price
Air Terminal Devices (Diffusers, Registers, Grilles)	Nailor	Titus, Carnes, E.H. Price, Krueger, Tuttle & Bailey
Air Handling Units (Indoor)	Daikin (Custom YRDSB Standard)	Haakon, Price Mechanical, York (High Performance Solutions) Eng-Air

2. MANUFACTURERS AND SUPPLIERS (CONT'D)

ITEM	BASE BID BASIS OF DESIGN	ACCEPTABLE ALTERNATE
Air Handling Units (Rooftop)	Aaon	Daikin, Eng-Air
Misc. Fans	Cook	Carnes, Greenheck, Penn, Jenn-Air, Acme, Twin City
Air Filters	Farr	Cambridge, Airguard, Vibron, A.A.F.
Filter Gauges	Dwyer	Airflow Developments (Canada) Ltd.
Dampers (except low leakage)	Tamco	Ruskin, Nailor, Ventex/Alumavent
Low Leakage Dampers	Tamco Series 9000	Alumavent 3965-BF, Ruskin, Nailor
Louvres	McGill	Ruskin, Nailor. Ventex/Alumavent
Supplementary Electric Heaters	Ouellet	Chromalox, Stelpro
Electrical Starters, Disconnects, MCC's, Alternator Panels	Siemens	Allen-Bradley, Square 'D', Eaton (Cutler-Hammer)
Noise and Vibration Control	Vibro-Acoustics	Korfund-Sampson, Vibron, E.H. Price, VAW
Variable Frequency Drives	Danfoss	(No Alternates)
Duct Access Doors	Ruskin	Nailor
Plate Heat Exchangers	ITT	Alfa-Laval, Armstrong
Dust Collector	N. R. Murphy	-
Spark Detection & Suppression	Hansentek	Argus
Vehicle Tailpipe Exhaust Systems	Nederman	PlymoVent
Welding Exhaust Systems	Nederman	PlymoVent

2. MANUFACTURERS AND SUPPLIERS (CONT'D)

ITEM	BASE BID BASIS OF DESIGN	ACCEPTABLE ALTERNATE
Fire Extinguisher Cabinets	National Fire Equipment	Wilson & Cousins
Fire Extinguishers And Cabinets	National Fire Equipment	Wilson & Cousins,
Floor Drains, Roof Drains, Cleanouts, Drainage Specialties	Zurn	Ancon, J. R. Smith
Plumbing Fixtures	American Standard	Crane, Kohler
Flush Valves	Cambridge Brass Teck	(No Alternate)
Stainless Steel Sinks	Franke Commercial	Arch. Metal
Drinking Fountain with Bottle Filler	Elkay	Halsey Taylor, Murdoch
Emergency Eyewash and Shower Equipment	Haws	Guardian, Speakman
Emergency Eyewash Mixing Valve	Lawler	Leonard, Haws
Plumbing Trim	Chicago Faucet	Moen, American Standard, Delta/Cambridge Brass
Toilet Seats	Centoco	Beneke, Moldex, Olsonite
Shower Controls	Symmons	Powers, Moen
Mop Sinks	Stern Williams	Fiat
Washfountains	Acorn	Bradley
Acid Neutralizer	SMS	(No Alternates)
Sediment Interceptors	SMS	-
Shower Mixing Valves	Symmons	Powers, Leonard, Rada
Grease Interceptor (Kitchen Area)	Can-Aqua	J.R. Smith, Watts, Zurn

2. MANUFACTURERS AND SUPPLIERS (CONT'D)

ITEM	BASE BID BASIS OF DESIGN	ACCEPTABLE ALTERNATE
Waste Oil Storage Tank	Stem Can	-
Oil Interceptor (Tech Area)	Zurn/Proceptor	-
Air Compressor	DeVilbis	-
Sprinkler Alarm Valves & Trim	Tyco	Grinnell, Central, Reliable, Viking, Automatic
Sprinkler Siamese Connections	National Fire Equipment	Wilson & Cousins, Stelpro
Sprinkler Excess Pressure Pump	Albany	
Sprinkler Heads	Tyco	Reliable, Viking, Automatic, Central
Sprinkler Equipment Cabinet	National Fire Equipment	Wilson & Cousins, Stelpro

PART 1 - GENERAL

1.1 GENERAL PROVISIONS AND REQUIREMENTS

.1 The Procurement and Contracting Requirements (Div. 00) and General Requirements (Div. 01) of the specifications apply to the Mechanical Divisions 21, 22 and 23 of the work.

.2 Conform in full accordance with applicable Codes, regulations, by-laws ordinances, designated insurance underwriters, and all Authorities having jurisdiction. In case of conflict with the Contract Documents, the Codes, by-laws and ordinances, etc. shall take precedence.

.3 Include all labour, products and services necessary for complete work, tested and ready for operation.

1.2 PERMITS, FEES AND INSPECTIONS

.1 Give all necessary notices, obtain all permits including all air and noise pollution permits and pay for all fees, taxes and other costs in connection with the work.

.2 File all necessary drawings, prepare all documents and obtain all necessary approvals of all regulatory bodies have jurisdiction. Obtain all required Certificates of Inspection for the work and submit to the Consultant. Correct installed work as directed by the local Authorized Inspector of the Regulatory Body without cost to the Owner.

.3 Make all arrangements with the Technical Standards and Safety Authority (TSSA) and coordinate/schedule a Fuels Safety inspection and a Boiler & Pressure Vessel inspection and obtain TSSA's inspection certificates for same. Submit inspection certificates to Owner and include in IOM manual.

1.3 DISCREPANCIES AND OMISSIONS

.1 These specifications are an integral part of the drawings which accompany them and neither the drawings nor specifications are used alone. Items omitted from one but indicated in the other are considered as properly and sufficiently specified and provided by Mechanical Division 21, 22 or 23, as applicable.

.2 Request clarification from the Consultant prior to the close of the tenders should discrepancies or omissions in the contract documents be evident, or should there be doubt as to the intent thereof. The Consultant is not responsible for any verbal instructions, but will issue formal written addenda.

1.4 SHOP DRAWINGS

.1 Submit prints of 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 Consultant 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 resubmittal.

.2 Submittals that are formatted for 11" x 17" (279 x 432mm) sheets or smaller may be submitted by

email, provided the total number of pages, for the entire submission, does not exceed 15. Submittals must be submitted in the same size and scale as they were originally prepared. Drawings may not be reduced in size for email transmission. If acceptable to the individual reviewers, larger format submittals and larger volume submittals may be reviewed by email submission.

.3 The Contractor shall subsequently print and submit full sized, red line copies of such reviewed documents to each reviewer. Each submission must be in pdf format and must be high quality documents, preferably generated by computer from the original documents (rather than scans of printed documents). If digital submissions are of insufficient quality, hard copies will be required. Emailed documents shall be reviewed and stamped digitally by the Contractor, or accompanied by a separate sheet from the Contractor listing the documents reviewed and bearing the Contractor's review stamp, along with copies of any revisions made. Email submission is only used as a convenient means of distributing drawings, in lieu of sending hard copies by courier. Reviewed drawings must still be printed for job site files, record copies, etc. All site copies shall be red line prints or colour prints.

.4 Shop drawing review by the Consultant is for the sole purpose of ascertaining conformance with general design concept. This review means that the Consultant 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.

1.5 AS-BUILT AND RECORD DRAWINGS

.1 Request one (1) additional set of white prints and clearly mark as the construction progresses, any and all changes in ductwork, piping and equipment sizes and locations. Show As-Built inverts and dimensions for underground piping, from two convenient reference points. Make drawings available for inspection at the site at all times.

.2 Upon completion of the project, and before final payment is made, transfer all of the construction information from the construction drawings to a clean set of white prints, using proper drafting techniques and instruments. Include the following statement on each drawing, "As-Built Drawing as prepared by (NAME OF COMPANY), complete with a signature of a signing officer of the company. Submit for review. Complete all corrections required and resubmit drawings. One set of as-built drawings is required prior to substantial performance.

.3 The Consultant will prepare Record Drawings and will be reimbursed for costs by the General Contractor through the Cash Allowance included in the Contract.

1.6 ADDITIONAL WORK

.1 The right is reserved to make changes to the Drawings and Specifications after the Contract is awarded. Submit detailed breakdown of costs with quotations for review. When costs are approved a Change Order will be issued covering the work.

.2 Written orders signed by the Consultant must accompany claims for additional compensation on account of extra labour and materials.

.3 For work performed by Mechanical Division 21, 22 and 23 own forces, a markup of 15% for additions unless otherwise stipulated in Divisions 00 and 01.

.4 For work performed by a Sub-Contractor of Mechanical Division 21, 22 and 23, a markup of 5% for additions unless otherwise stipulated in Divisions 00 and 01.

1.7 INSURANCE

.1 In addition to the insurance specified in Divisions 00 and/or 01, maintain insurance to fully protect both the Owner and all mechanical trades from all claims under the Worker's Compensation Act, etc.

1.8 GUARANTEES AND CERTIFICATES

.1 A "Substantial Performance Certificate" will be issued by the Consultant as soon as the work is complete and ready for its intended use and purpose. This certificate is a legal document with regard to lien period, final payment including holdback and guarantee period for all mechanical trades and systems and equipment except as noted herein.

.2 The guarantee period for all systems and equipment starts on the issue date of the Substantial Completion Certificate and extends for a period of one year unless specified otherwise. All systems are to be operated, tested and balanced before issuance of the Substantial Completion Certificate. Assign all warranties to the Owner and provide extended warranties on refrigeration compressors, etc. as applicable.

.3 All repairs to systems required during the guarantee period shall be performed by Mechanical Division 21, 22 or 23, as applicable, at no cost to the Owner.

1.9 DEFINITIONS AND INTERPRETATIONS

.1 The term "provide" means, to include labour, materials, and services necessary to supply and install items of work referenced.

.2 The term "instructions" or "as instructed" or "where instructed" means, as instructed by the Consultant including supplementary instruction notices; job site instruction notices; job site instructions by a field representative/inspector appointed by the Consultant and including all comments made regarding submittal of shop drawings and samples for review.

.3 The term "listed" means, that the materials or equipment are tested in accordance with applicable standards, and are approved and listed for their intended use by a testing company approved by the Authorities have jurisdiction.

.4 The term "approved", "approvals", etc. means, approved by Authorities having jurisdiction as conforming to the requirements of the contract documents.

.5 The term "acceptable" or "acceptance", etc. means, acceptable to the Consultant as conforming to the requirements of the contract documents.

.6 The term "submit for review" or "submit notice", etc. means, submit to the Consultant.

.7 The term "subject to review" means, work or materials laid out for review by the Consultant. Obtain instruction from the Consultant before proceeding with the work. Submit further information, shop drawings, samples, etc. as specified and/or as may be reasonably requested by the Consultant.

.8 The term "accessible" used alone means, readily accessible by a person using tools as required without cutting or breaking out materials.

.9 The term "noted" means, notes on the drawings, the detail drawings and on the schedules.

.10 The term "Contractor" means, the General Contractor or the Contract Manager as applicable for the project.

.11 The term "exposed" means, within the line of sight of any person standing or sitting in the occupied space, unless defined otherwise in other Sections of Mechanical specifications.

.12 The term "concealed" means, not exposed.

.13 The term "Mechanical" means Division 21 (Fire Suppression), Division 22 (Plumbing) and Division 23 (Heating, Ventilating and Air Conditioning).

1.10 CUTTING AND PATCHING

.1 For new work or where new work connects with existing and where existing work is altered, do all cutting and patching of building finishes. All work shall be performed by qualified tradesmen.

.2 Provide the location and dimension of required openings to the Contractor.

.3 Obtain Consultant's acceptance of location and methods before cutting, boring or sleeving load-bearing markers. All work shall be performed by qualified tradesmen.

.4 Do not endanger the work of other Divisions or property by cutting, digging or similar activity.

.5 Do not cut or alter the work of any other Section or Division.

.6 Should damage occur to the work of other Sections and Divisions, remedial work will be done by the trade who originally installed the work at the expense of the Sub-Contractor who caused the damage.

PART 2 - PRODUCTS

2.1 STANDARDS OF MATERIALS

.1 Materials, fixtures, fittings, appliances and apparatus provided shall be new, CSA approved, the best of the various kinds specified, free from all defects and of uniform pattern throughout the project. All fire protection materials are ULC approved and gas burning devices are CGA approved. All materials must also comply with any requirements of the Factory Mutual.

.2 Where a manufacturer's name or a product name is mentioned, it is for the purpose of establishing a standard of quality, performance, serviceability, appearance and capacity. Products and materials on which the design was based will be identified as the "Basis of Design" products and materials.

.3 Refer to the Mechanical Supplementary Bid Form (Section 23 00 01) and comply with the instructions indicated thereon. The Tender shall be based only on the "Basis of Design", or "Acceptable Alternate" product or material. Other "Substitute" products proposed must be shown separately in the Tender complete with the associated change in tender price for acceptance by the Owner.

.4 Indicate (circle) only one manufacturer for each product listed on the Mechanical Supplementary Bid Form on which the tender price is based. Where there is no indication of one name for each item, or where more than one name is indicated, the "Basis of Design" product, material or methods shall be provided.

.5 The Bidder is also encouraged to offer products and materials by manufacturers not indicated in the Specification. These shall not be included in the tender sum, but shall be shown separately in the Tender as substitutes complete with changes in price.

.6 The Consultant reserves the right to accept or reject any substitutes without explanation.

.7 Assume full responsibility for ensuring that when providing acceptable alternative or substitute items, all space, weight, connections, power and wiring requirements, etc. are considered. All costs incurred for additional components, changes to service, structural or space requirements, layouts and plans, etc. that may be necessary to accommodate the alternative or substitute items shall be borne by Mechanical Division 21, 22 or 23, as applicable.

.8 Ensure that items are suitable for operating at specified pressures and corresponding temperature where working pressure or pressure ratings are specified or shown on the drawings for valves, piping, fittings, equipment, pump schedules, etc.

2.2 PIPE HANGERS

.1 Provide adjustable wrought iron clevis type and/or adjustable ring with threaded suspension rods, pipe hangers for horizontal pipes.

.2 Provide extension split pipe clamps, rod threaded and sized to allow for pipe movement for vertical piping up to 63mm (2.1/2 inches) diameter. For vertical piping 75mm (3 inches) diameter and larger pipe supports consist of riser clamps or U-bolts fastened to structural steel channels or angles as necessary for the complete support.

.3 On copper piping, provide copper plated or epoxy type hangers or provide separation of the dissimilar

metals with approved dielectric materials. Insulating tape is not acceptable.

.4 On insulated piping, provide hangers external to the insulation. Provide pipe saddles for insulation protection which allows the weight of the pipe to bear directly on the insulation saddle rather than on the insulation.

.5 Refer to drawings or elsewhere in these specifications for special application pipe hangers as applicable.

.6 All horizontal pipes over 150mm (6") in diameter shall have hangers supported from at least two joists.

2.3 ELECTRIC MOTORS, STARTERS AND WIRING

.1 All electrical equipment supplied must be CSA and CEMA approved with motors manufactured in Canada with local service depots. Motor ratings scheduled or specified are output power ratings and are minimum power ratings acceptable with maximum motor speed of 1800 RPM, unless otherwise noted.

.2 Provide all electrical equipment for single point power connection, with compatible terminations, connections and plates for the line and load side for the type and size wiring specified in Electrical Division specification or shown on the electrical drawings.

.3 Where the power characteristics required to operate an electrical device differ from that specified or scheduled, provide and wire a suitable transformer to correct the voltage of the device. Submit notice of these arrangements and provide shop drawings detailing the size, weight and wiring of the transformer and its proposed location.

.4 Motors are ball bearing type unless noted otherwise, with continuous service rating and adequate capacity to start and run up to speed within ten (10) seconds and to operate the driven device under all conditions of load and service without overloading. Include a conduit terminal box in an approved location on each motor. Provide for all motors of 40 HP and larger, thermistors embedded in the windings of each phase for over temperature protection. All motors connected to variable frequency drives (VFDs) are inverter duty.

.5 Refer to schedules and starter legend for type required. Combination fused magnetic starters are complete with built-in disconnect switch; over-current protection relays in all three phases; fused control circuit; control transformer (24 volt unless indicated otherwise); hand-off-auto selector switch; running pilot light; reset button; sufficient auxiliary contacts to complete the control and interlocking sequences described in these specifications with minimum two NO and two NC contacts.

.6 Provide prewired starter mounted control relays compatible with thermistors in the motors where applicable. Include a pilot light to indicate when the sensing device has operated and separately identified reset button.

.7 All electrical equipment (except motors) installed in sprinklered rooms are of sprinkler proof construction as defined by Code.

.8 Armoured (BX) control cable may be used for thermostat wiring but must conform to flame and smoke developed classification required by Authorities. Provide a minimum of 14 gauge control wiring for 50 volts and above. Provide a minimum of 18 gauge control wiring for less than 50 volts.

.9 Fuses protecting motor circuits are Form I Class 'J' time delay. Other fuses up to 600A are Form I Class 'J'.

.10 Motor control centres are indoor type sprinkler proof, Class I Type B and consist of vertical sections fabricated of code gauge steel, shaped and reinforced to form a continuous rigid, free standing, closed, complete dead front assembly. All starters are designed for front access. Each section is Type B construction with all units and individual line and control leads brought out to terminal boards suitably located in each starter. All terminal boards have at least 20% spare capacity. The design and construction of the Sections is as follows:

- The main horizontal bus is copper and rated as indicated on the drawings.
- The vertical busses in each section are copper and rated a minimum of 300 amperes.
- Bus work and supports are suitably braced to safely withstand the stresses due to maximum short circuit of 50,000 amperes RMS.
- A continuous ground bus.
- Necessary rails, blank covers and hardware, where spaces are indicated for future starters.
- Full height barrier to isolate the starter compartments from the vertical bus and a full height wiring trough with cable supports for unit wiring.
- Starters are capable of being removed from a section for maintenance without the need of disconnection the power supply to the entire motor control centre, or each specific section.
- Terminal blocks are isolated to permit working on any section within the motor control centre with the remainder of the control centre being left alive.

The design and construction of the starter units is such that the connections are free floating, self-aligning construction which enable positive silver contact at all times. Unless otherwise noted, starters are combination magnetic type complete as described above.

.11 Provide multi-speed starters with a prewired time delay relay within the starter enclosure which will lock out the low speed for an adjustable time interval of 0-180 seconds on a transfer from high to low speed. Where multi-speed starters are controlled from an external source (control system) provide a Hand-Off-Auto (HOA) switch, and a Slow-Off-Fast switch wired through the "auto" position of the HOA switch. Provide also a mechanical interlock between the slow speed and fast speed contactors to prevent simultaneous operation.

.12 Where starters are required to be reversing type provide a cover mounted reversing switch and include both mechanical and electrical interlocks to prevent reversing during operation.

2.4 ACCESS PANELS

.1 Supply access panels for installation through Architectural finishes where they are required by arrangement of otherwise inaccessible equipment provided under this Division such as valves, cocks, drains, air vents, dampers etc. Access panels installed in fire rated walls, partitions or ceilings bear a fire resistance rating equal to the materials in which they are installed. Supply concealed type frame and door panels for locations in tiled or plaster finishes, for matching finishes to be installed in door panel.

.2 Provide panels in a minimum size 300 x 300mm (12" x 12") for hand access and 600 x 450mm (24" x 18") only where personnel entry is required. Panels are 12 gauge bonderized steel flush type with walls or ceiling with concealed flanges and complete with anchor straps, rust resistant concealed

hinges, socket head wrench or key operated locks.

2.5 VIBRATION CONTROL EQUIPMENT

.1 All spring isolators are complete with neoprene sound pads, zinc chromate plating on all hardware, colour coded stable springs, and levelling devices selected to operate at no greater than 2/3 solid deflection. All mounts installed where exposed to high humidity conditions shall have rust resistant paint coating and neoprene coating of the spring. Provide box style mounts with limit stops where control of lateral motion is required.

.2 Waffle pads are neoprene of minimum 12mm (½ inch) thickness or combination neoprene-steel-neoprene pads consisting of a layer of neoprene bonded to either side of a 6mm (1/4 inch) steel plate with total 13mm (1/2 inch) thickness as scheduled.

.3 Inertia bases have full depth perimeter structural channel frames, 18 gauge metal pan bottoms and reinforcing rods welded in place. Provide gusseted brackets welded to the steel channel sides and spring supports to carry the entire base. Fill with minimum 17 mPa concrete. Total weight of the filled bases is not to be less than the weight of the equipment isolated.

.4 Provide structural steel bases for equipment not designed for isolator point loads. All steel bases and inertia bases clear the sub-bases at least 25mm and 50mm (1 inch and 2 inches) respectively.

2.6 HIGH EFFICIENCY MOTORS

.1 All totally enclosed fan cooled or drip proof motors 1 HP to 500 Hp inclusive provided under this Division shall have a nominal full-load motor efficiency not less than the minimum specified in CSA Standard C390 "Energy Efficiency Test Methods for Three-Phase Induction Motors".

.2 All motors not complying with the above will be replaced by Mechanical Division 21, 22 or 23 (as applicable) at no cost to the Owner or his Agents.

2.7 ELECTRIC PIPE TRACING

.1 Tracing cables are Raychem's Chemelex Auto-Trace self regulating heat tracing system, cut to length for use on 120 volt single phase circuits.

.2 The self-regulating heater shall consist of two 16 AWG tinned-copper bus wires embedded in parallel in a self-regulating polymer core that varies its power output to respond to temperature all along its length, allowing the heater to be crossed over itself without overheating. The heater shall be covered by a radiation cross-linked modified polyolefin dielectric jacket.

.3 Provide all end seal, splicing and tee kit components as required to suit installation.

.4 Banding and heat transfer tape is Raychem AT180 aluminum banding and heat transfer tape.

.5 Each tracing circuit is controlled by a bulb-sensing thermostat set at 4.5°C. (40°F.) through an appropriate contactor.

PART 3 - EXECUTION

3.1 EXISTING CONDITIONS AND OTHER TRADES

.1 Visit the site to determine existing conditions affecting the work of Mechanical Divisions 21, 22 and 23, and include for the complications resulting from these conditions.

.2 Examine the Architectural, Structural, Mechanical and Electrical Drawings and become fully familiar with the work of all other trades. Co-operate with all other trades. Particular attention shall be paid to the proximity of electrical conduit and cable to ductwork and piping. Maintain maximum clear ceiling heights throughout.

3.2 DRAYAGE, HOISTING AND SCAFFOLDING

.1 Assume the responsibility for drayage, hoisting, warehousing and demurrage for all equipment and materials to be furnished and installed under Mechanical Divisions 21, 22 and 23. Include for the cost of dismantling and re-assembling of equipment where required to manufacturer's approval.

3.3 CUTTING AND PATCHING

.1 Provide all cutting and patching by qualified tradesmen or have the Contractor leave openings in walls, floors, ceilings and roof, as required by Mechanical Divisions 21, 22 and 23, for ducts, drains, pipes, recessed fixtures, etc. Provide the Contractor with location of all recesses and all holes for ducts, pipes, etc. before concrete is poured or walls are built.

.2 Do all drilling for hangers, rods, inserts, etc. Use approved inserts for existing conditions and slab thicknesses.

.3 Supply the Contractor with diagrams of all equipment bases showing exact location of anchor bolts. Provide anchor bolts as required.

.4 All flashing required for openings in walls, floors and roofs will be provided by the Contractor unless noted otherwise on the Drawings or specified as part of the mechanical equipment being installed.

.5 For cutting and patching performed by Mechanical Divisions 21, 22 and 23, execute to make work fit properly together. Make patches invisible in final assembly.

.6 Fit construction tightly to duct, pipes and conduits to stop air movement completely. The Section performing work that penetrates a fire, air, vapour, moisture, thermal or acoustic separation element of the building shall pack voids tightly with rock wool; seal air, vapour and moisture barriers; and caulk joints as may be required to ensure that no air movement through the penetration is possible.

3.4 TAGS, CHART, IDENTIFICATIONS AND DATA BOOK

.1 Provide for each major piece of equipment or apparatus engraved "Textolite" nameplates securely fastened with self-tapping screws in a conspicuous place on the equipment. Names and number correspond to those used on flow diagrams and operating instruction manuals. The lettering is minimum 6mm (1/4") high.

.2 Identify (paint in its entirety) all gas piping provided by Mechanical Divisions 21, 22 and 23 in accordance with the requirements of the Gas Code. Identify all other piping installed by Mechanical Divisions 21, 22 and 23 with plastic coated adhesive tape labels, marked as to contents and direction of flow. Labels are 25 x 100mm (1" x 4") and colours are to CSA standards and space at approximately 6 meters (20ft.) apart. Provide each pipe in each room with at least one label.

.3 Prepare operation and instruction manuals including the following:

- Title label on outside of the cover stating name and address of the project, trade(s) involved and the name and address of the Sub- Contractor.

- Neatly typewritten index furnishing immediate information as to location in the manual of all data regarding the installation.

- Complete typewritten index furnishing immediate information as to location in the manual of all data regarding the installation.

- Oiling and greasing schedule for all equipment indicating frequency and type of lubricant.

- Copy of balancing report.

- Complete nomenclature of all replaceable parts, their part numbers, and name and address of the nearest vendor.

- Copy of all guarantees and warranties issued on the installation, showing all dates of expiration.

- Copy of all approved "Shop Drawings".

