

PROJECT: PAUL A. FISHER RENOVATION

CLIENT: HALTON DISTRICT SCHOOL BOARD

PROJECT No.: 24131

DATE: MAY 2025

BINDER: **B** MECHANICAL & ELECTRICAL

ARCHITECT & CONSULTANTS:



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MECHANICAL & ELECTRICAL SPECIFICATIONS

HDSB PAUL A. FISHER PUBLIC SCHOOL INTERIOR RENOVATIONS

2175 CAVENDISH DR., BURLINGTON, ON L7P 3J8

Project #: 24122
Revision 00
May 22, 2025



RDZ ENGINEERS LIMITED
17A - 30 Pennsylvania Avenue
Vaughan, Ontario
L4K 4A5

May 22, 2025	1	ISSUED FOR TENDER	VK/MB	GR
May 5, 2025	0	ISSUED FOR BUILDING PERMIT	VK/MB	GR/TM
Date	Revision	Description	Prep. By	Check By

DIVISION 20

MECHANICAL COMMON WORK RESULTS

Section 20 05 01	Supplementary Mechanical Bid Form
Section 20 05 05	Mechanical Work General Instructions
Section 20 05 10	Basic Mechanical Materials and Methods
Section 20 05 20	Mechanical Vibration Control
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Section 20 05 35	Demolition and Revision Work
Section 20 05 40	Mechanical Work Commissioning
Section 20 05 50	Testing, Adjusting and Balancing
Section 20 05 55	Firestopping and Smoke Seal Systems

DIVISION 21

FIRE PROTECTION

Section 21 13 00	Fire Protection Sprinkler System
Section 21 20 05	Fire Extinguishers

DIVISION 22

PLUMBING

Section 22 11 00	Domestic Water Piping and Specialties
Section 22 13 00	Drainage and Vent Piping and Specialties
Section 22 42 00	Plumbing Fixtures and Fittings

DIVISION 23

HEATING, VENTILATING AND AIR CONDITIONING

Section 23 11 23	Natural Gas Piping System
Section 23 30 00	HVAC Air Distribution
Section 23 34 00	HVAC Fans
Section 23 36 00	Air Terminals
Section 23 70 00	Rooftop Units
Section 23 83 05	Electric Heaters

DIVISION 25

INTEGRATED AUTOMATION

Section 25 05 01	Supplementary Controls Bid Form
Section 25 09 23	Direct Digital Control System

END OF SECTION

PROJECT NAME: HDSB Paul A. Fisher Public School
Interior Renovations

RDZ PROJECT NUMBER: 24122

Following Supplementary Mechanical Bid Form is submitted by:

.....
(Bidding Company)

.....
(Street Address or P. O. Box No.)

.....
(City, Province and Postal Code)

Dated And which is an integral part of Bid Form.

In accordance with Instructions to Bidders, we provide the Supplementary Mechanical Bid Form. We understand that the information provided to be considered an integral part of Bid Form and is to be completed in full.

Where instructions are not provided, submit Supplementary Mechanical Bid Form by time of Bid closing, via e-mail addressed to:

RDZ Engineers Ltd.
Attention : Giovanni Rea
e-mail : Giovanni@rdzeng.ca

Supplementary Bid Form Signature:

.....
(Signature of Authorized Representative)

.....
(Print Name)

.....
(Title)

LIST OF MANUFACTURERS/SUPPLIERS

We submit, herein, typed or neatly printed, the names of the manufacturers upon whose products our Bid Price is based and which we will supply. If no name is indicated, or if name identified is not listed in issued documents, or if more than one name is indicated for a particular product, we will if requested, provide the base specified manufacturer's product. Where products are named in the specifications with only one (1) manufacturer/supplier, or are not listed herein, we are also prepared to provide the base specified named product. We will provide Canadian manufactured products if costs and quality are similar.

We understand that the first manufacturer specified for any product is the manufacturer upon whose product the design is based, and that the other manufacturers specified for a particular product are manufacturers acceptable to the Owner and whose product produces equivalent quality, performance and size. We further understand if we indicate a manufacturer other than the manufacturer whose product is the basis of the design, we are responsible for ensuring that the product supplied is equivalent in quality, performance and size to the base design product, and that any additional costs incurred as a result of use of such products will be borne by us. Acceptance of non-base specified manufacturers with respect to their equivalency shall be as sole discretion of Consultant.

We also acknowledge that failure to submit this list as specified or failure to submit within time defined may result in provision of base specified manufacturer's product, at discretion of Consultant.

SECTION	PRODUCT	MANUFACTURER/SUPPLIER & CATALOGUE NUMBER
20 05 20	Mechanical Vibration Control	
20 05 25	Mechanical Insulation	
20 05 55	Firestopping and Smoke Seal Systems	
22 42 00	Plumbing Fixtures	
23 30 00	Fire/Smoke Dampers	
23 30 00	Grilles & Diffusers	
23 30 00	Louvres	
23 30 00	Range Hood	
23 30 00	Dryer Booster Fan	
23 30 00	Silencers	
23 34 00	Roof Mounted Exhaust Fans	
23 34 00	Inline Exhaust Fan	
23 36 00	VAV boxes	
23 70 00	Packaged Rooftop Unit	
23 83 05	Electric Heaters	

END OF DOCUMENT

1 GENERAL

1.01 REFERENCES

- .1 Architect's front end documents are a part of this Section.

1.02 APPLICATION

- .1 This Section specifies requirements that are common to Mechanical Divisions work Sections and it is a supplement to each Section and is to be read accordingly. Where requirements of this Section contradict requirements of front end documents, conditions of front end documents to take precedence.
- .2 Be responsible for advising product vendors of requirements of this Section.

1.03 DEFINITIONS

- .1 "concealed" – means hidden from normal sight in furred spaces, shafts, ceiling spaces, walls and partitions.
- .2 "exposed" – means work normally visible, including work in equipment rooms, service tunnels, and similar spaces.
- .3 "finished" - means when in description of any area or part of an area or a product which receives a finish such as paint, or in case of a product may be factory finished.
- .4 "provision" or "provide" (and tenses of "provide") – means supply and install complete.
- .5 "install" (and tenses of "install") – means secure in position, connect complete, test, adjust, verify and certify.
- .6 "supply" – means to procure, arrange for delivery to site, inspect, accept delivery and administer supply of products; distribute to areas; and include manufacturer's supply of any special materials, standard on site testing, initial start-up, programming, basic commissioning, warranties and manufacturers' assistance to Contractor.
- .7 "delete" or "remove" (and tenses of "delete" or "remove") – means to disconnect, make safe, and remove obsolete materials; patch and repair/finish surfaces to match adjoining similar construction; include for associated re-programming of systems and/or change of documentation identifications to suit deletions, and properly dispose of deleted products off site unless otherwise instructed by Owner and reviewed with Consultant.
- .8 "barrier-free" – means when applied to a building and its facilities, that building and its facilities can be approached, entered and used by persons with physical or sensory disabilities in accordance with requirements of local governing building code.
- .9 "BAS" – means building automation system; "BMS" – means building management system; "FMS" – means facility management system; and "DDC" means direct digital controls; references to "BAS", "BMS", "FMS" and "DDC" generally mean same.
- .10 "governing authority" and/or "authority having jurisdiction" and/or "regulatory authority" and/or "Municipal authority" – means government departments, agencies, standards, rules and regulations that apply to and govern work and to which work must adhere.

- .11 "OSHA" and "OHSA" – stands for Occupational Safety and Health Administration and Occupational Health and Safety Act, and wherever either one is used, they are to be read to mean local governing occupational health and safety regulations that apply to and govern work and to which work must adhere, regardless if Project falls within either authority's jurisdiction.
- .12 "Mechanical Divisions" – refers to Divisions 20, 21, 22, 23, 25 and other Divisions as specifically noted, and which work as defined in Specifications and/or on drawings is responsibility of Mechanical Contractor, unless otherwise noted.
- .13 "Electrical Divisions" – refers to Divisions 26, 27, 28 and other Divisions as specifically noted, and which work as defined in Specifications and/or on drawings is responsibility of Electrical Contractor, unless otherwise noted.
- .14 "Consultant" – means person, firm or corporation identified as such in Agreement or Documents, and is licensed to practice in Place of the Work, and has been appointed by Owner to act for Owner in a professional capacity in relation to the Work.
- .15 Wherever words "indicated", "shown", "noted", "listed", or similar words or phrases are used in Contract Documents they are understood, unless otherwise defined, to mean product referred to is "indicated", "shown", "listed", or "noted" on Contract Documents.
- .16 Wherever words "reviewed", "satisfactory", "as directed", "submit", or similar words or phrases are used in Contract Documents they are understood, unless otherwise defined, to mean that work or product referred to is "reviewed by", "to the satisfaction of", "submitted to", etc., Consultant.

1.04 DOCUMENTS

- .1 Documents for bidding include but are not limited to issued Drawings, Specifications and Addenda.
- .2 Specification is arranged in accordance with CSI/CSC 50 Division Sections MasterFormat.
- .3 Drawings and Specifications are portions of Contract Documents and identify labour, products and services necessary for performance of work and form a basis for determining pricing. They are intended to be cooperative. Perform work that is shown, specified, or reasonably implied on the drawings but not mentioned in Specification, or vice-versa, as though fully covered by both.
- .4 Review Drawings and Specifications in conjunction with documents of other Divisions and, where applicable, Code Consultant's report.
- .5 Unless otherwise specifically noted in Specifications and/or on Drawings, Sections of Mechanical Divisions are not intended to delegate functions nor to delegate work and supply of materials to any specific trade, but rather to generally designate a basic unit of work, and Sections are to be read as a whole.
- .6 Drawings are performance drawings, diagrammatic, and show approximate locations of equipment and connecting services. Any information regarding accurate measurement of building is to be taken on site. Do not scale Drawings, and do not use Drawings for prefabrication work.

- .7 Drawings are intended to convey the scope of work and do not show architectural and structural details. Provide, at your cost, offsets, fittings, transformations and similar products required as a result of obstructions and other architectural and/or structural details but not shown on Drawings.
- .8 Locations of equipment and materials shown may be altered, when reviewed by Consultant, to meet requirements of equipment and/or materials, other equipment or systems being installed, and of building, all at no additional cost to Contract.
- .9 Specification does not generally indicate specific number of items or amounts of material required. Specification is intended to provide product data and installation requirements. Refer to schedules, Drawings (layouts, riser diagrams, schematics, details) and Specification to provide correct quantities. Singular may be read as plural and vice versa.
- .10 Starter/motor control centre (MCC)/variable frequency drive (VFD) schedule drawings are both mechanical and electrical, and apply to work of Mechanical Divisions and Electrical Divisions. Be responsible for reviewing starter, MCC, VFD, and motor specification requirements prior to Bid submission. Confirm and coordinate exact scope of work and responsibility of work between Mechanical Divisions and Electrical Divisions.
- .11 Drawings and Specifications have been prepared solely for use by party with whom Consultant has entered into a contract and there are no representations of any kind made by Consultant to any other party.
- .12 In the case of discrepancies between the drawings and specifications, documents will govern in order specified in "General Conditions", however, when scale and date of drawings are same, or where discrepancy exists within specification, most costly arrangement will take precedence.

1.05 METRIC AND IMPERIAL MEASUREMENTS

- .1 Generally, both metric and imperial units of measurement are given in Sections of Specification governed by this section. Measurement conversions may be generally "soft" and rounded off. Confirm exact measurements based on application. Where measurements are related to installation and onsite applications, confirm issued document measurements with applicable local code requirements, and/or as applicable, make accurate measurements onsite. Where significant discrepancies are found, immediately notify Consultant for direction.

1.06 EXAMINATION OF DOCUMENTS AND SITE

- .1 Carefully examine Documents and visit site to determine and review existing site conditions that will or may affect work, and include for such conditions in Bid Price.
- .2 Report to Consultant, prior to Bid Submittal, any existing site condition that will or may affect performance of work as per Documents. Failure to do so will not be grounds for additional costs.
- .3 Upon finding discrepancies in, or omissions from Documents, or having doubt as to their meaning or intent, immediately notify Consultant, in writing.

1.07 WORK STANDARDS

- .1 Where any code, regulation, bylaw, standard, contract form, manual, printed instruction, and installation and application instruction is quoted it means, unless otherwise specifically noted, latest published edition at time of submission of Bids adopted by and enforced by local governing authorities having jurisdiction. Include for compliance with revisions, bulletins, supplementary standards or amendments issued by local governing authorities.
- .2 Where regulatory codes, standards and regulations are at variance with Drawings and Specification, more stringent requirement will apply unless otherwise directed by Owner and reviewed with Consultant.
- .3 Supplementary mandatory specification and requirements to be used in conjunction with project include but are not limited to following:
 - .1 Air-Conditioning, Heating and Refrigeration Institute (AHRI);
 - .2 Air Movement and Control Association (AMCA);
 - .3 American Iron and Steel Institute (AISI);
 - .4 American National Standards Institute (ANSI);
 - .5 American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc., (ASHRAE);
 - .6 American Society of Mechanical Engineers (ASME);
 - .7 American Society of Testing and Materials (ASTM);
 - .8 American Water Works Association (AWWA);
 - .9 Associated Air Balance Council (AABC);
 - .10 Building Industry Consulting Services, International (BICSI);
 - .11 Canadian Gas Association (CGA);
 - .12 Canadian General Standards Board (CGSB);
 - .13 Canadian Standards Association (CSA);
 - .14 Electrical and Electronic Manufacturers Association of Canada (EEMAC);
 - .15 Electrical Safety Authority (ESA);
 - .16 Electronic Industries Association (EIA);
 - .17 Factory Mutual Systems (FM);
 - .18 Illuminating Engineering Society (IES);
 - .19 Institute of Electrical and Electronic Engineers (IEEE);

- .20 International Standards Organization (ISO);
 - .21 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS);
 - .22 National Building Code of Canada (NBC);
 - .23 National Electrical Manufacturers Association (NEMA);
 - .24 National Environmental Balancing Bureau (NEBB);
 - .25 National Fire Protection Association (NFPA);
 - .26 National Standards of Canada;
 - .27 NSF International;
 - .28 Occupational Health and Safety Act (OHSA);
 - .29 Ontario Building Code (OBC);
 - .30 Ontario Electrical Safety Code (OESC);
 - .31 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA);
 - .32 Technical Standards and Safety Authority (TSSA);
 - .33 Thermal Insulation Association of Canada (TIAC);
 - .34 Underwriters' Laboratories of Canada (ULC);
 - .35 Workplace Hazardous Materials Information System (WHMIS);
 - .36 Material Safety Data Sheets by product manufacturers;
 - .37 local utility inspection permits;
 - .38 Codes, standards, and regulations of local governing authorities having jurisdiction;
 - .39 additional codes and standards listed in Trade Sections;
 - .40 Owner's standards.
- .4 Provide applicable requirements for barrier free access in accordance with latest edition of local governing building code.
 - .5 Where any governing Code, Regulation, or Standard requires preparation and submission of special details or drawings for review they are to be prepared and submitted to appropriate authorities. Be responsible for costs associated with these submittals.
 - .6 Unless otherwise specified, install equipment in accordance with equipment manufacturer's recommendations and instructions, and requirements of governing Codes, Standards, and Regulations. Governing Codes, Standards, and Regulations take precedence over manufacturer's instructions. Notify Consultant in writing of conflicts between Contract Documents and manufacturer's instructions.

- .7 Work is to be performed by journeyperson tradesmen who perform only work that their certificates permit, or by apprentice tradesmen under direct on site supervision of experienced journeyperson tradesman. Journeyperson to apprentice ratio is not to exceed ratio determined by the Board as stated in Ontario College of Trades and Apprenticeship Act or local equivalent governing body in Place of the Work.
- .8 Journeyperson tradesmen are to have a copy of valid trade certificates available at site for review with Consultant at any time.
- .9 Experienced and qualified superintendent is to be on-site at times when work is being performed.
- .10 Protect existing areas above, below and adjacent areas of Work from any debris, noise, or interruptions to existing services to satisfaction of Owner and reviewed with Consultant. Maintain in operation existing services to these areas to allow Owner to continue use of these areas. If services that are required to be maintained run through areas of renovations, provide necessary protection to services or reroute, in coordination with Owner and Consultant. Include for required premium time work to meet these requirements.
- .11 Work being performed within occupied spaces and work affecting surfaces adjacent to occupied spaces may need to be performed after regular business hours. For areas where spaces are used by Owner on a 24 hours basis or over various hours, coordinate hours of work with Owner on a regular basis to suit Owner's schedule. Execute work at times confirmed with and agreed to by Owner and reviewed with Consultant, so as not to inconvenience Owner's occupation or in any way hinder Owner's use of building. Include for required premium time work to meet these requirements.
- .12 Coordinate work inspection reviews and approvals with governing inspection department to ensure construction schedule is not delayed. Be responsible for prompt notification of deficiencies to Consultant and submission of reports and certificates to Consultant.
- .13 Properly protect equipment and materials on site from damage and defacement due to elements and work of trades, to satisfaction of Owner and reviewed with Consultant. Equipment and materials are to be in new condition upon Substantial Performance of the Work.
- .14 Mechanical piping system work, including equipment, must comply in all respects with requirements of local technical standards authorities and CSA B51, Boiler, Pressure Vessels and Pressure Piping Code. Where required, mechanical work products are to bear a CRN number.
- .15 Electrical items associated with mechanical equipment are to be certified and bear stamp or seal of a recognized testing agency such as CSA, UL, ULC, ETL, etc., or bear a stamp to indicate special electrical utility approval.

1.08 PERMITS, CERTIFICATES, APPROVALS AND FEES

- .1 Contact and confirm with local authorities having jurisdiction including utility providers, requirements for approvals from such authorities. Obtain and pay for permits, certificates, and approvals required to complete Work.

- .2 Be responsible for ensuring that authorities having jurisdiction which require on-site inspection of work, have ample notification to perform inspection, with sufficient lead time to correct deficiencies in a manner that will not impede schedule of completion of Work. If any defect, deficiency or non-compliant is found in work by inspection, be responsible for costs of such inspection, including any related expenses, making good and return to site, until work is passed by governing authorities.
- .3 Obtain and submit to Consultant, approval/inspection certificates issued by governing authorities to confirm that Work as installed is in accordance with rules and regulations of local governing authorities and are acceptable.
- .4 Include in each copy of operating and maintenance instruction manuals, copies of approvals and inspection certificates issued by regulatory authorities.

1.09 REQUIREMENTS FOR CONTRACTOR RETAINED ENGINEERS

- .1 Professional engineers retained to perform consulting services with regard to Project work, i.e. seismic engineer, fire protection engineer or structural engineer, are to be members in good standing with local Association of Professional Engineers, and are to carry and pay for errors and omissions professional liability insurance in compliance with requirements of governing authorities in Place of the Work.
- .2 Retained engineer's professional liability insurance is to protect Contractor's consultants and their respective servants, agents, and employees against any loss or damage resulting from professional services rendered by aforementioned consultants and their respective servants, agents, and employees in regards to the Work of this Contract.
- .3 Unless otherwise specified in Division 00 or 01, liability insurance requirements are as follows:
 - .1 coverage is to be a minimum of \$1,000,000.00 CDN inclusive of any one occurrence;
 - .2 insurance policy is not to be cancelled or changed in any way without insurer giving Owner minimum thirty days written notice;
 - .3 liability insurance is to be obtained from an insurer registered and licensed to underwrite such insurance in the Place of the Work;
 - .4 retained consultants are to ascertain that sub-consultants employed by them carry insurance in the form and limits specified above;
 - .5 evidence of the required liability insurance in such form as may be required is to be issued to Owner, Owner's Consultant, and Municipal Authorities as required prior to commencement of aforementioned consultant's services.

1.10 WORKPLACE SAFETY

- .1 Comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage and disposal of hazardous materials. Submit WHMIS MSDS (Material Safety Data Sheets) for products where required, and maintain one copy at site in a visible and accessible location available to personnel.

- .2 Comply with requirements of Occupational Health and Safety Act and other regulations pertaining to health and safety, including worker's compensation/insurance board and fall protection regulations. When working in confined spaces, comply with requirements of Occupational Health and Safety Act - Ontario Regulation 632, "Confined Spaces" and any other applicable Ministry of Labour requirements.
- .3 If at any time during course of existing building work, hazardous materials other than those identified in Documents and pertaining to Project Scope of Work, are encountered or suspected that were not identified as being present and which specific instructions in handling of such materials were not given, cease work in area in question and immediately notify Consultant. Comply with local governing regulations with regards to working in areas suspected of containing hazardous materials. Do not resume work in affected area without approval from Owner and reviewed with Consultant.

1.11 PLANNING AND LAYOUT OF WORK

- .1 Base installation layout, design, terminations, and supply of accessories, on Contract Documents with specific coordination with reviewed shop drawings.
- .2 Plan, coordinate, and establish exact locations and routing of services with affected trades prior to installation such that services clear each other as well as other obstructions. Generally, order of right of way for services to be as follows:
 - .1 piping requiring uniform pitch;
 - .2 piping 100 mm (4") dia. and larger;
 - .3 large ducts (main runs);
 - .4 cable tray and bus duct;
 - .5 conduit 100 mm (4") dia. and larger;
 - .6 piping less than 100 mm (4") dia.;
 - .7 smaller branch ductwork;
 - .8 conduit less than 100 mm (4") dia..
- .3 Unless otherwise shown or specified, conceal work in finished areas, and conceal work in partially finished and/or unfinished areas to extent made possible by the area construction. Install services as high as possible to conserve headroom and/or ceiling space. Notify Consultant where headroom or ceiling space appears to be inadequate prior to installation of work.
- .4 Do not use Contract Drawing measurements for prefabrication and layout of piping, sheet metal work and such other work. Locations and routing are to generally be in accordance with Contract Drawings, however, prepare layout drawings for such work. Use established bench marks for both horizontal and vertical measurements. Confirm inverts, coordinate with and make allowances for work of other trades. Accurately layout work, and be entirely responsible for work installed in accordance with layout drawings. Where any invert, grade, or size is at variance with Contract Drawings, notify Consultant prior to proceeding with work.