.4 Provide one (1) digital copy and one (1) hard copy of contents of operating and maintenance manual. All digital files shall be loaded onto a USB flash drive and hard copies shall be in a stiff cover three-ring binder. All contents in digital copy shall be in Portable Document Format (PDF) and enhanced with bookmarks and internal document links. Each PDF file name shall match that indicated in the hard copy binder.

.5 Supply and attach to each valve installed, except draining cocks and stops at fixtures, a brass tag of 25mm (1") diameter with black numbers embossed thereon. Attach tags to the valves with a brass chain. Co-ordinate the numbering with all Sections to prevent duplication.

.6 Prepare a chart of each system showing the equipment, the location and the numbers and purpose of each valve. Prepare a chart showing number and location of each air vent. Provide one copy of each chart in each data book as mentioned herein and install another copy of each chart framed and glazed where instructed.

.7 Prepare a list of all motors, equipment etc., as follows:
- Location.
- Unit name.
- Motor manufacturer and serial number.
- Rated power output, voltage, frequency, amps and RPM.
- Starter manufacturer, type, size, and overload heater ratings.
- Fan manufacturer, serial number, R.P.M., airflow and static pressure.
- Oil or grease lubrication type.

.8 Compile a list on letter size sheets. Include copies of the lists in the data books and submit three additional copies of the list on completion of the project. Number all starters to correspond with the motors.

.9 Where the work is an extension of existing work, the equipment and valve tagging will follow the existing system sequentially. Co-ordinate with the Owner regarding the starting point and sequence number in accordance with sequences shown on the drawings.

3.5 INSTRUCTIONS

.1 Provide the services of a competent Consultant to instruct personnel designated by the Owner in the proper operation and maintenance of all equipment provided by this Division. Period of instruction shall be of sufficient duration to allow the Owner's designated personnel to become competent in the operation of the equipment. In addition, provide specialized instructions given by the respective manufacturers as required and as described under the appropriate articles of this Specification.

3.6 CLEANING AND PROTECTION

.1 Protect equipment properly from dirt and damage during the construction period. Where damage occurs repair and touch up with the manufacturer's paint. On completion of the work remove all waste materials and leave the work in a clean and perfect condition.

3.7 STANDARD OF WORKMANSHIP

.1 Only top quality workmanship using qualified tradesmen will be accepted. Work throughout shall present a neat and clean appearance on completion in a condition to receive paint.

3.8 PAINTING

.1 The Painting Section of the Contract provides all finished painting of ducts, piping (except gas piping), equipment and fittings. Paint all gas piping in colour complying with the requirements of the local Gas Company.

.2 Supply all equipment, etc. with manufacturer's standard prime coat as a minimum unless fabricated of non-corrosive materials.

.3 Supply all steel piping with standard factory oil coat. Paint all field welds with zinc rich primer.

3.9 CO-ORDINATION

.1 Mechanical Divisions are responsible for co-ordinating the work herein to suit project phasing schedule.

.2 Co-ordinate all work with the work of any other Section or Division to avoid conflicts. Be responsible for modifying installed work of Mechanical Divisions 21, 22 and 23 to accommodate space conflicts.

3.10 PIPE HANGERS

.1 Provide pipe hangers and their supports for all piping installed.

.2 Provide protection to prevent crushing of insulation where hangers are external to the insulation. Use insulating saddles manufactured for this purpose. Size hangers to accommodate saddles and insulation.

.3 Space support points for all piping as follows:

.1 Steel Pipe:

Nominal Pipe Size	Distance Between Supports
Up to 32mm (1.1/2")	2.4 meters (8 ft.)
38mm to 65mm (2.1/2")	3.0 meters (10 ft.)
75mm (3") and larger	3.6 meters (12 ft.)

.2 Copper Tubing:

Nominal Pipe Size	Distance Between Supports
Up to 16mm (5/8")	1.8 meters (6 ft.)
20mm to 25mm (1")	2.4 meters (8 ft.)
32mm to 50mm (2")	3.0 meters (10 ft.)
65mm (2.1/2")and larger	3.6 meters (12 ft.)

.3 PVC Pipe:

All Sizes

- 1.2 meters (4 ft.) centres or 1/2 lay length of pipe, whichever is less.
- Every length of pipe exceeding 0.3 meters (1 ft.) is supported at least once.

.4 Space all pipe hangers such that there is a hanger within 0.3 meters (1 ft.) of every bend and that the maximum spacing does not exceed the limits indicated below.

.5 Hangers for galvanized iron pipe are spaced at maximum of 2.4 meters (8 ft.) for pipe up to 150mm (6 inches) in size, and at maximum of 3.6 meters (12 ft.) for pipe 200mm (8 inches) and larger.

.6 Hangers for cast iron pipe are spaced at maximum of 1.5 meters (5 ft.) and at not more than 0.9 meters (3 ft.) where the pipe has mechanical joints and the length of pipe between fittings is 0.3 meters (12 inches) or less.

.7 Vertical lines are supported at each length and at the top and bottom of each riser and at each floor level.

.8 Do not suspend hangers from the metal roof deck or other mechanical or electrical system components.

.9 Obtain approval from the Structural Consultant for all hangers suspended from open web steel roof joist construction.

3.11 INSERTS

.1 Use only factory made, threaded or toggle type inserts as required for supports and anchors, properly sized for the load to be supported. Provide factory made expansion shields where inserts cannot be placed, but only where prior written instructions are obtained, and only for light weights.

3.12 EQUIPMENT SUPPORTS

.1 Provide structurally sound supports for the installation of equipment provided by Mechanical Division 21, 22 or 23 except where supports by other Sections are specifically indicated on the drawings. When instructed, submit the designs of the supports for review. Where equipment is not designed for the points loads imposed by supports or vibration isolation, provide structural steel bases to evenly distribute the loads on the equipment.

.2 Provide metal shims necessary for levelling all base mounted equipment and provide expanding grout under the entire base to give even support and weight distribution.

3.13 PIPE ANCHORS

.1 Anchor piping at all points where necessary, using substantial structural steel angles, channels, or plates secured to the building structure. Do not anchor pipes to open web joists. Install piping so that it is free to expand and contract without imposing undue stresses on any branch connection, or the building structure. Allow for expansion of building where indicated on the Architectural or Structural Drawings, in all piping and ductwork crossing building expansion joints. Utilize expansion compensators or expansion loops where required to allow for pipe expansion or contraction.

3.14 SLEEVES AND ESCUTCHEONS

.1 Provide standard weight steel pipe for sleeves passing through masonry or concrete walls and floors; 22 gauge galvanized steel for sleeves through partition walls; and minimum 75mm (3 inch) high concrete curbs for ducts or groups of pipes passing through floors. Ten (10) U.S. gauge angle iron frames around openings suitably waterproofed will be acceptable in lieu of concrete curbs.

.2 Provide chrome plated escutcheons of one piece construction complete with set screws on exposed pipes in finished and unfinished areas where building surfaces are penetrated.

.3 Supply to the Contractor all necessary frames for building into walls and partitions for grille outlets or passage of ducts. Provide also detailed information for location of same.

.4 Caulk annular space between pipes and sleeves with ULC listed thermo-fibre fire-proof type insulation or Tremco Fyre-Sil fire stop sealant complying with CAN4-5115 and finished to provide fire rating required for walls and floors.

.5 Extend sleeves passing through roof decks or floors not less than 75mm (3 inches) above finished roof or floor level and thoroughly caulk and seal. Water-proofing membranes will be flashed to sleeves by the Contractor.

3.15 ELECTRIC MOTORS, STARTERS AND WIRING

.1 Provide electric motors complete with drives, guards and starters for all motorized equipment.

.2 Include pilot lights, relay, transformers and other electrical devices required for the proper operation and control of the equipment.

.3 Remote disconnect switches where required by Code are provided by the Electrical Division, unless noted otherwise. Fuses for fusible disconnects and starters for mechanical equipment are supplied by Mechanical Division 21, 22 or 23 (as applicable) as specified regardless of who supplied the disconnect or starter. Co-ordinate the fuses with the starter or disconnect fuse clips to ensure compatibility.

.4 Unless specified otherwise in other Sections of this Division, the following principle shall apply to electric wiring:

- All starters; electric heaters (except duct heaters); and heating cable; power wiring both line and load side of all starters; and all line voltage thermostats will be installed and wired by Electrical Division.

- All control wiring including wiring between thermistors and relays and interlocking wiring shall be provided by Mechanical Division 21, 22 or 23, as applicable. No wiring shall be exposed. Make all Division 21, 22 and 23 power wiring conform with the requirements of Electrical Division Specifications.

- Install all wiring by Mechanical Division 21, 22 and 23, except as defined below, in EMT conduit. Where acceptable to Authorities, armoured (BX) control cable may be used in lieu of EMT and wiring in concealed accessible areas only. Length of armoured cable shall not exceed 3m (10 ft.). Armoured control cable must be attached to the structure with suitable clips at a maximum of 1m (3 ft.) on centre. Do not attach to ductwork or other conduit. Where wiring is exposed to outdoor conditions, or poured into concrete floor, install in rigid galvanized steel conduit with threaded and gasketted weather-proof fittings.

3.16 ACCESS PANELS

.1 Provide approved access panels to maintain access to all services, valves etc. Access panels in insulated surfaces must be of the double wall insulated type.

3.17 INSULATION

.1 Apply insulation in a workmanlike manner by Journeymen skilled in this trade employed by acceptable contractors normally doing this type of work. Apply insulation to piping and equipment only after all tests have been successfully made.

.2 All insulation, unless specifically excepted hereinafter has composite (insulation, jacket or facing and adhesive used to adhere the facing or jacket to the insulation) fire and smoke hazard ratings as tested by procedure complying with ASTME-84, ULC C723, ULI 723, NFPA 255 or CAN4-S102, 2-79 requirements, not exceeding a Flame Spread Rating of 25; Smoke Developed Rated of 50; and a Fuel Contribution Rating of 50.

.3 Pipe insulation is UL approved, 88kg/m3 (5.5lb/cu.ft.) density moulded sectional glass fibre complete

with vinyl coated foil-kraft laminated vapour barrier jacket reinforced with an open mesh fibreglass scrim fabric. Thermal conductivity: 0.0335 W/m-°C at 24°C (0.232 BTU-in/hr. ft^2-°F at 75°F) mean temperature.

.4 Refrigerant piping is UL approved, tubular foamed plastic of closed cell structure, having a thermal conductivity of 0.039 W/m-°C (0.27 Btu-in/sq.ft.-hr-°F). Comply to requirements of local authorities and obtain approval for same before using. If disallowed use standard glass fibre insulation.

.5 Concealed rectangular duct and all circular duct insulation is UL approved, 25mm (1") thick minimum, 16 kg/m3 (1 lb/cu. ft.) density glass fibre faced flexible blanket type with foil faced laminated vapour barrier jacket reinforced with an open mesh fibreglass scrim fabric. Thermal conductivity: 0.0409 W/m-°C at 24°C (0.283 BTU-in/hr. ft^2-°F at 75°F) mean temperature.

.6 Exposed rectangular duct insulation is UL approved 75 kg/m3 (4.5 lb/cu. ft.) density glass fibre faced rigid type with foil faced laminated vapour barrier jacket reinforced with an open mesh fibreglass scrim fabric. Insulation thickness is minimum 25mm (1), except for fresh air (outside air) which is minimum 38mm (1.1/2") thick and ductwork exterior to building which is minimum 50mm (2") thick. Thermal conductivity: 0.0337 W/m-°C at 24°C (0.234 BTU-in/hr. ft^2-°F at 75°F) mean temperature.

.7 Acoustic rectangular duct insulation is UL approved 25mm (1") thick, 72 kg/m3 (4.5 lb/cu. ft.) density glass fibre rigid type with membrane reinforced neoprene coating on one side. Plenums have 50mm (2") thick insulation.

.8 Heating tanks, equipment and breeching insulation is UL approved 38mm (1.1/2") thick, glass fibre rigid type having a 112 kg/m3 (7 lb/ft. 3) density. Thermal conductivity: 0.0303 W/m-°C at 24°C (0.2103 BTU-in/hr. ft^2-°F at 75°F) mean temperature.

9. Cold tanks and equipment can be as above in 75mm (3") thickness, or if approved for use by the local authorities, can also be Armaflex FR flexible elastomeric sheet having a thermal conductivity of 0.0412 W/m-°C (0.286 Btu-in/hr. sq. ft. °F) at 32.2 °C (90 °F) and 96 kg/m3 (6 lb/ft 3) density.

.10 Insulate the following ductwork and components externally unless otherwise noted:

- All non-tempered fresh air (outside air) ductwork from the fresh air fan to the terminal outlet.
- All supply air ducts (including silencers) in mechanical/service rooms, in non-conditioned spaces, and as follows:
  - Constant volume systems: From air handler or rooftop unit up to flexible branch ducts serving individual diffusers, except circular exposed ductwork external to mechanical/service rooms. Note that flexible branch ducts are pre-insulated.
  - Variable air volume systems: From air handler up to flexible branch ducts serving individual diffusers, except circular exposed ductwork external to mechanical/service rooms, acoustically lined ducts and VAV and fan-powered VAV boxes. Note that flexible branch ducts are pre-insulated.
- All outside air ductwork, mixing plenum, filter plenum, coil plenums up to fan section.
- Fan sections or fans on outside air or air conditioning system not factory insulated.
- Relief or exhaust air ducts or plenums at least 1524mm (5 ft.) inside of outside wall or roof or discharge damper, whichever is the greater.
- Under damper motor support brackets.
- All ductwork external to the building, except where noted otherwise.

.11 Insulate the following ductwork and components internally unless otherwise noted:

- All ductwork and plenums shown on the Drawings as acoustically lined.
- Plenums and duct access doors and panels on insulated ducts and plenums.

.12 Insulate the following piping and/or fittings unless otherwise noted:
- All hot water heating piping and fittings throughout.
- All chilled water piping and fittings throughout.
- All glycol heating piping and fittings throughout.
- Equipment drain piping and condensate drains.
- All metal piping for 1.5 meters (5 feet) from the outside wall or roof as a minimum (see also rainwater leaders below).
- Domestic cold water including water meter body.
- Domestic hot and tempered water supply and recirculation.
- Horizontal sanitary and metal rainwater leaders above grade including rainwater hoppers, upturn and downturn fittings, couplings, etc..
- Glycol and water valves (except circuit balancing valves), flanges and strainers.
- Refrigerant piping complete.
- All trace heated piping.
- Install manufacturer's moulded insulation package for circuit balancing valves (CBVs) installed on insulated piping. Co-ordinate with piping trades to include moulded insulation with purchase of CBVs.

.13 Do not insulate the following piping and/or fittings unless otherwise noted:
- Piping used exclusively for fire protection.
- Soil stacks, vents, etc. except as noted above.
- Unions.
- Flexible connections or expansion joints unless noted on the drawings.
- Check valve covers.
- Strainer legs and bucket covers.

.14 As applicable, insulate the following tanks, breeching and equipment unless otherwise insulated or noted:
- Domestic hot water tank.
- Boiler stacks and breeching within the building.
- Plate exchangers.
- Products of combustion exhausts - including mufflers.
- Chilled water pumps.

.15 Do not insulate the following equipment unless otherwise noted:
- Expansion tanks.
- Boilers.
- Pumps (other than above).
- Equipment nameplates or capacity plates.
- Type 'B' or "All Fuel" factory insulated vents.
- Products of combustion exhausts outside building except where required for personnel protection.

.16 Unless otherwise specified re-cover all insulated exposed piping and externally insulated ductwork, tanks, breeching and equipment in finished areas and mechanical rooms with 0.271 kg/m2 (8 ounce

per square yard) ULC labelled thermo canvas, secure with 2 coats of fire retardant lagging adhesive. No further re-covering or finishes are required on concealed ductwork unless otherwise specified. Re-cover all externally insulated piping and ductwork exterior to the building with 0.5mm thick embossed aluminum jacketing secured in place, with side longitudinal joints (facing down to shed water) and all joints lapped 100mm and sealed watertight with suitable waterproof coatings and joint sealers.

.17 Provide removable, internally insulated covers for manholes, removable heads, tops of split case pumps, etc. Construct covers of 1.27mm (18 gauge) aluminum, internally lined with acoustic insulation as specified elsewhere for ductwork. Provide suitable hardware as required to attach covers securely to the equipment.

.18 Apply rigid thermal or acoustic insulation to duct and/or plenum with edges tightly butted together. Secure insulation with 2.769mm (12 gauge) galvanized pins and clips spot welded on 30.48cm (12") centres each way. Apply insulation with vapour barrier to the warm side. Where mechanical fasteners penetrate vapour barrier, and at all corners and joints, apply vapour tape or vapour barrier strips adhered with Bakelite 230-06 vapour barrier adhesive. On acoustic insulation provide metal nosing (channel or Z profile) on upstream edges of liner duct sections at fan discharge, any point where lined duct is preceded by unlined duct and at each lined duct joint to eliminate the possibility of uplift. Metal nosing is securely installed over entire traverse liner edges facing the airstream and extends minimum 50mm (2") along the leading edge of duct liner. All edges not requiring metal nosing are coated. All minor damage to the airstream surface shall be repaired by coating damaged area with approved adhesive or coating designed for duct liner application. Duct liner with major damage shall be replaced. Where duct air velocity exceeds 7.62 m/s (1,500 fpm) provide 13mm x 13mm (1/2" x 1/2") galvanized expanded metal mesh on the first 3m (10 feet) of duct liner off of the discharge of a fan secured with the mechanical fasteners.

.19 For flexible insulation on rectangular ducts 762mm (30") or more in width, apply mechanical fasteners to bottom surface at approximately 45.7cm (18") centres. At joints and where mechanical fasteners penetrate the vapour barrier apply vapour barrier tape or cover with heavy coating of vapour barrier adhesive.

.20 Hold pipe covering without integral jacket in place with insulation fastenings at not less than 305mm (12") centres. Hold pipe covering with integral jacket in place by stapling the flap on 76mm (3") centres. Apply pipe covering with integral vapour barrier jacket to piping and hold in place by securing the jacket flap. Seal all flaps and butt strips with Bakelite 230-60 vapour barrier coating adhesive and lap sealer. Insulate fittings, valves and strainers with sections of the pipe covering mitred to fit tightly, or insulation cement, or with tightly placed flexible insulation covered with reinforcing membrane stapled in place. Apply hard coat finishing cement over insulating cement. Leave drains, blow-off plugs and caps uncovered. Insulate flanges with oversized pipe covering or mitred blocks to the thickness of the adjacent pipe covering. Terminate insulation 76mm (3") from fittings to provide working clearance and bevel insulation at 45 degree angle.

.21 Pipe insulation conforms to the following table, as applicable:

Application	Pipe Size	Insulation
Chilled water supply, brine, refrigerant piping (T ≥ 4.5°C)	Up to 50mm (2") 65mm - 200mm (2.1/2"-8") 250mm (10") and larger	25mm (1") 38mm (1.1/2") 50mm (2")
Chilled water supply, brine, refrigerant piping (T < 4.5°C)	Up to 25mm (1") 32mm - 200mm (1.1/4"-8") 250mm (10") and greater	25mm (1") 38mm (1.1/2") 50mm (2")
Chilled water return	All sizes	25mm (1")
Heating water and gycol supply and return	Up to 32mm (1.1/4") 40mm (1.1/2") and greater	38mm (1.1/2") 50mm (2")
Domestic cold water	All sizes	25mm (1")
Domestic hot and recirc. water	Up to 32mm (1.1/4") 40mm (1.1/2") and greater	25mm (1") 38mm (1.1/2")
Condensate drains	All sizes	12mm (1/2")
Horizontal storm and sanitary	All sizes	12mm (1/2")
Piping electrically traced	Up to 90mm (3.1/2") 100mm (4") and larger	50mm (2") 65mm (2.1/2")
Steam (T ≤ 121°C) and condensate	Up to 90mm (3.1/2") 100mm (4") and greater	65mm (2.1/2") 75mm (3")
Steam (T > 121°C) and condensate	Up to 20mm (3/4") 25mm - 32mm (1"-1.1/4") 40mm (1.1/2") and greater	75mm (3") 100mm (4") 115mm (4.1/2")

3.18 INSTALLATION OF UNDERGROUND PIPES

.1 Install pipes in trenches on Class 'B' bedding on solid stable soil. Extend Class 'B' bedding to 305mm (1'-0") above piping and finish with approved material above. Where solid stable soil bed is unobtainable, install pipes on concrete bed, solid concrete block, concrete piers or other approved bedding provided by Mechanical Division 21, 22 or 23 (as applicable), to the satisfaction of local Authorities.

3.19 EXCAVATION AND BACKFILL

.1 Provide all excavation and backfill in strict accordance with the requirements of the Authorities having jurisdiction. In the existing building areas which are to remain, the excavation shall include all necessary saw cutting of floors and walls.

.2 Grade excavation by hand at the trench bottom to fit the lower 1/3 segment of the pipe and to ensure even bearing along the barrels; prepared so that no portion of the pipe bears directly on rock or other hard surface, kept dry at all times; protected from freezing and damage by weather; deep enough to remove all silt, etc. and to provide for an adequate bedding.

.3 Refer to the Excavation and Backfill Section in Division 31 of the general specifications. Provide all excavation and backfill as specified therein.

.4 Do not commence backfilling until the work is reviewed, accepted and approved.

.5 Where settlement occurs fill depressions to restore correct grades. Be responsible for making good any subsequent settlement to fill placed, and pay all costs involved in making good paving, floors, lawns, curbs and other surfaces damaged by such settlement.

.6 Pile and store excavated materials under the direction of the Contractor to ensure a minimum of inconvenience to all trades. Remove and dispose of all remaining excavated material on completion of the work and the site left clear and unencumbered.

3.20 CONCRETE

.1 Provide all concrete work for the support of all piping laid in backfilled ground and include concrete bed, solid concrete block or concrete piers to the approval of the local Inspectors. Concrete is 10.3 MPa (1500 psi) at 28 days complete with reinforcing steel as required, and complies with the concrete section of the Specification.

.2 Provide all cast-in-place concrete, including concrete bases for equipment, concrete curbs at pipe/duct floor penetrations, trench drains, etc., unless otherwise noted.

.3 Provide all precast concrete work, including catch basins, manholes, etc.

3.21 COMMISSIONING

.1 A Commissioning Agent will be appointed and paid by the Owner to commission all aspects of work of Mechanical Divisions 21, 22 and 23. Refer to Section 01 91 00 in Division 01 of the Specification and Section 23 08 00 and comply with all applicable requirements indicated therein.

.2 Each trade Section of Mechanical Divisions 21, 22 and 23 shall include for the cost of one qualified serviceman, completely familiar with the project, complete with appropriate spare parts and tools, to become part of the commissioning team for the project. The serviceman shall assist the Commissioning Agent during the commissioning process. This work will be required at or near the substantial completion phase of the project. Each Division and/or trade providing servicemen shall ensure continuity of their function by having only one such person assigned to the commissioning team. The actual performance of this work will be scheduled and coordinated by the Commissioning Agent.

3.22 SCHEDULE FOR COMPLETION

.1 All work must be substantially performed by the date as indicated in Division 00.

3.23 INSPECTION AND TESTING

.1 All inspection and testing of all equipment and systems as required by Regulatory Authorities, as well as all piping and ductwork pressure testing and chemical flushing and cleaning, shall be witnessed by the Owner and the Owner's written acceptance obtained. Minimum 48 hours prior notice of such inspections and testing shall be given to the Owner.

3.24 ELECTRIC PIPE TRACING

.1 Field Measurement:

.1 Establish the quantities of cable required by field measurement. Do not use drawing estimates for ordering materials.

.2 Manufacturer's Instructions:

.1 Adhere to the manufacturer's requirements and recommendations in the installation of the system.
.2 For steel and copper piping, secure cables with fibreglass tape applied circumferentially. For all other piping materials, secure cables with aluminum tape applied longitudinally continuously over the cable.

.3 Application & Test Procedures:

.1 Install cables with temporary banding until the installation is complete and megger checked.
.2 Replace with permanent circumferential banding and place heat transfer tape over and parallel to the cable.
.3 Test each cable with 500 volt "Biddle" insulation tester prior to initial installation, after initial installation, prior to insulating and after insulation installed. An acceptable reading shall not be less than 10 megohms.
.4 Submit six (6) copies of the test results for review.

.4 Tagging:

.1 Provide a permanent non-corroding type metal tag, securely fastened to each cable identifying the cable number, total watts, watts per foot, cable length, amperage and voltage.

3.25 INTEGRATED LIFE SAFETY SYSTEMS TESTING

.1 Integrated fire protection and life safety systems testing will be provided by an independent company selected by the Owner. The work will be tendered and administered by the Commissioning Agent. A representative of this Section shall be present at the time of the systems' testing procedure.

END OF SECTION 23 00 10

PART 1 - GENERAL

1.1 REQUIREMENT

.1 Sections 23 00 01, 23 00 10 and 23 08 00 form part of this Section. Related work is specified in Sections 23 00 30, 23 00 40, 25 00 00 and 25 08 00. Refer to same.

1.2 CONFORMANCE TO ARCHITECTURAL & STRUCTURAL LAYOUTS

.1 Ensure that all equipment and piping can be installed in the locations indicated. Refer to Architectural and Structural Drawings and Specification to establish the existence of interferences. Make changes to the routing of piping and shifting of equipment locations to accommodate structural conditions and work of other trades at no change to the Contract Price.

PART 2 - PRODUCTS

2.1 PIPING SYSTEMS

.1 All fabrication, welded or otherwise meets the requirements of the ASA B-31.1 code for pressure piping and the CSA 15-1951 Canadian regulation for the construction of boilers and pressure vessels. All pipe welding is done by a welder holding a certificate from the Department of Labour for the class of piping to be welded.