- .5 Prepare plan and interference drawings (at a minimum drawing scale of 1:50 or $\frac{1}{4}"=1' 0"$) of work for coordination with each trade Contractor. Arrange for preparation of detailed section drawings of ceiling spaces of corridors and any other congested areas. Sections are to be cross referenced with plan drawings so that trades may make use of section drawings. Section drawings to indicate lateral and elevation dimensions of major services within ceiling space. Lateral dimensions are to be from grid lines and elevations from top of floor slab. Obtain from Consultant, engineering drawings for this use. Contractors' interference drawings are to be distributed among other Trade Contractors. Submit drawings to Consultant for review. Failure of General Contractor to prepare and coordinate overall interface drawings of trades does not relieve respective Division Contractor of responsibility to ensure that work is properly planned and coordinated.
- .6 Carry out alterations in arrangement of work that has been installed without proper coordination, study, and review, even if in accordance with Contract Documents, in order to conceal work behind finishes, or to allow installation of other work, without additional cost. In addition, make necessary alterations in other work required by such alterations, without additional cost.
- .7 Shut-off valves, balancing devices, air vents, equipment and similar products, particularly such products located above suspended ceilings must be located for easy access for servicing and/or removal. Products which do not meet this location requirement are to be relocated to an accessible location at no additional cost.
- .8 Be responsible for making necessary changes, at no additional cost, to accommodate structural and building conditions that were missed due to lack of coordination.

1.12 COORDINATION OF WORK

- .1 Review Contract Documents and coordinate work with work of each trade. Coordination requirements are to include but not be limited to following:
 - .1 requirements for openings, sleeves, inserts and other hardware necessary for installation of work;
 - .2 concrete work such as housekeeping pads, sumps, bases, etc., required for work, and including required dimensions, operating weight of equipment, location, etc.;
 - .3 depth and routing of excavation required for work, and requirements for bedding and backfill;
 - .4 wiring work required for equipment and systems but not specified to be done as part of mechanical work, including termination points, wiring type and size, and any other requirements.
- .2 Ensure materials and equipment are delivered to site at proper time and in such assemblies and sizes so as to enter into building and be moved into spaces where they are to be located without difficulty.
- .3 Wherever possible, coordinate equipment deliveries with manufacturers and/or suppliers so equipment is delivered to site when it is required, or so it can be stored within building, subject to available space as confirmed with Owner and reviewed with Owner, and protected from elements.

- .4 Ensure proper access and service clearances are maintained around equipment, and, where applicable, access space for future equipment removal or replacement is not impeded. Comply with code requirements with regards to access space provision around equipment. Remove and replace any equipment which does not meet this requirement.
- .5 Where work is to be integrated, or is to be installed in close proximity with work of other trades, coordinate work prior to and during installation.

1.13 PRODUCTS

- .1 Be responsible for ordering of products (equipment and materials) in a timely manner in order to meet project-scheduling timelines. Failure to order products to allow manufacturers sufficient production/delivery time to meet project-scheduling timelines is an unacceptable reason to request for other suppliers or substitutions.
- .2 Provide Canadian manufactured products wherever possible or required and when quality and performance is obtainable at a competitive price. Products are to be supplied from manufacturer's authorized Canadian representative, unless otherwise noted. Unless otherwise specified, products are to be new and are to comply with applicable respective Canadian standards. References to UL listings of products to include requirements that products are to be also Underwriters Laboratories of Canada (ULC) listed for use in Canada. Products are to meet or exceed latest ANSI/ASHRAE/IES 90.1 standards, as applicable. Do not supply any products containing asbestos materials or PCB materials.
- .3 Systems and equipment of this Project are to be "State of the Art" and be most recent and up to date series/version of product that is available at time of shop drawing review process. Products that have been stored or "on shelf" for an extended period of time will not be accepted. Software is to be of latest version available and be provided with updates available at time of shop drawing review process. Systems are to be designed such that its software is backwards compatible. Future upgrades are not to require any hardware replacements or additions to utilize latest software.
- .4 Products scheduled and/or specified have been selected to establish a performance and quality standard, and, in some instances, a dimensional standard. In most cases, base specified manufacturers are stated for any product specified by manufacturer's name and model number. Where acceptable manufacturers are listed, first name listed is base specified company. Bid Price may be based on products supplied by any of manufacturers' base specified or named as acceptable for particular product. If acceptable manufacturers are not stated for a particular product, base Bid Price on product supplied by base specified manufacturer.
- .5 Documents have been prepared based on product available at time of Bidding. If, after award of Contract, and if successful manufacturer can no longer supply a product that meets base specifications, notify Consultant immediately. Be responsible for obtaining other manufacturers product that complies with base specified performance and criteria and meets project timelines. Proposed products are subject to review and consideration by Consultant and are considered as substitutions subject to a credit to Contract. In addition, if such products require modifications to room spaces, mechanical systems, electrical systems, etc., include required changes. Such changes are to be submitted in detail to Consultant for review and consideration for acceptance. There will be no increase in Contract Price for revisions. Above conditions supplement and are not to supersede any specification conditions with regards to substitutions or failure to supply product as per issued documents.

- .6 Listing of a product as "acceptable" does not imply automatic acceptance by Consultant and/or Owner. It is responsibility of Contractor to ensure that any price quotations received and submittals made are for products that meet or exceed specifications included herein.
- .7 If products supplied by a manufacturer named as acceptable are used in lieu of base specified manufacturer, be responsible for ensuring that they are equivalent in performance and operating characteristics (including energy consumption if applicable) to base specified products. It is understood that any additional costs (i.e. for larger starters, larger feeders, additional spaces, etc.), and changes to associated or adjacent work resulting from provision of product supplied by a manufacturer other than base specified manufacturer, is included in Bid Price. In addition, in equipment spaces where equipment named as acceptable is used in lieu of base specified equipment and dimensions of such equipment differs from base specified equipment, prepare and submit for review accurately dimensioned layouts of rooms affected, identifying architectural and structural elements, systems and equipment to prove that equipment in room will fit properly meeting design intent. There will be no increase in Contract Price for revisions.
- .8 In addition to manufacturer's products base specified or named as acceptable, other manufacturers of products may be proposed as substitutions to Consultant for review and consideration for acceptance, listing in each case a corresponding credit for each substitution proposed. However, base Bid Price on products base specified or named as acceptable. Certify in writing to Consultant that proposed substitution meets space, power, design, energy consumption, and other requirements of base specified or acceptable product. It is understood that there will be no increase in Contract Price by reason of any changes to associated equipment, mechanically, electrically, structurally or architecturally, required by acceptance of proposed substitution. Consultant has sole discretion in accepting any such proposed substitution of product. Indicate any proposed substitutions in areas provided on Bid Form. Do not order such products until they are accepted in writing by Consultant.
- .9 Indicate in Supplementary Mechanical Bid Form, names of manufacturers for proposed products to be supplied, and which were based specified or scheduled with a manufacturer's name. Names of proposed manufacturers on list must be one of names stated as acceptable for particular products, unless prior approval from Owner has been given for use of products by other manufacturers. Submit to Consultant for review as directed.
- .10 Where products are listed as "or approved equal", certify in writing that product to be used in lieu of base specified product, at least meets space, power, design, energy consumption, and other requirements of base specified product and is equivalent or better than base specified product. When requested by Consultant, provide full design detail drawings and specifications of proposed products. Acceptance of these "or approved equal" products is at sole discretion of Consultant. It is understood that there will be no increase in Contract Price by reason of any changes to associated equipment, mechanically, electrically, structurally or architecturally, required by acceptance of approved equal product. There must be no increase in Contract price due to Consultant's rejection of proposed equivalent product.
- .11 Whenever use of product other than base specified product is being supplied, ensure corresponding certifications and product information (detailed catalogue and engineering data, fabrication information and performance characteristics) are submitted to Consultant for review. Failure of submission of these documents to Consultant in a timely manner to allow for review will result in base specified product to be supplied at Consultant's discretion, at no additional cost to Contract.

- .12 Products supplied by a manufacturer/supplier other than a manufacturer listed as acceptable may be considered for acceptance by Consultant if requested in writing with full product documentation submitted, a minimum of 10 working days prior to Bid closing date.
- .13 Any proposed changes initiated by Contractor after award of Contract may be considered by Consultant at Consultant's discretion, with any additional costs for such changes if accepted by Owner and reviewed with Consultant, and costs for review, to be borne by Contractor.
- .14 Whenever use of product other than based specified products or named as acceptable is being supplied, time for process of submission of other products and Consultant's review of products will not alter contract time or delay work schedule.

1.14 SHOP DRAWINGS

- .1 At start-up meeting, review with Consultant products to be included in shop drawing submission. Prepare and submit list of products to Consultant for review.
- .2 Submit electronic copies of shop drawings unless otherwise directed by Consultant. Coordinate exact requirements with Consultant.
- .3 Submit for review, drawings showing detail design, construction, and performance of equipment and materials as requested in Specification. Submit shop drawings to Consultant for review prior to ordering and delivery of product to site. Include minimally for preparation and submission of following, as applicable:
 - .1 product literature cuts;
 - .2 equipment data sheets;
 - .3 equipment dimension drawings;
 - .4 system block diagrams;
 - .5 sequence of operation;
 - .6 connection wiring schematic diagrams;
 - .7 functionality with integrated systems.
- .4 Each shop drawing or product data sheet is to be properly identified with project name and product drawing or specification reference. Shop drawing or product data sheet dimensions are to match dimension type on drawings.
- .5 Where any item of equipment is required by Code or Standard or By-Law to meet a specific energy efficiency level, or any other specific requirement, ensure this requirement is clearly indicated on submission.
- .6 Ensure proposed products meet each requirement of Project. Endorse each shop drawing copy "CERTIFIED TO BE IN ACCORDANCE WITH ALL REQUIREMENTS". Include company name, submittal date, and sign each copy. Shop drawings that are received and are not endorsed, dated and signed will be returned to be resubmitted.

- .7 Consultant to review shop drawings and indicate review status by stamping shop drawing copies as follows:

- .1 "REVIEWED" or "REVIEWED AS NOTED" (appropriately marked) – If Consultant's review of shop drawing is final, Consultant to stamp shop drawing;
- .2 "RETURNED FOR CORRECTION" – If Consultant's review of shop drawing is not final, Consultant to stamp shop drawing as stated above, mark submission with comments, and return submission. Revise shop drawing in accordance with Consultant's notations and resubmit.

- .8 Following is to be read in conjunction with wording on Consultant's shop drawing review stamp applied to each and every shop drawing or product data sheet submitted:

"THIS REVIEW BY CONSULTANT IS FOR SOLE PURPOSE OF ASCERTAINING CONFORMANCE WITH GENERAL DESIGN CONCEPT. THIS REVIEW DOES NOT MEAN THAT CONSULTANT APPROVES DETAILED DESIGN INHERENT IN SHOP DRAWINGS, RESPONSIBILITY FOR WHICH REMAINS WITH CONTRACTOR. CONSULTANT'S REVIEW DOES NOT RELIEVE CONTRACTOR OF RESPONSIBILITY FOR ERRORS OR OMISSIONS IN SHOP DRAWINGS OR OF CONTRACTOR'S RESPONSIBILITY FOR MEETING REQUIREMENTS OF CONTRACT DOCUMENTS. BE RESPONSIBLE FOR DIMENSIONS TO BE CONFIRMED AND CORRELATED AT JOB SITE, FOR INFORMATION THAT PERTAINS SOLELY TO FABRICATION PROCESSES OR TO TECHNIQUES OF CONSTRUCTION AND INSTALLATION, AND FOR COORDINATION OF WORK OF SUB-TRADES."

- .9 Submit each system and each major component as separate shop drawing submissions. Submit together, shop drawings for common devices such as devices of each system are to be submitted together.
- .10 Obtain shop drawings for submission from product manufacturer's authorized representatives and supplemented with additional items specified herein.
- .11 Do not order product until respective shop drawing review process has been properly reviewed with Consultant.
- .12 Where extended warranties are specified for equipment items, submit specified extended warranty with shop drawing submittal.

1.15 ENGINEERED SUBMITTALS

- .1 Submittals for items required to be sealed by a professional engineer (engineered) are to be duly prepared, sealed, and signed under direct control and supervision of a qualified professional engineer licensed in jurisdiction of the work. Professional engineer is to conform to requirements specified in this Section in article entitled Requirements for Contractor Retained Engineers.
- .2 Engineered submittals are to include, but not be limited to, following:
 - .1 complete CAD layout drawings indicating equipment, piping schematic, pipe routing and sizing, zones, devices, wiring schematics, and any other pertinent data;
 - .2 listing of design data used to determine system layout and sizing;

- .3 complete copies of design calculations and listing of design data used in preparing calculations;
 - .4 list detailing standards, codes, regulations, etc. adhered to when designing system;
 - .5 items as noted in other Sections of the Specification.
- .3 Professional engineer responsible for engineered submittals is to perform periodic field reviews, including review of associated mock-ups where applicable, at locations wherever work as described by engineered submittal is in progress, during fabrication and installation of such work, and submit a field review report after each visit. Submit field review reports to Consultant and authorities having jurisdiction as required.
 - .4 Field reviews are to be at intervals as necessary and appropriate to progress of work described by engineered submittal to allow engineer to be familiar with progress and quality of such work and to determine if work is proceeding in general conformity with Contract Documents including reviewed shop drawings and design calculations.
 - .5 Upon completion of work as described by engineered submittal, professional engineer responsible for preparation of engineered submittal and for performing periodic field reviews is to prepare and submit to Consultant and, if applicable, authorities having jurisdiction, a letter certifying that work has been supplied and installed in accordance with requirements of Contract Documents, authorities having jurisdiction and engineered submittal.

1.16 EQUIPMENT LOADS

- .1 Supply equipment loads (self-weight, operating weight, housekeeping pad, inertia pads, etc.) to Consultant, via shop drawing submissions, prior to construction.
- .2 Where given choice of specific equipment, actual weight, location and method of support of equipment may differ from those assumed by Consultant for base design. Back-check equipment loads, location, and supports, and include necessary accommodations.
- .3 Where supporting structure consists of structural steel framing, it is imperative that equipment loads, location, and method of support be confirmed prior to fabrication of structural steel. Review locations of equipment with Consultant prior to construction.

1.17 OPENINGS

- .1 Supply opening sizes and locations to Consultant to allow verification of their effect on design, and for inclusion on structural drawings where appropriate.
- .2 No openings are permitted through completed structure without written approval from Owner and reviewed with Consultant. Show required openings on a copy of structural drawings. Identify exact locations, elevations, and size of proposed openings and submit to Consultant for review, well in advance of doing work.
- .3 Prior to leaving site at end of each day, walk through areas of work and check for any openings, penetrations, holes, and/or voids created under scope of work of project, and ensure that any openings created under scope of work have been closed off, fire-stopped and smoke-sealed. Unless otherwise directed by Owner and reviewed with Consultant, do not leave any openings unprotected and unfinished overnight.

1.18 SCAFFOLDING, HOISTING AND RIGGING

- .1 Unless otherwise specified or directed, supply, erect and operate scaffolding, rigging, hoisting equipment and associated hardware required for work, and subject to approval from Owner and reviewed with Consultant.
- .2 Use scaffolds in such a manner as to interfere as little as possible with work of other trades.
- .3 Do not place major scaffolding/hoisting equipment loads on any portion of structure without approval from Owner and reviewed with Consultant. No supports, clips, brackets or similar devices are to be welded, bolted or otherwise affixed to any finished member or surface without approval from Owner and review with Consultant.
- .4 Immediately remove from site scaffolding, rigging and hoisting equipment when no longer required.

1.19 CHANGES IN THE WORK

- .1 Whenever Consultant proposes in writing to make a change or revision to design, arrangement, quantity or type of work from that required by Contract Documents, prepare and submit to Consultant for review, a quotation detailing proposed cost for executing change or revision.
- .2 Quotation is to be a detailed and itemized estimate of product, labour, and equipment costs associated with change or revision, plus overhead and profit percentages and applicable taxes and duties.
- .3 If overhead and profit percentages are not specified in Division 00 or 01, but allowable under Contract as reviewed with Consultant prior to contract signing, then allowable maximum percentages for overhead and profit are as per HDSB's standards in front end documents (Article 8.1).
- .4 Unless otherwise specified in Divisions 00 or 01, following additional requirements apply to all quotations submitted:
 - .1 when change or revision involves deleted work as well as additional work, cost of deleted work (less overhead and profit percentages but including taxes and duties) is to be subtracted from cost of additional work before overhead and profit percentages are applied to additional work;
 - .2 material costs are not to exceed those published in local estimating price guides;
 - .3 mechanical material labour unit costs are to be in accordance with Mechanical Contractors Association of America Labour Estimating Manual, less 25%;
 - .4 electrical material labour unit costs are to be in accordance with National Electrical Contractors Association Manual of Labour Units at difficult level, less 25%;
 - .5 costs for journeyman and apprentice labour must not exceed prevailing rates at time of execution of Contract and must reflect actual personnel performing work;
 - .6 cost for site superintendent must not exceed 10% of total hours of labour estimated for change or revision, and change or revision must be such that site superintendent's involvement is necessary;

- .7 costs for rental tools and/or equipment are not to exceed local rental costs;
- .8 overhead percentage will be deemed to cover quotation costs other than actual site labour and materials, and rentals;
- .9 quotations, including those for deleted work, to include a figure for any required change to Contract time.
- .5 Quotations submitted that are not in accordance with requirements specified above will be rejected and returned for re-submittal. Failure to submit a proper quotation to enable Consultant to expeditiously process quotation and issue a Change Order will not be grounds for any additional change to Contract time.
- .6 Make requests for changes or revisions to work in writing to Consultant and, if accepted by Owner, Notice of Change to be issued.
- .7 Do not execute any change or revision until written authorization for the change or revision has been obtained from Consultant.

1.20 PROGRESS PAYMENT BREAKDOWN

- .1 Prior to submittal of first progress payment draw, submit a detailed breakdown of work cost to assist Consultant in reviewing and approving progress payment claims.
- .2 Payment breakdown is subject to Owner's approval and Consultant's review. Progress payments will not be processed until an approved breakdown is in place. Breakdown is to include one-time claim items such as mobilization and demobilization, insurance, bonds (if applicable), shop drawings and product data sheets, commissioning including testing, adjusting and balancing, system testing and verification, and project closeout submittals.
- .3 Indicate equipment, material and labour costs for site services (if applicable) and indicate work of each trade in same manner as indicated on progress draw.

1.21 NOTICE FOR REQUIRED FIELD REVIEWS

- .1 Whenever there is a requirement for Consultant to perform a field review prior to concealment of any work, to inspect/re-inspect work for deficiencies prior to Substantial Performance of the Work, for commissioning demonstrations, and any other such field review, give minimum 5 working days' notice in writing to Consultant.
- .2 If Consultant is unable to attend a field review when requested, arrange an alternative date and time.
- .3 Do not conceal work until Consultant advises that it may be concealed.
- .4 When Consultant is requested to perform a field review and work is not ready to be reviewed, reimburse Consultant for time and travel expenses.

1.22 PRELIMINARY TESTING

- .1 When directed by Consultant, promptly arrange, pay for, and perform site tests on any piece of equipment or any system for such reasonable lengths of time and at such times as may be required to prove compliance with Specification and governing Codes and Regulations, prior to Substantial Performance of the Work.

- .2 When, in Consultant's opinion, tests are required to be performed by a certified testing laboratory, arrange and pay for such tests.
- .3 These tests are not to be construed as evidence of acceptance of work, and it is agreed and understood that no claim for delays or damage will be made for injury or breakage to any part or parts of equipment or system due to test where such injuries or breakage were caused by faulty parts and/or workmanship of any kind.
- .4 When, in Consultant's opinion, tests indicate that equipment, products, etc., are defective or deficient, immediately remove such equipment and/or products from site and replace them with acceptable equipment and/or products, at no additional cost.

1.23 PROVISIONS FOR SYSTEMS/EQUIPMENT USED DURING CONSTRUCTION

- .1 Permanent building mechanical systems are not to be used for temporary heating or cooling purposes during construction.
- .2 Confirm with Consultant what equipment can be used during construction.
- .3 Any system or piece of equipment that is specified to be provided under requirements of Documents and is required to be used during construction stages of work prior to issuing of Certificate of Substantial Performance of the Work, are to be provided with special interim maintenance and service to cover systems/equipment during time of use during construction period of project until project has been certified as substantially performed and such systems/equipment are turned over to Owner.
- .4 During this period of construction, such systems/equipment to not become property of Owner or be Owner's responsibility for maintenance or service. Systems/equipment are to remain property of respective manufacturers/suppliers or Contractor, who are responsible for full maintenance and servicing of systems/equipment in order to maintain validity of warranties after turn over to Owner.
- .5 Prior to application for a Certificate of Substantial Performance of the Work and turn over to Owner, such systems/equipment to be cleaned, restored to "new" condition, paint finishes "touched-up", filters cleaned or replaced, etc.

1.24 TEMPORARY SERVICES

- .1 Coordinate with Prime Contractor, requirements for temporary services including but not limited to temporary heating, cooling and water. Unless otherwise noted, provide required services in compliance with requirements of local governing building code and local governing inspection authorities.
- .2 Maintain fire protection of areas which may include fire watch during temporary shutdowns of existing systems, in accordance with requirements of local governing code and local governing authorities.

1.25 MAINTAINING EQUIPMENT PRIOR TO ACCEPTANCE

- .1 Maintain equipment in accordance with manufacturer's instructions prior to start-up, testing and commissioning.
- .2 Employ a qualified millwright to check and align shafts, drives, and couplings on all base mounted split coupled motor driven equipment.

- .3 Where equipment lubrication fittings are not easily accessible, extend the fittings to accessible locations using copper or aluminium tubing.
- .4 All filters are to be new upon Substantial Performance of the Work. This is in addition to any spare filters specified.

1.26 CLEANING

- .1 During construction, keep site reasonably clear of rubbish and waste material resulting from work on a daily basis to the satisfaction of Owner and Consultant. Before applying for a Certificate of Substantial Performance of the Work, remove rubbish and debris, and be responsible for repair of any damage caused as a result of work.
- .2 Clean equipment and devices installed as part of this project.

1.27 RECORD AS-BUILT DRAWINGS

- .1 Drawings for this project have been prepared on a CAD system using AutoCAD software of release version reviewed with Consultant. For purpose of producing record "as built" drawings, copies of Contract Drawings can be obtained from Consultant, at expense of \$500.00 CDN plus HST, per drawing, up to first 5 drawings, and \$100.00 CDN plus HST, per any additional drawings thereafter. Drawings may also to be used for preparation of layouts and interference drawings.
- .2 As work progresses at site, clearly mark in red in a neat and legible manner on a set of bound white prints of Contract Drawings, changes and deviations from routing of services and locations of equipment shown on Contract Drawings, on a daily basis. Changes and deviations include those made by addenda, change orders, and site instructions. Use notes marked in red as required. Maintain white print red line as-built set at site for exclusive use of recording as-built conditions, keep set up-to-date at all times, and ensure set is always available for periodic review. As-built set is also to include the following:
 - .1 dimensioned location of inaccessible concealed work;
 - .2 locations of control devices with identification for each;
 - .3 for underground piping and ducts, record dimensions, invert elevations, offsets, fittings, cathodic protection and accessories if applicable, and locate dimensions from benchmarks to be preserved after construction is complete;
 - .4 for fire protection systems, record actual locations of equipment, sprinkler heads, and valves, drains, and test locations, and deviations of pipe routing and sizing from that shown on the drawings;
 - .5 location of piping system air vents;
 - .6 location of concealed services terminated for future extension and work concealed within building in inaccessible locations.
- .3 Before applying for a Certificate of Substantial Performance of the Work, update a clean copy of Contract Drawing set in accordance with marked up set of "as-built" white prints including deviations from original Contract Drawings, thus forming an "as-built" drawing set. Submit "as-built" site drawing prints to Consultant for review. Make necessary revisions to drawings as per Consultant's comments, to satisfaction of Consultant.

- .4 Use final reviewed "as-built" drawing set to provide CAD files of drawings thus forming true "as-built" set of Contract Drawings. Identify set as "Project Record Copy". Load digital copies of final reviewed by Consultant as-built drawings onto USB type flash drive. Provide 2 complete sets of "as-built" drawings on separate USBs. Submit "as-built" sets of white prints and USBs to Consultant.
- .5 Submitted drawings are to be of same quality as original Contract Drawings. CAD drawing files are to be compatible with AutoCAD software release version confirmed with Consultant.
- .6 Unless otherwise noted in Divisions 00 or 01, failure to maintain accurate record drawings will incur additional 5% holdback on progress claims until drawings are brought up to date to satisfaction of Owner and reviewed with Consultant.

1.28 OPERATING AND MAINTENANCE MANUALS

- .1 For each item of equipment for which a shop drawing is required (except for simple equipment), supply minimum 3, project specific, indexed copies of equipment manufacturers' operating and maintenance (O&M) instruction data manuals. Review exact quantity of manuals with Consultant. Consolidate each copy of data in an identified hard cover three "D" ring binder. Each binder to include:
 - .1 front cover: project name; wording – "Mechanical Systems Operating and Maintenance Manual"; and date;
 - .2 introduction sheet listing Consultant, Contractor, and Subcontractor names, street addresses, telephone and fax numbers, and e-mail addresses;
 - .3 equipment manufacturer's authorized contact person name, telephone number and company website;
 - .4 Table of Contents sheet, and corresponding index tab sheets;
 - .5 copy of each "REVIEWED" or clean, updated "REVIEWED AS NOTED" shop drawing or product data sheet, with manufacturer's/supplier's name, telephone and fax numbers, email address, company website address, and email address for local source of parts and service; when shop drawings are returned marked "Reviewed As Noted" with revisions marked on shop drawing copies, they are to be revised by equipment supplier to incorporate comments marked on "Reviewed" shop drawings and a clean updated copy is to be included in operating and maintenance manuals;
 - .6 operating data as follows:
 - .1 pressure test reports, and certificates issued by governing authorities;
 - .2 description of each system and its controls;
 - .3 control schematics for equipment/systems including building environmental controls;
 - .4 wiring and connection diagrams;
 - .5 if applicable, BAS architecture and all required operating data;

- .6 description of operation of each system at various loads together with reset schedules and seasonal variances;
- .7 operation instruction for each system and each component;
- .8 description of actions to be taken in event of emergencies and/or equipment failure;
- .9 valve tag schedule, and flow diagrams to indicate valve locations.
- .7 maintenance data as follows:
 - .1 operation and trouble-shooting instructions for each item of equipment and each system;
 - .2 schedules of tasks, frequency, tools required, and estimated task time;
 - .3 recommended maintenance practices and precautions including warnings of any maintenance practice that will damage or disfigure equipment/systems;
 - .4 complete parts lists with numbers.
- .8 performance data as follows:
 - .1 equipment and system start-up data sheets;
 - .2 equipment performance verification test results, and final commissioning report;
 - .3 final testing, adjusting and balancing reports.
- .9 copies of warranties;
- .10 items requested specifically in Section Articles.
- .2 Generally, binders are not to exceed 75 mm (3") thick and not to be more than 2/3 full.
- .3 Operating and maintenance instructions are to relate to job specific equipment supplied under this project and related to Owner's building. Language used in manuals is to contain simple practical operating terms and language easy for in-house maintenance staff to understand how to operate and maintain each system.
- .4 Before applying for a Certificate of Substantial Performance of the Work, assemble one copy of O & M Manual and submit to Consultant for review prior to assembling remaining copies. Incorporate Consultant's comments into final submission.
- .5 Provide 2 digital copies of contents of operating and maintenance manuals and load onto separate USB type flash drives and submit to Consultant. Prepare digital copies using version of Adobe Acrobat Portable Document Format or equal as reviewed with Consultant and enhanced with bookmarks and internal document links.

1.29 COMMISSIONING

- .1 After successful start-up and prior to Substantial Performance of the Work, commission the mechanical work. Commissioning work is the process of Contractor demonstrating to Owner and Consultant, for purpose of final acceptance, by means of successful and documented functional performance testing, that systems and/or subsystems are capable of being operated and maintained to perform in accordance with requirements of Contract Documents, as further described below.
 - .1 Retain services of a testing, adjusting, and balancing agency to perform testing and balancing of mechanical system air/fluid flows and capacities, prior to operational performance testing. Refer to Section entitled Testing, Adjusting and Balancing.
 - .2 Test, adjust and operate equipment and systems after start-up but before functional performance testing, to confirm operations are in accordance with requirements of Contract Documents. Verify modes and sequences of control and monitoring, interlocks, and responses to emergency conditions. Complete commissioning data sheets to document successful operational performance testing.
 - .3 Repeat successful operational performance testing with completed commissioning data sheet documentation in the presence of Consultant and Owner to validate and verify equipment and systems are complete in all respects, function correctly, and are ready for acceptance.
 - .4 Submit final commissioning data sheets, TAB reports as specified in Section entitled Testing, Adjusting and Balancing, project closeout documents, and other required submittals.

1.30 WARRANTY

- .1 Unless otherwise specified in Divisions 00 and 01, warrant mechanical work to be in accordance with Contract Documents and free from defects for a period of 1 year from date of issue of a Certificate of Substantial Performance of the Work.
- .2 Where equipment includes extended warranty period, e.g., 5 years, first year of warranty period is to be governed by terms and conditions of warranty in Contract Documents, and remaining years of warranty are to be direct from equipment manufacturer and/or supplier to Owner. Submit signed and dated copies of extended warranties to Consultant.
- .3 Warranty to include parts, labour, travel costs and living expenses incurred by manufacturer's authorized technician to provide factory authorized on-site service.
- .4 Repair and/or replace any defects that appear in Work within warranty period without additional expense to Owner. Be responsible for costs incurred in making defective work good, including repair or replacement of building finishes, other materials, and damage to other equipment. Ordinary wear and tear and damage caused wilfully or due to carelessness of Owner's staff or agents is exempted.
- .5 Do not include Owner deductible amounts in warranties.
- .6 Visit building during warranty period with Owner representatives. Owner to organize these visits. At these meetings, Owner representatives are to review performance of systems. If performance is satisfactory, then no further action needs to be taken. If unsatisfactory, then correct deficiencies, as directed by Owner representatives, to satisfaction of Owner's representatives. These site visits to occur:

- .1 once during 1st month of building operation;
- .2 once during 3rd month of building operation;
- .3 once between 4th and 10th month in a season opposite to 1st and 3rd month visits.

1.31 PROJECT CLOSEOUT SUBMITTALS

- .1 Prior to application for Substantial Performance of the Work, submit required items and documentation specified, including following:
 - .1 Operating and Maintenance Manuals;
 - .2 as-built record drawings and associated data;
 - .3 extended warranties for equipment as specified;
 - .4 operating test certificates, i.e. Sprinkler Test Certificate;
 - .5 final commissioning report and TAB report;
 - .6 identified keys for equipment and/or panels for which keys are required, and other items required to be submitted;
 - .7 other data or products specified.

1.32 INSTRUCTIONS TO OWNER

- .1 Refer to equipment and system operational and maintenance training requirements specified in Division 01.
- .2 Train Owner's designated personnel in aspects of operation and maintenance of equipment and systems as specified. Demonstrations and training are to be performed by qualified technicians employed by equipment/system manufacturer/supplier. Supply hard copies of training materials to each attendee.
- .3 Unless where specified otherwise in trade Sections, minimum requirements are for manufacturer/suppliers of each system and major equipment, to provide minimum two separate sessions each consisting of minimum 4 hours on site or in factory training (at Owner's choice), of Owner's designated personnel (for up to 6 people each session), on operation and maintenance procedures of system.
- .4 For each item of equipment and for each system for which training is specified, prepare training modules as specified below. Use Operating and Maintenance Manuals during training sessions. Training modules include but are not limited to:
 - .1 Operational Requirements and Criteria – equipment function, stopping and starting, safeties, operating standards, operating characteristics, performance curves, and limitations;
 - .2 Troubleshooting – diagnostic instructions, test and inspection procedures;
 - .3 Documentation – equipment/system warranties, and manufacturer's/supplier's parts and service facilities, telephone numbers, email addresses, and the like;

- .4 Maintenance – inspection instructions, types of cleaning agents to be used as well as cleaning methods, preventive maintenance procedures, and use of any special tools;
- .5 Repairs – diagnostic instructions, disassembly, component removal and repair instructions, instructions for identifying parts and components, and review of any spare parts inventory.
- .5 Before instructing Owner's designated personnel, submit to Consultant for review preliminary copy of training manual and proposed schedule of demonstration and training dates and times. Incorporate Consultant's comments in final copy.
- .6 Obtain in writing from Consultant list of Owner's representatives to receive instructions. Submit to Consultant prior to application for Certificate of Substantial Performance of the Work, complete list of systems for which instructions were given, stating for each system:
 - .1 date instructions were given to Owner's staff;
 - .2 duration of instruction;
 - .3 names of persons instructed;
 - .4 other parties present (manufacturer's representative, consultants, etc.).
- .7 Obtain signatures of Owner's staff to verify they properly understood system installation, operation and maintenance requirements, and have received operating and maintenance instruction manuals and "as-built" record drawings.
- .8 Submit to Consultant, copy of electronic version of training materials loaded on USB flash drive. Include in operating and maintenance manuals submission.

1.33 FINAL INSPECTION

- .1 Submit to Consultant, written request for final inspection of systems. Include written certification that:
 - .1 deficiencies noted during job inspections have been completed;
 - .2 field quality control procedures have been completed;
 - .3 systems have been tested and verified, balanced and adjusted, and are ready for operation;
 - .4 maintenance and operating data have been completed and submitted to, reviewed with Consultant and accepted by Owner;
 - .5 tags and nameplates are in place and equipment identifications have been completed;
 - .6 clean-up is complete;
 - .7 spare parts and replacement parts specified have been provided and acknowledged by Consultant;
 - .8 as-built and record drawings have been completed and submitted to and reviewed with Consultant and accepted by Owner;

.9 Owner's staff has been instructed in operation and maintenance of systems;

.10 commissioning procedures have been completed.

2 PRODUCTS

NOT USED

3 EXECUTION

NOT USED

END OF SECTION

1 GENERAL

1.01 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Mechanical Divisions. It is intended as a supplement to each Section and is to be read accordingly.

1.02 SUBMITTALS

- .1 Submit shop drawings/product data sheets for:
 - .1 pressure gauges and thermometers;
 - .2 electric motors (submit with equipment they are associated with).
- .2 Submit weight loads for selected equipment (upon request).
- .3 Submit copy of reflected ceiling plan drawings and elevation drawings to indicate proposed access door locations.
- .4 As specified in Part 2 of this Section, submit a spare belt set, tagged and identified, for each belt driven piece of equipment.
- .5 Submit any other submittals specified in this Section or other Sections of Mechanical Divisions.

2 PRODUCTS

2.01 PIPE SLEEVES

- .1 Galvanized Sheet Steel – Minimum #16 gauge galvanized steel with an integral flange at one end to secure sleeve to formwork construction.
- .2 Polyethylene – Factory fabricated, flanged, high density polyethylene sleeves with reinforced nail bosses.
- .3 Galvanized Steel or Cast Iron Pipe – Schedule 40 mild galvanized steel, or Class 4000 cast iron.

2.02 FIRESTOPPING AND SMOKE SEAL MATERIALS

- .1 Firestopping and smoke seal system materials for mechanical penetrations through fire rated construction are specified in Section entitled Firestopping and Smoke Seal Systems and work is to be included as part of mechanical work.

2.03 WATERPROOFING SEAL MATERIALS

- .1 Modular, mechanical seal assemblies consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and pipe sleeve or wall opening, assembled with stainless steel bolts and pressure plates and designed so when bolts are tightened the links expand to seal the opening watertight. Select seal assemblies to suit pipe size and sleeve size or wall opening size.
- .2 Acceptable products are:

- .1 Thunderline Corp. (Power Plant Supply Co.) "LINK SEAL" Model S-316;
- .2 The Metraflex Co. "MetraSeal" type ES.

2.04 PIPE ESCUTCHEON PLATES

- .1 One-piece chrome plated brass or #4 finish type 302 stainless steel plates with matching screws for attachment to building surface, each plate sized to completely cover pipe sleeve or building surface opening, and to fit tightly around pipe or pipe insulation.

2.05 PIPING HANGERS AND SUPPORTS

- .1 Pipe hanger and support materials, including accessories, are to be, unless otherwise specified, in accordance with Manufacturers Standardization Society (MSS) Standard Practice Manual SP-58, Pipe hangers and Supports-Materials, Design and Manufacture, and where possible, MSS designations are indicated with each product specified below. Conform to following requirements:
 - .1 unless otherwise specified, ferrous hanger and support products are to be electro-galvanized;
 - .2 hangers and supports for insulated piping are to be sized to fit around insulation and insulation jacket.
- .2 Hangers and supports for horizontal suspended piping as follows:
 - .1 adjustable steel clevis hanger – MSS Type 1;
 - .2 adjustable swivel ring band hanger – MSS Type 10;
 - .3 adjustable roller hanger – MSS Types 41, 43, and/or 45, with MSS Type 39 steel protection saddle.
- .3 Supports for horizontal pipe on vertical surfaces as follows:
 - .1 steel offset pipe clamp – Anvil Fig. 103 or Myatt Fig. 170;
 - .2 heavy-duty steel pipe clip – MSS Type 26;
 - .3 single steel pipe hook – Myatt Fig. 156;
 - .4 epoxy coated steel pipe stays are not permitted.
- .4 Base support for vertical risers in excess of 6 m (20') high extending out from base mounted equipment is to consist of a base elbow support with flange.
- .5 Floor supports for vertical risers as follows:
 - .1 copper tubing riser clamp – MSS Type 8;
 - .2 heavy-duty steel riser clamp – MSS Type 8.
- .6 Supports for vertical piping on vertical surfaces as follows:
 - .1 steel offset pipe clamp – Anvil Fig. 103 or Myatt Fig. 170;

- .2 heavy-duty steel pipe bracket or soil pipe bracket – MSS Type 26;
- .3 extension split pipe clamp – MSS Type 12;
- .4 epoxy coated steel pipe stays are not permitted.
- .7 For horizontal pipe on racks, Unistrut or equal galvanized steel pipe racks with pipe securing hardware as follows:
 - .1 standard galvanized steel U-bolts/clamps supplied by rack manufacturer;
- .8 Special hangers and supports for various applications as follows:
 - .1 for groups of pipes having same slope – MSS Type 32 welded steel brackets, Anvil Fig. 46 universal trapeze assemblies, or Unistrut or equal support assemblies, all with U-bolts, clamps, etc., to secure pipes in place;
 - .2 for fire protection piping – generally as above but ULC listed and/or FM approved, and in accordance with Chapter requirements of NFPA Standard applicable to piping system;
 - .3 for bare horizontal copper piping – generally as above but factory vinyl coated to prevent direct copper/steel contact;
 - .4 for bare copper vertical piping – corrosion resistant ferrous clamps with flexible rubber gasket type material (not tape) to isolate pipe from clamp;
 - .5 insulation protection shields to and including 40 mm (1-1/2") dia. – MSS Type 40 galvanized steel shields with ribs to keep shield centred on hanger.
- .9 Hanger rods are to be electro-galvanized carbon steel (unless otherwise specified), round, threaded, to ASTM A36, complete with captive machine nuts with washers at hangers, sized to suit loading in accordance with Table 3 in MSS SP-58, but in any case minimum 9.5 mm (3/8") diameter.
- .10 Acceptable manufacturers are:
 - .1 E. Myatt & Co. Inc.;
 - .2 Anvil International Inc.;
 - .3 Empire Industries Inc.;
 - .4 Hunt Manufacturing Ltd.;
 - .5 Unistrut Canada Ltd.;
 - .6 Nibco Inc. "Tolco";
 - .7 Taylor Pipe Supports.

2.06 ACCESS DOORS

- .1 Access doors to be provided under work of Division 08 by General Trades Contractor.

- .2 Coordinate with Mechanical Contractor and General Trades Contractor to ensure access doors on project are provided by a single manufacturer, installed as part of work of General Trades Contractor and work involving both mechanical and electrical services, where possible, be accessible from common access door. Coordinate work to ensure same common location access doors are not supplied by more than one Division.
- .3 Size access doors to suit the concealed work for which they are supplied, and wherever possible they are to be of standard size for all applications, but in any case they are to be minimum 300 mm x 300 mm (12" x 12") for hand entry and 600 mm x 600 mm (24" x 24") for body entry.
- .4 Access doors in fire rated construction are to be ULC listed and labelled and of a rating to maintain fire separation integrity.
- .5 Identify on reflected ceiling plans and wall elevation drawings, coordinated locations of proposed access door locations and submit to Consultant for review.

2.07 PRESSURE GAUGES AND THERMOMETERS

- .1 Pressure gauges as follows:
 - .1 adjustable, glycerine filled, 100 mm or 115 mm (4" or 4-½") diameter and each accurate to within 1% of scale range;
 - .2 type 304 stainless steel case with relief valve and polished stainless steel bayonet;
 - .3 stainless steel rotary movement with stainless steel bushings and socket;
 - .4 clear acrylic window;
 - .5 dual scale white dial with a scale range such that working pressure of system is at approximate mid-point of scale;
 - .6 black pointer.
- .2 Pressure gauge accessories and additional requirements as follows:
 - .1 a bronze ball type shut-off valve is to be provided in the piping to each pressure gauge;
 - .2 each pressure gauge for piping and equipment with normal everyday flow is to be equipped with a brass pressure snubber;
- .3 Thermometers as follows:
 - .1 round, 125 mm (5") diameter, adjustable (90°) angle bimetal dial type thermometers, each accurate to within 1% of full scale;
 - .2 hermetically sealed stainless steel case with stainless steel ring;
 - .3 dampened bimetal coil;
 - .4 calibration adjustment screw;

- .5 white aluminum dual scale dial with black and blue markings and a range such that working temperature of system is approximate mid-point of the scale;
- .6 black aluminum pointer;
- .7 double strength glass window;
- .8 12 mm (1/2") NPT connection with 6.4 mm (1/4") diameter stainless steel stem;
- .9 suitable thermowell.
- .4 Acceptable manufacturers are:
 - .1 H.O. Trerice Co.;
 - .2 Weiss Instruments;
 - .3 Ashcroft.

2.08 EQUIPMENT BELT DRIVES

- .1 ANSI/RMA Standard V-belt type rated at minimum 1.5 times motor nameplate rating, and in accordance with following requirements:
 - .1 belts are to be reinforced cord and rubber, and multiple belts are to be matched sets;
 - .2 sheaves are to be cast iron or steel, secured to shafts with removable keys unless otherwise specified, standard adjustable pitch ($\pm 10\%$ range) for motors under 10 HP, fixed pitch type with split tapered bushing and keyway for motors 10 HP and larger, and, if required, replaced as part of mechanical work to suit system air/water quantity testing and balancing work;
 - .3 motor slide rail adjustment plates are to allow for centre line adjustment.
- .2 Supply a spare belt set (tagged and identified) for each belt drive and hand to Owner upon Substantial Performance of the Work.