.2 Class 1 Systems includes low pressure steam condensate as applicable. Piping is black steel to ASTM A-53 minimum Schedule 80. Fittings for piping 50mm and smaller are screwed ends, 1720 kPa (250 psig) cast iron. Fittings for larger piping are Schedule 80 black steel butt welding type. Flanges and accessories, unions, strainers, gate, globe and check valves are as specified herein for low pressure steam service.

.3 Class 2 Systems include low pressure steam less than 860 kPa (125 psig), heating water and heating glycol less than 121°C (250°F) and 1035 kPa (150 psig), chilled water and condenser water less than 66°C (150°F) and 1035 kPa (150 psig). Piping is black steel to ASTM A-53 minimum Schedule 40. Fittings for piping 50mm and smaller are screwed ends, minimum 1035 kPa (150 pound) Malleable Iron: fittings for larger piping are standard black steel butt welding type. For branch to main tap-in connections use Weldolets for sizes larger than 50mm; use Threadolets for sizes 50mm or smaller. Make flanges a minimum 1035 kpa (150 pound) standard carbon steel for sizes larger than 50mm and they may be of the welding neck or slip on welding types. Gaskets for flanged joints are 1.6mm (1/16") approved for the applicable service.

.4 Class 3 Systems include domestic water piping above grade, cold water make-up piping and cooling tower sump filter piping, all suitable for a minimum working pressure of 1375 kPa (200 psi). Conform to applicable plumbing and building codes. Piping is type 'L' hard drawn copper tubing to ASTM B88 standard, sweat pattern, connected using 95 percent tin and 5 percent antimony solder.

.5 Class 4 Systems include condensate drains, vents and surface drains from equipment. Piping is DWV copper pipe to ASTM A306 standard and fittings are sweat pattern copper or brass.

.6 Class 5 Systems include refrigerant piping. Piping is type K seamless copper tubing, soft temper for 16mm (5/8") OD and smaller, hard temper for 19mm (3/4") OD and larger. Joints to be silver solder.

.7 Provision of mechanical grooved pipe, fittings and couplings is not acceptable.

2.2 PIPING SPECIALTIES

.1 Manual air vents are nickel-plated screwdriver operated vent cock type with 6mm (¼") O.D. copper tubing connections to air chambers. Automatic air vents are float type, designed for minimum 860 kPa (125 psi) complete with isolating cocks. Make air eliminator fittings full line size complete with an automatic air vent. Provide automatic air vents at all high points in each closed water system and at all other points necessary to free the system from air binding. Vents installed in concealed locations are equipped with type 'L' copper drain tubing run to the nearest drain and complete with access panel for servicing.

.2 Strainers are 'Y' type unless specified otherwise with monel or stainless steel screens having 1.5mm (1/16") perforations. Strainers 50mm (2") smaller have cast iron body with screwed end and screw-in cap. Strainers larger than 50mm (2") have iron body, flanged ends, minimum 20mm (3/4") threaded blow down connection and plug, bolt-on cover. Strainers 50mm (2") and smaller on copper lines have bronze body with screwed end and screw-in cap.

.3 Suction guides at pump inlets are designed for direct connection to the pump; conforming to the specifications for strainers herein and have full pipeline size inlets and outlets, and tappings for gauge connections.

.4 Unions are ground joint type, brass seat, wrought iron body.

.5 Backflow preventers are listed; conforming to the requirements of the Plumbing and Drainage Section and are Watts No. 900 Series. Water make-up assemblies consist of pressure reducing valves with built-in strainer, check valves, pressure relief valve, pressure gauge and three valve bypass. Make assemblies minimum 20mm (3/4") size.

.6 Pressure gauges are Bourdon type, minimum one percent accuracy throughout the entire range, complete with phosphor bronze full size Bourdon tube, forged brass socket, brass rotary movement, bronze bushings, cast aluminum case. Mount tube and movement independently from the case for shock protection. Gauges are minimum 110mm (4½") dial size, black case, black ring, silver brazed joints, METRIC/IMPERIAL indication. Use liquid filled gauges for application directly on pumps. Select gauges to suit fluid working pressure and where possible the test pressure. Where test pressure falls outside safe instrument range, attach a note to this effect to the installation instructions. The normal working pressure occurs at approximately mid-scale. Install each gauge complete with 6mm petcock and provide snubbers (restrictors) in the connection where pressure surges could cause damage to the gauge. For steam services also provide a coil syphon between gauge and steam to prevent the steam from reaching the bourdon tube. Provide a gauge at the inlet and discharge of all water coils, boilers, pumps, heat exchangers and where detailed on the drawings.

.7 Thermometers for installation in piping are minimum 225mm (9") adjustable angle type with blue/black aluminum finish, clear acrylic plastic lens, white scale with black figures, brass stems, chrome plated brass sockets and fittings, brass separable wells, combination METRIC/IMPERIAL indication. Provide thermometers at the inlet and discharge of all water coils, boilers, condensers, heat exchangers, water heaters, and where detailed on the drawings.

.8 Wells for temperature sensing will be supplied by Section 25 00 00 for installation by this trade Section. Install in piping systems as directed.

2.3 VALVES

.1 Valves are line size having a minimum rating of 860 kPa (125 psig) saturated steam and 1375 kPa (200 psig) water. Rate valves for the specified services and pressures. Except for specialty valves, all valves are of one manufacturer; bear the manufacturer's name and the pressure rating cast or stamped on the body. All valves have non-asbestos packing. Valve operators have sufficient neck extension to clear pipe insulation. Before the date of Substantial Completion, turn over two sets of lockshield valve keys for each size of lockshield valve installed. Use metals in bronze valves conforming to ASTM B62 standard. Shut-off valves installed more than 3 meters above floors or service platforms have chain operators. Use iron in iron valves conforming to ASTM A-126 standard, Class "B" or "C".

.2 Gate and globe valves are designed to allow repacking under pressure when fully open; have rising stems unless specified otherwise or unless space is not available. Obtain written instructions to use valves with non-rising stems. Unless noted otherwise, provide gate and globe valves with handwheels. All valves 50mm (2") and smaller are bronze with screwed ends. All larger valves are cast iron body, bronze trim, flanged ends.

.3 Gate valves 50mm (2") and smaller have solid wedge disc, union or screw-in bonnet. Gate valves larger than 50mm (2") have O.S.&Y., solid wedge disc, bolted bonnet.

.4 Globe valves 50mm (2") and smaller, except for steam service, have replaceable composition disc, union bonnet. Globe valves 50mm (2") and smaller for steam service have stainless steel disc and seat ring, union bonnet. Globe valves larger than 50mm (2") have O.S.&Y., bronze disc, renewable bronze seat ring, bolted bonnet.

.5 Check valves 50mm (2") and smaller, except for pump discharge or pipes with pulsating flow, are swing type with regrindable seat and screw-in cap. Check valves larger than 50mm (2"), except for pump discharge or pipes with pulsating flow, are swing type with regrindable seat and bolted cap. Check valves for pulsating flows such as pump discharge are silent check type, bronze trim, spring loaded, globe or wafer type body, stainless steel disc, renewable composition seal for tight shut-off and non-corroding spring.

.6 Butterfly valves are an acceptable substitute for gate valves installed in water systems which do not exceed the valve pressure and temperature ratings. Butterfly valves are not acceptable on steam services. Butterfly valves are lug type with cast iron body; floating disc; replaceable high temperature EPDM lining; bubble-tight shut-off to 1103 kPa (160 psi) when downstream piping is removed. Valves 150mm (6") and smaller have a bronze or stainless steel disc and 10 position lever handle. Valves larger than 150mm (6") have a bronze or stainless steel disc and a handwheel operator. Where the optional grooved piping system is used, grooved end butterfly valves may be used in sizes 63mm (2-1/2") through 300mm (12") in lieu of gate valves, but the valves must conform to the specifications herein.

.7 Circuit balancing valves are globe style, equal to Tour & Andersson STA, with the following design features: flow measurements; flow balancing with vernier-type handwheel settings; positive shut-off with no-drip seat/plug type stem with Teflon disc; tamperproof hidden memory; positive shut-off metering valves for connection of portable differential pressure meter. All valves are rated at 1725 kPa (250 psi) maximum working pressure, 121 degrees C (250 degrees F) maximum operating temperature. Valves 50mm (2") and smaller have all metal parts of non-ferrous pressure die cast hard copper alloy, NPT connections, built-in 20mm (3/4") drain connection with shut-off valve and protective caps (except 50mm (2") size). Valves larger than 50mm (2") have cast iron body with hard copper alloy trim, 860 kPa (125 psi) flanged connections. All valves to be complete with minimum 4.5 R-factor insulation moulded specifically for the valve size. Install insulation on valves as part of the piping system overall insulation.

.8 Ball valves have bronze body with screwed ends, large bore, double-seated hard-chromium plated brass ball, resilient seat, blow-out proof stem with "O" ring material designed for the service, quarter turn lever operated with stop, bubble-tight shut-off. In general ball valves are an acceptable substitute for gate valves in water systems except that gate valves shall be provided where temperature and pressure ratings of the piping system exceed valve ratings. Ball valves are not acceptable on steam services.

.9 Plug valves are cast iron body with bronze plug, eccentric action, non-lubricated type with oil impregnated sintered metal bushings, resilient seals, quarter turn lever operated, bubble-tight shut-off.

.10 Drain valves are ball type complete with anti-condensing cap and chain.

2.4 SUPPLEMENTARY ELECTRIC HEATERS

.1 Supply to Electrical Division for installation and wiring, all supplementary cabinet type convectors, horizontal and vertical projection type unit heaters and baseboard type electric heaters shown on the drawings and noted in the Schedules.

.2 Supply each heater with mounting brackets, concealed cable entry, terminal box with space for control devices, thermal cutouts and (where applicable) relays/contactors. Provide fan-forced units complete with time-delay relays and airflow interlocks. Provide each unit with a built-in thermostat unless noted otherwise. Where noted, provide remote thermostats complete with 24 volt control transformers, relays and contactors. Size transformers for connected relay loads and include for wiring losses. Electrical Division will mount relays, contactors, transformers, line voltage thermostats and power wire each heater. Provide all control wiring and mount low voltage thermostats.

2.5 PUMPS

.1 N/A

2.6 EXPANSION TANKS

.1 N/A

2.7 WATER TREATMENT SYSTEMS

.1 N/A.

2.8 HEAT EXCHANGERS

.1 N/A

2.9 HEATING AND COOLING COILS

.1 Provide coils as shown on the drawings and/or noted in the Schedules. Make coil sections installed in banks of equal size and capacity, unless noted otherwise.

.2 Coils are certified in accordance with ARI Standard, fully enclosed within casing and mounted on angle frames manufactured to allow coils to be individually removed. Cooling coil racks are 12 Ga. 304 stainless steel. Heating coils are mounted on galvanized angle racks. Coil construction comprises: copper horizontal tubes, aluminum fins mechanically bonded to tubes; fin spacing not exceeding 2.5mm (1") on centres; seamless copper headers with vent and drain connections; 16 gauge galvanized (heating coils) or stainless steel (cooling coils) channels with 16 gauge centre and end supports; counterflow, with vent, drain, supply and return stubs extended to outside of unit casing with grommets for airtight casing. All refrigerant coils are designed to conform to ANSI-B9.1 Safety Code for Mechanical Refrigeration. All DX coils contain a holding charge of dry nitrogen when shipped from the factory. Unless noted otherwise, coil connections are at the same end. Provide gasketted plates around each pipe connection and seal air tight to the coil casing. Contain coil headers and U-bends within the air handling unit casing or alternatively cover with internally insulated sheet metal enclosures with construction and finish as specified herein for coil casings.

.3 Make water coils drainable of the return bend type and arrange for counterflow of water and air, with water inlet at the bottom. Coils are self-venting except for coils with headers. Provide each coil header with a hose-end valve with cap and chain, for draining and/or venting. Capped pipes are not acceptable for this purpose. Test coils with 1725 kPa (250 psig) air under water at 93°C. (200°F.) and suitable for 1375 kPa (200 psig) working pressure.

.4 Design chilled water coils to provide uniform leaving air temperature over the coil face. Provide coils with drain pans of minimum 22 gauge double-wall continuously welded stainless steel construction. Extend pans minimum 75mm (3") beyond each side of the coils and headers, and minimum 150mm (6") beyond the leaving side. Provide intermediate drain pans for multiple bank coils, with two stainless steel drop pipes to guide condensate to main pan.

.5 Provide duct mounted heating coils of the multi-pass serpentine, or continuous tube type construction, suitable for use with steam or hot water as noted on the drawings and/or in the schedules.

.6 Provide galvanized steel eliminators for cooling coils to prevent moisture carry-over where design face velocities exceed 2.5m/s (500 ft./min) for coils of the helically wound fin type and 2.8m/s (600 ft./min) for coils of the wavy plate fin type.

.7 Where glycol is used in the water systems, reinforce the tube-to header joints with brass orifice bushings.

.8 Individually support coils and make removable without interference with other coil sections. Design supports for side withdrawal so that coil sections slip into place without bolting into position. Where shown on the drawings, make coils removable into adjacent access plenums. Provide adequately sized and suitably positioned access panels for coil removal. Panels shall be double wall insulated construction with 25mm (1") thick rigid fibreglass insulation sandwiched between two minimum 18 gauge galvanized steel sheets. Provide a heavy gauge galvanized steel angle frame and rivet or bolt the frame to the casing. Provide a continuous neoprene gasket to seal the bearings surfaces between the panel and the frame. Panels may be attached with compression type catches in lieu of hinged panels.

2.10 PACKAGED AIR HANDLING UNITS (INDOOR)

.1 Provide heat recovery air handling units of type, size and capacity scheduled on the drawings. Rate units as completely assembled packages and not as individual components alone. Refer to related

specification articles for requirements of individual components. Include fan curves and both transmitted and radiated sound power levels for each air handling unit as part of the shop drawing submittal. A five percent (5%) deviation of RPM and fan power will be accepted for proposed alternative and substitute products.

.2 Provide units complete with: supply and return fan sections; cooling coil section; access section between coils; heating coil section; filter section; mixing box complete with dampers; belt guard; drive package and motor; drain pans and other accessories as noted. Match filter sections to the dimensions and appearance of the fan/coil sections. Construct unit casings of heavy gauge sheet metal braced to prevent drumming, sagging, vibrating. Casings are double wall construction comprising factory painted minimum 18 gauge galvanized steel outer wall, minimum 2" (50mm) thick 1.1/2 lb/cu.ft. (24kg/mg³) density flexible duct liner fully secured to casing, minimum 22 gauge solid galvanized steel inner liner. Fans and motors are installed on an all welded steel base on free standing vibration isolation springs with sound deadening pads, levelling bolts and 25mm (1") static deflection. Provide flexible connection between fan and casing. Provide structural steel supports suitable for mounting all components as an integral unit on the concrete housekeeping pad provided. Provide full size hinged access doors with "Lever-lock" latches and full perimeter gaskets in fan, coil access and mixing sections for access to all internal parts. Provide removable panels at coil and filter sections for their removal. All access doors and removable panels provide airtight closures. Provide a vapourproof, weathertight incandescent marine light with die-cast aluminum guard inside the units at each section provided with an access door. Provide two 3-way switches for all marine lights in weathertight enclosures factory wired to the light fixtures through sealed metal conduits. Mount switches on unit exterior adjacent to supply/return fan access doors on latch side. Provide double "plexiglass" viewing windows in all access doors. All marine lights shall be LED type bulbs.

.3 Provide fans statically and dynamically balanced in the factory after installation in the unit complete with full size drain pans. All plenum fans are complete with screen on air inlet and protective wheel enclosure. Provide coils as specified in the "Heating and Cooling Coils" article, factory installed in the units complete with full size drain pans. Provide eliminators as required to prevent carry-over of condensate at design face velocities. Mixing sections are complete with low leakage dampers arranged for proper mixing of the air streams during all control sequences. Low leakage dampers are opposed blade Tamco Series 9000 installed by unit manufacturer prior to unit shipment to site. Damper shafts extend through unit casing on unit access side. Provide filters and metal filter frames as specified in the "Air Filters, Frames and Gauges" article of this Specification complete with access doors and magnahelic gauges. Provide one set of spare filters for each unit. Filter rails are extruded aluminum tracks designed for filter slide in/out. Filters slide into an integral track in the aluminum extrusion. Unit supply air and exhaust air sides are equipped with filters. All filters are installed upstream of heat recovery device. Provide 25mm Ø (1" Ø) instrument test ports equal to Duro-Dyne IP-2 at each pressure drop section of the units.

.4 Drain pan bases are welded, sloped galvanized steel with insulation and drain connection. Water shall not remain in base. Provide a minimum 20mm (3/4 inch) condensate drain line complete with deep seal trap and extend to the nearest hub drain. The trap seal depth exceeds the fan static pressure by 25mm (1 inch) W.G.

.5 Unless noted otherwise fans are belt driven. Provide variable pitch sheaves on fans with motors up to and including 7.5 HP, and multiple belt fixed pitch drives on fans with larger motors. For each fan with fixed pitch drive, include for the supply and installation of one extra drive package of a size to be determined after air balancing has been completed.

.6 Units are complete with a cooling coil where scheduled on the drawings. All other units are to be provided without a cooling coil. A cooling coil will be installed in these units at a later date, but the units shall be complete with suitable coil section with accessible coil rack, (including drain pan) which

will accept a future cooling coil. Future cooling coil face velocity shall not exceed 2.54 m/s (500 fpm). Fan and motor selection shall include future coil air pressure drop (assume 250 Pa {1.0"}). Shop drawings shall include current and future fan performance.

.7 Air handling units are complete with heat recovery wheel where indicated on drawings. Provide heat recovery wheels as specified in the "Heat Recovery Wheels" Article in this Section, factory installed in the units. Refer to Sketch SK-M1 in Section 25 00 00 for general arrangement of the units.

2.11 HOT WATER UNIT HEATERS AND CABINET HEATERS

.1 Provide horizontal and vertical type unit heaters and cabinet heaters with capacities as noted. Unless noted otherwise, capacities shall be based on 82°C (180°F) entering water and 15.5°C (60°F) entering air.

.2 Heater coils are copper tube with aluminum plate fins, tested for water at 1380 kPa (200 psig) and 149°C. (300°F.). Cabinet heaters have cast iron headers each with screwdriver operated manual air vent.

.3 Motors are thermally protected, permanent split capacitor, permanently lubricated, resiliently mounted type. Fan and motor speeds noted shall not be exceeded under any circumstances. Unit heater motors are totally enclosed type.

.4 Cabinet heater motors have minimum two speeds, complete with starter and integrally wired manual speed-control switch. Starter and speed control are mounted within the cabinet, outside the air stream, behind an access panel in the front face of the casing. Access panels to be metal construction and tamperproof.

.5 Casings are minimum 16 gauge steel with zinc chromate prime paint finish inside and outside. Casings for cabinet heaters are designed for recessed ceiling, recessed wall, semi-recessed or surface wall mounting as shown. Provide suitable mounting flanges.

.6 Unit heaters have fan guards on the inlet side and adjustable diffusers on the outlet side, with single deflection blades for vertical units and double deflection blades for horizontal units. Cabinet heaters have inlet and outlet grilles.

.7 Unless noted otherwise, unit heaters are controlled by single stage, 120 volt electric thermostats provided by others.

.8 Cabinet heaters will be controlled (ON/OFF) from remote space temperature sensors via the Owner's BAS.

.9 Suspend vertical blow unit heaters rigidly to prevent rotation on start-up.

2.12 CONVECTORS AND FINNED TUBE ELEMENTS

.1 Provide convectors and finned tube elements of the type, configuration and capacity as noted. Unless noted otherwise, capacities shall be based on 15.5°C (60°F) entering air and 77°C (170°F) average water temperatures.

.2 Convector heating elements are copper tube with aluminum plate fins, cast iron headers, tested for

water at 1380 kPa (200psi) and 149°C (300°F.). Tube finned unit elements are 32mm (1¼") copper tube aluminum fin unless noted otherwise.

.3 Tube finned unit elements are mounted in ball bearing, cradle type hangers designed for quiet operation with unrestricted longitudinal movement during expansion and contraction.

.4 Enclosures and casings are minimum 16 gauge steel with factory applied baked primer coat inside and outside. Where enclosures are installed across doorways or in other locations subject to traffic the casings shall be sufficiently rigid to prevent distortion under a point load of 150 kilograms.

.5 Enclosures for tube finned units are wall-to-wall, complete with trim strips, end panels, inside and outside corners where required. This Section shall co-operate fully with the manufacturer and take field measurements as necessary to ensure proper, neat fitting installation.

.6 For each unit which is not thermostatically controlled, or where detailed or noted, provide a factory built, knob operated internal damper at the enclosure outlet grille unless noted otherwise. Damper is fully adjustable and stable in all positions.

.7 Provide 300mm (12") removable enclosure/cabinet end covers for access to permit easy operation of unit valves and vents.

.8 Hangers are supported on enclosure brackets at maximum 1.2 meter centres with elements evenly distributed within the space.

.9 Provide expansion compensators where recommended by the manufacturer to allow for expansion and contraction.

.10 Provide two valves for each unit. One valve is a hand operated shut-off valve and the other, a circuit balancing valve with memory stop.

.11 Provide a manual air vent on the return water side of each unit. For each unit which is below the piping mains, provide a drain cock with chain and cap on the supply water side. Where air vents are not easily accessible, extend the vent through the unit enclosure/cabinet for screwdriver operation.

2.13 RADIANT CEILING PANELS (HOT WATER)

.1 N/A

2.14 VARIABLE FREQUENCY DRIVES

.1 Supply variable frequency drive (VFD) units to the Electrical Division for installation and wiring. All VFD's shall be of one manufacturer.

.2 VFD's are CSA approved, pulse width modulated (PMW) AC design for speed control of EEMAC design high efficiency squirrel cage induction motors. The inverter section is complete with necessary devices to reduce motor noise.

.3 Unit enclosure is heavy all steel construction.

.4 Units are rated for the specified 3 phase, 60 Hz voltage supply and have the following features:

- Total harmonic distortion 5%.

- Input and output line reactors.
- Radio frequency interference and electro-mechanical interference filters on PWM drives.
- Under and over voltage protection, phase loss protection, and phase unbalance protection.
- Ground fault protection.
- Inherent short circuit protection for line to line and line to ground faults providing safe shutdown without damage to power circuit devices.
- Instantaneous electronic over-current protection.
- Current limit adjustable from 0-115%.
- Min/Max speed independently adjustable (10-100%).
- Acceleration/deceleration time independently adjustable (2-300 sec).
- Internal over-temperature protection.
- Motor stall protection.
- Rotating motor restart, match voltage and frequency to actual speed before accelerating to control speed signal.
- Key pad and display for set-up, adjustment and diagnostics.
- Door mounted H.O.A. to provide local or remote control, output contacts for remote status indication.
- Local/remote selector for source speed reference (local control to be digital not potentiometer).
- Door mounted status indicators: power on, drive ready, run, H.O.A., local/remote, keypad lockout on, reverse.
- Fault indicators: under voltage, high line voltage, phase loss, bus overvoltage, overcurrent, output open, external fault, overload, ground fault, overtemperature. Fault codes are not acceptable.
- Digital meter with selector switch to indicate: percent load and speed, output frequency, input KW, output voltage and current.
- Output signals to Building Management System: run and fault (dry contacts), speed and load (4-20mA).
- Input signals: stop/start, safety shutdown(freeze, smoke, etc.), speed control signal (4-20mA, 0-5 VDC, 0-10 VDC).
- Two resonant frequency lockouts (adjustable bond width).
- 3-contactor by-pass (where indicated on drawings).

.5 VFD's are complete with minimum 36 month onsite warranty which includes parts, labour, travel and living, and a 36 month warranty on the motors connected to the VFD's against insulation damage from VFD operation.

.6 Provide complete start-up and commissioning by factory trained technicians who shall also provide training to the Owner.

2.15 HEAT RECOVERY WHEELS

.1 Provide total energy recovery wheels of sizes and capacities noted, factory installed in the air handling units. Supply and return air tunnels are stacked or side-by-side, as shown on drawings. The manufacturer guarantees the performance of the wheel as to its total heat transfer capability and its operation. Alternate heat reclaim devices are not acceptable.

.2 Energy recovery wheels are constructed of corrugated aluminum treated for corrosion resistance and coated with a high water vapor capacity desiccant with low co-adsorption characteristics to adsorb and transfer humidity in the vapor phase while avoiding adsorption and transfer of typical ambient none water vapor molecules. Paper or synthetic wheels will not be accepted.

.3 The aluminum element and desiccant are treated with an EPA registered bacteriostatic agent capable of inhibiting growth or reproduction of bacteria on the wheel. Wheels are capable of being cleaned by soft brush, vacuum-cleaner, low-pressure compressed air or a water wash, all without damage to the aluminum or desiccant.

.4 Wheel surfaces are smooth to provide consistent seal gap between the wheel face and the cassette seal ring for the multi-pass seal.

.5 Wheels 1800mm (72 inch) diameter and smaller are one-piece construction. Larger diameter wheels are segmented construction with the wound element cut into pie shapes and bolted together to form the wheel.

.6 Energy recovery wheels have a flame-spread rating of 25 or less and smoke-developed rating of 50 or less as tested in accordance with ASTM E84.