2.09 EQUIPMENT DRIVE GUARDS AND ACCESSORIES

- .1 For V-belt drives – removable, 4-sided, fully enclosed, galvanized sheet steel guards to OHSA standards, cleaned, factory primed and painted with yellow equipment enamel, complete with a 2-piece full length hinged front panel to permit belt maintenance or replacement without removing guard, and 40 mm (1-1/2") diameter tachometer openings at each shaft location.
- .2 For flexible couplings – removable "U" shaped galvanized steel guards to OHSA Standards with a 2.3 mm (3/32") thick frame and expanded mesh face.
- .3 For unprotected fan inlets and outlets – unless otherwise specified, removable 20 mm (3/4") galvanized steel wire mesh with galvanized steel frames, all to OHSA Standards.

2.10 ELECTRIC MOTORS

- .1 Unless otherwise specified, motors are to conform to NEMA Standard MG1, applicable IEEE Standards, and applicable CSA C22.2 Standards, and are to meet NEMA standards for maximum sound level ratings under full load. Confirm motor voltages prior to ordering.
- .2 Vertically mounted and submersible motors are to be purposely designed for mounting in this attitude.
- .3 Efficiency of 1-phase motors to 1 HP is to be in accordance with CAN/CSA C747. Efficiency of 3-phase motors 1 HP and larger is to be in accordance with CAN/CSA C390 or IEEE 112B.
- .4 Unless otherwise specified, 1-phase motors smaller than ½ HP are to be 115 volt, continuous duty capacitor start type with an NEMA 48 or 56 frame size, solid base, heavy-gauge steel shell with solid die-cast end shields, dynamically balanced die-cast rotor, integral automatic reset thermal overload protection, Class "B" insulation, and a 1.15 service factor at 40°C (105°F) ambient temperature.
- .5 Explosion-proof 1-phase motors are to be totally enclosed, fan cooled, 115 volt continuous duty capacitor start type in accordance with CSA C22.2 No. 145, as specified for standard 1-phase motors but suitable for use in Class 1 Group D hazardous locations and complete with a rolled steel shell and a 1.0 service factor at 40°C (105°F) ambient temperature.
- .6 Unless otherwise specified, motors ½ HP and larger are to be totally enclosed, fan cooled, 3-phase, T-frame, squirrel cage continuous duty induction motors suitable for voltages indicated on Drawings, NEMA Design "B" for normal starting torque or Design "C" for high starting torque as required by the application, each complete with Class "B" insulation, a 1.15 service factor at 40°C ambient temperature, grease lubricated open ball bearings with grease fittings to permit re-lubrication without dismantling motor, a cast iron frame with cast iron feet where required, cast iron end bracket and precision machined bearing fit, and balanced carbon steel shaft assembly with die-cast aluminum rotor windings.
- .7 Explosion-proof 3-phase motors are to be totally enclosed fan cooled motors in accordance with CSA C22.2 No. 145, generally as specified above for standard 3-phase motors but suitable for use in Class 1 Group D hazardous locations and with a 1.0 service factor at 40°C (105°F) ambient temperature.
- .8 Motors for equipment with variable frequency drives are to be generally as specified above but inverter duty type to NEMA Standard MG-1 Part 31, quantified by CSA for operation from a variable frequency drive of type specified, and complete with Class "H" insulation. Motors are to be equipped with AEGIS, or approved equal, shaft grounding ring system to protect bearings from damage by diverting harmful shaft voltages and bearing currents to ground.
- .9 Motors for equipment which is scheduled or specified with a corrosion resistant coating or constructed from corrosion resistant materials are to be factory coated with a primer and epoxy paint finish.
- .10 Acceptable manufacturers are:
 - .1 TECO-Westinghouse Motors (Canada) Inc.;
 - .2 Canadian General Electric;

- .3 Baldor Electric Co.;
- .4 U.S. Electrical Motors;
- .5 Weg Electric Corp.;
- .6 Marathon Electric;
- .7 Toshiba Corp.;
- .8 Leeson Canada.

2.11 MOTOR STARTERS AND ACCESSORIES

- .1 Motor starters must be capable of starting associated motors under the imposed loads. Confirm starter voltage matches motor prior to ordering.
- .2 Unless otherwise specified, starters for 1-phase motors are to be 115 volt, thermal overload protected manual starting switches with a neon pilot light, a surface or recessed enclosure to suit the application, and, where automatic operation is required, a separate H-O-A switch in an enclosure to match starter enclosure.
- .3 Unless otherwise specified, starters for 3-phase motors less than 50 HP are to be combination "quick-make" and "quick-break" fused disconnects and full voltage non-reversing across-the-line starters, each complete with and overload relay per phase, an enclosure to suit the application, and, a H-O-A switch, pilot lights, control transformer, auxiliary contacts, and other accessories as per motor starter schedule.
- .4 Starters for 2-speed double winding motors are to be generally as specified above but suitable for motor and equipped with a 45 second time delay to permit equipment to coast down to low speed before it is operated at low speed.
- .5 Starters for 2-speed single winding motors are to be generally as specified above but suitable for motor and equipped with a 45 second time delay to permit equipment to coast down to low speed before it is operated at low speed.
- .6 Starters for reversible motors for cooling towers are to be generally as specified above but suitable for motor and equipped with a 45 second time delay to allow fan(s) to coast down to a stop before being operated in reverse rotation.
- .7 Unless otherwise specified, motor starter enclosures are to be in accordance with following NEMA ratings:
 - .1 enclosures located in sprinklered areas – Type 2;
 - .2 enclosures exposed to the elements – Type 3R, constructed of stainless steel;
 - .3 enclosures inside the building in wet areas – Type 3R, constructed of stainless steel;
 - .4 enclosures in explosion rated area – Type 7 with exact requirements to suit the area and application;
 - .5 enclosures except as noted above – Type 1;

- .6 enclosures located in finished areas – as above but recess type with brushed stainless steel faceplate.
- .8 Acceptable manufacturers are:
 - .1 Rockwell Automation Inc. - Allen-Bradley;
 - .2 Eaton Corp. – Cutler-Hammer;
 - .3 Eaton Corp. – Moeller Electric;
 - .4 Siemens Canada;
 - .5 Schneider Electric.

2.12 SPRINKLER PROOFING

- .1 Provide drip shields for protection of surface mounted equipment enclosures from water spray and dripping of liquids. Features of shields include:
 - .1 factory constructed by respective equipment manufacturers;
 - .2 constructed from non-combustible materials (sheet steel);
 - .3 enamel painted to match equipment;
 - .4 surfaces and edges filled/sanded smooth prior to painting;
 - .5 supported from equipment with structural steel rods/metal framing or other method approved by Consultant;
 - .6 structural support finish painted to match shield.
- .2 Include with equipment shop drawings, detailed dimensions of drip shields and methods of supporting.
- .3 Equipment with top cable/conduit entries to include additional sealing of entries with gasketting and/or waterproof sealant to prevent water from entering enclosure.
- .4 Design ventilation louvers such that live components are not exposed to water spray and dripping liquids.
- .5 Above requirements are additional minimum "sprinkler proof" standards for equipment specified as NEMA 1, 2 or 12.
- .6 Obtain CSA approval where required by local governing authorities.

2.13 MECHANICAL WORK IDENTIFICATION MATERIALS

- .1 Equipment nameplates are to be minimum 1.6 mm (1/16") thick 2-ply laminated coloured plastic plates, minimum 12 mm x 50 mm (½" x 2") for smaller items such as damper motors and control valves, minimum 25 mm x 65 mm (1" x 2-½") for equipment, and minimum 50 mm x 100 mm (2" x 4") for control panels and similar items. Additional requirements are as follows:

- .1 unless otherwise specified or required, each nameplate is to be white, complete with bevelled edges and black engraved wording to completely identify equipment and its use with no abbreviations;
 - .2 wording is generally to be as per drawings, i.e. Fan EF-1, and is to include equipment service and building area/zone served, but must be reviewed prior to engraving;
 - .3 supply stainless steel screws for securing nameplates in place;
 - .4 nameplates for equipment suspended above floor level or generally not within easy viewing from floor level are to be increased in size so as to be easily readable from floor level.
- .2 Valve tags are to be coloured, 40 mm (1-½") square, 2-ply laminated plastic with bevelled edges, red-white, green-white, yellow-black, etc., to match piping identification colour, each complete with a 3.2 mm (1/8") diameter by 100 mm (4") long brass plated steel bead chain, and four lines of engraved maximum size identification wording, i.e.:
- VALVE V12
200 mm (8")
CHILL. WATER
NORMALLY OPEN
- .3 Standard pipe identification is to be equal to Smillie McAdams Summerlin Ltd., Brady or Primark Manufacturing Inc. vinyl plastic with indoor/outdoor type vinyl ink lettering and directional arrows, as follows:
- .1 for pipe less than or equal to 150 mm (6") diameter, coiled type snap-on markers of a length to wrap completely around pipe or pipe insulation;
 - .2 for pipe larger than 150 mm (6") diameter, saddle type strap-on markers with 2 opposite identification locations and complete with nylon cable ties.

- .4 Identification wording and colours for pipe identification materials are to be as follows:

PIPE SERVICE	IDENTIFICATION COLOUR	LEGEND
domestic cold water	green	DOM. COLD WATER
domestic hot water supply	green	DOM. HW SUPPLY
domestic hot water recirculation	green	DOM. HW RECIRC.
storm drainage	green	STORM
sanitary drainage	green	SAN.
plumbing vent	green	SAN. VENT
fire protection sprinklers	red	F.P. SPRINKLER
natural gas	to Code	to Code, c/w pressure
natural gas vent	to Code	to Code

- .5 Colours for pipe identification legends and directional arrows are to be as follows:

IDENTIFICATION COLOUR	LEGEND & ARROW COLOUR
yellow	black
green	white
red	white

- .6 Duct identification is to be custom made Mylar stencils with 50 mm (2") high lettering to accurately describe duct service, i.e. "AHU-1 SUPPLY", complete with a directional arrow, and coloured ink with ink pads and roller applicators. Ink colour is generally to be black but must contrast with lettering background.

2.14 FLEXIBLE CONNECTORS

- .1 Double wall stainless steel flexible connectors for piping connections to vibration isolated equipment, each selected by manufacturer to suit the application. Shop drawings or product data sheets must indicate construction and performance requirements that suit the application. Acceptable manufacturers are:
- .1 Hyspan Precision Products Inc.;
 - .2 Senior Flexonics Ltd.;
 - .3 The Metraflex Co.

3 EXECUTION

3.01 GENERAL PIPING AND DUCTWORK INSTALLATION REQUIREMENTS

- .1 Unless otherwise specified, locate and arrange horizontal pipes and ducts above or at ceiling on floors, arranged so that under consideration of all other work in area, maximum ceiling height and/or usable space is maintained. If required to maintain ceiling heights, reroute and/or resize ductwork, with Consultant's approval.
- .2 Unless otherwise specified, install work concealed in finished spaces, and concealed to degree possible in partially finished and unfinished spaces. Refer to and examine Architectural drawings and room finish schedules to determine finished, partially finished, and unfinished areas. Walls which are painted are considered finished.
- .3 Install pipes and ducts parallel to building lines and to each other.
- .4 Neatly group and arrange exposed work.
- .5 Locate work to permit easy access for service or maintenance as required and/or applicable. Locate valves, dampers and any other equipment which will or may need maintenance or repairs and which are to be installed in accessible construction so as to be easily accessible from access doors. Where valves, dampers and similar piping or ductwork accessories occur in vertical services in shafts, pipe spaces or partitions, locate accessories at floor level.
- .6 Make connections between pipes of different materials using adapters suitable for application. Provide cast brass dielectric type adapters/unions at connections between ferrous and copper pipe.
- .7 Comply with equipment and material manufacturer's installation instructions unless otherwise specified herein or on drawings, and unless such instructions contradict governing codes and regulations.
- .8 Carefully clean ducts, pipe and fittings prior to installation. Temporarily cap or plug ends of pipe, ducts and equipment which are open and exposed during construction.
- .9 Install piping and ductwork which are to be insulated so that they have sufficient clearance to permit insulation and finish to be applied continuously and unbroken around pipe or duct, except for ductwork at fire barriers, in which case insulation will be terminated at each side of the duct fire damper.
- .10 Inspect surfaces and structure prepared by other trades before performing work. Verify surfaces or structure to receive work has no defects or discrepancies which could result in poor application or cause latent defects in installation and workmanship. Report defects in writing. Installation of work will constitute acceptance of such surfaces as being satisfactory.
- .11 Any ferrous piping that exhibits in excess of 5% surface rust, either inside or outside or both, is to be wire brush cleaned to bare metal and coated with suitable primer. Steel pipe, fittings and accessories are to be free of corrosion and dirt when work is complete or prior to being concealed from view. Where dirt is evident, clean piping prior to being concealed.
- .12 For factory applied finishes, repaint or refinish surfaces damaged during shipment and installation. Quality of repair work is to match original finish. This requirement also applies to galvanized finishes.

- .13 Where mechanical work is located in high humidity areas where ferrous metal products will be subject to corrosion and protection for such products is not specified, provide finishes on products to protect against corrosion or provide products which will not corrode in the environment, i.e. aluminium ductwork, copper or stainless steel pipe, etc.
- .14 Provide screwed unions or flanges in piping connections to equipment and in regular intervals in long (in excess of 12 m [40']) piping runs to permit removal of sections of piping.
- .15 Unless otherwise specified and except where space limitations do not permit, piping elbows are to be long radius. Eccentric reducers are to be installed with straight side at top of piping.

3.02 PIPE JOINT REQUIREMENTS

- .1 Do not make pipe joints in walls or slabs.
- .2 Ream piping ends prior to making joints.
- .3 Properly cut threads in screwed steel piping and coat male threads only with Teflon tape or paste, or an equivalent thread lubricant. After pipe has been screwed into fitting, valve, union, or piping accessory, not more than 2 pipe threads are to remain exposed.
- .4 Site bevel steel pipe to be welded or supply mill bevelled pipe. Remove scale and oxide from bevels and leave smooth and clean. Use factory made welding tees or welding outlet fittings for piping branches off mains. Do not use shop or site fabricated fittings unless written approval has been obtained.
- .5 Welded joints are to be made by CWB certified licensed journeyman welders qualified in accordance with CSA B51, Boiler Pressure Vessel and Pressure Piping Code, and who are in possession of a proper certificate of qualification for each procedure to be performed. Each weld is to be identified with the welder's identification symbol, and welds are not to be concealed until they have been inspected and approved. Electrodes are to be in accordance with CSA W48 Series, Electrodes, and requirements of CAN/CSA W117.2, Safety in Welding, Cutting and Allied Processes are to be followed.
- .6 Unless otherwise specified, make flanged joints with Garlock 5500 or equivalent gasket materials to suit the application, and bolts and nuts. Bolts are not to be longer than length necessary to screw nut up flush to the end of bolt. Bolts used for flanged connections in piping with a working pressure of 690 kPa (100 psi) and greater are to be ASTM A-193 Grade B-7, with heavy hexagon nuts to ASTM A-194 CL-2H. Provide suitable washers between each bolt head and flange and between each nut and flange.
- .7 A random check of bolted flanged connections will be made to verify flanged connections are properly mated with no shear force acting on bolts. Supply labour to disconnect and reconnect selected flanged joints. If improperly mated joints are found, remove and reinstall affected piping so flanges mate properly. If improperly mated joints are found, additional joints will be checked, and you will be responsible for the repair of any other improper joints discovered.
- .8 Unless otherwise specified make soldered joints in copper piping using flux suitable for and compatible with type of solder being used. Clean the outside of pipe end and inside of fitting, valve, or similar accessory prior to soldering.

- .9 Install mechanical joint fittings and couplings in accordance with manufacturer's instructions.
- .10 Grooves are to be rolled. Make arrangements with coupling and fitting manufacturer for shop and/or site instructions and demonstrations as required, and adhere to manufacturer's instructions with respect to pipe grooving, support, type of gasket required, anchoring and guiding the grooved piping system.
- .11 If pressure crimped couplings and fittings are used, ensure gaskets are fully compatible with piping fluid, and valves and piping accessories are suitable. Use only fitting manufacturer supplied crimping equipment. Comply with manufacturer's latest published specification, instructions, and recommendations with respect to pipe, coupling, and fitting preparation and installation, and support, anchoring and guiding of the piping system.
- .12 Solvent weld PVC piping in 2 parts, primer stage and cementing stage, in accordance with manufacturer's recommendations, ASTM D2855, and CSA requirements.
- .13 Install PVC piping with gasketed joints in accordance with manufacturer's current published specifications, instructions and recommendations, and CSA requirements.

3.03 INSTALLATION OF PIPE SLEEVES

- .1 Where pipes pass through concrete and/or masonry surfaces provide pipe sleeves as follows:
 - .1 in poured concrete slabs – unless otherwise specified, minimum 16 gauge flanged galvanized steel or, where permitted by governing authorities, factory fabricated plastic sleeves;
 - .2 in concrete or masonry walls – Schedule 40 galvanized steel pipe or Class 4000 cast iron pipe.
- .2 Sleeves in waterproofed slabs or walls are to be lengths of Schedule 40 mild galvanized steel pipe with a waterstop plate in accordance with drawing detail. Provide waterproof sleeves in following locations:
 - .1 in mechanical room floor slabs, except where on grade;
 - .2 in slabs over mechanical, fan, electrical and telephone equipment rooms or closets;
 - .3 in floors equipped with waterproof membranes;
 - .4 in roof slab;
 - .5 in waterproof walls.
- .3 Size sleeves, unless otherwise specified, to leave 12 mm (½") clearance around pipes, or where pipe is insulated, a 12 mm (½") clearance around pipe insulation.
- .4 Pack and seal void between pipe sleeves and pipe or pipe insulation in non-fire rated construction for the length of sleeves as follows:
 - .1 pack sleeves in interior construction with mineral wool and seal both ends of sleeves with non-hardening silicone base caulking compound;

- .2 pack sleeves in exterior walls above grade with mineral wool and seal both ends of sleeves water-tight with approved non-hardening silicone base caulking compound unless mechanical type seals have been specified;
- .3 seal sleeves in exterior walls below grade (and any other wall where water leakage may be a problem) with link type mechanical seals as specified.
- .5 Where sleeves are required in masonry work, accurately locate and mark sleeve location, and hand sleeves to mason for installation.
- .6 Terminate piping for sleeves that will be exposed so sleeve is flush at both ends with building surface concerned so sleeve may be completely covered by an escutcheon plate, except for sleeves in waterproof floors which are to terminate 100 mm (4") above finished floor.
- .7 "Gang" type sleeving will not be permitted.
- .8 Where sleeves are provided in non-fire rated construction for future piping, or where piping has been removed from existing sleeves, cap and seal both ends of sleeved opening.

3.04 INSTALLATION OF WATERPROOF MECHANICAL SEALS

- .1 Provide watertight link type mechanical seals in exterior wall openings.
- .2 Assemble and install each mechanical seal in accordance with manufacturer's instructions.
- .3 After installation, periodically check each mechanical seal installation for leakage and, if necessary, tighten link seal bolts until seal is completely watertight.

3.05 SLEEVE AND FORMED OPENING LOCATION DRAWINGS

- .1 Prepare and submit for review, drawings indicating size and location of required sleeves, recesses and formed openings in poured or precast concrete work.
- .2 Such drawings are to be completely and accurately dimensioned and relate sleeve, recesses, and formed openings to suitable grid lines and elevation datum, and are to take into account structural items such as grade beams, column caps, and column drop slabs.
- .3 Begin to prepare such drawings immediately upon notification of acceptance of bid and award of Contract.

3.06 INSTALLATION OF PIPE ESCUTCHEON PLATES

- .1 Provide escutcheon plates suitably secured over exposed piping passing through finished building surfaces. A finished building surface is any surface with a factory finish or that receives a site applied finish.
- .2 Install plates so they are tight against building surface concerned, completely covering pipe sleeves and/or openings, except where waterproof sleeves extend above floors, in which case fit plate tightly around sleeve.

3.07 INSTALLATION OF FASTENING AND SECURING HARDWARE

- .1 Provide fastening and securing hardware required for mechanical work to maintain installations attached to structure or to finished floors, walls and ceilings in a secure and rigid manner capable of withstanding dead loads, live loads, superimposed dead loads, and any vibration of installed products.
- .2 Use fasteners compatible with structural requirements, finishes and types of products to be connected. Do not use materials subject to electrolytic action or corrosion where conditions are liable to cause such action.
- .3 Where floor, wall or ceiling construction is not suitable to support loads, provide additional framing or special fasteners to ensure proper securement to structure that is to support the products. Provide reinforcing or connecting supports where required to distribute loading to structural components.
- .4 Obtain written consent before using explosive actuated fastening devices. If consent is obtained, comply with requirements of CAN/CSA Z166.1 and CAN/CSA Z166.2.
- .5 Do not attach fasteners to steel deck without written consent from Consultant.