.7 Provide wheels with a factory set, field adjustable purge sector designed to limit cross contamination to less than 0.04 percent of that of the exhaust air stream concentration. The purge plate is mounted to a pivot and locked into position by secure fasteners for quick field adjustment. Wheel manufacturer shall ensure that the ambient pressure at the entering air side of the exhaust sector of the wheel is lower than the pressure at the leaving air side of the supply air sector.

.8 The supply and exhaust air stream are isolated from each other by means of adjustable multi-pass seals secured to the cassette panels and air separator tube. Multi-pass seals consist of a non-contact four or eight finger labyrinth seal. The selection of the seal is based on the differential pressure between the supply air plenum and the return plenum as measured in proximity to the wheel face. Multi-pass seals are installed with a 2mm gap between the seal and the wheel flange.

.9 The cassette frame is constructed of 11 gauge heavy wall welded tube to ensure rigidity and stability. Galvanized block-off and casing side panels are included to form a unitized cassette. Side panels are removable to provide access to the wheel for future replacement. Provide removable panels for motor compartment access.

.10 Wheels are shaft mounted and supported by externally mounted pillow block ball bearings supported by the cassette frame. The pillow block bearings are provided with a grease fitting mounted to allow convenient service and replacement without the removal of the energy recovery wheel from the cassette.

.11 Rotor is driven by a self-adjusting belt system. Provide an A/C motor with internal overload protection for variable speed applications. Motor is 3-phase, 60 Hz, with voltage as scheduled on the plans. Wire motor to a junction box on the exterior of the unit. Wiring through the unit casing shall be sealed.

.12 Variable speed control is accomplished by the use of an A/C inverter. Mechanical Contractor to supply a suitable VFD for each wheel to Electrical Division for installation and wiring.

2.16 NATURAL GAS DISTRIBUTION SYSTEM

.1 Gas service is existing, to be reused and piping modified as shown. Contact and provide to the Gas Company information necessary for their assessment of the suitability of the existing service and meter/regulator relative to the new requirements. The Gas Company will upgrade the incoming gas mains, pressure regulators and gas meter as required and payment for this work, if any, will be made by the Contractor from the gas service cash allowance. Gas meter is pulse type suitable for remote

BAS monitoring. Co-ordinate exact requirements with Section 25 00 00. Contact the Gas Company and make all applications for the provision of the incoming gas service. Become familiar with the Gas Company's exact requirements regarding installation, testing and inspection procedures for work of this Section. All x-rays and tests of welds required by the Gas Company for work of this Section shall be included in the tender sum. Co-ordinate all Gas Company work to service equipment provided under this contract, with the work of the other trades. Refer also to Article 3.23 in Section 23 00 10.

.2 Piping shall be black wrought steel to ASTM A-53 minimum Schedule 40 standard. Piping 50mm (2") and smaller may have screwed ends. Fittings for screwed end piping 50mm (2") and smaller shall be minimum 150 pound malleable iron; fittings for welded piping shall be standard black steel butt welding type.

.3 Piping larger than 50mm (2") and all piping installed in supply air and return air plenums shall be all welded construction, with work performed by a welder holding a Gas Company Licence.

.4 Provide an approved gas cock at every outlet on the gas piping system and place it in a readily accessible location as close as practicable to the equipment served. Where required by Code, provide and emergency gas shut-off valve at the exit from service rooms. Use lubricated cocks for all outdoor applications; where gas pressure exceeds 3.5 kPa (0.5 psig); and where required by Authorities. All gas cocks must be approved for the application.

.5 Where the distribution system provides higher pressures than required by the connected appliances, provide an approved pressure regulator at each appliance or group of appliances.

.6 Paint, or arrange and pay for the painting of all gas piping in the colour required by the Gas Company.

2.17 HEATING WATER BOILERS (CONDENSING)

.1 N/A

2.18 MAGNETIC FLOW METER

.1 N/A

2.19 PACKAGED AIR HANDLING UNITS (ROOFTOP – GLYCOL HEATING)

.1 Supply and install packaged commercial roof-top heating/cooling units of size, capacity, etc. as shown on the drawings complete with minor details not specifically mentioned or shown, but as may be reasonably inferred and necessary to complete the system and place same in satisfactory operating condition.

.2 Each unit shall be shipped completely factory assembled, pre-charged, piped and wired internally ready for field connections of electric power, hydronic heating piping, control wiring and drain line from drain pan. Provide deep seal trap. Units are factory tested, C.S.A. and C.G.A. approved, U.L. listed and ASHRAE 90.1 compliant. Performance ratings are based upon tests in accordance with the most recent issue of ARI Standard 210.

.3 Supply and install for each unit, a 600mm high steel roof mounting frame mating to the bottom perimeter of the equipment. When flashed into the roof it makes a unit mounting curb and provides weatherproof duct connection and entry into the conditioned area. Equipment is capable of bottom

handling of conditioned air, where shown. Side discharge units are complete with insulated weatherproof downturn sections.

.4 The units carry a standard one year warranty on parts and labour plus minimum additional materials only warranty as follows:
- additional 4 years on compressors
- additional 2 years on microprocessor based unit controller

.5 Frame for each unit is of welded construction with casing of double wall heavy gauge galvanized steel panels with baked on outdoor acrylic finish, full perimeter heavy gauge galvanized steel base rail, raised (or flanged) edges around duct and power entry openings, stainless steel sloped condensate drain pan, hinged access panels for compressor/controls/heating/economizer/blower/air filter areas, sealed air/water tight and complete with latching handles. Casing insulation is rigid polyurethane foam panels having a minimum density of 2 pounds/cubic foot. Make all components, wiring and inspection areas completely accessible through removable gasketed panels.

.6 Each unit with multiple compressors has multiple separate refrigeration systems. All compressors are scroll type, resiliently mounted, have built-in 3 mode crankshaft lubrication, crankcase heater, discharge temperature limiter, current and temperature sensing motor overloads. Each lead compressor is variable capacity capable of modulation from 10-100% of its capacity, and each lag compressor is on/off. Complete factory sealed refrigeration system consists of compressor, condenser coil and fans, evaporator coil, factory installed thermal expansion valves, twin blower, liquid line filter dryer, liquid line sight glasses, refrigerant lines connected and a full charge of refrigerant R-454B. Controls consist of magnetic contactors for compressor and evaporator fan motors, low pressure cutout, high pressure cutout, compressor relay, three-leg overload protection and "timed-off' cycle. Each unit is capable of cooling operating down to -18°C (0°F) without installation of additional controls. Unless indicated otherwise, coils (condenser and evaporator) are constructed of ripple-edged aluminum fins flat bonded to seamless copper tubes. Pressure leak test coils at 450 p.s.i. Condenser coils have sub-cooling rows.

.7 Condenser fans are corrosion resistant propeller type. Fan motors are ECM type, direct drive, complete with thermal overload protection (automatic reset) and permanently lubricated ball bearings.

.8 Centrifugal conditioned air (evaporator) blowers are resiliently mounted and statically and dynamically balanced at factory and shall not pass through their first critical speed at any catalogued RPM. Fan wheels are mounted on shafts and have self-aligning permanently lubricated bearings. Fans are complete with mounted and wired Danfoss variable frequency drives (VFD). Provide a suitable external weather-proof enclosure with mounting supports to house field installed Danfoss drives. Field supply, installation and wiring of the VFDs is the responsibility of unit manufacturer, including start-up and commissioning. All VFDs shall be of the VLT line. Motors are premium efficiency, inverter duty complete with inherent protection devices. Supply and exhaust fan motors 1.5 HP and larger shall be directly coupled to the fan and shall be complete with a variable frequency drive (VFD). Fan motors less than 1.5 HP may be electronically cumulated (EC) type.

.9 Provide each unit with an automatic economizer section, allowing the use of up to 100% outside air. Economizer section includes mechanically linked outdoor air and return air dampers operated by a spring return, multi-position damper motor with adjustable minimum damper position and position feedback. The economizer section is completely factory wired and terminalized, ready for direct connection to the building BAS. Install outdoor air hood with rain eliminator vanes over outdoor air dampers. The economizer section incorporates exhaust air dampers, louvres or hood. Other options are noted on the drawings.

.10 All filters are replaceable media type in permanent metal frames. Media is 50mm (2") thick pleated

non-woven micro-fine cotton or synthetic fabric. Provide temporary MERV-8 filters for testing and trial usage. Replace temporary trial filters with clean MERV-13 filter media at the time of unit turn-over for Owner's use.

.11 Each unit is complete with factory mounted and wired non-fused power disconnect switch. Disconnect switches are externally mounted, weatherproof configuration, permanently labelled, heavy duty complete with front operating handle, quick-make, quick-break mechanism, cover/handle/switching mechanism interlocks.

.12 Units have hydronic heating sections as noted. Provide heating coils, as specified in the "Heating and Cooling Coils" article in this Section, factory installed in the units.

.13 Units are suitable for control from a remote building automation system. Co-ordinate with Section 25 00 00. A terminal strip in unit control panel facilitates the remote control/monitoring and includes terminals for:

- lead compressor cooling enable (DO)
- lead compressor cooling control (AO)
- lag compressor cooling enable (DO, each compressor)
- damper control (AO)

.14 Power wiring to unit unfused disconnect and service outlet is by Electrical Division. BAS control wiring is by Section 25 00 00.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

.1 All piping irrespective of size is installed as neatly and inconspicuously as possible, complete with supports and guides as necessary. Install piping in such a manner so that the strain and weight of the piping is not taken by connections to the equipment and apparatus. Keep all openings in pipes plugged and capped during installation to keep out dirt and debris. Place and install piping so that there will be no interference with the installation of equipment, other piping systems, ducts, etc., to ensure noiseless circulation.

.2 No pipe shall be cut with a cutting torch where the cut could be made with pipe cutters. When welding or cutting with a torch take every precaution to prevent fire. Ensure that welding or torch cutting operators have a fully charged minimum 4.5 kg. (10 lb.) CO2 fire extinguisher with them whenever welding or cutting in the building. Protect wooden structures with non-flammable blankets.

.3 Use approved fittings for all connections. Job made fittings or reducers will not be accepted. Make reductions in pipe sizes on horizontal runs using eccentric reducing couplings properly installed. Use concentric reducing couplings only on vertical runs.

.4 Provide di-electric unions, bushings and couplings at all connections between piping of dissimilar metals. Supply adequate numbers of unions and/or flanges to facilitate maintenance and dismounting of each piece of equipment and apparatus which could at any time require dismounting or removal. Assemble flanges using American Standard heavy machine bolts with hex nuts, in accordance with codes and standards specified above. Threaded steel rod will not be accepted for this purpose regardless of material strength.

.5 On screwed piping, make up metal to metal joints with red or white lead and oil applied to the thread. Ream all pipe before installation. No hemp, wick or packing will be permitted in making up screwed joints. Thoroughly clean inside of fittings and outside of pipe with steel wool or emery paper and coat with flux before soldering any copper pipework. Remove working parts of valves during soldering.

.6 Grade water piping at minimum 1 in 480 for proper venting and draining, and 1 in 240 for steam/condensate services. Provide hose end gate valves at all piping low points and at drains from equipment and apparatus. Provide automatic air vents at all high points on closed systems and at all other points necessary to free the system of air binding. Vents installed in concealed locations shall be equipped with type 'L' copper drain tubing run to the nearest drain and complete with access panel for servicing.

.7 Anchor piping at all points shown on the drawings or as is necessary, using structural steel angles, channels, plates, rigidly secured to the building structure. Do not anchor piping to open web steel joists. Design calculations and layout of the anchors shall be subject to review. Make adequate allowance for expansion and contraction of all piping. No expansion joints of any kind shall be used. Provide for expansion and contraction by means of pipe anchors, guides and welded pipe loops.

.8 Install valves used for shut-off service so that a shut-off, system side pressure is exerted against the valve seat. Ball type valves have bronze body, double-seated solid bronze or stainless steel ball, resilient set, blow-out proof stem with 'O' ring material designed for the service.

.9 Do not install any valve for an application for which it is not suited. Provide gate valves on upstream and downstream side of equipment and control valves to facilitate removal without draining the system. Provide balancing valve on the downstream side of each piece of equipment which requires flow balancing. Do not use ball or butterfly valves on steam and condensate piping systems.

.10 Pipe all blowdown outlets on backflow preventers to the nearest hub drain. Ensure that there is a proper air gap on the drain to conform to Plumbing Codes.

3.2 HYDRONIC SYSTEMS' TESTING

.1 Provide all gauge ports, valves, etc., required for testing and balancing and make any changes required for the final balancing results. Co-operate with the balancing contractor to ensure satisfactory completion of his work. Provide all equipment necessary to perform the required tests.

.2 Tests shall be performed after roughing-in and before pipes are insulated, enclosed in pipe spaces or buried in trenches. Submit notice of all tests in ample time to allow the Consultant or his representative to be present when the tests are conducted. Any components of the systems which might be damaged during tests shall be removed before the tests and reinstalled after the tests. All water piping shall be tested for minimum of six (6) hours under hydraulic pressure of 150 percent of working pressure and a minimum of 1015 kPa (150 psig). All welded joints shall be hammer tested. Refer also to Article 3.23 in Section 23 00 10.

.3 Leaks found shall be made tight while system is still under test. If this is impossible, defective parts shall be removed and refitted. Caulking of threaded joints or welds will not be permitted. After leaks, etc. have been repaired, the tests shall be repeated as often as necessary to demonstrate acceptable results.

3.3 HYDRONIC SYSTEMS' BALANCING

.1 This work will be provided by an independent Balancing Company selected by the Owner. Refer to Section 23 00 30.

3.4 LABORATORY EQUIPMENT

.1 Gas supply fittings are provided by this Section. Rough-in and make final gas connections to this equipment. Include shut-off valves for each in an accessible location.

.2 Co-ordinate with laboratory equipment suppliers to fix the location of all roughing-in, pipe size and pipe runs. Holes in floor for roughing-in are drilled prior to finished flooring installation. All sleeves to be tightly sealed.

.3 Co-ordinate with other trades with respect to servicing all laboratory equipment. For gas supply fittings with mounting height adjustment to accommodate handicapped access, provide final connection to suit using CGA approved flexible hose.

END OF SECTION 23 00 20

PART 1 - GENERAL

1.1 REQUIREMENTS

.1 Work of this Section will be provided by an independent Testing, Adjusting and Balancing (TAB) company selected by the Owner. TAB work will be tendered and administered by the Commissioning Agent. The cost of work of this Section will be paid by the Owner independent of this Contract.

.2 Test and balance all water systems to ensure that all coils, convertors, radiators, etc. are operating to design conditions.

.3 Test and balance all air systems including air volumes and control settings under maximum system pressure drop conditions (filters at replacement condition).

.4 Section 23 00 10 forms part of this Section. Related work is specified in Sections 23 00 20, 23 00 40 and 25 00 00. Refer to same.

.5 Submit a proposal for assessment. The proposal shall include:

- Company's experience in projects of this size and nature.
- Fixed cost for the work required.
- Equipment to be used for the testing and balancing.
- Personnel to be used, complete with their experience.
- Description of procedures and methods.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 GENERAL

.1 Co-ordinate with Sections 23 00 20 and 23 00 40 to ensure that all necessary devices (valves, dampers, gauge ports, pitot tube test holes, access facilities, etc.) required for proper testing and balancing are installed by respective Sections in all locations required by this Section. Notify the Consultant in writing that this co-ordination has taken place. Include in this letter any recommendations made regarding devices, locations, installation, etc. If this Section fails to co-ordinate with Sections 23 00 20 and 23 00 40, and if failure to co-ordinate results in being unable to balance the systems, any changes required shall be provided by this Section at no extra cost to the Owner.

.2 Co-ordinate, co-operate and perform the testing and balancing, wherever applicable, in conjunction with Section 25 00 00 so that Section 25 00 00 may calibrate their instrumentation to display proper readings.

.3 Automatic Temperature Controls Section will accommodate this Section with a loan of a system specific portable device so that this Section may adjust control signals from minimum to maximum for proper balancing and/or calibration. Alternatively, Automatic Temperature Controls Section will provide a trained technician complete with portable two-way radios to adjust control signals as instructed by this Section. Co-ordinate with Automatic Temperature Controls Section. This Section is responsible for the loss/damage of all loaned devices.

.4 Refer to, and become familiar with, systems' sequences of operation as specified in Section 25 00 00.

3.2 HYDRONIC SYSTEMS

.1 All piping is pressure tested by Section 23 00 20.

.2 Prior to the final inspection of the building or project, adjust all hydronic systems as necessary to provide the design flow rates for each part. Adjust system to provide the design pressure drops and flows through the heat transfer elements prior to the thermal testing. Perform balancing by measurement of temperature differential only in conjunction with the air balancing. Affect system balancing with automatic control valves fully open to the heat transfer elements. Affect adjustment of water distribution systems by means of balancing cocks, valves and fittings. Do not use service or shut-off valves for balancing.

.3 Calibrate all gauges, thermometers, thermostats, etc., before conducting tests. Use only calibrated test gauges for pump adjustment; the use of pressure gauges installed with the system will not be accepted. Where calibrated venturi tubes, or other metering fittings and pressure gauges are installed in the piping system, use them in conjunction with the portable type flow meters to determine the flow rates for system balance. Where flow metering devices are not installed, base flow balance on the temperature difference across the various heat transfer elements in the system.

.4 At the time of final inspection, re-check in the presence of the appointed Field Representative random selections of data recorded in the Certified Reports. Points or areas for re-check shall be as instructed on site.

3.3 AIR SYSTEMS

.1 Ductwork is pressure tested by Section 23 00 40. This Section shall inspect the ductwork for undue restrictions, incorrect fittings, duct leakage, type and fastening method of duct insulation, mixing plenum arrangements, baffles and other related work. Inspect ductwork, outlets, dampers, etc. for excessive noise and/or vibration. Submit notice of all such problems.

.2 Locate pitot tube test holes and ensure that insulated capped pitot tube fittings are provided.

.3 Adjust inlets, outlets, grilles, registers and diffusers to ensure capacities within 10% of design up to and including 70 L/s (150 cfm) and within 5% of design for capacities greater than 70 L/s (150 cfm).

.4 Set pattern controllers to eliminate objectional air motion and sound levels.

.5 Check branch, zone and total capacity readings by pitot tube traverse as proof of individual location readings. Test duct static pressure at same location readings. Test duct supply and return system air flow and pressure capacities for both maximum outside and maximum return conditions. Record mixing plenum pressure for both. In case of V.A.V. units, test as above for both maximum and minimum volumes.

.6 Test air mixing plenums to ensure proper air mixing and that air stratification does not exist. Perform such tests when outdoor air temperatures are below 0C. (32F.). Provide temperature readings on a grid basis of five (5) positions horizontally and vertically. Submit notice immediately of all stratification problems.

.7 Check fans and record results of pressure, temperature and R.P.M. and make note of pulley and belt adjustments positions. Test filter and coil pressure drops noting whether wet or dry coil. Perform test with clean filters.

.8 Test motor voltage and amperage for each phase; record excessive vibration, noise or heat; record horsepower, voltage, frame size and amperage. For starters, record rating of fuses or circuit breakers; size and rating of thermal overload elements.

.9 For all VAV boxes and by-pass boxes record air quantity readings, as indicated above, for maximum and minimum primary air.

.10 At the time of final inspection, re-check in the presence of the appointed Field Representative random selections of data recorded in the Certified Reports. Points or areas of re-check shall be as instructed on site.

3.4 CERTIFIED REPORTS

.1 Prepare a Certified Report for each system with headings (or identification) the same as those on drawings and specifications.

.2 Include the following information in the report:

- Name of project, location and date.
- Names of Mechanical Contractor, Consultant and Report Evaluator.
- Description of test methods and list of equipment used in testing.
- Name of building equipment manufacturers and equipment identification.
- Evaluation of fan capacities.
- Electrical characteristics and readings.
- Evaluation of air outlets.
- Stratification test readings.
- Schematics for description of the systems showing design requirements, quantities achieved through tests and locations of all pitot tube test openings.
- Evaluation of heat exchange elements.
- For Motors: manufacturer, size, horsepower, voltage, amperage (nameplate and final operating) current characteristics, starter and heater size, RPM (design and final equipment operating).
- For Pumps: manufacturer, model, impeller size, flow (design and final operating), total head (design and final operating), discharge and suction pressures, brake horsepower.
- Methods used to determine flows.
- Evaluation of V.A.V. boxes, by-pass boxes, etc.
- All other pertinent data relating to the testing and balancing.

.3 Report shall be certified by a qualified Consultant or Technician who is versed in the field of air and water balancing. Include types, serial numbers and dates of calibration of all instruments used.

.4 Submit three (3) copies of bound Certified Report. Provide reports complete with index page and indexing tabs, and cover identification at front. In case of 3-ring binder, provide side identification in addition to the above.

END OF SECTION 23 00 30

PART 1 - GENERAL

1.1 REQUIREMENT

.1 Sections 23 00 01, 23 00 10 and 23 08 00 form part of this Section. Related work is specified in Sections 23 00 20, 23 00 30, 25 00 00 and 25 08 00. Refer to same.

1.2 CONFORMANCE TO ARCHITECTURAL AND STRUCTURAL LAYOUTS

.1 Do not fabricate ductwork without confirmation that diffuser, register and grille locations are in accordance with Architectural reflected ceiling plans. Make changes to duct sizes and locations as required to accommodate structural conditions and work of other trades at no change to the Contract Price.

.2 Where Underwriters Laboratory rated floor/ceiling assemblies, or roof/ceiling assemblies are utilized, the requirements of the tested assembly supersedes all other requirements. It is the responsibility of this Division to establish the existence of such an assembly by reference to Architectural and Structural Drawings and Specifications.

1.3 DUCTWORK

.1 Comply with NFPA standards for exhaust ductwork and hoods which are used in applications resulting in airborne grease entrainment.

.2 Clean ductwork internally prior to issue of the Certificate of Completion.

.3 Plenums and casings include all outside air intakes, discharges, recirculating plenums, division plates, connections between components, built-up air handling units, etc.

.4 All supply air ductwork from air handling unit fan discharge to first VAV component or first reheat coil shall be constructed to SMACNA 750 Pa (3" wg) duct construction class. All other supply air ductwork upstream of VAV components or reheat coils shall be constructed to SMACNA 500 Pa (2" wg) duct construction class. For all other constant volume systems, all supply air ductwork installed in mechanical rooms shall be constructd to SMACNA 500 Pa (2" wg) duct construction class.

.5 All supply air ductwork downstream of VAV components or reheat coils shall be constructed to SMACNA 250 Pa (1" wg) duct construction class.

.6 All return air ductwork and all exhaust air ductwork installed in mechanical rooms shall be constructed to SMACNA 500 Pa (2" wg) duct construction class. All other return air ductwork and all other exhaust air ductwork shall be constructed to SMACNA 250 Pa (1" wg) duct construction class.

.7 Tie rods shall not be used in lieu of external duct reinforcement. Tie rods may be used only where specifically mandated by SMACNA duct construction standards.

.8 This Section shall provide a schedule of proposed duct construction, meeting SMACNA standards, to be used on the project. Schedule shall include panel width, gauge, transverse connector, reinforcement, longitudinal seam, sealing class and sealing compound. Submit schedule prior to performing any duct fabrication/installation.

PART 2 - PRODUCTS

2.1 DUCTWORK

.1 Galvanized sheet metal used to fabricate ductwork conforms to ASTM A-446, with designated Z275 coating to meet the ASTM Specifications. Construct aluminum ductwork, where required, of aluminum sheets one gauge heavier than if the duct were to be made from galvanized steel. Make stainless steel ducts of no. 316 Atlas mill finish stainless steel using one gauge lighter material than if the ducts were to be made from galvanized steel.

.2 Turning vanes are double wall construction with correct air foil pattern fabricated by Duro-Dyne or other Acceptable Manufacturers. Provide a turning vane in each slot on vane rail.

.3 Duct sealants (sealers) and duct tapes are water resistant, compatible with mating materials meeting U.L.C. flame resistance requirements.

.4 Rivets, screws and other fasteners are the same material as ductwork except use zinc or cadmium plated fasteners with galvanized sheets.

.5 Sizes shown on the drawings for internally lined ductwork are clear inside dimensions.

.6 Bolted duct connecting systems such at Ductmate or Nexus couplings joining methods may be used. Caulk joints and corners of joints as for standard SMACNA seal Class B.

.7 Use galvanized ductwork for all systems, except as follows, as applicable:

- Fume hood and acid/solvent cabinet exhaust ductwork: stainless steel.
- Gymnasium change room exhaust ductwork: aluminum with horizontal runs sloped to drain at point of inlet.
- Kitchen dishwasher exhaust ductwork: stainless steel, or stainless steel where ductwork is exposed and aluminum elsewhere, with horizontal runs sloped to drain at point of inlet.
- Kitchen cooking hood exhaust ductwork: refer to "Exhaust Hoods and Ducts" Article in this Section.

.8 Aluminum and stainless steel ductwork is watertight, externally all welded construction.

.9 All flexible ductwork for all supply air systems is thermal type, pre-insulated and factory-wrapped with vapour barrier jacket.

2.2 DUCTWORK ACCESS PANELS

.1 Provide access panels as specified and noted and where required for periodic servicing of equipment, control elements, etc. including; upstream and downstream of all duct and plenum mounted cooling coils and heating coils; at all air filters; at all fire dampers and fusible links unless noted; at all backdraft dampers; and at motorized dampers for access to linkage and actuator.

.2 Access panels are rectangular, 457mm (18") long and the width of the duct in ducts up to and including 305mm (12 inches) in width. In ducts and plenums 330mm (13 inches) to 610mm (24 inches), size of access panels are 305mm x 457mm (12 x 18 inches) or larger where required for easy access. In ducts and plenums 635mm (25 inches) and larger, size of access panels are 610mm x 610mm (24 x 24 inches) or larger as indicated on the drawings. Fabricate panels of same material as duct and of metal gauge suitable for the application and size of panels. Hinge panels larger than 450mm x 450mm (18 x 18 inches) to galvanized steel mounting frame and provide sash locks to give tight closure on neoprene gasket. All hardware is made of corrosion resistant material including attaching bolts.

.3 Provide access panels on thermally insulated ducts of double panel construction with insulation as specified for adjacent ducts sandwiched between panels. Depth of access door stand-off matches the thickness of thermal insulation finish with minimum 25mm (1") face for termination of thermal insulation.

2.3 DAMPERS

.1 Supply Air Systems: Provide deflecting or splitter dampers where shown on the drawings and where required for balancing the system. Fabricate dampers of minimum 22 gauge galvanized steel or same gauge as duct in which damper is installed. Hinge damper at the air leaving edge and construct damper so that the entering edge presents a round nose to the air flow. Make the length of the splitter at least 1½ times the width of the smaller branch duct but in no case less than 300mm (12 inches). Attach a minimum 6mm (¼ inch) diameter galvanized steel push rod hinged to the splitter near the air entering edge and passing through a locking clamp on the side of the duct which is accessible for adjustment. Make all hardware of corrosion resistant materials including attaching bolts and hinges.

.2 Return/Exhaust Air Systems: Provide manual opposed multi-blade control dampers in ductwork where shown and where required for balancing the system. Fabricate manual duct dampers from galvanized steel 0.048" - 18 GSG gauge (1.26mm) thick or heavier. Dampers for ducts up to 300mm (12") deep shall be one blade carried on a 9mm (3/8") square steel rod mounted inside the duct. Dampers for ducts of greater depth than 300mm (12") shall be multi-blade, opposed-acting type, and shall have blades mounted in 38mm (1.5") steel channel frame, and interconnected for operation from one locking type hand quandrant. Fit dampers snuggly into the duct so that they may be used as shut-off dampers. The two edges at right angles to the shaft shall be bent 90 degrees or beaded to make the damper more rigid. Provide extra bracing wherever necessary. Fit each damper with a locking type quadrant with a handle pointing in the direction of air-flow with damper open (and at right angles with damper closed) using proper manufactured hardware. Where dampers are installed on insulated ducts, mount quadrant on sheet metal standoffs built out to beyond insulation thickness.

.3 Construct all fire dampers and rate in accordance with U.L.C. Standards with U.L.C. label. Protect all openings in fire rated ceilings or rated ceiling assemblies for diffusers, registers and grilles by fire stop flaps or ceiling fire stops approved, tested and listed the by U.L.C. Fire dampers are interlocking blade type unless specifically noted otherwise. For square and rectangular ducts with the height dimensions up to and including 305mm (12 inch) damper blades are out of the airstream. For larger ducts dampers in the airstream are acceptable. Install fire dampers in walls and floor slabs in duct extension sleeves with perimeter angles and breakaway fittings. Install all fire dampers and fire stop flaps in accordance with local Authorities and all codes being applied by such Authorities. Where fire damper access is from below, provide dampers complete with manufacturer's "pull-ring".

.4 All motorized dampers are supplied and installed by this trade Section. All two position control dampers are parallel neoprene edging. All dampers installed at fresh air inlets or at exhaust air outlets from the building are approved "low leakage" type with inflatable type seal applied to the blade edges to provide leakage in the fully closed position not exceeding 20.3 L/s per square meter (4 CFM per square foot) of damper area at 1500 Pa (6 inches W.C.) of differential pressure across the damper. Frames are formed channels of not less than 13 gauge galvanized steel. Blades are Extruded aluminum airfoil section not exceeding 205mm (8 inch) in width and 1220mm (48 inch) in length. Shaft bearings are nylon with Teflon coated thrust bearings provided at the ends of each blade. Use spring stainless steel or multi-fin neoprene seals on blade side edges. Make dampers suitable for operation with the temperature limit of 93°C to -40°C. All dampers are flanged to ductwork. Insert type dampers and inaccessible intermediate bell cranks on multiple damper section are unacceptable. All dampers for modulating service are opposed blade type and all dampers for two-position service are parallel blade type. Low leakage dampers shall be Tamco Series 9000. All motorized dampers inside air handling units are provided by air handling unit manufacturer.

.5 Smoke Dampers: Dampers shall meet the requirements of NFPA 80, 90A, 92, 101 and 105. Dampers are classified by Underwriter's Laboratories and labeled as a 1.5 hour or 3 hour (as required) fire damper under UL 555 and as a Class 1 smoke damper under UL 555S at an elevated temperature of 121°C (250°F) for use in dynamic or static Smoke Control Systems. Dampers are tested under UL 555 and UL 555S by UL to a minimum velocity/pressure rating of 10 m/s @ 1 kPa (2000 ft/min @ 4" w.g.).

- Dampers are opposed blade configuration with an interlocking blade design that provides complete flame and smoke seal under fire conditions at an elevated temperature of 1093°C (2000°F) when in the closed position.
- Frames are 1.6mm (16ga) galvanized steel hat channel with mitered corners reinforced with die-formed corner gussets for strength. Blades are 2mm (14ga) equivalent galvanized steel formed double-skin airfoil design on 140mm (5.1/2") centers. Blade axles are 13mm (1/2") diameter plated steel, double bolted at each end of blade to ensure positive locking connection. Bearings are self-lubricating oilite bronze type. Blade linkage is zero-maintenance, concealed in frame, out of airstream. Jamb seals are compression type stainless steel.
- Dampers are complete with factory installed sleeves, length dependent on wall thickness, minimum 406mm (16"). Wall thickness shall be field verified by contractor. Factory sleeves are caulked to UL requirements and are 1.0mm (20ga) through 2134mm (84") wide and 1.2mm (18ga) above 2134mm (84") wide.
- Dampers are complete with suitable factory-installed, externally mounted electric actuators. Actuators are Belimo (no alternates), fast-acting, 2-position, spring return, direct-coupled, 120VAC complete with auxiliary switch which "makes" on damper closed position and momentary test switch for local push-button testing/inspection for proper operation.
- Actuator assembly is suitably factory-wired and terminated at a junction box ready for single point power connection in the field by Electrical Division.
- Smoke detectors are provided by the Electrical Division, including all wiring.

.6 Combination Fire/Smoke Dampers: Combination dampers are smoke dampers (as specified herein) complete with a UL Classified heat responsive device that will cause the damper to close in a controlled manner, and lock in a closed position by means of an over center/knee lock linkage, when the duct temperature reaches the maximum degradation temperature of the damper/actuator assembly as required by UL 555S. Closure devices that cause instantaneous closure are not acceptable.

2.4 INTAKE AND EXHAUST VENTILATORS

.1 Provide air intake and exhaust roof ventilators of throat size and height as scheduled on the drawings.

.2 Ventilators shall be extruded aluminum, complete with birdscreen, anti-condensate coating and 450 high prefabricated insulated aluminum curb.

2.5 DIFFUSERS, REGISTERS & GRILLES

.1 Grilles and registers are extruded aluminum type and diffusers are either steel or aluminum. Diffusers, registers and grilles have baked enamel factory applied finish, unless specified or noted otherwise with colour as selected by the Consultant. Frames shall have mitred corners designed for the surface of application. Use concealed mountings on diffusers, registers or grilles where physically possible. Where fastenings are visible, install with oval head cadmium plated screws in countersunk holes.

.2 Provide diffusers, registers and grilles with gaskets to prevent air leakage. Provide supply diffusers and registers and exhaust registers with opposed blade dampers, except where volume extractors are used (see Drawings and Schedules). Return diffusers; return grilles; and supply grilles only where so designated; do not require opposed blade dampers.

.3 On linear diffuser installations involving more than one length of diffuser, provide alignment strips to ensure that the diffusers represent a neat straight line when installed. Provide blank-off baffles or throw reducing vanes where specific directions of throw or length of throw is detailed on the drawings. Provide airflow straightening grids behind all supply diffusers. Perforated supply diffusers have curved louvre pattern controllers.

.4 Door grilles when supplied by this Section are complete with adjustable frames on both sides of door to suit any door width. Door grilles are all steel construction and installed by the Architectural Division.

.5 Where floor grilles are used, frames and bars are heavy duty type to prevent deflection when walked upon.

.6 When air handling "boot" type diffusers are used to supply air through light troffers or through apertures in the ceiling suspension system they are capable of delivering cool air at a temperature of 10 degrees C. (18 degrees F.) below that of the space into which it is being introduced, in a horizontal pattern throughout the design air flow range. Provide dampers separate from pattern controllers for each boot.

2.6 FANS

.1 Provide fans complete with drives and motors, capacities as noted. Construct fans in conformance to AMCA with certified ratings based on tests performed in accordance with AMCA Bulletins 210, 211A and 300, unless noted otherwise. Note carefully the installation of each fan as shown on the drawings and allow for the `system effects' in the selection and application of fans. Submit for each fan before fabrication, certified acoustical and fan curve performance data rated at the actual speeds required, showing static pressure, total pressure, fan power, and mechanical efficiency and sound power level plotted against air flow. Do not exceed fan speeds specified, noted and calculable, from the scheduled data, by more than five percent (5%) by alternate or substitute manufacturers. Fans operating beyond this limit will not be accepted.

.2 Provide fan motors of at least the size specified or noted, and larger when necessary to accelerate the fan to operating speed from a dead start within ten (10) seconds. Refer to "Electric Motors,

Starters and Wiring" article in Section 23 00 10. Electrical Division will provide power wiring for fans and will wire firestats unless noted otherwise. Refer to Section 25 00 00 and co-ordinate the firestat wiring requirement.

.3 Provide all fans exposed to the weather with a heavy gauge vented housing that completely protects the fan and motor. Treat casings, except those constructed of aluminum with corrosion resistant paint. Provide all casings with suitable access for motor bearing and belt servicing. Provide discharge openings of fans discharging to outdoor air with aluminum or galvanized steel 12mm (½ inch) mesh birdscreen. Unless another closure is specified or noted, provide a gravity activated backdraft damper for each exhaust fan. Dampers have neoprene or felt blade edge seals. Provide fans with exposed inlets or outlets with protective screens, guards or grilles. Statically and dynamically balance fan assemblies to provide vibration-free operation. Operate fans at not more than 75% of their first critical speed. Provide scroll dampers as necessary to ensure stable air flow at all operating conditions. Unless noted otherwise fans are belt driven. Provide variable pitch sheaves on fans with motors up to and including 7.5 HP (5.6 KW), and fixed pitch drives on fans with larger motors. For each fan with fixed pitch drive, include for the supply and installation of one extra drive package of a size to be determined after air balancing has been completed.

.4 Provide bearings with a minimum life expectancy of 60,000 hours. Shaft sizes 32mm (1½ inch) and smaller are permanently lubricated anti-friction type. Larger shaft sizes have horizontally split pillow block grease lubricated, regreasable bearings. Fans other than roof ventilators are complete with flexible connections on inlet and outlet ductwork, suspension clips, mounting legs, and where noted, fan platform, etc.

.5 Duct blowers mounted in ceiling spaces include internal acoustic lining and filter section where air is being recirculated to the occupied space.

.6 Inlet vanes (vortex dampers) where required operate from a positive peripheral control mechanism located out of the air stream and supported at both ends in bronze bearings. On double inlet fans inlet vanes are interconnected to operate in unison. Positively position the control mechanism through a pneumatic or electric operator as specified or noted. Provide external grease lubrication for bearings. Provide extended tubing and grease fittings where standard fittings are not readily accessible.

.7 Propeller type fans are multi-blade design with steel or aluminum wheel; drive package; resilient motor mounts; totally enclosed air over motor; inlet venturi; mounting frame; blade guards.

.8 Axial type fans are complete with heavy gauge steel casing, belt fairing, removable cap to permit access to sheave and bearings, adjustable motor base and motor, heavy gauge belt guard over exposed portion of belt with tachometer openings and standard steel wheel with airfoil blade section mounted on a steel shaft equipped with shaft seal. Provide heavy gauge steel inlet and outlet cones with 7 degree cone angles and/or fan inlet bell where shown on the drawings. Equip axial fans with heavy plate support legs where installed on slab and heavy duty suspension clips where suspended. Where noted provide fans with hinged doors to provide complete access to internal parts of fan for cleaning and maintenance. Direct drive, adjustable pitch type fans are acceptable in lieu of belt drive specified above. Include guide vanes on all vane axial type fans. Provide variable pitch-in-motion fans where noted. Provide thrust restraining springs for all axial fans.

.9 In-line centrifugal fans are complete with box type or tubular steel casing (see schedule), belt fairing, removable cap for drive and bearing access, adjustable motor base and motor, belt guard with tachometer opening, an in-line air foil centrifugal wheel mounted on a steel shaft equipped with shaft seal. Provide inlet and outlet cones with 7 degree cone angles and/or fan inlet bell where detailed or scheduled. Include support legs where floor mounted and suspension clips where suspended. Where noted or detailed include hinged doors to provide access to all internal parts of the fan for cleaning and maintenance.

.10 Centrifugal fans have fan wheels constructed of heavy gauge steel with spun or die formed shroud, inspection openings with pressure tight, quick opening cover plates in housing scroll where fan wheel diameters are over 560mm. Fan wheels have non-overloading horsepower characteristics unless otherwise noted. Utility sets have motors mounted on an integral frame with the fan. Cabinet fans are mounted in an integral steel housing as detailed and shall include double width, double inlet fans. Arrangement 3 fans include single inlet, single width fans.

.11 Roof mounted spun aluminum fans are centrifugal type, having low contour, spun aluminum, weatherproof housing and curb caps. Units have adequate structural members to support fan wheels, motor and bearings, and vibration isolators to prevent transmission of vibration to the housing. Motors are located outside of air stream. Where noted, provide housing hood with heavy duty corrosion resistant hinged and friction catches, to permit convenient access to motor, etc. for servicing and lubrication. Construct fan wheels of aluminum with non-overloading horsepower characteristics. Provide each fan with weatherproof, non-fused listed safety type disconnect switch located under the housing, adjacent to the motor. Factory wire the motor through the switch in flexible metal conduit. Where noted, provide each fan with prefabricated insulated roof curb a 600mm (24 inches) high, complete with nailing strip, cant and flashing pan. Secure roof exhaust fans to curbs with fastening devices as recommended by the manufacturer.

.12 Ceiling mounted fans have centrifugal fan wheel, resiliently mounted motor, 12mm thick acoustic insulation on inside of sheet metal housing, inlet grille, backdraft damper and terminal box in housing. Provide speed controller where scheduled or noted.

.13 Each cabinet type fan consists of a double inlet centrifugal fan installed in a housing having access panels on both sides. Fans are resiliently mounted. Mount fan motor inside the cabinet on the blower with a hinged bolt for belt adjustment. Acoustically line the casing throughout. Provide filter section capable of accepting 25mm thick disposable filters. Where scheduled or detailed provide a silent closing, tightly sealing backdraft damper.

.14 Ceiling ("Casablanca") fans are UL listed with matching UL listed solid state controls. Motors have built-in thermal overload protection. Fans are complete with: perfectly balanced motor and blades; permanently sealed and greased bearings; corrosion resistant, durable epoxy enamel paint finish; 20mm (13/16") diameter steel downrod of suitable length; safety cable secondary support assembly factory connected to motor shaft; with rated breaking strength complying with CSA-C22.2; totally enclosed fan guard (where indicated); solid state motor speed control; mounting hardware. Fan performance shall be AMCA certified.

.15 Install dampers for exhaust fans as close as possible to the point of discharge from the building. Insulate exhaust ductwork inside the building for a distance of 1.5 meters (5 feet) upstream from the damper or for the Code required distance, whichever is greater.

2.7 AIR FILTERS, FRAMES AND GAUGES

.1 Provide air filters, frames and gauges of sizes, types and capacities noted. Filter material is non-combustible and carries a ULC Class II label. Unless noted otherwise, efficiencies specified and noted are as measured by the ASHRAE Standard 52-76. Filter approach velocities shall not exceed 2.5 m/s (500 FPM).

.2 Construct frames, supports and all fitments of non-corroding materials such as galvanized steel, stainless steel, bronze, etc. Fabricate support frames so that they may be bolted or rivetted together to form filter banks. Provide frames complete with gaskets and seals to prevent air bypass. Design and install filters and frames for upstream, downstream, or side loading service access as noted. Lock matching frames for side loading filters together with aligned locking devices.

.3 Filters are replaceable media type supported by a metal grid on downstream side and enclosed in a heavy duty chipboard frame. Media is minimum 50mm (2 inch) pleated non-woven cotton and synthetic fabric with MERV-13 rating. Media support grid is welded wire bonded to media to eliminate media oscillation and pull-away. Wire grid has an effective area not less than 96%. Enclosing frame is a rigid, heavy-duty, high wet-strength board with diagonal support members bonded to each pleat on both sides of media for pleat stability. Inside periphery of enclosing frame is bonded to filter pack to eliminate air bypass.

.4 Each filter is complete with a universal metal holding frame. Holding frames are designed to accommodate standard size filters, minimum 16 ga construction with a minimum in-line depth of 68mm (2.7"), complete with full perimeter polyurethane foam gaskets, suitable filter retainer clips and automatic filter centering devices. Holding frames are Farr Type 8, or equal.

.5 Provide filter gauges for each filter bank. Gauges are magnehelic type with scale reading of zero to 125% of manufacturer's published dirty filter pressure drop.

.6 No air conditioning, heating or ventilating unit, or transfer fan shall operate without filters in place. Replace temporary or trial usage filters with clean filter media for the opening of the building.

2.8 NOISE CONTROL DEVICES

.1 Provide noise control devices as specified and noted which includes silencers, acoustic panels and acoustic plenum enclosures.

.2 Acoustic insertion losses are minimum acceptable and pressure drops are maximum allowable. Submit copies of certified performance data for each noise control device, signed by an acceptable, independent, AMCA rated, test laboratory such as Riverbanks Laboratories. Acceptable noise (NC) levels are defined as follows:-

Office & Classroom Areas	35
Library Area	35
Lobby & Corridor Areas	40
Service Areas & Fan Rooms	60

.3 Where alternate and substitute materials and equipment is provided, this Division shall recalculate the silencer insertions losses based on the actual sound data necessary to meet the specified noise criteria. Submit these calculations with the shop drawings.

.4 Engage the services of the noise control equipment manufacturer to inspect the installation, assess the operation of the attenuation equipment and submit a written report. The report includes:-

.1 An analysis of all areas not meeting the specified performance, complete with corrective proposals.

.2 Noise measurements taken over the complete audible frequency range in occupied zones adjacent to silencer installations; adjacent to, above and below equipment/fan/service rooms.

.3 Readings plotted on IC curves, substantiating that acceptable noise levels exist in the occupied zones.

.5 Where vibration control equipment and noise control devices (silencers) are supplied by the same manufacturer, the isolation and attenuation reports specified, may be combined.

.6 Fabricate sound attenuators in accordance with ASHRAE and SMACNA Standards for the ductwork application. Construct silencers of galvanized steel as described for "Ductwork". Prime coat after fabrication where galvanizing is not possible. Acoustic media is pre-compressed glass fibre. Reinforce the media with a glass fibre cloth where velocities exceed 22.9 m/s (4500 FPM). Provide integral silencer enclosures where required to eliminate break-in/break-out noise transmission.

.7 Crosstalk silencers are constructed of galvanized steel with acoustic quality glass fibre blanket protected by perforated galvanized metal liner.

.8 Install guide vanes up and downstream of silencers where excessive turbulence occurs and as necessary to achieve the design pressure drop.

2.9 LOUVRES AND BLANK-OFF PANELS

.1 Provide prefinished aluminum, high performance drainable louvres complete with birdscreens. Heads, sills, jambs and mullions are one-piece 6063-T52 aluminum alloy structural members with fasteners of same material as fabricated items. Frames are 3mm (0.125") thick channel type, blades are 2mm (0.081") thick. Screens are 13mm (1/2") mesh expanded aluminum secured within a 2mm extruded aluminum frame. Finish as selected by Consultant.

.2 Louvres are equal to McGill DSP-635, 153mm (6") wide with minimum 50% free area on a 1219mm x 1219mm (48" x 48") test size, tested in accordance with AMCA 511 Standard to 4.83 m/s (950 FPM) air intake face velocity at no water penetration, maximum 30 Pa (0.12") pressure drop at 4.83 m/s (950 FPM) air intake rate.

.3 All louvres are complete with vertical stiffeners spaced to meet required loads.

.4 Provide where indicated on the drawings, insulated louvre blank-off panels. Panels are fabricated with a urethane (or styrofoam) core, faced on both sides with 8.1mm (0.32") thick stucco embossed aluminum sheet 5005-H134. Panel perimeter frames are 6063-T52 extruded aluminum sections 2mm (.080") thick. Panel frames are mitred at corners. The assembled 50.8mm (2") thick panel has a U factor of less than .06 watts per sq. meter deg. C. (10 BTU per hour/sq.ft. deg. F.). Provide closed

cell PVC perimeter compression gaskets 3.17mm x 25.4mm (1/8" x 1") to ensure tight closure of panel to louvre. Blank-off panels shall be painted black on the outside (louvre side).

2.10 VARIABLE AIR VOLUME VALVES

.1 N/A

2.11 PREFABRICATED CHIMNEYS

.1 N/A

2.12 PACKAGED AIR HANDLING UNITS (ROOFTOP – NATURAL GAS HEATING)

.1 Supply and install packaged commercial roof-top heating/cooling units of size, capacity, etc. as shown on the drawings complete with minor details not specifically mentioned or shown, but as may be reasonably inferred and necessary to complete the system and place same in satisfactory operating condition.

.2 Each unit shall be shipped completely factory assembled, pre-charged, piped and wired internally ready for field connections of electric power, natural gas piping, control wiring and drain line from drain pan. Provide deep seal trap. Units are factory tested, C.S.A. and C.G.A. approved, U.L. listed and ASHRAE 90.1 compliant. Performance ratings are based upon tests in accordance with the most recent issue of ARI Standard 210.

.3 Supply and install for each unit, a 600mm high steel roof mounting frame mating to the bottom perimeter of the equipment. When flashed into the roof it makes a unit mounting curb and provides weatherproof duct connection and entry into the conditioned area. Equipment is capable of bottom handling of conditioned air, where shown. Side discharge units are complete with insulated weatherproof downturn sections.

.4 The units carry a standard one year warranty on parts and labour plus minimum additional materials only warranty as follows:
- additional 4 years on compressors
- additional 2 years on microprocessor based unit controller
- additional 14 years on stainless steel heat exchanger.

.5 Frame for each unit is of welded construction with casing of double wall heavy gauge galvanized steel panels with baked on outdoor acrylic finish, full perimeter heavy gauge galvanized steel base rail, raised (or flanged) edges around duct and power entry openings, stainless steel sloped condensate drain pan, hinged access panels for compressor/controls/heating/economizer/blower/air filter areas, sealed air/water tight and complete with latching handles. Casing insulation is rigid polyurethane foam panels having a minimum density of 2 pounds/cubic foot. Make all components, wiring and inspection areas completely accessible through removable gasketed panels.

.6 Each unit with multiple compressors has multiple separate refrigeration systems. All compressors are scroll type, resiliently mounted, have built-in 3 mode crankshaft lubrication, crankcase heater, discharge temperature limiter, current and temperature sensing motor overloads. Each lead compressor is variable capacity capable of modulation from 10-100% of its capacity, and each lag compressor is on/off. Complete factory sealed refrigeration system consists of compressor, condenser coil and fans, evaporator coil, factory installed thermal expansion valves, twin blower,

liquid line filter dryer, liquid line sight glasses, refrigerant lines connected and a full charge of refrigerant R-454B. Controls consist of magnetic contactors for compressor and evaporator fan motors, low pressure cutout, high pressure cutout, compressor relay, three-leg overload protection and "timed-off' cycle. Each unit is capable of cooling operating down to -18°C (0°F) without installation of additional controls. Unless indicated otherwise, coils (condenser and evaporator) are constructed of ripple-edged aluminum fins flat bonded to seamless copper tubes. Pressure leak test coils at 450 p.s.i. Condenser coils have sub-cooling rows.

.7 Condenser fans are corrosion resistant propeller type. Fan motors are ECM type, direct drive, complete with thermal overload protection (automatic reset) and permanently lubricated ball bearings.

.8 Centrifugal conditioned air (evaporator) blowers are resiliently mounted and statically and dynamically balanced at factory and shall not pass through their first critical speed at any catalogued RPM. Fan wheels are mounted on shafts and have self-aligning permanently lubricated bearings. Fans are complete with mounted and wired Danfoss variable frequency drives (VFD). Provide a suitable external weather-proof enclosure with mounting supports to house field installed Danfoss drive. Field supply, installation and wiring of the VFDs is the responsibility of unit manufacturer, including start-up and commissioning. Motors are premium efficiency, inverter duty complete with inherent protection devices. Supply and exhaust fan motors 1.5 HP and larger shall be directly coupled to the fan and shall be complete with a variable frequency drive (VFD). Fan motors less than 1.5 HP may be electronically cumulated (EC) type.

.9 Provide each unit with an automatic economizer section, allowing the use of up to 100% outside air. Economizer section includes mechanically linked outdoor air and return air dampers operated by a spring return, multi-position damper motor with adjustable minimum damper position and position feedback. The economizer section is completely factory wired and terminalized, ready for direct connection to the building BAS. Install outdoor air hood with rain eliminator vanes over outdoor air dampers. The economizer section incorporates exhaust air dampers, louvres or hood. Other options are noted on the drawings.