3.08 INSTALLATION OF PIPE HANGERS AND SUPPORTS

- .1 Provide required pipe hangers and supports.
- .2 Provide any additional structural steel channels, angles, inserts, beam champs and similar accessories required for hanging or supporting pipe. Unless otherwise shown or specified, hang or support pipes from structure only.
- .3 For insulated pipe, size hanger or support to suit diameter of insulated pipe and install hanger or support on outside of insulation and insulation finish.
- .4 Unless otherwise shown or specified, hang and/or support horizontal pipe above ground by means of hangers and/or supports specified in Part 2 of this Section. Unless otherwise shown or specified, hangers for suspended pipe less than or equal to 25 mm (1") dia. are to be clevis type or adjustable ring type, and hangers for suspended pipe greater than or equal to 40 mm (1-½") dia. are to be adjustable clevis type.
- .5 Space hangers and supports in accordance with following:
 - .1 cast iron pipe – hang or support at every joint with maximum 2.4 m (8') spacing;
 - .2 copper and steel pipe – hang or support at spacing in accordance with following schedule:

PIPE DIA.	MAX. SPACING STEEL (meters)	MAX. SPACING COPPER (meters)
to 25 mm (1")	2.4 m (8')	1.8 m (6')
40 mm (1-½")	2.7 m (9')	2.4 m (8')
50 mm (2")	3.0 m (10')	2.7 m (9')
65 mm (2-½")	3.6 m (12')	3.0 m (10')

PIPE DIA.	MAX. SPACING STEEL (meters)	MAX. SPACING COPPER (meters)
75 mm (3")	3.6 m (12')	3.0 m (10')
90 mm (3-½")	3.6 m (12')	3.6 m (12')
100 mm (4")	4.2 m (14')	3.6 m (12')
250 mm (10")	6.0 m (20')	
300 mm (12")	6.7 m (22')	

- .3 flexible grooved pipe/coupling joint piping – as above but with not less than one hanger or support between joints.
- .6 Where pipes change direction, either horizontally or vertically, provide a hanger or support on horizontal pipe not more than 300 mm (12") from elbow, and where pipes drop from tee branches, support tees in both directions not more than 50 mm (2") on each side of tee.
- .7 When pipes with same slope are grouped and a common hanger or support is used, space hanger or support to suit spacing requirement of smallest pipe in group and secure pipes in place on common hanger or support.
- .8 Provide roller hangers or supports for heat transfer piping greater than or equal to 150 mm (6") diameter and conveying a material 75°C (170°F) or greater to facilitate pipe movement due to expansion and contraction, and at each hanger or support tack weld a steel protection saddle to pipe to protect piping insulation.
- .9 Unless otherwise shown or specified, support vertical piping by means of supports specified in Part 2 of this Section, spaced in accordance with following:
 - .1 support vertical pipes at maximum 3 m (10') intervals or at every floor, whichever is lesser;
 - .2 for sections of vertical piping with a length less than 3 m (10'), support pipe at least once;
 - .3 for vertical cast iron plain end pipe (mechanical joint type), secure riser or pipe clamp around pipe under a flange integral with pipe for vertical support purposes, or provide a length of hub and spigot pipe to facilitate proper support;
 - .4 for vertical steel pipe risers in excess of 3 m (10'), weld shear lugs to pipe to carry load;
 - .5 for vibration isolated piping risers, provide rubber-steel-rubber vibration isolation pads between riser clamps and floor.
- .10 Each hanger, support or securement for horizontal bare copper tubing is to be plastic coated to prevent direct contact between pipe and ferrous hanger. Each wall or floor clamp for vertical bare copper piping is to be isolated from pipe by means of strips of flexible rubber inserts. Use of painted ferrous hangers and supports, including those painted with copper coloured paint, is not acceptable. Site application of tape or other types of isolation is not acceptable.

- .11 For insulated horizontal piping less than or equal to 40 mm (1-½") diameter, provide galvanized steel insulation protection shields between insulation and hanger or support. Install shields immediately after pipe is insulated.
- .12 Do not support piping from steel deck without written consent from Consultant.

3.09 SUPPLY OF ACCESS DOORS

- .1 Supply access doors to give access to mechanical work which may need maintenance or repair but which is concealed in inaccessible construction, except as otherwise specified herein or on drawings.
- .2 Before commencing installation of mechanical work, coordinate with other trades and prepare on a set of reflected ceiling plans and wall elevations, complete layouts of access doors. Submit these layouts for Consultant's review and show exact sizes and locations of such access doors. Locate and arrange mechanical work to suit.
- .3 Access doors will be installed by trade responsible for particular type of construction in which doors are required. Supply access doors to trade installing same at proper time.
- .4 Wherever possible, access doors to be of a standard size for each application. Confirm exact dimensions and minimum size restrictions with Consultant prior to ordering.
- .5 Group piping and ductwork to ensure minimum number of access doors is required.
- .6 Submit a sample of each proposed access door for review prior to ordering.
- .7 Coordinate with Electrical Contractor and General Trades Contractor to ensure access doors on project are provided by a single manufacturer, installed as part of work of General Trades Contractor and work involving both mechanical and electrical services should, where possible, be accessible from common access door. Coordinate work to ensure common location access doors are not supplied by both Mechanical Divisions and Electrical Divisions.

3.10 INSTALLATION OF VALVES

- .1 Generally, valve locations are indicated or specified on drawings or specified in Sections of the Specification where valves are specified, however, regardless of locations shown or specified, following requirements apply:
 - .1 provide shut-off valves to isolate systems, at base of vertical risers, in branch take-offs at mains and risers on floors, to isolate equipment, to permit work phasing as required, and wherever else required for proper system operation and maintenance;
 - .2 install shut-off valves with handles upright or horizontal, not inverted, and located for easy access;
 - .3 unless otherwise specified, provide a check valve in discharge piping of each pump;
 - .4 valve sizes are to be same as connecting pipe size;
 - .5 valves are to be permanently identified with size, manufacturer's name, valve model or figure number and pressure rating, and wherever possible, valves are to be product of same manufacturer;

- .6 for valves in insulated piping, design of valve stem, handle and operating mechanism is to be such that insulation does not have to be cut or altered in any manner to permit valve operation.

3.11 INSTALLATION OF PRESSURE GAUGES AND THERMOMETERS

- .1 Provide pressure gauges in following locations:
 - .1 in valved tubing across suction, suction strainer (if applicable), and discharge piping of each circulating pump;
 - .2 in supply and return piping connections to main mechanical plant equipment such as boilers, chillers, heat exchangers, main coils, etc.;
 - .3 in expansion tank(s);
 - .4 in piping at each side of a pressure reducing valve;
 - .5 wherever else shown and/or specified.
- .2 Provide thermometers in following locations:
 - .1 in supply and return piping connections to main mechanical plant equipment such as boilers, chillers, cooling towers, heat exchangers, main coils, etc., unless temperature indication is supplied with equipment;
 - .2 wherever else shown and/or specified.
- .3 Conform to following installation requirements:
 - .1 for installation of thermometers in piping wells, provide a coat of metallic base heat transfer paste or grease in piping well;
 - .2 for pressure gauges in piping at equipment locations, install pressure gauge between equipment and first pipe fitting;
 - .3 locate, mount and adjust instruments so they are easily readable;
 - .4 where pressure gauges and/or thermometers are located at high level or in an area where they cannot be easily seen, provide remote reading instruments.

3.12 INSTALLATION OF EQUIPMENT DRIVE GUARDS AND ACCESSORIES

- .1 Provide OSHA guards for exposed accessible rotating parts such as belt drives, couplings, fan wheels, and shaft ends on mechanical equipment.
- .2 Install belt guards to allow movement of motors for adjusting belt tension.
- .3 Provide a means to permit lubrication and use of test instruments with guards in place.
- .4 Secure guards to equipment or equipment base but do not bridge sound or vibration isolation.

- .5 Where equipment oil level gauges, oil reservoirs, grease cups, or grease gun fittings are integral with equipment but are not easily accessible for service, extend to an accessible location using aluminium or copper tubing.

3.13 MECHANICAL WORK IDENTIFICATION

- .1 Identify new exposed piping and ductwork as per Part 2 of this Section in locations as follows:
 - .1 at every end of every piping or duct run;
 - .2 adjacent to each valve, strainer, damper and similar accessory;
 - .3 at each piece of connecting equipment;
 - .4 on both sides of every pipe and duct passing through a floor, wall or partition, unless otherwise specified;
 - .5 at 6 m (20') intervals on pipe and duct runs exceeding 6 m (20') in length;
 - .6 at least once in each room, and at least once on pipe and duct runs less than 6 m (20') in length.
- .2 Unless otherwise specified identify new concealed piping and ductwork as per Part 2 of this Section in locations as follows:
 - .1 at points where pipes or ducts enter and leave rooms, shafts, pipe chases, furred spaces, and similar areas;
 - .2 at maximum 6 m (20') intervals on piping and ductwork above suspended accessible ceilings, and at least once in each room;
 - .3 at each access door location;
 - .4 at each piece of connected equipment, automatic valve, etc..
- .3 Provide an identification nameplate for equipment provided as part of this project, including items such as control valves, motorized dampers, instruments, and similar products. Secure nameplates in place, approximately at eye level if possible, with stainless steel screws unless such a practice is prohibitive, in which case use epoxy cement applied to cleaned surfaces. Locate nameplates in the most conspicuous and readable location.
- .4 Paint new natural and/or propane gas piping with primer and 2 coats of yellow paint in accordance with Code requirements and requirements of Painting Section in Division 09. Identify piping at intervals as specified above.
- .5 Provide an identification nameplate for each motor starter or disconnect switch located in a motor control centre or on a motor starter panel, and on each individually mounted starter provided as part of mechanical work, and on each disconnect switch provided as part of the electrical work for motorized equipment provided as part of mechanical work.
- .6 Tag valves and prepare a valve tag chart in accordance with following requirements:

- .1 attach a valve tag to each new valve, except for valves located immediately at equipment they control;
- .2 prepare a computer printed valve tag chart to list tagged valves, with, for each valve, the tag number, location, valve size, piping service, and valve attitude (normally open or normally closed);
- .3 if an existing valve tag chart is available at site, valve tag numbering is to be an extension of existing numbering and new valve tag chart is to incorporate existing chart;
- .4 frame and glaze one copy of chart and, unless otherwise directed, affix to a wall in each main Mechanical and/or Equipment Room;
- .5 include a copy of valve tag chart in each copy of operating and maintenance instruction manuals;
- .6 hand an identified CD of valve tag chart to Owner at same time O & M Manuals are submitted.
- .7 Where shut-off valves, control dampers, sensors, and similar items which will or may need maintenance and/or repair are located above accessible suspended ceilings, provide round coloured ceiling tacks in ceiling panel material, or stickers equal to Brady "Quick Dot" on ceiling grid material to indicate locations of items. Unless otherwise specified, ceiling tack or sticker colours are to be as follows:
 - .1 HVAC piping valves and equipment: yellow
 - .2 fire protection valves and equipment: red
 - .3 plumbing valves and equipment: green
 - .4 HVAC ductwork dampers and equipment: blue
 - .5 control system hardware and equipment: orange

3.14 PIPE LEAKAGE TESTING

- .1 Before piping has been insulated or concealed, and before equipment, fixtures and fittings have been connected, test piping for leakage.
- .2 Tests are to be witnessed by Consultant and/or Owner's representative, and, where required, representatives of governing authorities. Give ample notice of tests in writing and verify attendance. Have completed test report sheets dated and signed by those present to confirm proper test results.
- .3 When circumstances prevent scheduled tests from taking place, give immediate and adequate notice of cancellation to all who were scheduled to attend.
- .4 Gravity Drainage and Vent Piping
 - .1 Test piping in accordance with local governing building code.

- .2 After fixtures and fittings are set and pipes are connected to building drain or drains, turn on water into pipe, fixtures, fittings and traps in order to detect any imperfect material or workmanship. Perform a smoke test if required by local governing authorities.
- .5 Domestic Water Piping
 - .1 Test piping with cold water at a pressure of 1-½ times normal working pressure and maintain pressure for a minimum of 2 hours.
- .6 Sprinkler System Piping
 - .1 Test system piping in accordance with requirements of NFPA No. 13, "Installation of Sprinkler Systems", and in accordance with any additional requirements of governing authorities.
- .7 Natural Gas Piping
 - .1 Test piping in accordance with requirements of CAN/CSA B149.1 and any additional requirements of local governing authorities.
 - .2 After completion of the verification test, locate required tag stating results of the verification test at the point of entry of gas main into building, affixed to the pipe in a secure manner.
 - .3 Check piping joints and connections for leaks with a water/soap solution while piping is under pressure.
- .8 Following requirements apply to all testing:
 - .1 ensure piping has been properly flushed, cleaned and is clear of foreign matter prior to pressure testing;
 - .2 temporarily remove or valve off piping system specialties or equipment which may be damaged by test pressures prior to pressure testing systems, and flush piping to remove foreign matter;
 - .3 when testing is carried out below highest level of the particular system, increase test pressure by the hydrostatic head of 7 kPa (1 psi) for every 600 mm (24") below the high point;
 - .4 include for temporary piping connections required to properly complete tests;
 - .5 piping under test pressure is to have zero pressure drop for length of test period;
 - .6 make tight leaks found during tests while piping is under pressure, and if this is impossible, remove and refit piping and reapply test until satisfactory results are obtained;
 - .7 where leaks occur in threaded joints in steel piping, no caulking of these joints will be allowed under any conditions;
 - .8 tests are to be done in reasonably sized sections so as to minimize number of tests required;

- .9 in addition to leakage tests specified above, demonstrate proper flow throughout systems including mains, connections and equipment, as well as proper venting and drainage, and include for any necessary system adjustments to achieve proper conditions.

3.15 SUPPLY OF MOTOR STARTERS AND ACCESSORIES

- .1 Motor starters for mechanical equipment, except for starters integral with packaged equipment and starters factory installed in equipment power and control panels, will be provided as part of the electrical work.

3.16 ELECTRICAL WIRING WORK FOR MECHANICAL WORK

- .1 Unless otherwise specified or indicated, following electrical wiring work for mechanical equipment will be done as part of the electrical work:
 - .1 "line" side power wiring to motor starters or disconnect switches in motor control centres and starters or disconnects on motor starter panels, and "load" side wiring from starters or disconnects to equipment;
 - .2 "line" side power wiring to individual wall mounted starters, and "load" side wiring from starters to equipment;
 - .3 "line" side power wiring to pre-wired power and control panels and variable frequency drives (VFD), and "load" side power wiring from the panels and VFD's to equipment;
 - .4 provision of receptacles for plug-in equipment;
 - .5 provision of disconnect switches for motors in excess of 10 m (30') from starter location, or cannot be seen from starter location, and associated power wiring;
 - .6 motor starter interlocking in excess of 24 volts;
 - .7 120 volt power connections to electrical receptacles integral with small ceiling exhaust fans, including wiring through light switches or speed controllers;
 - .8 120 volt wiring connections to lighting fixture/switch combinations integral with air handling units;
 - .9 120 volt wiring connections to duplex receptacles integral with air handling unit control panels.
- .2 Mechanical wiring work not listed above or specified herein or on drawings to be done as part of electrical work is to be installed in conduit and is to be done as part of mechanical work in accordance with wiring requirements specified for electrical work.

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

- .1 Coordinate shut-down and interruption to existing mechanical systems with Owner. Generally, shut-downs may be performed only between the hours of 12:00 midnight Friday until 6:00 a.m. Monday morning. Include for costs of premium time to perform work during nights, weekends or other times outside of normal working hours, which may be necessary to comply with stipulations specified herein this Article. Services for operation of existing non-renovated areas of building are to be maintained.

- .2 Upon award of a Contract, submit a list of anticipated shut-down times and their maximum duration.
- .3 Prior to each shut-down or interruption, inform Owner and Consultant in writing 5 working days in advance of proposed shut-down or interruption and obtain written consent to proceed. Do not shut-down or interrupt any system or service without such written consent. Shutdowns of some essential services may require additional advance notification time.
- .4 Perform work associated with shut-downs and interruptions as continuous operations to minimize shut-down time and to reinstate systems as soon as possible, and, prior to any shut-down, ensure materials and labour required to complete the work for which shut-down is required are available at site.
- .5 Pipe freezing may be used to connect new piping to existing piping without draining existing piping. Pipe freeze equipment is to be equal to "NORDIC FREEZE" equipment supplied by Mag Tool Inc. (1-800-661-9983) or Rigid Tool Co. RIGID "SuperFreeze".

3.18 CUTTING, PATCHING AND CORE DRILLING

- .1 Unless otherwise provided by General Trades, perform cutting, patching, and core drilling of existing building required for installation of mechanical work. Perform cutting in a neat and true fashion, with proper tools and equipment to Consultant's approval. Patching is to exactly match existing finishes and be performed by tradesmen skilled in particular trade or application. Work is subject to review and acceptance by Consultant.
- .2 Criteria for cutting holes for additional services:
 - .1 cut holes through slabs only; no holes to be cut through beams;
 - .2 cut holes 150 mm (6") diameter or smaller only; obtain approval from Structural Consultant for larger holes;
 - .3 keep at least 100 mm (4") clear from beam faces;
 - .4 space at least 3 hole diameters on centre;
 - .5 for holes that are required closer than 25% of slab span from supporting beam face, use cover meter above slab to clear slab top bars;
 - .6 for holes that are required within 50% of slab span, use cover meter underside of slab to clear slab bottom bars;
 - .7 submit sleeving drawings indicating holes and their locations for Structural Consultant's review.
- .3 Do not cut or drill any existing work without approval from Owner and Consultant. Be responsible for damage done to building and services caused by cutting or drilling.
- .4 Where pipes pass through existing construction, core drill an opening. Size openings to leave 12 mm (½") clearance around pipes or pipe insulation.

- .5 Prior to drilling or cutting an opening, determine, in consultation with Consultant and Owner, and by use of non-destructive radar scan (magnetic scan) of slab or wall, presence of any existing services and reinforcement bars concealed behind building surface to be cut and locate openings to suit. Coring is not permitted through concrete beams or girders.
- .6 Where drilling is required in waterproof slabs, size opening to permit snug and tight installation of a pipe sleeve sized to leave 12 mm (½") clearance around pipe or pipe insulation. Provide a pipe sleeve, constructed of Schedule 40 galvanized steel pipe with a flange at one end and of a length to extend 100 mm (4") above slab, in opening. Secure flange to the underside of slab and caulk void between sleeve and slab opening with proper non-hardening silicone base caulking compound to produce a water-tight installation.
- .7 Firestop and seal openings in fire rated construction in accordance with requirements of article entitled Firestopping and Smoke Seal Materials in this Section. Do not leave openings open overnight unless approved by Owner and Consultant.

3.19 PACKING AND SEALING CORE DRILLED PIPE OPENINGS

- .1 Pack and seal void between pipe opening and pipe or pipe insulation for length of opening as follows:
 - .1 non-fire rated interior construction – pack with mineral wool and seal both ends of opening with non-hardening silicone base caulking compound to produce a water-tight seal;
 - .2 exterior walls above grade – pack with mineral wool and seal both ends of sleeves water-tight with non-hardening silicone base caulking compound unless mechanical type seals have been specified;
 - .3 exterior walls below grade (and any other wall where water leakage may be a problem) – seal with link type mechanical seals as specified.

3.20 FLASHING FOR MECHANICAL WORK PENETRATING ROOF

- .1 Perform required flashing work, including counter-flashing, for mechanical work penetrating and/or set in roof.
- .2 Perform flashing work in accordance with requirements of drawing details, and requirements specified in Division 07.

3.21 CLEANING MECHANICAL WORK

- .1 Refer to cleaning requirements specified in Division 01.
- .2 Clean mechanical work prior to application for Substantial Performance of the Work.
- .3 Include for vacuum cleaning interior of air handling units and ductwork systems.

3.22 CONNECTIONS TO OTHER EQUIPMENT

- .1 Carefully examine Contract Documents during bidding period and include for mechanical work piping and/or ductwork connections to equipment requiring such connections.

3.23 INSTALLATION OF FLEXIBLE CONNECTORS

- .1 Provide flexible connectors in piping connections to seismically restrained equipment, and wherever else shown.
- .2 Provide flexible connectors in piping connections to vibration isolated equipment.

3.24 FAN NOISE LEVELS

- .1 Submit sound power levels with fan shop drawings/product data, with levels measured to AMCA 300 and calculated to AMCA 301.

3.25 EQUIPMENT AND SYSTEM MANUFACTURER'S CERTIFICATION

- .1 When equipment/system installation is complete, but prior to start-up procedures, arrange and pay for equipment/system manufacturer's authorized representative to visit site to examine installation, and after any required corrective measures have been made, to certify in writing to Consultant that equipment/system installation is complete and in accordance with equipment/system manufacturer's instructions.

3.26 EQUIPMENT AND SYSTEM START-UP

- .1 When installation of equipment/systems is complete but prior to commissioning, perform start-up for equipment/systems as specified in mechanical work Sections in accordance with following requirements:
 - .1 submit a copy of each equipment/system manufacturer's start-up report sheet to Consultant for review, and incorporate any comments made by Consultant;
 - .2 under direct on-site supervision and involvement of equipment/system manufacturer's representative, start-up equipment/systems, make any required adjustments, document procedures, leave equipment/systems in proper operating condition, and submit to Consultant complete set of start-up documentation sheets signed by manufacturer/supplier and Contractor.

END OF SECTION

1 GENERAL

1.01 APPLICATION

- .1 This Section specifies vibration isolation product requirements that are common to mechanical work Sections of the Specification and it is a supplement to each Section and is to be read accordingly. n

1.02 SUBMITTALS

- .1 Submit copies of manufacturer's product data sheets for products specified in this Section. Product data sheets are to include product characteristics, limitations, dimensions, finishes, and installation recommendations.
- .2 Submit a letter from vibration isolation manufacturer to certify correct installation of products, as specified in Part 3 of this Section.