.10 All filters are replaceable media type in permanent metal frames. Media is 50mm (2") thick pleated non-woven micro-fine cotton or synthetic fabric. Provide temporary MERV-8 filters for testing and trial usage. Replace temporary trial filters with clean MERV-13 filter media at the time of unit turn-over for Owner's use.

.11 Each unit is complete with factory mounted and wired non-fused power disconnect switch. Disconnect switches are externally mounted, weatherproof configuration, permanently labelled, heavy duty complete with front operating handle, quick-make, quick-break mechanism, cover/handle/switching mechanism interlocks.

.12 Units have gas fired heating sections and are equipped with stainless steel heat exchanger, induced draft blower, flame observation port, stainless steel power gas burner, automatic spark pilot ignition, gas train including pressure regulator, gas valves and manual shut-off cocks, operating, limit and electronic flame proving controls, combustion and venting system, electronic controller. Heat exchanger is controlled with minimum 10:1 turndown with minimum 80% efficiency over the full turndown range.

.13 Units are suitable for control from a remote building automation system. Co-ordinate with Section 25 00 00. A terminal strip in unit control panel facilitates the remote control/monitoring and includes terminals for:

- lead compressor cooling enable (DO)
- lead compressor cooling control (AO)
- lag compressor cooling enable (DO, each compressor)
- damper control (AO)
- heating enable (DO)
- heating control (AO)
- heating blower fan status (DI)

.14 Power wiring to unit unfused disconnect and service outlet is by Electrical Division. BAS control wiring is by Section 25 00 00.

2.13 WELDING FUME EXTRACTION SYSTEMS

.1 Provide welding fume extraction systems comprising exhaust fans and adjustable position extractor arms, as detailed.

.2 Fans are centrifugal, statically and dynamically balanced, non-overloading, air delivery as scheduled, complete with suitable mounting bracket.

.3 Extractor arms are adjustable position, 2m long, fibreglass reinforced PVC, 160mm diameter complete with wall support bracket, 360° swivel elbow, support flange, internal support, adjustable joints with wear discs, polycarbonate hood with handle for its positioning and lever operated regulating airflow damper.

.4 Extraction systems are Nederman, or PlymoVent equal.

.5 Install systems to manufacturer's instructions. Electrical Division will provide fan motor power wiring through motor starter. Supply starter to Electrical Division for installation and wiring.

2.14 VEHICLE TAILPIPE EXHAUST SYSTEMS

.1 Provide vehicle exhaust systems comprising manually operated, spring recoil exhaust hose reels complete with mounting brackets, exhaust fan mounting adapter, exhaust fan with motor guard, 7.5m (25 ft.) length of 100mm (4") diameter exhaust hose, EPDM tailpipe nozzle with clamping device. Exhaust hose is high temperature type, silicone impregnated Fibreglass interior ply, Nomex exterior ply with enclosed steel helix, temperature rating of 315°C (600°F) continuous. Exhaust fan: centrifugal, statically and dynamically balanced, non-overloading, air delivery as scheduled.

.2 Extraction system is Nederman, or PlymoVent equal.

.3 Install system to manufacturer's instructions. Electrical Division will provide fan motor power wiring through motor starter. Supply starter to Electrical Division for installation and wiring.

2.15 DUST COLLECTOR

.1 Provide a packaged dust collector as shown. Unit is factory fabricated, assembled and tested prior to shipment. Unit includes all components for proper operation.

.2 Unit is pull through design, minimum 12 gauge satin coat galvanized steel casing continuous welded,

angle iron reinforced, with support legs and mounting pads.

.3 Unit is complete with:

.1 Belt driven exhauster with belt guard, motor cover and electric gear motor driven shaker. All motors are TEFC. Fan and motor are complete with an overall acoustic enclosure.

.2 Filter tubes suspended from shaker rack and fitted tight on cell plate.

.3 Polyester spun (terylene) filters, 8.0 oz. per sq. yard type, permeability of 20 - 30 CFM, maximum air/cloth ratio of 8.8 to 1.

.4 Access door with continuous hinge and explosion relief latch.

.5 Inlet section comprising material deflector, inlet with matching flanges and internal blowback damper.

.6 Storage drums with flexible drum connectors, lifting handles, drum lid lifting racks and casters.

.7 Square-to-round flanged transition with matching flange at fan discharge.

.8 Inline silencer with silencing media, perforated metal wall and drilled matching flanges (both ends).

.9 Return air fire damper to suit.

.10 Explosion venting section complete with NFPA-68 deflagration relief vent.

.11 NFPA-69 non-return valve complete with shut-down switch, dust level sensor and intrinsic control panel.

.12 Roof-mounted heat detector.

.13 High speed abort damper complete with discharge cowl, limit switch, weather cowl and drilled flanges both ends.

.14 Prewired EEMAC-12 control panel complete with fan starter, shaker starter, 120V control transformer, solid state auto shaker control, stop/start pushbuttons pilot lights and disconnect switches in cover.

.4 Unit is N.R. Murphy Model MKAW-693-4D filter unit; type EA-1 exhaust fan rated at 5,200 CFM at 15" TSP, 20 HP, 1800 RPM high efficiency TEFC motor; 1/2 HP shaker motor; 600V/3 phase, 60 Hz, OSHA style shaft and belt guards.

.5 Provide and commission an NFPA approved spark detection and suppression system equal to Argus Fire Protection System (distributed by Levitt Safety). The system is complete with infrared detectors, CSA approved water valve and control panel. Acceptable Alternate: Hansentek. In accordance with NFPA requirements, the system is complete with a calibrated sensitivity test method to confirm detector operation once installed.

.6 Electrical Division will provide power wiring to control panels as well as exhaust and shaker motors

from panel. All other wiring, including interlock of abort damper, is by this Section.

.7 Provide all floor sweeps. Units are of heavy gauge welded construction, complete with hinged access door with seals and transition to round duct.

.8 Provide all ductwork and accessories including final connection to shop equipment. Ductwork is rigid up to individual pieces of equipment, terminating at 1200mm (48") above finished floor. Provide final connections to equipment from this point using approved flexible hose.

.9 Provide duct access doors in horizontal ducts adjacent to elbows, junctions and vertical ducts to NFPA Standards. Access doors are located on the side of the ductwork, of the same material of equal or greater thickness than the duct, and tightly fitted, gasketted and sealed. Access doors are standard sizes, as follows:

- Duct size 5"Ø to 9"Ø - 8" x 4" access door
- Duct size 10"Ø to 14"Ø - 12" x 8" access door
- Duct size 15"Ø to 28"Ø - 16" x 12" access door
- Duct size 29"Ø and greater - 24" x 18" access door

.10 All equipment to be installed and wired in strict accordance with manufacturer's recommendations. Provide the services of a factory trained technician to carry out a thorough check of system installation and its operation. Ensure that a representative of the installing contractor is present at this time to correct any deficiencies. Submit a complete test report to Consultant and include a copy in the Data Books.

PART 3 - EXECUTION

3.1 DUCTWORK FABRICATION METHODS

.1 Ductwork fabrication, supporting and sealing methods shall be in accordance with methods described in the Equipment Volume of the ASHRAE handbook latest edition or current edition of Duct Manual and Sheet Metal Construction for Ventilating and Air Conditioning Systems, published by SMACNA where methods in these volumes are not at variance with the requirements of any Authority have jurisdiction, and do not conflict with those shown and specified herein.

.2 Construct duct transitions with a maximum gradient of 1 in 4 for low velocity and 1 in 7 for medium and high velocity ductwork. Limit duct transitions on the upstream side of equipment or coils to 30 degrees and on the leaving side of equipment or coils to 45 degree inclined angle.

.3 Support vertical ducts passing through floors on angles secured to duct and bearing on the floor. Protect floor openings by 75mm (3 inch) high water stop all around.

.4 Paint visible internal portions of ductwork at grilles, registers and diffusers flat black by this Section.

.5 Seal joints and seams in outdoor air intake ducts and plenums watertight. Provide suitable drain connection at low points. Slope ductwork and plenum towards drain connections. Weatherproof all ductwork including access panels and flexible duct connections located outdoors.

.6 Do not suspend duct hangers including wires and rods from the steel roof deck nor from other mechanical or electrical components. Support hangers from structural bearings such as beams, top chords of steel joists or structural concrete slabs. Where structural bearings do not exist, provide angle or channel iron from nearest structural bearings to support hangers.

.7 Internally insulate all ductwork and plenums to the extent specified or noted on the drawings. Refer to the "Insulation" Article in Section 23 00 10 for duct liner requirements.

.8 Caulk joints and corners of joints on all supply ductwork with high velocity duct sealer on the interior of the duct during erection to ensure air tightness.

.9 Make pitot tube openings in ductwork of supply, return, relief and exhaust systems as required by Section 23 00 30. Provide openings before and after all fans and at each branch take-off, at each floor, etc. Provide acceptable devices for closing of pitot openings.

.10 Use Listed and Labelled flexible connections at the inlets and outlets of all air handling equipment except curb mounted roof exhausters and ceiling exhaust fans.

.11 Where vibration occurs in the ductwork while the system is in operation, provide and install such additional members as is necessary to overcome this vibration.

.12 Make changes in direction of horizontal ducts with elbows having a throat radius not less than 3/4 of the width of the duct. Make changes of direction from horizontal to vertical duct with elbows having a throat radius equal to the depth of the duct. Where available space limits the throat radius, use the largest possible radius complete with long radius turning vanves to maintain a loss co-efficient no greater than 0.25 according to SMACNA Standards.

.13 Construct round ducts of helically wound galvanized steel strips with spiral lock seam.

.14 Use flexible ductwork of corrugated aluminum construction with minimum average wall thickness of 0.15mm (6 mil inch) and minimum positive and negative pressure rating of 4000 Pa (16 inch W.G.) for high pressure ductwork applications. Thermal flexible ducts have cores factory-wrapped with 25mm (1") thick flexible fibreglass insulation covered with a flame retardant scrim foil mylar vapour barrier. Length of flexible duct connecting branch ducts to air terminal and diffuser shall not exceed 3 meters (10 feet) and is continuous with no intermediate joints. Provide 0.6 meters (2 feet) slack over the length shown on the drawings. Connect flexible ducts to other ductwork or units by airtight slip joints with a minimum of 3 screws and secure joints by at least three wraps of pressure sensitive vapour seal adhesive tape with mastic duct sealant. Support flexible ducts by hangers every 1.5 meters (5 feet) such that duct or insulation cannot be damaged by vibration or other motion. Do not lay ducts across lighting fixture or hot surface or make abrupt changes in direction.

.15 Install fire dampers without strain or distortion of any part and ensure that all parts move freely without binding or rattling.

.16 The position of air outlets shown on the drawings is approximate only. Check the location of outlets and make adjustments in position as is necessary to conform with Architectural features, acoustic tile pattern, brick or block courses, etc. and with the outlets required by other trades, without additional charge.

3.2 EXHAUST HOODS AND DUCTS

.1 Where exhaust hoods are detailed on the drawings as the work of this Division, fabricate from 18 gauge stainless steel in compliance with N.F.P.A. Standards.

.2 Provide grease filters and frames in a readily accessible rack for hoods which are used in applications resulting in airborne grease entrainment. Grease filters shall be listed.

.3 Fabricate exhaust ducts from all cooking exhaust hoods of galvanized steel constructed in accordance with N.F.P.A. Standards. Use 16 U.S. gauge minimum thickness unless heavier gauge is required by local building ordinances. All seams and joints have a liquid-tight smooth continuous external weld. Provide a grease tight access door at each change in direction. Make doors sufficiently large to permit inspection and cleaning and installed not less than 35mm (1½ inch) from the bottom of the duct. Paint all external welds with corrosion resistant zinc rich paint after assembly.

3.3 PLENUMS AND CASINGS

.1 Fabricate plenums and casings from minimum 16 gauge galvanized steel suitably reinforced with angles so that after insulation is applied no sagging or buckling will occur.

.2 Join both sidewall and top panels by 38mm (1½ inch) high standing seams, bolted on 300mm (12 inch) centres.

.3 Place standing seams on outside of casings and supplementary reinforcing angles, where required, on the inside of casing parallel to air flow. Bolt or rivet inside angles to casing wall, on approximately 300mm (12 inch) centres, adjacent to standing seams.

.4 To ensure airtight structure, insert an approved gasketting material between each companion flange and compress the material tightly using joint fasteners on approximately 150mm (6 inch) centres.

.5 Where panels join masonry or concrete construction, bolt panels on 150mm (6 inch) centres to 38 x 38 x 3mm (1½ x 1½ x 1/8 inch) angles; securely fasten to the masonry; seal airtight using an approved caulking compound.

.6 Provide sleeves, metal collars, escutcheons, flanges, etc. around all penetrations including electrical conduit; seal airtight using an approved caulking compound.

.7 Fabricate access doors using double wall construction of 22 gauge galvanized iron. If the casing is to be insulated, install insulation equal to any thickness to that specified for the casing between the two panels of the door. Fit plenum doors suitable for operation from either side with rigid hinges and fire resistant gaskets and a minimum of two catches. Provide an access door to all equipment contained within the plenum which requires service or maintenance.

.8 On insulated plenums, mount metal collars or faces around all openings to allow a neat finish for the insulating materials.

3.4 ANTI-STRATIFICATION DEVICES

.1 N/A

3.5 AIR SYSTEM TESTING AND RUNNING-IN

.1 Provide all equipment necessary to perform the required tests. Test all air systems for leakage in accordance with SMACNA procedures. Calibrated orifices shall be used to measure all leakage airflow rates. All ductwork shall be pressure tested at minimum 500 Pa (2" WG). For any system, total leakage at the test pressure shall not exceed 5% of respective fan design air flow rate. For all variable air volume (VAV) systems, test all supply air ductwork from air handler to VAV or fan-powered VAV boxes, including runout ducts to VAV or fan-powered VAV boxes and associated fire dampers. For constant volume (CV) systems, test all supply air ductwork from air handler to air terminals, including fire dampers, reheat coils, etc. excluding air terminals. In cases of by-pass boxes on CV systems, test all supply air ductwork from air handler to by-pass boxes, including runout ducts to by-pass boxes and associated fire dampers. Repair all leaks and repeat test. Pressurize with small blower. Test system as a whole, or in parts, provided that all ductwork is accessible for inspection at the time of test.

.2 Tests shall be performed before ducts are insulated or enclosed. Submit notice of all tests in ample time to allow the Consultant or his representative to be present when the tests are conducted. Refer also to Article 3.23 in Section 23 00 10.

.3 Any components of the systems which might be damaged during tests shall be removed before the tests and reinstalled after the tests.

.4 Provide all test holes (including prefabricated insulated capped test hole fittings), dampers, access facilities, etc. as required for air balancing and make any changes required for the final balancing results. Co-operate with the balancing contractor to ensure satisfactory completion of his work. Provide test holes prior to application of thermal insulation.

.5 Start-up and run-in and test the complete heating, ventilating and air conditioning system.

3.6 AIR SYSTEM TESTING AND BALANCING

.1 This work will be provided by an independent balancing company selected by the Owner. Refer to Section 23 00 30.

3.7 FIRE PROTECTION AND SMOKE CONTROL

.1 Provide for fire protection and smoke control as noted hereafter.

.2 Electrical Division provides smoke detectors in air handlers in accordance with NFPA 90A and wires same including the relays. Mechanical Divisions 21, 22 and 23, as applicable, provide the relays for shut-down of the air handler on actuation of the corresponding smoke detector. Co-ordinate with Electrical Division for the location of these detectors.

.3 Electrical Division provides all smoke detectors required for proper operation of smoke dampers in fire rated assemblies. Smoke dampers are provided by this Section.

.4 Whether shown on the drawings or not, provide sufficient ductwork off the air handling units, distribution ductwork, transfer air ductwork, etc. to install the smoke detectors. Co-ordinate with Electrical Division.

.5 Supply to the Contractor for installation in architectural finishes, suitable sized access doors where they are required by location of otherwise inaccessible firestats and smoke detectors.

3.8 LABORATORY EQUIPMENT

.1 Laboratory fume hoods, acid storage cabinets and solvent storage cabinets will be provided by other trade sections. Rough-in and make final duct connections to this equipment, as applicable.

.2 Co-ordinate with equipment suppliers to fix the location of all roughing-in, duct sizes and duct runs. All sleeves to be tightly sealed.

.3 Co-ordinate with other trades with respect to servicing all laboratory equipment.

END OF SECTION 23 00 40

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

.1 Refer and conform to the requirements of Sections 23 00 10 and 25 08 00.

.2 Refer to Electrical Division documents and all Sections of Mechanical Divisions 21, 22 and 23 for related information.

1.2 SCOPE

.1 Existing building is equipped with a Delta building automation system (BAS). The existing BAS shall be replaced in its entirety under this Contract, and modifications indicated for the building renovation shall be added as an extension of the replaced system. New and existing BAS points list (appended to this Section) is provided as reference for the scope involved. All other information required shall be determined by site investigation by this Section.

.2 Intent of this project is to remove all existing DDC controls in the existing building and install a new DDC building automation system, as follows. Refer to the I/O Summary (Points List) appended to this Section.

.3 This Section shall:

1. Replace all existing terminal unit heating control valve actuators throughout (classrooms, offices, storage rooms, reheat coils, radiant panels, radiators, etc.).
2. Replace all existing AHU heating and cooling control valve actuators.
3. Supply to the Mechanical Division new terminal unit heating control valves and AHU heating/cooling control valves. Terminal unit control valves are 2-way, NO, globe type or characterized ball type as manufactured by Siemens or Belimo. AHU control valves are globe type, 2-way or 3-way matching existing, as manufactured by Siemens. Porting for 3-way valves shall match existing.
4. Supply to the Mechanical Division new differential pressure sensors.
5. Spare.
6. Replace all existing BAS controllers, associated power supplies and associated end devices (temperature sensors, freezestats, pressure sensors, etc.).
7. All existing pipe sensor wells shall be reused.
8. Existing metal conduits, non-metallic tubing and cabling may be reused. Cable splicing shall not be accepted.
9. Provide all new software, graphics and main control panels.
10. Provide a full 3-year warranty on all new equipment and wiring, including all reused wiring.

.4 Mechanical Division will:

1. Remove all existing terminal unit heating control valves and AHU heating/cooling control valves.
2. Install/pipe all new terminal unit heating control valves and AHU heating/cooling control valves.
3. Replace all existing differential pressure sensor stations, including installation of new differential pressure sensors.
4. Supply new variable frequency drives (VFDs) for new AHU-5 supply and return air fans. Existing starters will be removed by the Electrical Division.

.5 The Building Automation System (BAS) shall be fully integrated and functional.

.6 This Section shall coordinate their efforts to maximize efficiencies (wiring/cabling).

.7 This Section shall follow all pre-established installation practices that are established for work in the Owner's buildings.

.8 Installation of the BAS shall be done in a semi-concurrent fashion. Main system control shall be maintained throughout the installation period. This Section shall coordinate work with the Owner to put together an action plan.

.9 Complete demolition of the old system(s) shall occur once the new system(s) are online. This Section shall review equipment salvage with Owner prior to disposal.

.10 In the event that overtime is required (weekends/weekdays), the Owner requires 72 hours advanced notice for the scheduling of school staff. This work shall be scheduled through the Prime Contractor (General Contractor).

.11 Site visits are encouraged in the development of bids for this project. Reasonable efforts shall be made by Bidders to visit the site outside of school hours (8:00am – 4:00pm). Check-in at main office shall be made.

.12 A Commissioning Agent (CA) will be engaged by the Owner on this project. All aspects of the project will be reviewed by the CA with project reports issued (shop drawings, above ceiling inspections, etc.).

.13 Provide temperature control systems, equipment and associated operating controls, as detailed on the drawings, or as described in the specifications.

.14 Systems shall be complete in all details not necessarily defined or shown, but as may be reasonably inferred as necessary to complete each system and provide operating service in an acceptable manner. Provide all necessary relays, transformers, etc. to interconnect the equipment where required.

.15 System installers shall be mechanics and electricians regularly employed by the control equipment manufacturer.

.16 This Section is responsible for the provision of all control systems including the provision of the Energy Management and Control System (EMCS) and wiring of all related devices installed under all Sections of Mechanical Divisions 21, 22 and 23, and Electrical Division. Provide all engineering and prepare all data files, wiring diagrams and system schematics. Submit for review prior to commencing field work. Provide written operating instructions for the temperature control system and include a description of the sequence of operation, and "As Built" drawings of the system schematics. The graphic appearance, setup and general hardware/software architecture for the EMCS shall be in accordance with the Owner's standards. Provide hard copies of all graphic screens, sequences of operation, function block graphic program, etc. as part of the operating and maintenance manual.

.17 In general, unless otherwise noted, all valve and damper actuation is electric or electronic. Refer to drawings and sequences of operation in this Section for exact requirements.

.18 Upon completion of the installation, all control equipment supplied under this contract shall be adjusted to place the system in complete operating condition subject to the Consultant's approval. All adjustments shall be made in co-ordination with the field engineer responsible for balancing the air and water systems.

1.3 QUALITY ASSURANCE

.1 Base bid basis of design products referenced under this Section establish the minimum acceptable standards of product quality, features and performance.

.2 Work of this Section shall be provided by a recognized contractor regularly employed in the installation and wiring of EMCS and temperature control system and equipment. The following are pre-qualified to bid the work: Siemens Building Technologies (Siemens System), ESC Automation (Delta System), Mircom Group (Schneider/Andover System).

1.4 EQUIPMENT INSTALLED BY OTHERS

.1 As required, the following equipment shall be supplied by this Section and installed by Others:

- Automatic Controls Valves.
- Temperature Sensing Wells.
- Pipe System Flow and Pressure Station Fittings.
- Line Voltage Thermostats.
- Terminal Box Actuators.

1.5 GUARANTEE

.1 Guarantee the installed controls system and all components thereof free from defects in operation sequences, materials and workmanship for a period of three years of normal use and service from the date of certified acceptance by the Owner.

1.6 AIR/WATER BALANCING

.1 Co-ordinate, co-operate and perform the calibration of all devices (flow measuring, pressure differential, temperature, pressure, etc.) with the Balancing Contractor.

.2 Accommodate the Balancing Contractor with a loan of a system specific portable device so that the Balancing Contractor may adjust control signals from minimum to maximum for proper balancing and/or calibration. Demonstrate proper use of the portable device. Alternatively, provide a trained technician complete with portable two-way radios to adjust control signals as instructed by the Balancing Contractor. Co-ordinate with the Balancing Contractor. The Balancing Contractor will be responsible for the loss/damage of all loaned devices.

1.7 AS-BUILT DRAWINGS AND OPERATOR MANUALS

.1 Prepare record drawings on a CAD system utilizing AutoCad Release 14 Software.

.2 On completion of the contract work, provide a set of CAD produced reproducible contract drawings and associated diskettes of relevant approved, "As-Built" controls documentation. This documentation must identify and show all existing and new controls work for each phase or project.

.3 As-Built documentation also includes the following as a minimum:

.1 Schematic outline of the BAS for quick reference of overall system scope.

.2 Adequate record of the work as installed, including its exact location and the wiring and route.

.3 Adequate record of existing controls retained and/or interfaced, including its exact location and the wiring, tubing, etc. route.

.4 System hardware specification manual, which provides a functional description of all hardware components.

.5 System operator's manual which provides concise instructions for the operation of the system and an explanation and recovery route for all system alarms.

.6 System engineering manual which provides all of the information, for system set-up, definition and application.

.7 System data manual which provides the applications data programmed into the system.

.8 System servicing and maintenance manuals for central unit components including: video monitor; printer; digital control panels (DCP); application specific controllers (ASC); field devices (sensor, switches, etc.).

.9 All data specified in the shop drawings section in its final as-built form.

.10 System software documentation.

.11 List of equipment supplied, including its make, model number, name of local suppliers and quantity.

.4 All manuals are 3-ring binders with index pages, indexing tabs and cover identification at front and side. Binder size is 215mm x 280mm (8.5" x 11") extension catalogue type bound with heavy weight fabric hot stamped in black lettering front and spine. Each spine is lettered with full identification of the project. The front face of each binder contains the following:

.1 Full identification title of the Project and Project No.
.2 Full identification title of the Consultant.
.3 Full identification title of the Contractor.

.5 Should there be more than one (1) volume for each type of application, each volume shall be identified as above.

.6 Submit a detailed description and configuration of the manuals to the Consultant for review.

PART 2 - PRODUCTS

2.1 AUTOMATIC CONTROL DAMPERS

.1 All motorized dampers are supplied and installed by Section 23 00 40. Refer to the "Dampers" article in Section 23 00 40 of Division 23.

2.2 DAMPER OPERATORS

.1 Provide electric or electronic actuators (as specified in sequences of operation). Size damper operators to operate dampers under all system conditions. All actuators are complete with spring return to fail safe position and position feedback. Size actuators to provide sufficient force to maintain damper rated leakage characteristics.

.2 Provide dedicated damper actuators on all dampers used for minimum fresh air application.

.3 Mount all damper actuators rigidly and supply with heavy duty linkage consisting of a crankarm, pushrod and swivel ball joint to connect to the damper shaft. Secure linkages in such a manner as to prevent slipping under normal operating torque. Actuators shall not be installed in freezing air streams. Locate damper operators outside the air stream and provide sheet metal standoffs on insulated ducts.

.4 Acceptable manufacturers: Siemens, Belimo.