2 PRODUCTS

2.01 GENERAL

- .1 Vibration isolation products are to be in accordance with drawing schedule and details, and as specified below.
- .2 Springs are to be stable, colour coded, selected to operate at no greater than $\frac{2}{3}$ solid load, designed in accordance with Society of Automotive Engineers Handbook Supplement 9 entitled Manual on Design and Application of Helical and Spiral Springs, and with spring diameters in accordance with manufacturer's recommendations to suit static deflection and maximum equipment load.
- .3 Steel components of isolation products not exposed to the weather or moisture are to be zinc plated. Steel components of isolation products exposed to the weather or in a damp, moist environment are to be factory painted with rust inhibiting primer and 2 coats of neoprene.
- .4 Where weight of isolated equipment may change significantly due to draining or filling with a liquid, vibration isolators are to be equipped with limit stops to limit spring extensions.
- .5 Flexible piping connections to vibration isolated equipment are specified in the appropriate piping sections of the Specification.

2.02 ISOLATION PADS

- .1 Sandwich type pads, 20 mm ($\frac{3}{4}$ ") nominal thickness, selected for 3.2 mm ($\frac{1}{8}$ ") static deflection unless otherwise specified, consisting of 2 waffle type or ribbed 50 durometer neoprene pads permanently bonded to a minimum #10 gauge steel plate, and complete with rubber bushed bolt holes and equipment anchor bolts with neoprene isolation grommets.
- .2 Acceptable products are:
 - .1 Vibro-Acoustics Ltd. Type NSN;
 - .2 The VMC Group Vibration Mounting & Controls Inc. (Korfund-Dynamics) "SHEAR-FLEX PLATES";

- .3 Kinetics Noise Control Vibron Products Group Type NGS/NGD;
- .4 Mason Industries Inc. Type SW/S/SW with HG Bolt Insertion Washers;
- .5 J. P. America Inc. Type JSJ.

2.03 SPRING HANGERS

- .1 Welded steel plate housing with top and bottom rod mounting holes and spring retainer, neoprene double deflection isolation element, stable colour coded spring, and heavy-duty rubber washers.
- .2 Acceptable products are:
 - .1 Vibro-Acoustics Ltd. Type SHR-SN;
 - .2 The VMC Group Vibration Mounting & Controls (Korfund-Dynamics) "Spring-Flex" Series HRSA;
 - .3 Kinetics Noise Control Vibron Products Group. Type SRH;
 - .4 Mason Industries Inc. Type 30N;
 - .5 J. P. America Inc. Type TSH.

2.04 NEOPRENE HANGER ISOLATORS

- .1 Neoprene double deflection rod isolators with steel housing and hanger rod bushing, selected for a minimum 4 mm (0.15") static deflection unless otherwise specified.
- .2 Acceptable products are:
 - .1 Vibro-Acoustics Ltd. Type NH;
 - .2 The VMC Group Vibration Mounting & Controls (Korfund-Dynamics) Type HR;
 - .3 Kinetics Noise Control Vibron Products Group Type RH;
 - .4 Mason Industries Inc. Type HD or WHD;
 - .5 J. P. America Inc. Type TRH.

3 EXECUTION

3.01 INSTALLATION OF VIBRATION ISOLATION MATERIALS

- .1 Provide vibration isolation products for mechanical work in accordance with drawing schedule and details, and requirements specified herein and/or on drawings.
- .2 Supply to vibration isolation product manufacturer or supplier a copy of a "reviewed" shop drawing or product data sheet for each piece of equipment to be isolated and dimensioned pipe layouts of associated piping to be isolated.
- .3 Unless otherwise specified, vibration isolation products are to be product of one manufacturer.

- .4 Ensure vibration isolation manufacturer coordinates material selections with equipment provided in order to ensure adherence to performance criteria. Allow for expansion and contraction when material is selected and installed.
- .5 Isolate piping larger than 25 mm (1") dia. directly connected to motorized and/or vibration isolated equipment with 25 mm (1") static deflection spring hangers at spacing intervals in accordance with following:
 - .1 for pipe less than or equal to 100 mm (4") dia. – first 3 points of support;
 - .2 for pipe 125 mm (5") to 200 mm (8") dia. – first 4 points of support;
 - .3 for pipe equal to or greater than 250 mm (10") dia. – first 6 points of support;
- .6 First point of isolated piping support is to have a static deflection of twice the deflection of the isolated equipment but maximum 50 mm (2").
- .7 Secure top of spring hanger frame rigidly to structure, and do not install spring hangers in concealed locations.
- .8 Where it is impossible to use at least 2 spring hangers, provide Senior Flexonics Ltd. Style 102 (or 102-U as required) or equal, twin sphere, moulded rubber flexible connection assemblies, selected by manufacturer and suitable in all respects for intended application, and complete with required nipples and connections to provide proper vibration isolation.
- .9 For control wiring connections to vibration isolated equipment ensure flexible metallic conduit with 90° bend is used for conduit 25 mm (1") dia. and smaller, and for conduit larger than 25 mm (1") dia., use Crouse Hinds EC couplings. Connections are to be long enough so that conduit will remain intact if equipment moves 300 mm (12") laterally from its installed position, and flexible enough to transmit less vibration to structure than is transmitted through vibration isolation. Coordinate these requirements with mechanical trades involved. If electrical power connections are not made in a similar manner as part of the electrical work, report this fact to Consultant.
- .10 Arrange and pay for vibration isolation product manufacturer to visit site to inspect installation of his equipment. Perform revision work required as a result of improper installation. When vibration isolation equipment manufacturer is satisfied with the installation, obtain and submit a letter stating manufacturer has inspected the installation and equipment is properly installed.

END OF SECTION

1 GENERAL

1.01 APPLICATION

- .1 This Section specifies insulation requirements common to Mechanical Divisions work Sections and it is a supplement to each Section and is to be read accordingly.

1.02 DEFINITIONS

- .1 "concealed" – means mechanical services and equipment above suspended ceilings, in non-accessible chases, in accessible pipe spaces, and furred-in spaces.
- .2 "exposed" – means exposed to normal view during normal conditions and operations.
- .3 "mineral fibre" – includes glass fibre, rock wool, and slag wool.
- .4 "domestic water" or "potable water" – means piping extended from building Municipal supply main.

1.03 SUBMITTALS

- .1 Submit a product data sheet for each insulation system product.
- .2 In accordance with Part 3 of this Section, submit a letter from fire rated duct wrap supplier to certifying duct wrap has been properly installed.

1.04 QUALITY ASSURANCE

- .1 Mechanical insulation is to be applied by a licensed journeyman insulation mechanic, or by an apprentice under direct, daily, on-site supervision of a journeyman mechanic.
- .2 Do not apply insulation unless leakage tests have been satisfactorily completed.
- .3 Ensure surfaces to be insulated are clean and dry.
- .4 Ensure ambient temperature is minimum 13°C (55°F) for at least 1 day prior to application of insulation, and for duration of insulation work, and relative humidity is and will be at a level such that mildew will not form on insulation materials.
- .5 Insulation materials must be stored on site in a proper and dry storage area. Any wet insulation material is to be removed from site.

2 PRODUCTS

2.01 FIRE HAZARD RATINGS

- .1 Unless otherwise specified, insulation system materials inside building must have a fire hazard rating of not more than 25 for flame spread and 50 for smoke developed when tested in accordance with ULC S102, Surface Burning Characteristics of Building Materials and Assemblies.

2.02 THERMAL PERFORMANCE

- .1 Unless otherwise specified, thermal performance of insulation is to meet or exceed values given in Tables entitled Minimum Piping Insulation Thickness Heating and Hot Water Systems and Minimum Piping Insulation Thickness Cooling Systems, as stated in ANSI/ASHRAE/IES Standard 90.1 version referenced in Ontario Building Code.

2.03 PIPE INSULATION MATERIALS

- .1 Horizontal pipe insulation at hangers and supports are to be equal to Belform Insulation Ltd. "Koolphen K-Block" insulated pipe support inserts consisting of minimum 150 mm (6") long, pre-moulded, rigid, sectional phenolic foam insulation (of same thickness as adjoining insulation) with a reinforced foil and kraft paper vapour barrier jacket and a captive galvanized steel saddle.
- .2 Pre-moulded mineral fibre is to be rigid, sectional, sleeve type insulation to ASTM C547, with a factory applied vapour barrier jacket. Acceptable products are:
 - .1 Johns Manville Inc. "Micro-Lok AP-T Plus";
 - .2 Knauf Fiber Glass "Pipe Insulation" with "ASJ-SSL" jacket;
 - .3 Manson Insulation Inc. "ALLEY K APT";
 - .4 Owens Corning "Fiberglas" Pipe Insulation.
- .3 Blanket mineral fibre is to be blanket type roll insulation to CGSB 51-GP-11M, 24 kg/m³ (1-½ lb/ft³) density, with a factory applied vapour barrier facing. Acceptable products are:
 - .1 Johns Manville Inc. Microlite FSK Duct Wrap Type 150;
 - .2 Knauf Fiber Glass Blanket Insulation FSK Duct Wrap Type III;
 - .3 Manson Insulation Inc. ALLEY WRAP FSK Duct Wrap Type III;
 - .4 Certainteed Corporation Softtouch FSK Duct Wrap Type 150.

2.04 BARRIER-FREE LAVATORY PIPING INSULATION KITS

- .1 Removable, flexible, reusable, white moulded plastic insulation kits for barrier-free lavatory drain piping and potable water supplies exposed under lavatory.
- .2 Acceptable products are:
 - .1 Truebo "Lav-Guard 2" E-Z Series;
 - .2 Zeston "SNAP-TRAP";
 - .3 McGuire Manufacturing Co. Inc. "ProWrap".

2.05 EQUIPMENT INSULATION MATERIALS

- .1 Blanket mineral fibre is to be blanket type roll form insulation to ASTM C553, 24 kg/m³ (1-½ lb/ft³) density, with a factory applied vapour barrier facing. Acceptable products are:

- .1 Johns Manville Inc. Microlite FSK Duct Wrap Type 150;
- .2 Knauf Fiber Glass Blanket Insulation FSK Duct Wrap Type III;
- .3 Manson Insulation Inc. ALLEY WRAP FSK Duct Wrap Type III;
- .4 Certainteed Corporation Softtouch FSK Duct Wrap Type 150.

2.06 REMOVABLE/REUSABLE INSULATION COVERS

- .1 Valve, etc. covers are to be NO SWEAT reusable insulation wraps with vapour barrier jacket and self-sealing ends and longitudinal seam, with a length to suit the application and an insulation thickness equal to adjoining insulation.

2.07 DUCTWORK SYSTEM INSULATION MATERIALS

- .1 Rigid mineral fibre board is to be pre-formed board type insulation to ASTM C612, 48 kg/m³ (3 lb/ft³) density, with a factory applied reinforced aluminum foil and kraft paper facing. Acceptable products are:
 - .1 Knauf Fiber Glass Insulation Board with FSK facing;
 - .2 Manson Insulation Inc. "AK BOARD FSK";
 - .3 Johns Manville Inc. Type 814 "Spin-Glas";
 - .4 Owens Corning 703.
- .2 Semi-rigid mineral fibre board is to be roll form insulation to ASTM C1393, consisting of cut strips of rigid mineral board insulation glued to an aluminium foil and kraft paper facing. Acceptable products are:
 - .1 Multi-Glass Insulation Ltd. "Multi-Flex MKF";
 - .2 Glass-Cell Fabricators Ltd. "R-FLEX";
 - .3 Owens Corning Pipe and Tank Insulation;
 - .4 Johns Manville Inc. Pipe and Tank Insulation.
- .3 Blanket mineral fibre is to be blanket type roll form insulation to ASTM C553, 24 kg/m³ (1½ lb/ft³) density, 40 mm (1½") thick, with a factory applied vapour barrier facing. Acceptable products are:
 - .1 Johns Manville Inc. Microlite FSK Duct Wrap Type 150;
 - .2 Knauf Fiber Glass Blanket Insulation FSK Duct Wrap Type III;
 - .3 Manson Insulation Inc. ALLEY WRAP FSK Duct Wrap Type III;
 - .4 Certainteed Corporation Softtouch FSK Duct Wrap Type 150.
- .4 Flexible foam elastomeric sheet is to be sheet form, CFC free, closed cell, self-adhering elastomeric nitrile rubber insulation with a water vapour permeability rating of 0.08 in accordance with ASTM E96 Procedure A. Acceptable products are:

- .1 Armacell "AP/Armaflex SA";
- .2 IK Insulation Group "K-Flex Duct Wrap", S2S.

2.08 INSULATING COATINGS

- .1 Equal to Robson Thermal Manufacturing Ltd. insulating coatings as follows:
 - .1 anti-condensation coating, "No Sweat-FX";
 - .2 thermal insulating coating, "ThermaLite".

2.09 INSULATION FASTENINGS

- .1 Wire – minimum #15 gauge galvanized annealed wire.
- .2 Wire with Mesh – minimum #15 gauge galvanized annealed wire factory woven into 25 mm (1") hexagonal mesh.
- .3 Aluminium Banding – equal to ITW Insulation Systems Canada "FABSTRAPS" minimum 12 mm (½") wide, 0.6 mm (1/16") thick aluminium strapping.
- .4 Duct Insulation Fasteners – weld-on 2 mm (3/32") diameter zinc coated steel spindles of suitable length, complete with minimum 40 mm (1-½") square plastic or zinc plated steel self-locking washers.
- .5 Tape Sealant – equal to MACtac Canada Ltd. self-adhesive insulation tapes, types PAF, FSK, ASJ, or SWV as required to match surface being sealed.
- .6 Mineral Fibre Insulation Adhesive – clear, pressure sensitive, brush consistency adhesive, suitable for a temperature range of -20°C to 82°C (-4°F to 180°F), compatible with type of material to be secured, and WHMIS classified as non-hazardous.
- .7 Flexible Elastomeric Insulation Adhesive – Armacell "Armaflex" #520 air-drying contact adhesive.
- .8 Lagging Adhesive – white, brush consistency, ULC listed and labelled, 25/50 fire/smoke rated lagging adhesive for canvas jacket fabric, suitable for colour tinting, complete with fungicide and washable when dry.
- .9 Screws – No. 10 stainless steel sheet metal screws.

2.10 INSULATION JACKETS AND FINISHES

- .1 Canvas Jacket Material – ULC listed and labelled, 25/50 fire/smoke rated, roll form, minimum 170 g (6 oz.).
- .2 Roll Form Sheet and Fitting Covers – minimum 15 mil (0.4mm) thick white PVC, 25/50 fire/smoke rated tested in accordance with ULC S102, complete with installation and sealing accessories. Acceptable products are:
 - .1 Proto Corp. "LoSMOKE";
 - .2 The Sure-Fit System "SMOKE-LESS 25/50";

- .3 Johns Manville Inc. "Zeston" 300.
- .3 Rigid Aluminium Jacket – equal to ITW Insulation Systems Canada "Lock-on" 0.406 mm (0.016") thick embossed aluminum jacket material to ASTM B209, factory cut to size and complete with polysurlyn moisture barrier and continuous modified Pittsburgh Z-Lock, butt straps with "Fabstraps" to weatherproof the end to end joints, and 2-piece epoxy coated pressed aluminum fittings with weather locking edges.
- .4 Flexible foam elastomeric insulation protective coating equal to Armacell "WB Armaflex" weatherproof, water-based latex enamel finish.

3 EXECUTION

3.01 GENERAL INSULATION APPLICATION REQUIREMENTS

- .1 Unless otherwise specified, do not insulate following:
 - .1 factory insulated equipment and piping;
 - .2 heating piping within radiation unit enclosures, including blank filler sections of enclosures;
 - .3 branch potable water piping located under counters to serve counter mounted plumbing fixtures and fittings, except barrier-free lavatories;
 - .4 exposed chrome plated potable water angle supplies from concealed piping to plumbing fixtures and fittings, except barrier-free lavatories;
 - .5 manufactured expansion joints and flexible connections;
 - .6 acoustically lined ductwork and/or equipment;
 - .7 factory insulated flexible branch ductwork;
 - .8 piping unions, except for unions in "cold" category piping.
- .2 Install insulation directly over pipes and ducts, not over hangers and supports.
- .3 Install piping insulation and jacket continuous through pipe openings and sleeves.
- .4 Install duct insulation continuous through walls, partitions, and similar surfaces except at fire dampers.
- .5 When insulating "cold" piping and equipment, extend insulation up valve bodies and other such projections as far as possible, and protect insulation jacketing from the action of condensation at its junction with metal.
- .6 When insulating vertical piping risers 75 mm (3") diameter and larger, use insulation support rings welded directly above lowest pipe fitting, and thereafter at 4.5 m (14.7') centres and at each valve and flange. Insulate as per Thermal Insulation Association of Canada National Insulation Standards, Figure No. 9.
- .7 Where existing insulation work is damaged as a result of mechanical work, repair damaged insulation work to Project work standards.

- .8 Where mineral fibre rigid sleeve type insulation is terminated at valves, equipment, unions, etc., neatly cover exposed end of insulation with a purpose made PVC cover on "cold" piping, and with canvas jacket material on "hot" piping.
- .9 Carefully and neatly gouge out insulation for proper fit where there is interference between weld bead, mechanical joints, etc., and insulation. Bevel away from studs and nuts to permit their removal without damage to insulation, and closely and neatly trim around extending parts of pipe saddles.
- .10 Where thermometers, gauges, and similar instruments occur in insulated piping, and where access to heat transfer piping balancing valve ports and similar items are required, create a neat, properly sized hole in insulation and provide a suitable grommet in the opening.

3.02 INSULATION FOR HORIZONTAL PIPE AT HANGERS AND SUPPORTS

- .1 At each hanger and support location for piping 50 mm (2") diameter and larger and scheduled to be insulated, except where roller hangers and/or supports are required, and unless otherwise specified, supply a factory fabricated section of phenolic foam pipe insulation with integral vapour barrier jacket and captive galvanized steel shield. Supply insulation sections to piping installers for installation as pipe is erected.
- .2 For 100 mm (4") diameter and larger heating system piping where roller type hangers and supports are provided, a steel saddle will be tack welded to pipe at each roller hanger or support location. Pack saddle voids with loose mineral wool insulation.

3.03 PIPE INSULATION REQUIREMENTS – MINERAL FIBRE

- .1 Insulate following pipe inside building and above ground with mineral fibre insulation of thickness indicated:
 - .1 domestic cold water piping, less than 100 mm (4") dia. – 25 mm (1") thick;
 - .2 domestic cold water piping, greater than or equal to 100 mm (4") dia. – 40 mm (1-½") thick;
 - .3 domestic hot water piping, less than 40 mm (1-½") dia. – 25 mm (1") thick;
 - .4 domestic hot water piping, greater than or equal to 40 mm (1½") dia. – 40 mm (1-½") thick;
 - .5 storm drainage piping from roof drains to the point where main vertical risers extend straight down, without offsets, and connect to horizontal underground mains – 25 mm (1") thick;
 - .6 condensate drainage piping from fan coil unit or any other air conditioning system/unit drain pans to main vertical drain risers or to indirect drainage point – 25 mm (1") thick;
- .2 Secure overlap flap of the sectional insulation jacket tightly in place. Cover section to section butt joints with tape sealant.

- .3 Insulate fittings with sectional pipe insulation mitred to fit tightly, and cover butt joints with tape sealant, or, alternatively, wrap fittings with blanket mineral fibre insulation to a thickness and insulating value equal to the sectional insulation, secure in place with adhesive and/or wire, and cover with PVC fitting covers.
- .4 Unless otherwise specified, insulate unions, valves, strainers, and similar piping system accessories in "cold" piping with cut and tightly fitted segments of sectional pipe insulation with joints covered with tape sealant, or, alternatively, wrap piping union, valve, strainer, etc., with blanket mineral fibre and cover with PVC covers as for paragraph above.
- .5 Terminate sectional insulation approximately 50 mm (2") from flange or coupling on each side of flange or coupling. Cover flange or coupling with a minimum 50 mm (2") thickness of blanket mineral fibre insulation wide enough to butt tightly to ends of adjacent sectional insulation. Secure blanket insulation in place and cover with a purpose made PVC coupling cover.
- .6 Take special care at concealed water rough-in piping at plumbing fixtures to ensure piping is properly insulated. If necessary due to space limitations, use 12 mm (½") thick sectional pipe insulation in lieu of 25 mm (1") thick insulation.

3.04 INSTALLATION OF BARRIER FREE LAVATORY INSULATION KITS

- .1 Provide manufactured insulation kits to cover exposed drainage and water piping under barrier free lavatories.

3.05 EQUIPMENT INSULATION REQUIREMENTS – BLANKET TYPE MINERAL FIBRE

- .1 Insulate following equipment with mineral fibre blanket type insulation of thickness indicated:
 - .1 roof drain sumps where inside the building – 25 mm (1") thick;
- .2 Unless otherwise noted, wrap equipment to a thickness and insulating value equal to an equivalent thickness of rigid sectional pipe insulation. Laminate insulation in place with a full coverage of adhesive and secure with wire. Apply a jacket of insulation vapour barrier material secured in place with adhesive or sealant tape.
- .3 Cover roof drain sumps with purpose made PVC fitting covers.
- .4 Lay fibreglass blanket on radiant ceiling panels after testing is complete.