2.3 ELECTRICAL LINE VOLTAGE THERMOSTATS

.1 Provide heavy duty type. Include backplate and bracket for mounting on standard size outlet box where required.

.2 Provide heating/cooling type thermostat with deadband where sequencing of heating and cooling/ventilation is required.

2.4 ELECTRICAL LOW VOLTAGE THERMOSTATS

.1 Provide complete with heat anticipator, and backplate and bracket for mounting on standard size outlet box where required. Include sub-base with fan On-Off-Auto switch with each thermostat where summer ventilation is required. Include modulating heating or cooling stage where used in conjunction with control valves; step controllers; SCR's; or similar equipment requiring modulation, and mercury switches where On-Off control is required.

2.5 CONTROL VALVES

.1 Provide valves for the operating pressure and temperature conditions of the system. Ensure that valves will close against system operating differential pressures.

.2 Provide globe body control valves with characteristics to suit the application. Straight through (two-port) water valves shall be single seated with equal percentage flow characteristics. Three-port valves shall be linear for each port to give constant total flow. Characterized ball valves may be used for terminal unit applications (perimeter/panel radiation and reheat coils).

.3 Valves shall have stainless steel stems and packing to suit the application.

.4 Valves 50mm (2") and smaller shall have screwed 1035 kPa (150 lb.) bronze bodies. Valves 65mm (2½") and larger shall have flanged 860 kPa (125 lb.) cast iron bodies.

.5 Use positive positioning relays on valves that are sequenced with other actuators or where necessary for high shut-off rating.

.6 Unless specifically mentioned otherwise, the design flow pressure drop shall be as follows:-

- Hot water valves — 20 kPa (3 psi)
- Glycol valves — 20 kPa (3 psi)
- Valves for terminal unit application (radiation and reheat coils) — 7 kPa (1 psi)

.7 Acceptable manufacturers: Siemens (all valves), Belimo (ball valves only).

2.6 VALVE ACTUATORS

.1 Control valves shall be provided with electric or electronic actuators (as specified in sequences of operation). Select actuators to allow the control valve to shut off against normal inlet operating pressures.

.2 Electric valve actuators are of the enclosed reversible gear drive type with spring return to fail safe position and position feedback.

.3 Electric valve actuators accept modulating control signals as required. Actuators have no balance relays or mechanical travel limiting switches. Provide actuators with potentiometer adjustment of zero signal position and angular rotation. Conceal all adjustments with access by means of removable cover plate.

.4 Acceptable manufacturers: Siemens, Belimo.

2.7 POSITIVE POSITIONING RELAYS

.1 Whenever a controller has to proportion more than one motor on a single damper, a positive positioning relay must be used. Whenever a controller has to sequence two or more devices, such as valves or dampers, and for all damper operators on modulating dampers, positive positioning relays must be used. Sequencing by spring ranges alone will not be acceptable. Positive positioning relays have positive mechanical feedback of the controlled device, ratio relays are not acceptable.

2.8 HIGH TEMPERATURE LIMIT THERMOSTATS (FIRESTATS)

.1 Provide DPDT high limit thermostats to shut down respective fan system(s) as follows:-

- For ducts where the longest dimension is not over 760 millimeters (30") provide a bi-metal type manual reset limit thermostat set at 57.2° Celsius. (135°F.)

- For ducts of greater dimension, provide multiple limit thermostats or, when compressed air is available, multiple temperature sensitive heads connected to a normally open pressure electric switch. Provide one limit thermostat or sensing heat per 1.1 meter (4 ft.) square of duct cross sectional area. Install in a staggered arrangement to give complete coverage of the duct.

2.9 LOW TEMPERATURE LIMIT THERMOSTATS (FREEZESTATS)

.1 Provide manual reset DPDT low temperature limit thermostats complete with sensing capillary. Length of sensing capillary shall be such that every 0.1 sq.m. (1 sq. ft.) of coil is covered by element. Provide one limit thermostat for approximately every 6 square meters (60 sq. ft.) of duct area.

.2 Each freezestat is complete with two contacts. One contact is hardwired to fan starter, and the second for BAS interface.

2.10 SWITCHES

.1 Pressure electric switches have diaphragm operated D.P.D.T. snap acting contacts with electrical rating suitable for applications as specified. Pressure electric switches withstand up to 25 psig. and are provided with adjustable cut-in and cut-out settings between 3 and 20 psig.

.2 Water flow switches are general purpose with a paddle actuated snap acting D.P.D.T. switch rated at 16 amp 120/1/60 A.C. full load.

.3 Air proving (differential pressure) switches utilize a differential pressure activated, diaphragm actuated, snap-acting D.P.D.T. switch rated at 9.8 amp 120/1/60 A.C. full load. Select differential pressure range to suit the application and setpoint is adjustable. Mount switches with diaphragm in a vertical plane. Switches are CSA approved.

.4 Install minimum positioning switches inside local cabinets and lock switches after system balancing.

.5 Damper end switches are DPDT, lever operated, activated by damper blade movement and mounted securely on damper frame. Switches have contact ratings of 5A at 120 VAC and are CSA approved.

2.11 ELECTRONIC TEMPERATURE SENSORS

.1 All mixed air sensors are 1000 ohm nickel, resistance temperature detector (RTD) type with a twenty-five foot averaging element. Accuracy of the RTD sensor shall be +/- 0.6°C over a range of -7°C to 49°C (19°F to 120°F).

.2 All supply and return air sensors are thermister or 1000 ohm nickel RTD type temperature detectors. The sensor probe has a minimum length of 450mm (18"). The accuracy of the sensor is +/- 0.6°C over a range of 4°C to 66°C (39°F to 151°F).

.3 All space sensors are thermister or 1000 ohm nickel RTD type temperature detectors. All space sensors are provided with vented protective covers. The accuracy of the sensor is +/- 0.6°C over a range of 4°C to 49°C (39°F to 120°F). Sensors may be complete with optional RJ-11 communication jack.

.4 All liquid immersed sensors are thermister or 1000 ohm nickel RTD type temperature detectors. Each sensor is provided with a stainless steel well, suitable for the working temperature and pressure of the fluid. The accuracy of the sensor is +/- 0.6°C over a range of -7°C to 49°C (19°F to 120°F).

.5 Outdoor air sensor is the thermister or 1000 ohm nickel RTD type temperature detector. The RTD sensor is mounted in a weatherproof enclosure. The accuracy of the sensor is +/- 0.6°C over a range of -34°C to 40°C (-29°F to 120°F).

.6 All sensor elements other than those for space sensors shall be housed in a factory made stainless steel sheath.

.7 All sensors shall be calibrated and linearized.

2.12 ELECTRONIC HUMIDITY SENSORS

.1 The humidity sensors incorporate solid state all polymer capacitance type sensing element and have a range of 0-100% RH with a temperature operating range of 0°C to 60°C (32°F to 140°F).

.2 The sensing element has an accuracy of +/- 3% RH over the humidity range.

.3 Duct mounted sensors are mounted halfway across the duct. Room mounted sensors are provided with vented covers.

2.13 DIFFERENTIAL PRESSURE SENSORS

.1 Provide differential pressure sensors for water velocity pressure and static pressure applications. The differential pressure range is selected to match the applications. Select materials suitable for the measured variable, i.e. water and air, and to withstand a minimum of twice the normal working pressure.

.2 Each sensor is provided with an industry standard 4-20 mA transmitter, mounted at the sensor not the SCU or panel unless in a finished area. The transmitter and sensor have a combined accuracy of 0.5% of the differential pressure range.

.3 Static pressure pickups within finished areas are in blank thermostat cases. Outside static pressure reference heads are complete with a wind baffle cap to eliminate wind pressure effects. The static pressure controller is of the slack diaphragm type with a minimum setpoint range of .01 inches to 6.0 inches W.G.

2.14 NAMEPLATES

.1 Provide lamicoid nameplates 25mm x 63mm (1" x 2½") minimum size 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 are similarly labelled. Permanent painted stencil labels may be used on the controllers and relays mounted inside local panels, if so desired. Tape labels are not acceptable.

.2 All controllers (except application specific controllers) shall have a laminated points list left inside the controller enclosure, or wall mounted adjacent to the controller. All controllers shall have power source location identification. All application specific controllers shall be labelled with their system name and their system address number for future replacement and reload.

.3 All end devices (sensors, relays, switches, transducers, etc.) installed in service rooms shall be labelled with the name, point descriptor and point address on a plastic tag mechanically fastened (or tie-wrapped) to the device. All end devices installed in ceiling spaces outside of service rooms shall be labelled with name, point descriptor, location of ASC to which the end device is connected and location of power supply serving the end device on a yellow sticker tag installed on the T-bar ceiling grid.

2.15 WIRING

.1 Electrical wiring incidental to the control system conforms to Electrical Division specifications except that control wiring from 50 to 120 volts may be minimum of #14 gauge wire and all wiring less than

50 volts may be a minimum of #18 gauge wire. Two-wire systems have black and white conductors; three-wire systems have black, white and red conductors.

.2 Plenum cable may be used for 24V and less in concealed, fully accessible non-corridor areas only, provided that said cable meets Code requirements for flame-spread rating and smoke developed classification. Use conduits in equipment rooms, exposed areas, corridor ceiling spaces and non-accessible areas. In mechanical rooms, NMT (Nylon Mechanical Tube) is acceptable for wiring of last 1000mm for sensors, damper actuators and valve actuators. In accessible corridor ceiling spaces, control wiring in cable tray is acceptable. Cable outer jacket is yellow, no other colour is acceptable.

.3 Sensor wire for each analog input is colour coded #18 AWG twisted-shielded cable.

2.16 PANELS

.1 Control panels are NEMA rated fully enclosed cabinets with all steel construction. Cabinets have hinged door with locking latch or bolt on cover plate. All cabinet locks are common keyed finished with two coats of paint.

.2 Panels are wall mounted or free standing located as per the Mechanical Drawings.

.3 All controllers, relays, transducers, etc. are located within the control panels.

.4 Each control enclosure has a standard duplex AC power receptacle located within the enclosure to provide power for test equipment, operation communication devices and cassette tape storage devices. Receptacles are labelled with circuit number of breaker supplying power to panel.

2.17 CONTROL RELAYS

.1 Control relays are DPDT for control of electrical starters and equipment where shown on the Point Schedule.

.2 Coil voltage matches the Unit Controller. Contacts are rated at 5A at 120 VAC.

2.18 POWER CONDITIONERS

.1 All electronic equipment shall be complete with all necessary devices to safeguard against voltage spikes, fluctuations or any other power line anomalies which might damage the equipment.

2.19 FACILITY MANAGEMENT SYSTEM - GENERAL

.1 The Facility Management System (FMS) shall be capable of integrating multiple building functions, including equipment supervision and control, alarm management, energy management, and trend data collection. The FMS shall be the top of the line system available from the installation contractor that has been previously reviewed and accepted by the Owner. This system will reside in the Caretaker's office.

.2 The FMS shall consist of the following:

.1 Network Control Units.

.2 Standalone Application Specific Controllers (ASCs)
.3 Local Operator's Workstation located in Custodial Office.
.4 Sensing devices, relays, switches, indicating devices, transducers, etc. required to perform functions listed.
.5 Monitoring and control wiring and air tubing, as applicable.
.6 Required software loaded at the on-site workstation, including graphics.
.7 Set-up of Owner's central office terminals, including graphics, for receipt, logging, reporting, trending, etc. of data received via the Owner's wide area network.

.3 The system shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, ASCs, and operator devices.

.4 The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.

.5 The design of the FMS shall be networked. Inherent in the system's design shall be the ability to expand or modify the network via a local network.

.6 FMS is complete with suitable communication protocol for connection to Owner's wide area network.

.7 Each ASC is complete with a communication outlet for a portable operator terminal connection. Provide a notebook cable to allow connection to the ASC.

2.20 OPERATOR ON-SITE WORKSTATION

.1 Operator Interface: A standard Terminal shall be provided for command entry, information management, network alarm management, data base management and dynamic colour graphic display functions. All real-time control functions shall be resident in the ASCs to facilitate greater fault tolerance and reliability. Provide an on-site workstation system configuration that includes, as a minimum, the following components. Provide all cabling and accessories as necessary.

.1 The Owner will supply a Windows XP-PS2 based personal computer (PC) complete with mouse and keyboard. This Section shall be responsible for:

.1 Provision of all necessary control interfaces and co-ordination.
.2 Provision of all software, including proper operation. All software is pre-approved by the Owner and is the current top of the line package without any limitations for operation or programming.
.3 Recovery and re-installation of the system in the event of hardware failure on the PC within the warranty period.
.4 Maintaining proper off-site system back-up as the project progresses and during the warranty period.

.2 Monitor: Obtain from Owner and install on site.

.3 Printer: Obtain from Owner and install on site.

.2 All communication to the BAS is through the front end software installed on the Operator's Workstation. Off-site communication is through a modem connection at the P.C. This Section shall

provide a telephone line from telephone backboard in electrical room to Custodial Office, including telephone jack adjacent to the P.C. This telephone line shall be tied into the last building phone line through a commercial grade line sharing device. Provide the line sharing device and co-ordinate work with the phone system installer.

.3 The Owner will monitor electrical metering equipment (by others) via the on-site workstation. For this purpose, this Section shall allow metering software to be loaded and set-up by others on the on-site computer and shall ensure that the on-site computer is complete with a dedicated serial port to be used as a communications gateway.

2.21 AIR QUALITY (CO2) DETECTORS

.1 Provide carbon dioxide (CO2) sensors with suitable duct mounting kits as required where shown, or specified in the Sequences of Operation. Sensors are photo-acoustic, requiring 24 VAC power supply, transmitting a 0-10 VDC output signal with a range of 0-2000 PPM. Sensors are Siemens Model QPM2100N in-duct type, alternates will not be accepted.

2.22 PHOTO SENSORS

.1 Greystone Model PSR-1 sensor, CSA approved, light sensitive resistor, mounted in a weatherproof enclosure. The unit produces 4-20 mA output signal and is coupled with a transmitter.

2.23 OCCUPANCY SENSORS

.1 Provide CSA approved passive infrared type occupancy sensors, providing automatic control of HVAC equipment, complete with gasketed watertight enclosure, DIP switch control, adjustable time delay, single pole, double throw isolated relay for use with HVAC control, data logging or other control options. Sensors shall be Watt-Stopper model DT-200 for corridors, and Watt-Stopper model CB-100 for gymnasiums. Each sensor is complete with wired cage. Classroom sensors will be provided by the Electrical Division.

PART 3 - EXECUTION

3.1 GENERAL

.1 The building operator communicates with the modular controller network through the terminal located in the Building Operator Office.

.2 Provide all installation work required for a complete operational system, under this Section. The system includes all control and remote hardware, software, all interconnecting wire and conduit as required for a fully operational system as specified, and be in accordance with local and national codes and Electrical Division.

.3 Provide all engineering, data file preparation and entry, system check out and calibration labour for a complete and fully operational system.

.4 Electrical material and installation is in accordance with the appropriate requirements of the Electrical Division of these Specifications, and in accordance with applicable sections of the current edition of the applicable local codes for signaling systems. Wiring is in conduit or approved totally enclosed

raceways. No cable raceway, troughs or open wiring (except plenum cable) of any kind is permitted.

.5 Assume full responsibility for locating all sensing devices so as to provide an accurate and representative measure of the parameter being measured. Any sensing devices which do not meet this requirement shall be relocated by this Section at its expense.

3.2 SYSTEM COMMISSIONING

.1 Refer to, and comply with, Section 25 08 00 and "System Commissioning" Article in Section 23 08 00.

.2 Adjust, calibrate, set and test the controls systems by a qualified manufacturer's representative prior to the commissioning process. Upon completion this Section shall request, in writing, to the Owner that the commissioning procedure can commence.

.3 The procedure is conducted with the Owner and Commissioning Agent present and consists of:-

- A point log of all points connected to the system, detailed in the input/output summary.
- Each commandable point, i.e. analog output and digital outputs is commanded.
- Each program sub-routine is demonstrated as functioning.
- Each DDC loop is demonstrated as functioning and stable.
- All other functions and reports detailed in this Section are demonstrated as functioning.

.3 Should this procedure prove satisfactory then the system will perform, without any downtime, for a period of 30 days before the system is accepted by the Owner.

3.3 TRAINING

.1 Provide training to the Owner's designated representative which will cover the complete operation of the building control system, and the software procedures to allow the representative to add, modify or create points, DDC loops or energy management programs.

.2 The duration of the training period is not less than two (2) days, conducted during normal working hours. Each day is defined as 4.0 working hours, and the time allocated will be used at the Owner's discretion within the warranty period. The instruction consists of both hands-on and classroom training at the job site.

.3 For the training sessions, provide:
- Qualified engineer or certified engineering technologist.
- Working prototype of the BAS.
- Training program for the Owner's maintenance personnel.
- Three (3) copies of all documentation related to the training program.

3.4 THERMOSTATS (ROOM TEMPERATURE SENSORS)

.1 Mounting Heights (roughed-in by Electrical Division in new masonry walls):

- Office Areas	1.5 meters
- Service Areas	1.5 meters
- Classrooms and Corridors	1.5 meters

.2 Provide all thermostats and sensors in public and service areas with vandal-proof guards. Where classroom sensors are installed in control panels provided by others, co-ordinate mounting heights with panel supplier. Calibrate all sensors to compensate for inaccuracy of type of installation. Calibrate all thermostats.

3.5 SENSORS

.1 Where sensors are specified to be in the outside air they shall be installed so as not to be affected by exhaust air, reverse warm airflow through air supply units, or the direct ray of the sun.

.2 Where sensors are installed in pipe walls apply temperature sensitive grease for increased response. Ensure sensor elements are immersed in heat transfer compound and firmly seated against tip of well. Elements to extend at least two-thirds of pipe diameter into the pipe. Use thermowells with extensions where required to accommodate pipe insulation.

.3 Use averaging element sensors in mixing plenums.

.4 Provide pressure sensor transmitters with valved pressure connections.

.5 Mount sensors and combination sensor-controllers in accessible locations.

.6 Where sensors and controllers are to be mounted on or within air handling units, co-ordinate with the air handling unit assembler before mounting control devices.

.7 All sensors are calibrated to such a level as to permit on the job installation that will require minimum field adjustment or calibration. All sensors are mounted to provide ready access for calibration, servicing and removal.

3.6 WIRING

.1 Extend wiring and provide all ancillaries from 15 amp/120 volt separately fused circuits provided by the Electrical Division. Where none are provided this Section shall arrange (and pay) for Electrical Division to extend a suitable service.

.2 Label each wire with its point descriptor at the point where it attaches to the panel. All wiring between panels and end devices shall be provided continuous; terminations/splicing/joints are not acceptable.

3.7 FREEZESTATS AND LOW LIMIT CONTROLLERS

.1 Freezestats are directly interlocked with fan starter control circuits and the interlock signal does not pass through any device which requires calibration nor any device which interrupts the signal.

.2 Demonstrate the calibration and proper functioning of freezestats at +2°C (35°F) and low limit controllers at the specified temperatures.

3.8 FIRE ALARM AND SMOKE DETECTORS

.1 As applicable and required by local Codes, Electrical Division will wire the smoke detectors into the fire alarm system.

.2 Mechanical Divisions shall arrange the motor starter control circuits wiring to allow the fire alarm

system to shut down the fans and air handling systems.

.3 Electrical Division will provide suitable switches and/or 120 VAC auxiliary relays at the fire alarm panel, and wire from the relay contacts to alarm terminals in fan starters.

3.9 FIRESTATS

.1 Firestats are directly interlocked with supply and/or exhaust fan starter control circuits and the interlock signal does not pass through any device which interrupts the signal.

.2 Interconnect shutdown with combination smoke and fire dampers as required.

3.10 CONTROLLER PANELS

.1 Wherever possible, locate panels on wall surfaces which are not occupied by other equipment at a centreline height of approximately 5'-0". Locate in an area which satisfies the environmental requirements of the panels. Panels may not be located in hallways, offices, classrooms or any other areas normally accessible to the public.

.2 All panel penetrations are located at the bottom. Panels with penetrations at top will not be acceptable.

.3 Where existing equipment must be moved to accommodate panels ensure that all relocated existing equipment is properly reconnected and mounted in a neat and workmanlike manner.

.4 Ensure that all panels are mounted so as to provide ready access for servicing purposes.

.5 Provide wiring diagrams for each panel and install plastic laminated copy inside each panel, on wall adjacent to panel or provide folder inside cabinet door with wiring diagrams.

3.11 GRAPHICS

.1 Provide colour graphic schematic representations for all systems controlled. Graphics are based on the system schematics included as part of the Shop Drawing submission.

.2 Graphic displays of building systems shall include the system name. Identify all major system components, including fans and sensors, using English descriptors. Adjacent to each sensor, display the current sensed value with the setpoint (where applicable) displayed in brackets directly beneath. Display actual equipment status. All status displays shall indicate "true status" achieved by wiring through current sensing/metering devices at equipment starters. A point in alarm shall be highlighted with a flashing display or a coloured background which is different to that used when point is in normal condition.

.3 Display outside air (or fresh air) temperature on all system graphics.

.4 For additional requirements refer to pages 70 and 71 of Owner's guidelines for a Prototypical Elementary School (attached to this Section).

3.12 CONTROL STRATEGIES

.1 The intended operation of major systems are described in the Sequences of Operation and I/O Summary included hereinafter. Provide, install, pipe and wire such components as are required to achieve the end result as described.

.2 Unless otherwise specified, all information and schedules required to initialize and implement control programs is to be based on information provided by the Owner. This Section shall list all requirements for information and submit to Consultant.

.3 Where a system does not fit into any of the categories defined for control purposes, notify Consultant before proceeding.

.4 Be responsible for maintaining the correct sequence of operation for controlled devices in the event that there is a change or reduction in the number of existing control loops.

.5 The local operator shall be able to change and/or define all setpoints and schedules outlined in this Section, unless otherwise specified.

SEQUENCES OF OPERATION

1. GENERAL

.1 All control is electronic or electric as noted. Line voltage control, including mounting and wiring of thermostats, will be by the Electrical Division.

.2 Abbreviations used in describing the sequences of operation hereinafter:

EA	-	Exhaust Air
OA	-	Outside Air
MA	-	Mixed Air
RA	-	Return Air
SA	-	Supply Air
EAT	-	Exhaust Air Temperature
OAT	-	Outside Air Temperature
MAT	-	Mixed Air Temperature
RAT	-	Return Air Temperature
SAT	-	Supply Air Temperature
HWS	-	Heating Water Supply
HWR	-	Heating Water Return
±	-	Plus or Minus
<	-	Less Than
>	-	Greater Than
=	-	Equal to
</=	-	Less Than or Equal To
>/=	-	Greater Than or Equal To
RH	-	Relative Humidity
GLS	-	Glycol Supply
GLR	-	Glycol Return
VFD	-	Variable Frequency Drive

2. HEATING PLANT

1. Applicable for boilers B1 and B2, heating water pumps P1 and P2, new glycol heating pumps P3 and P4, existing glycol heating pumps P5 and P6, 2-position (NO) motorized valves V-3 and V-4, and 2-way (NO) control valves V-1 (existing) and V-2 (new). Refer to Heating System Flow Diagram. Division 16 will provide a 120 VAC power source for controls in boiler room. Provide transformation.

2. Plant is enabled/disabled from the EMCS from an operator defined seasonal time schedule and ambient temperature. Boiler lead/lag sequencing is operator defined.

3. Plant Disabled: All equipment Off.

4. Plant Enabled: Plant enabling starts one heating water pump (P1 or P2 as defined by the operator), one new glycol heating pump (P3 or P4 as defined by the operator), and one existing glycol heating pump (P5 or P6 as defined by the operator).

    1. On a call for heat, operating heating water pump status allows the lead boiler (B1 or B2 as defined by operator) burner to fire, and fully opens associated 2-position motorized valve (V3 or V4). If the lead boiler cannot keep up with demand, second boiler in sequence is enabled

and its 2-position motorized valve fully opened, etc. Each boiler burner fire is modulated to maintain an operator defined common primary heating water temperature setpoint. Setpoint is scheduled according to ambient temperature and is operator adjustable; obtain schedule from Owner. Maximum design temperature is 82.2°C (180°F).

2. Differential pressure sensor (DPS) on heating water loop, through a variable frequency drive, varies water pump speed to maintain setpoint. Two-way control valves V-1 and V-2 are modulated in parallel to prevent operating pump (P1 or P2) flow below minimum. Minimum pump speed to be determined at time of balancing. Locate DPS in Mechanical or Boiler room. Connect DPS across heating water mains.

3. Differential pressure sensors (DPS) on the new and existing glycol heating loops, through a variable frequency drive, varies associated glycol pump speed to maintain setpoint. Locate DPS in Mechanical or Boiler room. Connect DPS across heating glycol mains.

5. Time delay each successive pump start. Each pumped circuit is designed with 100% stand-by pump capacity. In each case, operating pump and changeover are defined by the operator. Failure of any one operating pump automatically starts stand-by pump and the condition is alarmed.

6. Final system pressure setpoints for control of heating water and heating glycol pumps are as determined at the time of system balancing.

7. Provide for a low heating water temperature critical alarm (loss of heat) interface with building security system. Wire a DO point to a relay at the security system console unit located in the main office. Provide the relay. Final connection of relay to console unit will be by others.

3. <u>AHU-6 SYSTEM (CLASSROOMS) - VAV-DDC</u>

1. Applicable Equipment: AHU-6 System: AHU-6

2. Refer to Sketch SK-M1 herein for damper and temperature references below. Note that the point count indicated on the sketch is incomplete. For actual points required refer to I/O Summary.