3.06 DUCTWORK INSULATION REQUIREMENTS – MINERAL FIBRE

- .1 Insulate following ductwork systems inside building and above ground with mineral fibre insulation of thickness indicated:
 - .1 outside air intake ductwork, casings and plenums from fresh air intakes to and including mixing plenums or sections, or, if mixing plenums or sections are not provided, to first heating coil, or if both mixing plenums or sections and heating coil sections are not provided, and fresh air is not tempered, then the fresh air ductwork system complete – minimum 40 mm (1-½") thick as required;
 - .2 mixed supply air or preheated supply air casings, plenums and sections to and including the fan section where not factory insulated – minimum 25 mm (1") thick rigid board or minimum 40 mm (1-½") thick flexible blanket as required;

- .3 supply air ductwork outward from fans, except for supply ductwork exposed in area it serves – minimum 25 mm (1") thick rigid board or minimum 40 mm (1-½") thick flexible blanket as required;
 - .4 exhaust discharge ductwork for a distance of 3 m (10') downstream (back) from exhaust openings to atmosphere, including any exhaust plenums within the 3 m (10') distance – minimum 25 mm (1") thick rigid board or minimum 40 mm (1-½") thick flexible blanket as required;
 - .5 any other ductwork, casings, plenums or sections specified or detailed on drawings to be insulated – thickness as specified.
- .2 Provide rigid board type insulation for casings, plenums, and exposed rectangular ductwork. Provide blanket type insulation for round ductwork and concealed rectangular ductwork.
- .3 Liberally apply adhesive to surfaces of exposed rectangular ducts and/or casings. Accurately and neatly press insulation into adhesive with tightly fitted butt joints. Provide pin and washer insulation fasteners at 300 mm (12") centres on bottom and side surfaces. Secure and seal joints with 75 mm (3") wide tape sealant. Additional installation requirements as follows:
- .1 at trapeze hanger locations, install insulation between duct and hanger;
 - .2 provide drywall type metal corner beads on edges of ductwork, casings and plenums in equipment rooms, service corridors, and any other area where insulation is subject to accidental damage, and secure in place with tape sealant.
- .4 Liberally apply adhesive to surfaces of concealed rectangular or oval ductwork, and wrap insulation around duct with a top butt joint and tight section to section butt joints. Provide pin and washer insulation fasteners at 300 mm (12") centres on bottom surfaces. Secure and seal joints with 75 mm (3") tape sealant. At each trapeze type duct hanger, provide a 100 mm (4") wide full length piece of rigid mineral fibre board insulation between duct and hanger.
- .5 Accurately cut sections of insulation to fit tightly and completely around exposed and concealed round or oval ductwork. Liberally apply adhesive to surfaces of duct, and wrap insulation around duct with a top butt joint and tight section to section butt joints. Seal joints with tape sealant. At duct hanger locations install insulation between duct and hanger. At each hanger location for concealed ductwork where flexible blanket insulation is used, provide a 100 mm (4") wide full circumference strip of semi-rigid board type duct insulation between duct and hanger.
- .6 Insulation application requirements common to all types of rigid ductwork are as follows:
- .1 at duct connection flanges, insulate flanges with neatly cut strips of rigid insulation material secured with adhesive to side surfaces of flange with a top strip to cover exposed edges of the side strips, then butt the flat surface duct insulation up tight to flange insulation, or, alternatively, increase insulation thickness to depth of flange and cover top of flanges with tape sealant;
 - .2 installation of fastener pins and washers is to be concurrent with duct insulation application;

- .3 cut insulation fastener pins almost flush to washer and cover with neatly cut pieces of tape sealant;
- .4 accurately and neatly cut and fit insulation at duct accessories such as damper operators (with standoff mounting) and pitot tube access covers;
- .5 prior to concealment of insulation by either construction finishes or canvas jacket material, patch vapour barrier damage by means of tape sealant.

3.07 DUCTWORK INSULATION REQUIREMENTS – FLEXIBLE ELASTOMERIC

- .1 Insulate exposed exterior ductwork (except fresh air intake ductwork) and associated plenums and/or casings outside building with minimum 40 mm (1-½") thick flexible elastomeric sheet insulation as required, applied in 2 minimum 20 mm (¾") thick layers with staggered tightly butted joints.
- .2 Install with adhesive in strict accordance with manufacturer's instructions to produce a weather-proof installation. Ensure sheet metal work joints are sealed watertight prior to applying insulation.

3.08 APPLICATION OF INSULATING COATINGS

- .1 Apply, in accordance with manufacturer's instruction, insulating coatings to following bare metal surfaces:
 - .1 paint bare metal surfaces clear of "cold" piping and/or equipment insulation for a distance of from 300 mm (12") to 600 mm (24") clear of pipe or equipment insulation, with "No Sweat-FX" anti-condensation coating;
 - .2 paint bare metal surfaces associated with mechanical systems with an operating temperature 60°C (140°F) with "ThermaLite" insulating coating.
- .2 Apply coatings with a brush. Remove any splatter or excess coating from adjacent surfaces.

3.09 INSULATION FINISH REQUIREMENTS

- .1 Unless otherwise shown and/or specified, jacket exposed mineral fibre insulation, and calcium silicate duct insulation work inside building with canvas secured in place with a full covering coat of lagging adhesive. Accurately cut canvas with scissors or a knife. Do not rip or tear canvas to size. Remove lagging adhesive splatter from adjacent uninsulated surfaces.
- .2 Jacket exposed pipe insulation work inside building with white sheet PVC and fitting covers. Install sheet PVC and fitting covers tightly in place with overlapped circumferential and longitudinal joints arranged to shed water. Seal joints to produce a neat water-tight installation. Provide slip-type expansion joints where required by manufacturer's instructions.

END OF SECTION

1 GENERAL

1.01 APPLICATION

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

2 PRODUCTS

Not Used

3 EXECUTION

3.01 DISCONNECTION AND REMOVAL OF EXISTING MECHANICAL WORK

- .1 Where indicated on drawings, disconnect and remove existing mechanical work, including hangers, supports, insulation, etc. Disconnect at point of supply, remove obsolete connecting services and make system safe. Cut back obsolete piping behind finishes and cap water-tight unless otherwise specified.
- .2 Scope and extent of demolition or revision work is only generally indicated on drawings. Estimate scope, extent and cost of work at site during bidding period site visit(s). Claims for extra costs for demolition work not shown or specified but clearly visible or ascertainable at site during bidding period site visits will not be allowed.
- .3 If any re-design is required due to discrepancies between mechanical drawings and site conditions, notify Consultant who will issue a Site Instruction. If, in the opinion of Consultant, discrepancies between mechanical drawings and actual site conditions are of a minor nature, required modifications are to be done at no additional cost.
- .4 Where existing mechanical services extend through, or are in an area to serve items which are to remain, maintain services in operation. Include for rerouting existing services concealed behind existing finishes and which become exposed during renovation work, so as to be concealed behind new or existing finishes.
- .5 Unless otherwise specified, remove from site and dispose of existing materials which have been removed and are not to be relocated or reused.

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

- .1 Co-ordinate shut-down and interruption to existing mechanical systems with school. Generally, shut-downs may be performed only between the hours of 12:00 midnight Friday until 6:00 a.m. Monday morning.
- .2 Upon award of contract, submit a list of anticipated shut-down times and their maximum duration.
- .3 Prior to each shut-down or interruption, inform Owner in writing 5 business days in advance of proposed shut-down or interruption and obtain written consent to proceed. Do not shut-down or interrupt any system or service without such written consent.

- .4 Perform work associated with shut-downs and interruptions as continuous operations to minimize shut-down time and to reinstate systems as soon as possible, and, prior to any shut-down, ensure materials and labour required to complete the work for which shut-down is required are available at site.
- .5 Pipe freezing may be used to connect new piping to existing piping without draining existing piping. Pipe freeze equipment is to be equal to "NORDIC FREEZE" equipment supplied by Mag Tool Inc. or Rigid Tool Co. RIGID "SuperFreeze".

3.03 DECOMMISSIONING OR ALTERATIONS TO REFRIGERATION EQUIPMENT

- .1 Remove and reclaim refrigerant from applicable equipment to be decommissioned and/or altered. Refrigerant reclaim and recycling work is to be in accordance with Refrigerant Management Canada guidelines, and governing codes and regulations. Do not under any circumstances vent refrigerant from existing equipment to atmosphere.
- .2 Use refrigerant recovery equipment designed specifically to reclaim and recycle refrigerant, and use only skilled refrigeration mechanics to perform reclaim and recycle work.
- .3 Provide approved, properly sized and sealable refrigerant containers for reclaimed refrigerant.
- .4 Dispose of reclaimed refrigerant by engaging services of a licensed firm specializing in recycling of reclaimed refrigerant. Submit documentation to confirm refrigerant has been properly removed from site and recycled or disposed.

END OF SECTION

1 GENERAL

1.01 APPLICATION

- .1 This Section specifies commissioning requirements that are common to Mechanical Divisions work Sections and it is a supplement to each Section and is to be read accordingly. When requirements of this Section contradict requirements of Divisions 00 or 01, conditions of Divisions 00 or 01 to take precedence.

1.02 COMMISSIONING AGENT INVOLVEMENT VERSUS WARRANTY OBLIGATIONS

- .1 Involvement of Commissioning Agent performing duties as described in this Section is not in any way to void or alter any Contractual warranty obligations.

1.03 SUBMITTALS

- .1 Submit to Commissioning Agent, at same time as submittal to Consultant, one copy of each shop drawing or product data sheet associated with equipment or systems to be commissioned.
- .2 Submit for review, a Commissioning Plan with schedule, commissioning procedures for commissioning events, and a copy of Commissioning Agent's commissioning data sheets for equipment/systems to be commissioned.
- .3 Submit a list of commissioning instruments and for each instrument, indicate purpose of instrument and include a recent calibration certificate.
- .4 Submit equipment and system manufacturer's start-up and test report sheets for review a minimum of 1 month prior to equipment and system start-up procedures.
- .5 After start-up and successful pre-functional performance testing and submittal of completed forms, submit, for each system or subsystem, a letter confirming pre-functional performance testing has been successfully completed and system or subsystem is ready for functional performance testing and commissioning process to commence.

1.04 DEFINITIONS

- .1 Commissioning: process of demonstrating to Owner and Consultant, for purpose of final acceptance, by means of successful and documented functional performance testing, that systems and/or subsystems are capable of being operated and maintained to perform in accordance with requirements of Contract Documents, all as further described below.
- .2 Commissioning Agent: commissioning authority who will supervise commissioning process, and who will recommend final acceptance of commissioned mechanical work.
- .3 Start-Up and Adjusting: process of equipment manufacturer's/supplier's technical personnel, with Contractor, starting and operating equipment and systems, making any required adjustments, documenting process, and submitting manufacturer's/supplier's start-up reports to confirm equipment has been properly installed and is operational as intended.

- .4 Pre-Functional Performance Testing: testing, adjusting and operating of components, equipment, systems and/or subsystems, by Contractor, after start-up but before functional performance testing, to confirm components, equipment, systems and/or subsystems operate in accordance with requirements of Contract Documents, including modes and sequences of control and monitoring, interlocks, and responses to emergency conditions, and including submittal of pre-functional performance testing documentation sheets.
- .5 Functional Performance Testing: a repeat of successful pre-functional performance testing by Contractor, in presence of Commissioning Agent and Consultant with completed Commissioning Agent's commissioning documentation sheets to document, validate and verify equipment, systems and subsystems are complete in all respects, function correctly, and are ready for acceptance.
- .6 Commissioning Documentation Sheets: prepared sheets for pre-functional performance testing and for functional performance testing supplied by Commissioning Agent for each piece of equipment/system to be commissioned, each sheet or set of sheets complete with Project name and number, date of commissioning, equipment/system involved, equipment/system name and model number, equipment tag in accordance with drawings, and, for each commissioning procedure listed, a column giving expected data in accordance with Contract Documents, a column to fill in observed data during commissioning, and space for signatures of Contractor and Commissioning Agent.
- .7 Systems Operating Manual: a manual prepared by Commissioning Agent to present an overview of building mechanical systems and equipment to be used by building maintenance personnel to assist them in daily operation of systems.
- .8 Validate: to confirm by examination and witnessing tests correctness of equipment and system operation.

1.05 COMMISSIONING AGENT

- .1 Retain services of a qualified Commissioning Agent.

1.06 QUALITY ASSURANCE

- .1 Commissioning work is to be in accordance with requirements of following:
 - .1 CSA Z320, Building Commissioning Standard and Check Sheets;
 - .2 ASHRAE Guideline 0, The Commissioning Process;
 - .3 ASHRAE Guideline 1.1, The HVAC Commissioning Process;
 - .4 ASHRAE Guideline 1.2, The Commissioning Process for Existing HVAC&R Systems;
- .2 Commissioning Agent is to meet following qualifications:
 - .1 be a member of Professional Engineers Association in Province of the work;
 - .2 be a member of Building Commissioning Association, and a Certified Commissioning Professional (CCP) as designated by Building Commissioning Association;
 - .3 have a minimum of 5 years of successful documented commissioning experience on projects of similar size and complexity as this Project;

- .4 supply a qualified P. Eng. and a Building Commissioning Association Certified Commissioning Professional (CCP) or an ASHRAE Commissioning Project Management Professional (CPMP) on site to supervise commissioning process.

1.07 COMMISSIONING OBJECTIVES

- .1 Objectives of commissioning process:
 - .1 to support quality management by means of monitoring and checking installation;
 - .2 to verify equipment/system performance by means of commissioning of completed installation;
 - .3 to move completed equipment/systems from "static completion" state to "dynamic" operating state so as to transfer a complete and properly operating installation from Contractor to Owner.

1.08 TESTING EQUIPMENT

- .1 Supply instruments and test equipment required to conduct start-up, testing and commissioning procedures.

2 PRODUCTS

Not Used

3 EXECUTION

3.01 COMMISSIONING

- .1 Commission work in accordance with requirements of this Section and as required by Commissioning Agent.
- .2 Prerequisites to successful completion of commissioning:
 - .1 submittal of signed start-up and test reports;
 - .2 completion of system testing, adjusting and balancing (TAB), and acceptance of TAB reports;
 - .3 permanent electrical and control connections of equipment;
 - .4 successful completion and documentation of pre-functional performance testing;
 - .5 submittal of letters to Consultant certifying systems and subsystems have been started, tested, adjusted, successfully pre-functional performance tested, are ready for functional performance testing, and are in accordance with requirements of Contract Documents.

3.02 DEFICIENCIES LISTED DURING COMMISSIONING

- .1 Correct deficiencies listed by Consultant and Commissioning Agent during commissioning process within 15 calendar days of notification unless agreed otherwise with Consultant, and when deficiencies have been corrected, notify Consultant and Commissioning Agent immediately.

3.03 SYSTEMS TO BE COMMISSIONED

- .1 Mechanical systems to be commissioned include, but are not to be limited to, systems described below. Specific commissioning procedures are to be as directed by Commissioning Agent.
- .2 Commissioning of fire protection systems will be considered complete upon preparation and submittal by Contractor of completion certificates required by applicable NFPA Standards, demonstration of proper system operation to local Fire Chief and any other authorities, including Owner's insurance underwriter as required, and coordination and cooperation with fire alarm system commissioning procedures, in particular smoke control systems and other such fan system control sequences.
- .3 Commissioning of water systems (all piping extended from Municipal main) includes:
 - .1 commissioning of water heaters;
 - .2 commissioning of piping specialties such as backflow preventers, mixing valves, and similar components;
 - .3 commissioning of trap seal primer units, including adjustment of water flows and confirmation of water flow at each connected trap;
 - .4 commissioning of plumbing fixtures.
- .4 Commissioning of natural gas system includes pressure regulating equipment. Perform commissioning in accordance with requirements of CAN/CSA B149.1, and any supplemental requirements of governing authorities.
- .5 Commissioning of air handling systems includes equipment, ductwork, ductwork specialties, controls, interlocks, and checking and validating air capacities and flows in accordance with TAB reports.
- .6 Control work commissioning includes confirmation of proper operation of individual control components, and overall operation of controls in conjunction with operation of connected building systems, including heating season/cooling season testing requirements specified above.
- .7 Commissioning of BAS includes confirmation of proper operation of components, input/output points, hardware and software, and demonstration of system performing required procedures.

3.04 COMMISSIONING PROCESS

- .1 Perform commissioning process in stages and include, but not be limited to, following:
 - .1 Stage 1: Commissioning of equipment/systems as listed in this Section, which is a prerequisite to an application for Substantial Performance of the Work and includes supervising and validating results of functional performance testing, and submittal of reviewed Systems Operating Manual.
 - .2 Stage 2: Commissioning work performed 12 months after issue of a Certificate of Substantial Performance and which includes supervision of Contractor's "fine tuning" of equipment/systems through seasonal occupancy, and any other such work to achieve optimal comfort and performance conditions.

- .3 Stage 3: Successful completion of satisfactory equipment/system operation during 1st month after issue of a Certificate of Total Performance of the Work.
- .4 Stage 4: Successful completion of satisfactory equipment/system operation during 3rd month after issue of a Certificate of Total Performance of the Work.
- .5 Stage 5: Successful seasonal commissioning of building.

3.05 RESPONSIBILITIES OF COMMISSIONING AGENT

- .1 During construction phase, Commissioning Agent is to:
 - .1 review Contractor's shop drawings for commissioning related issues, and report any such issues to Consultant;
 - .2 as soon as possible after project start-up, prepare and issue a Commissioning Plan based on Contractor's construction schedule;
 - .3 prior to tests, supply pre-functional performance test commissioning data sheets for equipment and systems to be commissioned to Contractor;
 - .4 monitor and inspect installation on a regular basis throughout construction stages, issue reports identifying any issues which may have an impact on commissioning process, and work with project team to expeditiously resolve any problems that may arise due to site conditions;
 - .5 arrange with Contractor for on-site commissioning meetings on an as-required basis, to be attended by Contractor and applicable subcontractors, Owner, and Consultant, chair meetings, and prepare and distribute meeting minutes to attendees;
 - .6 witness and validate tests, identify deficiencies, and issue progress reports;
 - .7 coordinate commissioning scheduling with Contractor;
 - .8 review final TAB report on site with Contractor, and check 100% of TAB results for fan equipment, 30% of TAB results for duct systems outward from fan equipment, and issue a report to Consultant;
 - .9 for smaller multiple items of equipment such as air terminal boxes, fan coil units, backflow preventers, and similar equipment, review completed commissioning data sheets submitted by Contractor and review data sheet information on-site with Contractor for 30% of quantity of each item of equipment;
 - .10 review pre-functional performance test commissioning data sheets submitted by Contractor, then witness and supervise functional performance testing and supervise and direct commissioning process, validate commissioning procedures, witness completion of commissioning data sheets by Contractor, and sign completed data sheets;
 - .11 perform a preliminary review of Contractor's O & M Manuals, before they are issued to Consultant, and issue any comments to Consultant;

- .12 coordinate, with Contractor and Owner, training and instructions by Contractor and his equipment and system manufacturers/suppliers to Owner's operating and maintenance personnel, and comment on quality of training and instructions to Consultant;
- .13 prepare and issue Systems Operation Manual to Owner prior to equipment and system training by Contractor.
- .2 During post construction phase, Commissioning Agent is to:
 - .1 prepare and issue final report on commissioning, identifying any deficiencies that remain outstanding;
 - .2 recommend any training and/or instructions to be given to Owner's operating and maintenance personnel in addition to training and instructions already given;
 - .3 after Substantial Performance of the Work, witness system checks and validate documentation by Contractor as follows:
 - .1 once during 1st month of building operation;
 - .2 once during 3rd month of building operation;
 - .3 once between 4th and 10th month of building operation but during a season opposite to 1st or 3rd month visits.
 - .4 ensure any deficient work resulting from system checks described above are corrected;
 - .5 3 months after Substantial Performance of the Work, attend a question and answer session(s) with Contractor to answer any questions and concerns related to commissioning work from Owner's operating personnel.

3.06 RESPONSIBILITIES OF CONTRACTOR

- .1 During construction phase, Contractor is to:
 - .1 prepare and submit an installation schedule which includes a time schedule for each activity with lead and lag time allowed and indicated, shop drawing and working detail drawing submissions, and major equipment factory testing and delivery dates;
 - .2 prepare and submit a commissioning schedule which is to include a time schedule coordinated with installation schedule referred to above and Commissioning Agent, and allowances for additional time for re-tests as may be required, and update schedule on a monthly basis as required;
 - .3 when requested by Commissioning Agent, arrange site commissioning meetings with Owner, Consultant, and applicable subcontractors present, to be chaired by Commissioning Agent who will also prepare and distribute meeting minutes;
 - .4 promptly correct reported deficient work, and report when corrective work is complete;

- .5 where required by Codes and/or Specification, retain equipment manufacturers/suppliers or independent 3rd parties to certify correct installation of equipment/systems;
 - .6 under supervision of equipment manufacturers/suppliers, start-up and adjust equipment to design requirements, and submit start-up sheets which include equipment data such as manufacturer and model number, serial number where applicable, and performance parameters, all signed by equipment manufacturer/supplier and Contractor;
 - .7 complete Commissioning Agent's commissioning data sheets for multiple items of smaller equipment such as air terminal boxes, fan coil units, backflow preventers, etc., submit sheets to Commissioning Agent, accompany Commissioning Agent for an on-site check of 30% of data sheet information for each type of equipment, and perform any corrective action required as a result of site checks;
 - .8 perform system testing, adjusting and balancing and, when complete, issue a copy of final report to Commissioning Agent for review and a site check of results, and perform any corrective work required as a result of site checks by Commissioning Agent;
 - .9 in accordance with updated commissioning schedule and actual progress at site, certify in writing to Consultant and Commissioning Agent that equipment and/or systems are complete, have been checked, started and adjusted, successfully pre-functional performance tested and documented, and are ready for functional performance testing and commissioning procedures, giving Consultant and Commissioning Agent a minimum of 5 working days' notice;
 - .10 perform system and subsystem functional performance testing under supervision of Commissioning Agent, and submit to Consultant and Commissioning Agent, completed and signed functional performance testing and commissioning data sheets (issued by Commissioning Agent) and also signed by Commissioning Agent.
- .2 During post construction phase, Contractor is to:
- .1 optimize system operation in accordance with building occupant's needs and comments using System Operation Manual prepared by Commissioning Agent as reference;
 - .2 complete commissioning procedures, activities, and performance verification procedures that were delayed or not concluded during construction phase;
 - .3 accompanied by Commissioning Agent, complete system checks and "fine tuning" with signed documentation as follows:
 - .1 once during 1st month of building operation;
 - .2 once during 3rd month of building operation;
 - .3 once between 4th and 10th months in a season opposite to 1st and 3rd month visits.
 - .4 correct deficiencies revealed by system checks described above, and, where required, involve equipment manufacturers/suppliers during corrective actions, and report completion of corrective work;

- .5 3 months after Substantial Completion conduct a question and answer session(s) at building with Owner's operating and maintenance personnel, with duration of session(s) dictated by number of questions and concerns that have to be addressed.