3. UNOCCUPIED mode (System OFF): all fans OFF, heat recovery wheel speed control disabled, all dampers in fail safe position (EA and OA dampers closed, RA damper open), MAT sensor modulates 2-way valve on heating coil to maintain an operator defined setpoint (design: 13°C (55°F). Control valve on cooling coil closed to coil.

4. OCCUPIED mode (System ON - Time Schedule): RA and SA fans start at no-load via VFD's and status from SA fan initiates an operator adjustable software timer. Timer expires; damper control enabled and economizer (OA, EA and RA) dampers proceed to minimum OA position, heat recovery wheel speed control enabled, auxiliary exhaust fans start.

5. FAT sensor varies heat recovery wheel speed via VFD to obtain SAT setpoint with override from EAT sensor to maintain unit frost protection. At SAT < OAT and OAT < RAT heat reclaim control is automatically reversed and FAT sensor varies heat recovery wheel speed via VFD in reverse to obtain SAT setpoint.

6. SAT sensor modulates the mixing dampers, 2-way valve on heating coil and 3-way valve on cooling coil in sequence to maintain setpoint. SAT setpoint is reset (operator adjustable: 13°C minimum, 21°C maximum) from zone cooling demands (i.e.: all associated VAV boxes) to maintain 90% of maximum VAV box airflows to allow greater building air circulation. Low SAT protection (manual reset) shuts down system upon activation and is hardwire interlocked to RA and SA fan starters. Low SAT protection is also alarmed on the BAS.

7. Static pressure sensor in supply air duct at approximately 2/3 distance to most remote VAV terminal, through a VFD, varies SA fan speed to obtain operator defined setting. Static pressure setpoint is reset based on the VAV zone requiring most pressure (i.e. setpoint is reset incrementally until one zone damper is 95% open). OA damper position varies EA fan speed via VFD to prevent space over-pressurization. High SA discharge static pressure protection (manual reset) shuts down system upon activation and is hardwire interlocked to RA and SA fan starters.

4. <u>RTU-1 (CLASSROOMS) AND RTU-5 (TECH. CONSTR.) SYSTEMS - VAV-DDC</u>

1. Applicable Equipment:

    1. RTU-1 System: RTU-1, auxiliary exhaust fan F-34, F-37, F-47.
    2. RTU-5 System: RTU-5, auxiliary exhaust fan F-45, F-46.

2. UNOCCUPIED mode (System OFF): SA and EA fans OFF, heat recovery disabled, DX-cooling control disabled, auxiliary exhaust fans OFF, dampers in fail safe position (OA damper closed, RA damper open), MAT sensor modulates 2-way valve on heating coil to maintain an operator defined setpoint (design: 13°C (55°F).

3. OCCUPIED mode (System ON - Time Schedule): SA and EA fans start at no load via VFDs and SA fan status initiates an operator adjustable software timer. Timer expires, damper control is enabled (OA and RA dampers proceed to minimum OA position), heat recovery control enabled, DX-cooling is enabled, auxiliary exhaust fans start.

4. SAT sensor modulates the mixing dampers and 2-way control valve on heating coil and stages unit compressors in sequence to maintain setpoint. On a call for mechanical cooling lead compressor is modulated to maintain setpoint. On further calls for mechanical cooling, each lag compressor is energized in sequence with lead compressor modulated to maintain setpoint. SAT setpoint is reset (operator adjustable: 13°C minimum, 21°C maximum) from zone cooling demands (i.e.: all associated VAV boxes) to maintain 90% of maximum VAV box airflows to allow greater building air circulation. Low SAT protection (manual reset) shuts down system upon activation and is hardwire interlocked to RA fan starter. Low SAT protection is also alarmed on the BAS.

5. Static pressure sensor in supply air duct at approximately 2/3 distance to most remote VAV terminal, through a VFD, varies SA fan speed to maintain static pressure setpoint. Static pressure setpoint is reset based on the VAV zone requiring most pressure (i.e. setpoint is reset incrementally until one zone damper is 95% open). OA damper position varies EA fan speed via VFD to prevent space over-pressurization. High SA discharge static pressure protection (manual reset) shuts down system upon activation and is hardwire interlocked to SA and EA fan starters.

6. Unit heat recovery will be controlled by the manufacturer's discharge air temperature (DAT) control system to maintain setpoint, including heat recovery wheel speed modulation as required to prevent frost formation on the heat recovery device. Manufacturer's DAT setpoint shall be reset from the BAS.

5. RTU-2 & RTU-3 (GYMNASIUMS) AND RTU-8 (CAFETORIUM) SYSTEMS - CV-DDC

1. Applicable Equipment:
RTU-2 System: RTU-2, auxiliary exhaust fan F-35.
RTU-3 System: RTU-3, auxiliary exhaust fan F-36.
RTU-8 System: RTU-8.

2. UNOCCUPIED mode (System OFF): SA and EA fans OFF, heat recovery disabled, DX-cooling disabled, auxiliary exhaust fans OFF, dampers in fail safe position (OA damper closed, RA damper open), MAT sensor modulates 3-way (2-way for RTU-8) valve on heating coil to maintain an operator defined setpoint (design: 13°C (55°F). On a call for heat from any one space temperature sensor, SA fan starts, unit operates on full recirculated air and space temperature sensor modulates control valve on heating coil to maintain operator defined setback setting.

3. OCCUPIED mode (System ON - Time Schedule): SA fan starts and unit operates on full recirculated air to satisfy all operator defined space setup temperature. Space temperatures satisfied: EA fan starts, damper control is enabled (OA and RA dampers proceed to minimum OA position), heat recovery control enabled, DX-cooling enabled, auxiliary exhaust fans start.

4. Space temperature sensor (or average of multiple space sensors) modulates the mixing dampers and 3-way (2-way for RTU-8) control valve on heating coil and stages unit compressors in sequence to maintain setpoint. On a call for mechanical cooling lead compressor is modulated to maintain setpoint. On further calls for mechanical cooling, each lag compressor is energized in sequence with lead compressor modulated to maintain setpoint. Low SAT protection (manual reset) shuts down system upon activation and is hardwire interlocked to RA fan starter. Low SAT protection is also alarmed on the BAS.

.5 Unit heat recovery will be controlled by the manufacturer's discharge air temperature (DAT) control system to maintain setpoint, including heat recovery wheel speed modulation as required to prevent frost formation on the heat recovery device. Manufacturer's DAT setpoint shall be reset from the BAS.

.6 Carbon dioxide (CO2) sensor in common RA duct main overrides economizer control to maintain operator adjustable CO2 concentration level. Obtain setpoint from Owner. Limit excess OA amounts to prevent:
- SAT below setpoint at 100% heating.
- SAT above setpoint at 100% mechanical cooling.

.7 Unit mode of operation (OCCUPIED/UNOCCUPIED) is determined from motion sensors in the respective Cafeteria and Gymnasium spaces. Initiate OCCUPIED mode when any one motion sensor is activated and initiate UNOCCUPIED mode when all sensors are de-activated. Initiate each mode via time delay. Time delay durations are as necessary to prove status and are operator adjustable. Obtain setpoints from Owner.

.8 Motion sensors are provided by this Section complete with relays. All relay interface wiring is by this Section.

.9 VAV box serving Stage Area:
- Cooling: Space temperature sensor maintains setpoint by modulating box damper beyond minimum position when SAT is less than space temperature, and towards minimum position when SAT is greater than space temperature.

- Heating: Space temperature sensor maintains setpoint by modulating box damper beyond minimum position when SAT is greater than space temperature, and towards minimum position when SAT is less than space temperature.

6. RTU-4 (TRANPORTATION) and RTU-6 (THEATRE ARTS) SYSTEMS- CV-DDC

1. Applicable Equipment:

    1. RTU-4 System: RTU-4, auxiliary exhaust fan F-44.
    2. RTU-6 System: RTU-6.

2. UNOCCUPIED mode (System OFF): SA and EA fans OFF, DX-cooling disabled, auxiliary exhaust fans OFF, dampers in fail safe position (OA damper closed, RA damper open), MAT sensor modulates 2-way valve on heating coil to maintain an operator defined setpoint (design: 13°C (55°F).). On a call for heat from any one space temperature sensor, SA fan starts, unit operates on full recirculated air and space temperature sensor modulates control valve on heating coil to maintain operator defined setback setting.

3. OCCUPIED mode (System ON - Time Schedule): SA fan starts and unit operates on full recirculated air to satisfy all operator defined space setup temperature. Space temperatures satisfied: EA fan starts, damper control is enabled (OA and RA dampers proceed to minimum OA position), DX-cooling enabled, auxiliary exhaust fans start.

4. Space temperature sensor (or average of multiple space sensors) modulates the mixing dampers and 2-way control valve on heating coil and stages unit compressors in sequence to maintain setpoint. On a call for mechanical cooling lead compressor is modulated to maintain setpoint. On further calls for mechanical cooling, each lag compressor is energized in sequence with lead compressor modulated to maintain setpoint. Low SAT protection (manual reset) shuts down system upon activation and is hardwire interlocked to RA fan starter. Low SAT protection is also alarmed on the BAS.

5. Provide a deadband between heating and cooling occupied temperature setpoints. Between the setpoints, space temperature floats. Provide a discharge air temperature sensor (SA duct main) for monitoring purposes.

7. RTU-9 (WEIGHT ROOM) SYSTEM – CV_DDC

.1 Applicable Equipment: RTU-9 System: RTU-9, reheat coil RHC-1.

.2 UNOCCUPIED mode (System OFF): SA and EA fans OFF, DX-cooling disabled, auxiliary exhaust fans OFF, dampers in fail safe position (OA damper closed, RA damper open), MAT sensor modulates 2-way valve on heating coil to maintain an operator defined setpoint (design: 13°C (55°F).). On a call for heat from any one space temperature sensor, SA fan starts, unit operates on full recirculated air and space temperature sensor modulates control valve on heating coil to maintain operator defined setback setting.

3. OCCUPIED mode (System ON - Time Schedule): SA fan starts and unit operates on full recirculated air to satisfy all operator defined space setup temperature. Space temperatures satisfied: EA fan starts, damper control is enabled (OA and RA dampers proceed to minimum OA position), DX-cooling enabled, auxiliary exhaust fans start.

.4 Whenever ambient conditions permit free cooling, modulate economizer dampers beyond minimum position to maintain space temperature setpoint. For mechanical cooling and heating, set dampers in minimum OA position. On a call for cooling from space temperature sensor, energize unit cooling relay and modulate unit compressor capacity to maintain cooling setpoint. On a call for heating from space temperature sensor, energize unit heating relay and modulate gas heater capacity to maintain setpoint. Low SAT protection (manual reset) shuts down system upon activation and is hardwire interlocked to RA fan starter. Low SAT protection is also alarmed on the BAS.

.5 Provide a deadband between heating and cooling occupied temperature setpoints. Between the setpoints, space temperature floats. Provide a discharge air temperature sensor (SA duct main) for monitoring purposes.

.6 On failure of RTU gas heating, control valve on RHC-1 is modulated to maintain space temperature setpoint. Space temperature sensor downstream of reheat coil monitors discharge air temperature.

8. TERMINAL UNITS

.1 Applicable for VAV boxes.

.2 On a call for cooling space temperature sensor maintains operator defined setpoint by modulating terminal unit primary air damper beyond minimum position.

9. TERMINAL UNITS WITH REHEAT

.1 Applicable for VAV boxes with reheat.

.2 Space temperature sensor maintains operator defined setpoint by modulating terminal unit primary air damper beyond minimum position on a call for cooling with heating control valve on reheat coil closed.

.3 On a call for heating, temperature sensor positions terminal unit primary air damper to 50% of maximum cooling setting and modulates heating control valve on reheat coil to maintain operator defined setpoint. Duct mounted temperature sensor downstream of each reheat coil monitors SA temperature.

10. TERMINAL UNITS WITH AUXILIARY HEATING

.1 Applicable for VAV boxes with reheat and perimeter/panel radiation.

.2 Space temperature sensor maintains operator defined setpoint by modulating terminal unit primary air damper beyond minimum position on a call for cooling with heating control valves on perimeter/panel radiation and reheat coil closed.

.3 On a call for heating, temperature sensor positions terminal unit primary air damper to 50% of maximum cooling setting and modulates heating control valves on heating coil and perimeter/panel radiation in sequence to maintain operator defined setpoint. Valve on perimeter/panel radiation is first in sequence. At 50% full open position of first valve in sequence, start opening of second valve. Duct mounted temperature sensor downstream of each reheat coil monitors supply air temperature.

11. DOMESTIC HOT WATER SYSTEM

.1 Circulator control (ON/OFF) on time schedule. Temperature sensor in main domestic hot water line alarms an operator defined high and low supply water temperature (default 140°F high, 100°F low). This Section to supply sensor well to Section 22 00 00 for installation.

12. CEILING FANS

.1 Each group of fans is enabled/disabled from an operator defined time schedule. Electrical Division will provide a contactor for each group of fans and will wire line and load sides of these contactors. This Section to provide control side wiring of the contactors to enable/disable fan circuits. Co-ordinate with Electrical Division.

.2 A contactor will be provided for fan groups as follows:

- Tech Transportation #156 (F42/F43)
- Gym #152A (F62/F63/F64/F65)
- Gym #152B (F58/F59/F60/F61)
- Cafetorium #150 (F52/F53/F54/F55/F56)
- Stage #168 (F50/F51)
- Theatre Arts #164 (F48/F49)
- Atrium #C107 (F85/F86/F87/F88)

13. ELECTRIC PIPE TRACING

.1 Tracing circuits are enabled/disabled from an operator defined OAT. Design: OAT </= 5°C (41°) circuits enabled, OAT > 5° (41°) circuits disabled.

.2 Division 16 will provide contactors and wire line and load sides of the contactors for the tracing systems. Connect to the control side of these contactors. Provide current sensing relays for system status indication (ON/OFF). Co-ordinate with Division 16 to ensure compatibility.

.3 Refer to division 16 documents for quantity and location of contactors.

14. WASHROOM EXHAUST FANS

.1 Applicable Equipment: Exhaust fan F-57, F-90, F-94 and F-95.

.2 Each fan control (ENABLE/DISABLE) is from an operator defined time schedule. Electrical Division will provide a contactor on each fan circuit and wire line and load sides of each contactor. This Section to interface with the control side of the contactors to enable remote control. Co-ordinate exact requirements with Electrical Division.

.3 Once enabled, fans are controlled from wall switches provided by Electrical Division.

15. CONTROLLED RECEPTACLE POWER (CLASSROOMS)

.1 Receptacle power control (ENABLE/DISABLE) is from an operator defined time schedule. Electrical Division will provide a contactor on each power circuit and wire line and load sides of each contactor. This Section to interface with the control side of the contactors to enable remote BAS control. Refer to Electrical Division documents for location and quantity of contactors. Co-ordinate exact requirements with Electrical Division.

.2 This Section to provide a low voltage momentary contact pushbutton switch, complete with pilot light, for each of 1st floor, 2nd floor receptacles. All switches to be located in the Custodial office. Signal from momentary contact switch overrides the DISABLE mode of operation for the respective receptacles for an operator defined period of time (adjustable).

.3 All conduits and backboxes for low voltage control wiring will be provided by Electrical Division. All low voltage cabling and momentary contact switches, including lamacoid label for each switch, are by this Section.

16. REHEAT COILS AND PERIMETER/PANEL RADIATION

.1 Space temperature sensor modulates heating control valve on a call for heat to maintain an operator defined setpoint. For reheat coils, duct mounted temperature sensor downstream of each reheat coil monitors supply air temperature.

17. LIGHTING CONTROL

.1 Exterior (building, sign and parking lot) lighting control (ON/OFF) is via the BAS from time schedule and input from photo sensor. Electrical Division will provide contactors on each circuit and wire line and load sides of contactors for the lighting systems. Connect to the control side of these contactors. Co-ordinate with Electrical Division to ensure compatibility. Refer to Electrical Division documents for quantity and location of contactors.

.2 Interior (Vestibules, stairs and corridors) lighting control (ON/OFF) is via the BAS from time schedule and input from security system. Electrical Division will provide a terminal panel per floor complete with all required relays for control of each circuit and wire line and load sides of relays for the lighting systems. Connect to the control side of these relays. Co-ordinate with Electrical Division to ensure compatibility. Refer to Electrical Division documents for quantity and location of terminal boxes. This Section shall provide all required controllers, motion detectors, field wiring, terminations and programing. Motion detectors are complete with long range lens, and detector locations shall be determined on site between Controls contractor and Owner's representative. This Section shall provide the following:

- BAS panel located in the Custodial office.
- input from security panel (final connection to BAS panel only) in the Custodial office (DI).
- low voltage momentary contact pushbutton located adjacent to security system keypad in Custodial office (DI).
- low voltage key-operated momentary contact switch located adjacent to security system keypad in main entrance vestibule (DI).
- low voltage momentary contact pushbutton switch complete with pilot light, two per floor (DIx4). All switches to be located in Custodial area.
- lighting relay control (each circuit – DO).
- Ground Floor: Modulation of LED fixtures (AOx10) and status of motion detectors (DIx12).
- Second Floor: Modulation of LED fixtures (AOx5) and status of motion detectors (DIx8).
- Stairwells (total 3): Modulation of LED fixtures (AOx8).

.3 Interior (Classroom) lighting control (ENABLE/DISABLE) is via the BAS from time schedule and occupancy sensor. Electrical Division will provide a terminal panel in the ceiling space of each Classroom complete with all relays required for control of each circuit and will wire line and load sides of relays for the lighting systems. Connect to the control side of these relays. Electrical Division will provide occupancy sensors complete with relays. Coordinate with Electrical Division to ensure compatibility. Refer to Electrical Division documents for quantity and location of terminal panels and

occupancy sensors. This Section to provide the following for each Classroom:

- occupancy sensor interface (DI)
- low voltage momentary contact toggle switch installed adjacent to other light switches in dedicated single gang backbox (DI)
- modulating control for two (2) lighting circuits (AOx2)

.4 All conduits and backboxes for low voltage control wiring will be provided by the Electrical Division. All low voltage cabling and momentary contact switches, including lamacoid label for each switch, is by this Section.

.5 This Section shall provide a photo sensor in a suitable location on each of the four building exposures, including power wiring.

.6 Refer to lighting control schematics on Electrical Documents for additional information. Coordinate all requirements with Owner prior to installation and programming.

18. CABINET HEATERS

.1 Space temperature sensor energizes unit fan on a call for heat to maintain setpoint.

.2 Electrical Division will provide contactors on each circuit and wire line and load sides of each contactor. Interface with the control side of the contactors to enable remote control. Refer to Electrical Division documents for number and location of contactors. Co-ordinate exact requirements with Electrical Division.

19. UNIT HEATERS

.1 For hot water heating units, space temperature sensor energizes unit fan on a call for heat to maintain an operator adjustable setpoint, unless indicated otherwise.

.2 For electric heating units, space temperature sensor energizes unit fan and electric coil on a call for heat to maintain an operator adjustable setpoint, unless indicated otherwise.

.3 Electrical Division will provide a contactor on each unit heater circuit and wire line and load sides of each contactor. This Section to interface with the control side of the contactors to enable remote control. Co-ordinate exact requirements with Electrical Division.

20. MISCELLANEOUS VENTILATION

.1 Applicable for areas ventilated with building air: On a temperature rise above setpoint, space temperature sensor energizes exhaust fan to maintain an operator adjustable setpoint.

.2 Applicable for areas ventilated with outside air (low air capacity). On a temperature rise above setpoint, space temperature sensor energizes exhaust fan and NC low leakage electric motorized damper (24 VAC) at air intake duct to maintain an operator adjustable setpoint. This Section to provide all control wiring. Wiring of fan motors will be by Electrical Division through fan motor starters.

.3 Applicable for areas ventilated with outside air (high air capacity): On a temperature rise above setpoint, space temperature sensor opens low leakage NC motorized dampers (24 VAC) at air intake and exhaust ducts. An auxiliary switch on exhaust damper motor "makes" on damper full-open position which starts respective exhaust fan to maintain an operator adjustable setpoint. This Section to provide all control wiring. Wiring of fan motors will be by Electrical Division through fan motor starters.

21. MISCELLANEOUS HEATING AND VENTILATION

.1 Applicable for areas ventilated with building air: On a temperature rise above cooling setpoint, space temperature sensor energizes exhaust fan to maintain an operator adjustable cooling setpoint. On a temperature drop below heating setpoint, space temperature sensor energizes heater fan (and heater coil in case of electric heat) to maintain an operator adjustable heating setpoint.

.2 Applicable for areas ventilated with outside air (low air capacity): On a temperature rise above setpoint, space temperature sensor energizes exhaust fan and NC low leakage electric motorized damper (24 VAC) at air intake duct to maintain an operator adjustable setpoint. This Section to provide all control wiring. Wiring of fan motors will be by Electrical Division through fan motor starters. On a temperature drop below heating setpoint, space temperature sensor energizes heater fan (and heater coil in case of electric heat) to maintain an operator adjustable heating setpoint.

.3 Applicable for areas ventilated with outside air (high air capacity): On a temperature rise above setpoint, space temperature sensor opens low leakage NC motorized dampers (24 VAC) at air intake and exhaust ducts. An auxiliary switch on exhaust damper motor "makes" on damper full-open position which starts respective exhaust fan to maintain an operator adjustable setpoint. This Section to provide all control wiring. Wiring of fan motors will be by Electrical Division through fan motor starters. On a temperature drop below heating setpoint, space temperature sensor energizes heater fan (and heater coil in case of electric heat) to maintain an operator adjustable heating setpoint.

.4 Provide a deadband between heating and cooling space temperature setpoints. Between the setpoints, space temperature floats.

.5 Electrical Division will provide a contactor on each unit heater circuit and wire line and load sides of each contactor. This Section to interface with the control side of the contactors to enable remote control. Co-ordinate exact requirements with Electrical Division.

22. BY-PASS BOXES

.1 Cooling: Space temperature sensor maintains setpoint by modulating box damper beyond minimum position when SAT is less than space temperature, and towards minimum position when SAT is greater than space temperature. With box damper at fully open position and on a further call for cooling decrease SAT.

.2 Heating: Space temperature sensor maintains setpoint by modulating box damper beyond minimum position when SAT is greater than space temperature, and towards minimum position when SAT is less than space temperature. With box damper at fully open position and on a further call for heat increase SAT.

23. PURGE FANS F-9 , F-10, F-27, F-28, F-30

.1 This Section to provide a key-operated momentary contact type start-switch for respective fan control via the BAS. Locate start-switches as follows:

- Science Rooms: At the instructor's counter adjacent to devices provided by Electrical Division.

.2 Signal from start-switch opens respective low leakage motorized damper (24 VAC) and initiates two operator adjustable software timers. First timer expires (default 10 min.) low leakage damper closes and its operation is disabled until second timer expires (default 60 min.).

.3 An auxiliary switch on low leakage motorized damper motor "makes" on damper full-open position which starts exhaust fan. Power wiring to fan motor will be by Electrical Division through fan motor starters. All other wiring is by this Section.

25. GREASE INTERCEPTORS

.1 Section 22 00 00 will provide dry contact in unit control panel for remote high level alarm. This Section to interface with control panel to provide this high level alarm at the BAS.

26. ACID NEUTRALIZER

.1 Section 22 00 00 will provide dry contact in unit control panel for high pH level alarm. This Section to interface with unit control panel to provide this high-level alarm at the BAS.

27. KITCHEN GENERAL EXHAUST FAN F-39

.1 Exhaust fan is controlled (START/STOP) from an independent operator defined time schedule.

28. KITCHEN HOOD EXHAUST FAN F-38

.1 Exhaust fan is controlled (ENABLE/DISABLE) from an independent operator defined time schedule.

29. MAKE-UP AIR UNIT

.1 Applicable equipment: MAU-1 serving Kitchen.

.2 Unit is hardwire interlocked with respective general exhaust and kitchen hood exhaust fans by Section 23 00 20. Provide BAS control/monitoring as indicated herein and I/O Summary. Refer to "Kitchen Make-Up Air Units" Article in Section 23 00 20 for additional information.

.3 Upon unit start, space temperature sensor modulates the 2-way valve on heating coil and unit compressor in sequence to maintain setpoint. Low SAT protection (manual reset) shuts down system upon activation and is hardwire interlocked to SA fan starter. Low SAT protection is also alarmed on BAS.

30. HUB ROOMS

1. Space temperature sensor monitors room temperature and alarms high limit.

31. SMOKE DAMPERS

1. Smoke damper actuators are complete with auxiliary contacts. This Section to provide a BAS closed damper status alarm for each damper via interface with an auxiliary contact. All wiring, including relay, is by this Section.

32. B.F. WASHROOM EMERGENCY EXHAUST FANS F-91, F-92, F-93, F-83

.1 Fan control (ENABLE/DISABLE) is from the BAS via an operator defined time schedule. Once enabled, fans are controlled from a manual mechanical timers. Manual timers are 24 VAC, 0-30 minute max. range.

.2 Signal from manual mechanical timer opens low leakage NC motorized damper (24 VAC) at associated exhaust air duct. An end switch on exhaust damper "makes" on damper full open position which starts associated exhaust fan. Timer expires, fan stops.

.3 This Section to provide mechanical timers and all control wiring. Fan motor power wiring will be by Electrical Division through fan motor starters.

33. INPUT/OUTPUT SUMMARY

.1 I/O summary is appended hereto (total 12 pages).