END OF SECTION

1 GENERAL

1.01 APPLICATION

- .1 This Section specifies mechanical system testing, adjusting, and balancing requirements that are common to mechanical work Sections of the Specification and it is a supplement to each Section and is to be read accordingly.

1.02 DEFINITIONS

- .1 "Agency" – means agency to perform testing, adjusting and balancing work.
- .2 "TAB" – means testing, adjusting and balancing to determine and confirm quantitative performance of equipment and systems and to regulate specified fluid flow rate and air patterns at terminal equipment, e.g., reduce fan speed, throttling, etc.
- .3 "hydronic systems" – includes heating water, chilled water, glycol-water solution, condenser water, and any similar system.
- .4 "air systems" – includes outside air, supply air, return air, exhaust air, and relief air systems.
- .5 "flow rate tolerance" – means allowable percentage variation, minus to plus, of actual flow rate values in Contract Documents.
- .6 "report forms" – means test data sheets arranged for collecting test data in logical order for submission and review, and these forms, when reviewed and accepted, should also form permanent record to be used as basis for required future testing, adjusting and balancing.
- .7 "terminal" – means point where controlled fluid enters or leaves the distribution system, and these are supply inlets on water terminals, supply outlets on air terminals, return outlets on water terminals, and exhaust or return inlets on air terminals such as registers, grilles, diffusers, louvers, and hoods.
- .8 "main" – means duct or pipe containing system's major or entire fluid flow.
- .9 "submain" – means duct or pipe containing part of the systems' capacity and serving 2 or more branch mains.
- .10 "branch main" – means duct or pipe servicing 2 or more terminals.
- .11 "branch" – means duct or pipe serving a single terminal.

1.03 SUBMITTALS

- .1 Within 30 days of work commencing at site, submit name and qualifications of proposed testing and balancing agency in accordance with requirements of article entitled Quality Assurance below.
- .2 Submit sample test forms, if other than those standard forms prepared by Associated Air Balance Council (AABC) or National Environmental Balancing Bureau (NEBB), are proposed for use.

- .3 Submit a report by Agency to indicate Agency's evaluation of mechanical drawings with respect to service routing and location or lack of balancing devices. Include set of drawings used and marked-up by Agency to prepare report.
- .4 Submit a report by Agency after each site visit made by Agency during construction phase of this Project.
- .5 Submit a draft report, as specified in Part 3 of this Section.
- .6 Submit a final report, as specified in Part 3 of this Section.
- .7 Submit a testing and balancing warranty as specified in Part 3 of this Section.
- .8 Submit reports listing observations and results of post construction site visits as specified in Part 3 of this Section.

1.04 QUALITY ASSURANCE

- .1 Employ services of an independent testing, adjusting, and balancing agency meeting qualifications specified below, to be single source of responsibility to test, adjust, and balance building mechanical systems to produce design objectives. Agency is to have successfully completed testing, adjusting and balancing of mechanical systems for a minimum of 5 projects similar to this Project within past 3 years, and is to be certified as an independent agency in required categories by one of following:
 - .1 AABC - Associated Air Balance Council;
 - .2 NEBB - National Environmental Balancing Bureau.
- .2 Testing, adjusting and balancing of complete mechanical systems is to be performed over entire operating range of each system in accordance with 1 of following publications:
 - .1 National Standards for a Total System Balance published by Associated Air Balance Council;
 - .2 Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems published by National Environmental Balancing Bureau;
 - .3 Chapter 37, Testing, Adjusting, and Balancing of ASHRAE Handbook HVAC Applications.

2 PRODUCTS

Not Used

3 EXECUTION

3.01 SCOPE OF WORK

- .1 Perform total mechanical systems testing, adjusting, and balancing. Requirements include measurement and establishment of fluid quantities of mechanical systems as required to meet design specifications and comfort conditions, and recording and reporting results.
- .2 Mechanical systems to be tested, adjusted and balanced include:

- .1 TAB of domestic water systems (all piping extended from Municipal main) is to include:
 - .1 domestic hot water recirculation piping;
 - .2 tempered water piping flows.
- .2 TAB of air handling and exhaust systems is to include equipment and ductwork air temperatures, capacities and flows.

3.02 TESTING, ADJUSTING AND BALANCING

- .1 Conform to following requirements:
 - .1 as soon as possible after award of Contract, Agency is to carefully examine a white print set of mechanical drawings with respect to routing of services and location of balancing devices, and is to issue a report listing results of the evaluation;
 - .2 set of drawings examined by Agency is to be returned with evaluation report, with red line mark-ups to indicate locations for duct system test plugs, and required revision work such as relocation of balancing devices and locations for additional devices;
 - .3 after review of mechanical work drawings and specification, Agency is to visit site at frequent, regular intervals during construction of mechanical systems, to observe routing of services, locations of testing and balancing devices, workmanship, and anything else that will affect testing, adjusting and balancing;
 - .4 after each site visit, Agency is to report results of site visit indicating date and time of visit, and detailed recommendations for any corrective work required to ensure proper adjusting and balancing;
 - .5 testing, adjusting and balancing is not to begin until:
 - .1 building construction work is substantially complete and doors have been installed;
 - .2 mechanical systems are complete in all respects, and have been checked, started, adjusted, and then successfully performance tested.
 - .6 mechanical systems to be tested, adjusted and balanced are to be maintained in full, normal operation during each day of testing, adjusting and balancing;
 - .7 obtain copies of reviewed shop drawings of applicable mechanical plant equipment and terminals, and temperature control diagrams and sequences;
 - .8 Agency is to walk each system from system "head end" equipment to terminal units to determine variations of installation from design, and system installation trades will accompany Agency;
 - .9 Agency is to check valves and dampers for correct and locked position, and temperature control systems for completeness of installation before starting equipment;
 - .10 wherever possible, Agency is to lock balancing devices in place at proper setting, and permanently mark settings on devices;

- .11 for belt-driven equipment, Agency is to report to Contractor and Consultant of any situation where sheaves have to be replaced to suit testing and balancing, and replacements are to be done by Contractor at no cost;
 - .12 Agency is to leak test ductwork as specified in Section entitled HVAC Air Distribution in accordance with requirements of SMACNA "HVAC Air Duct Leak Test Manual", coordinate work with work of aforementioned Sections, provide detailed sketch(es) to Sheet Metal Contractor and Consultant identifying ductwork not in accordance with acceptable leakage values specified in aforementioned Sections, and retest corrected ductwork;
 - .13 Agency is to balance systems with due regard to objectionable noise which is to be a factor when adjusting fan speeds and performing terminal work such as adjusting air quantities, and should objectionable noise occur at design conditions, Agency is to immediately report problem and submit data, including sound readings, to permit an accurate assessment of noise problem to be made;
 - .14 Agency is to check supply air handling system mixing plenums for stratification, and where variation of mixed air temperature across coils is found to be in excess of $\pm 5\%$ of design requirements, Agency is to report problem and issue a detail sketch of plenum baffle(s) required to eliminate stratification;
 - .15 Agency is to perform testing, adjusting and balancing to within $\pm 5\%$ of design values, and make and record measurements which are within $\pm 2\%$ of actual values;
 - .16 for air handling systems equipped with air filters, test and balance systems with simulated 50% loaded (dirty) filters by providing a false pressure drop;
 - .17 test, adjust and balance air conditioning systems during summer season and heating systems during winter season, including at least a period of operation at outside conditions within 2.8°C (5°F) wet bulb temperature of maximum summer design condition, and within 5.5°C (10°C) dry bulb temperature of minimum winter design condition, and take final temperature readings during seasonal operation.
- .2 Prepare reports as indicated below.
- .1 Upon completion of testing, adjusting, and balancing procedures, prepare draft reports on AABC or NEBB forms. Draft reports may be hand written, but must be complete, factual, accurate, and legible. Organize and format draft reports in same manner specified for final reports. Submit 2 complete sets of draft reports. Only 1 complete set of draft reports will be returned.
 - .2 Upon verification and approval of draft reports, prepare final reports, type written, and organized and formatted as specified below. Submit 2 complete sets of final reports. Use units of measurement (SI or Imperial) as used on Project Documents.
 - .3 Report forms are to be those standard forms prepared by the referenced standard for each respective item and system to be tested, adjusted, and balanced. Bind report forms complete with schematic systems diagrams and other data in reinforced, vinyl, 3-ring binders. Provide binding edge labels with project identification and a title descriptive of contents. Divide contents of binder into divisions listed below, separated by divider tabs:
 - .1 General Information and Summary;

- .2 Air Systems;
 - .3 Hydronic Systems;
 - .4 Temperature Control Systems;
 - .5 Special Systems.
- .4 Agency is to provide following minimum information, forms and data in report:
- .1 inside cover sheet to identify Agency, Contractor, and Project, including addresses, and contact names and telephone numbers and a listing of instrumentation used for procedures along with proof of calibration;
 - .2 remainder of report is to contain appropriate forms containing as a minimum, information indicated on standard AABC or NEBB report forms prepared for each respective item and system;
 - .3 Agency is to include for each system to be tested, adjusted and balanced, a neatly drawn, identified (system designation, plant equipment location, and area served) schematic "as-built" diagram indicating and identifying equipment, terminals, and accessories;
 - .4 Agency is to include report sheets indicating building comfort test readings for all rooms.
- .3 After final testing and balancing report has been submitted, Agency is to visit site with Contractor and Consultant to spot check results indicated on balancing report. Agency is to supply labour, ladders, and instruments to complete spot checks. If results of spot checks do not, on a consistent basis, agree with final report, spot check procedures will stop and Agency is to then rebalance systems involved, resubmit final report, and again perform spot checks with Contractor and Consultant.
- .4 When final report has been accepted, Contractor is to submit to Owner, in name of Owner, a certificate equal to AABC National Guaranty Certification or a NEBB Quality Assurance Program Bond, and in addition, Contractor is to submit a written extended warranty from Agency covering one full heating season and one full cooling season, during which time any balancing problems which occur, with exception of minor revision work done during scheduled site visits, will, at no cost, be investigated by Agency and reported on to Owner, and if it is determined that problems are a result of improper testing, adjusting and balancing, they are to be immediately corrected without additional cost to Owner.
- .5 After acceptance of final report, Agency is to perform post testing and balancing site visits in accordance with following requirements:
- .1 post testing and balancing site visits are to be made:
 - .1 once during first month of building operation;
 - .2 once during third month of building operation;
 - .3 once between fourth and tenth months in a season opposite to first and third month visit.

- .2 during each return visit and accompanied by Owner's representative, Agency is to spot rebalance terminal units as required to suit building occupants and eliminate complaints;
- .3 Agency is to schedule each visit with Contractor and Owner, and inform Consultant;
- .4 after each follow-up site visit, Agency is to issue to Contractor and Consultant a report indicating any corrective work performed during visit, abnormal conditions and complaints encountered, and recommended corrective action.

END OF SECTION

1 GENERAL

1.01 APPLICATION

- .1 This Section specifies material requirements for firestopping and smoke seal systems that are common to mechanical work Sections and it is a supplement to each Section and is to be read accordingly.

1.02 SUBMITTALS

- .1 Submit a product data sheet and WHIMIS sheet for each firestopping and smoke seal product.
- .2 Submit for review, full company name and experience of proposed firestopping and smoke seal system applicator.
- .3 Submit letter of proper firestopping and smoke seal certification as specified in Part 3 of this Section.

1.03 QUALITY ASSURANCE

- .1 Applicator is to have a minimum of 3 years of successful experience on projects of similar size and complexity, and applicator's qualifications are to be submitted to Consultant for review.
- .2 Comply with firestopping and smoke seal product manufacturer's recommendations regarding suitable environment conditions for product installation.

2 PRODUCTS

2.01 FIRESTOPPING AND SMOKE SEAL SYSTEM MATERIALS

- .1 Asbestos-free, elastomeric materials and intumescent materials, tested, listed and labelled by ULC in accordance with CAN/ULC S115, and CAN/ULC S101 for installation in ULC designated firestopping, and smoke seal systems to provide a positive fire, water and smoke seal and a fire resistance rating (flame, hose stream and temperature) no less than fire rating for surrounding construction.
- .2 Firestopping and smoke seal material system to be specifically ULC certified with designated reference number for its specific installation. As part of shop drawing submission, submit copies of firestopping drawings with ULC certificate and system number for each specific installation.
- .3 Materials are to be compatible with abutting dissimilar materials and finishes and complete with primers, damming and back-up materials, supports, and anchoring devices in accordance with firestopping manufacturer's recommendations and ULC tested assembly. Coordinate material requirements with trades supplying abutting areas of materials.
- .4 Submit schedule of opening locations and sizes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance ratings.

- .5 Typically, for openings of up to 250 mm (10") in diameter, provide putty pad type firestop materials equivalent to Specified Technologies Inc. "SpecSeal" intumescent, non-hardening, water resistant putties containing no solvents, inorganic fibres or silicone compounds.
- .6 Typically, for openings of greater than 250 mm (10") in diameter, and for rectangular openings, provide pillow type firestop materials equivalent to Specified Technologies Inc. "SpecSeal" re-enterable, non-curing, mineral fibre core encapsulated on six sides with intumescent coating contained in a flame retardant poly bag.
- .7 Pipe insulation forming part of a fire and smoke seal assembly is specified in Section entitled Mechanical Insulation.
- .8 Supply products of a single manufacturer for use on work of this Division.
- .9 Installer to be manufacturer trained and certified on specific product. Submit copy of certificate with shop drawings.
- .10 Include for manufacturer's authorized representative to inspect and verify each installation and application. Submit test report signed and verified by system installer's authorized representative and manufacturer's representative.
- .11 Acceptable certification to also include certification by Underwriters Laboratories of Northbrook IL, using tests conforming to ULC-S115 and given cUL listing published by UL in their "Products Certified for Canada (cUL) Directory".
- .12 Acceptable manufacturers are:
 - .1 Specified Technologies Inc.;
 - .2 3M Canada Inc.;
 - .3 Tremco;
 - .4 A/D Fire Protection Systems;
 - .5 Nelson;
 - .6 Hilti Canada.

3 EXECUTION

3.01 INSTALLATION OF FIRESTOPPING AND SMOKE SEAL MATERIALS

- .1 Where work penetrates or punctures fire rated construction, provide ULC certified, listed and labelled firestopping and smoke sealing packing material systems to seal openings and voids around and within raceway and to ensure that continuity and integrity of fire separation is maintained. Openings not in immediate vicinity of working areas are to be firestopped and sealed same day as being opened.

- .2 Install firestopping and smoke seal materials for each installation in strict accordance with specific ULC certification number and manufacturer's instructions. Comply with local governing building code requirements and obtain approvals from local building inspection department. Ensure that openings through fire separations do not exceed maximum size wall opening, and maximum and minimum dimensions indicated in ULC Guide No. 40 U19 for Service Penetration Assemblies and firestopping materials.
- .3 Ensure that continuity and integrity of fire separation is maintained and conform to requirements of latest edition of ULC publication "List of Equipment and Materials, Volume II, Building Construction".
- .4 Comply with following requirements:
 - .1 Examine substrates, openings, voids, adjoining construction and conditions under which firestop and smoke seal system is to be installed. Confirm compatibility of surfaces.
 - .2 Verify penetrating items are securely fixed and properly located with proper space allowance between penetrations and surfaces of openings.
 - .3 Report any unsuitable or unsatisfactory conditions to Consultant in writing, prior to commencement of work. Commencement of work will mean acceptance of conditions and surfaces.
 - .4 Mask where necessary to avoid spillage and over coating onto adjoining surfaces. Remove stains on adjacent surfaces.
 - .5 Prime substrates in accordance with product manufacturer's written instructions.
 - .6 Provide temporary forming as required and remove only after materials have gained sufficient strength and after initial curing.
 - .7 Tool or trowel exposed surfaces to a neat, smooth, and consistent finish.
 - .8 Remove excess compound promptly as work progresses and upon completion.
 - .9 At fusible link damper locations, seal perimeter of angle iron framing on both sides of wall or slab with ULC listed and labelled sealant materials to provide a positive smoke seal.
- .5 Notify Consultant when work is complete and ready for inspection, and prior to concealing or enclosing firestopping and smoke seal materials and service penetration assemblies. Arrange for final inspection of work by local governing authority inspector prior to concealing or enclosing work. Make any corrections required.
- .6 On completion of firestopping and smoke sealing installation, submit a Letter of Assurance to Consultant certifying the firestopping and smoke sealing installation has been carried out throughout the building to service penetrations and that installation has been performed in strict accordance with requirements of local governing building code, any applicable local municipal codes, ULC requirements, and manufacturer's instructions.
- .7 Manufacturer's authorized representative to inspect and verify each installation and provide a test report signed by installing trade and manufacturer's representative. Test report to list each installation and respective ULC certification and number.

- .8 Where work requires removal of existing firestopping materials and replacement of firestopping materials after cabling changes have been made, ensure that replacement material is same material and manufacturer of existing if any remains in place, or ensure that all existing material is removed before installation of replacement material.

END OF SECTION

1 GENERAL

1.01 SUBMITTALS

- .1 Submit shop drawings/product data sheets to regulatory authority for review and approval prior to submitting to Consultant. Conform to following requirements:
 - .1 submit shop drawings/product data sheets for all products specified in this Section except pipe and fittings;
 - .2 submit complete CAD layout drawings indicating source of water supply with test flow and pressure, "head-end" equipment piping schematic, pipe routing and sizing, and zones, all signed and sealed by a qualified professional mechanical engineer registered in jurisdiction of the work as specified below;
 - .3 submit copies of all calculations, including hydraulic calculations, stamped and signed by same engineer who signs layout drawings, and a listing of all design data used in preparing the calculations, system layout and sizing, including occupancy-hazard design requirements;
 - .4 in addition to submitting shop drawings to regulatory authority as specified above, shop drawings must be approved by Owner's insurer prior to being submitted to Consultant for review.
- .2 Submit a complete sprinkler system test certificate as specified in Part 3 of this Section.
- .3 Sprinklers are to be identified on drawings and product submittals, and be specifically identified by manufacturer's listed model or series designation. Trade names and other abbreviated listings are unacceptable.

1.02 QUALITY ASSURANCE

- .1 Fire protection sprinkler system work is to be in accordance with following Codes and Standards:
 - .1 NFPA 13, Standard for the Installation of Sprinkler Systems;
 - .2 CSA B137.2, Polyvinylchloride (PVC) Injection-Moulded Gasketed Fittings for Pressure Applications;
 - .3 CSA B137.3, Rigid Polyvinylchloride (PVC) Pipe for Pressure Applications;
 - .4 ASTM A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless;
 - .5 ASTM A135, Standard Specification for Electric-Resistance-Welded Steel Pipe;
 - .6 ASTM A234, Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service;
 - .7 ASTM A536, Standard Specification for Ductile Castings;
 - .8 ASTM A795, Standard Specification for Black and Hot-Dipped Zinc Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use;

- .9 ANSI/ASME B16.4, Grey Iron Threaded Fittings (Classes 125 and 250);
- .10 CAN/CSA B64.10, Backflow Preventers and Vacuum Breakers.
- .2 Fire protection sprinkler work is to be performed by a sprinkler company who is a member in good standing of the Canadian Automatic Sprinkler Association. Site personnel are to be licensed in jurisdiction of the work and under the continuous supervision of a foreman who is an experienced fire protection system installer and a journeyman pipe fitter licensed in jurisdiction of the work.
- .3 Check and verify dimensions and conditions at site and ensure work can be performed as indicated. Coordinate work with trades at site and accept responsibility for and cost of making adjustments to piping and/or spacing to avoid interference with other building components.
- .4 System components must be ULC listed and labelled.
- .5 Grooved couplings, and fittings, valves and specialties are to be products of a single manufacturer. Grooving tools are to be of same manufacturer as grooved components.
- .6 Castings used for coupling housings, fittings, valve bodies, etc., are to be date stamped for quality assurance and traceability.

1.03 DESIGN REQUIREMENTS

- .1 Fire protection sprinkler work is to be designed in accordance with NFPA 13 and Provincial Standards, and, where required, local building and fire department requirements and standards of Owner's Insurer. If water supply flow and pressure test data is not available, conduct Municipal main water flow and pressure tests at nearest fire hydrant to obtain criteria to be used in system design. Include hydrant location and flow and pressure test data with system design calculations.
- .2 Include for a qualified mechanical professional engineer registered and licensed in the jurisdiction of the work to design the fire protection standpipe work. Refer to Section entitled Mechanical Work General Instructions for requirements regarding Contractor retained engineers.
- .3 Sprinkler /System Occupancy – Hazard Design requirements: In accordance with NFPA 13 occupancy-hazard density requirements, unless otherwise specified.

1.04 PROJECT CLOSEOUT

- .1 Provide all required closeout documents to engineer for review and record, including but not limited to, sprinkler test certificate, NFPA conformance letter stamped by a professional engineer, etc.

2 PRODUCTS

2.01 PIPE, FITTINGS AND JOINTS

- .1 Pipe, fittings and joints are to be as follows, with exceptions as specified in Part 3 of this Section:
 - .1 PVC

- .1 Class 200, DR14, rigid, hub and spigot pattern PVC pipe and CSA certified fittings to CAN/CSA B137.2 and B137.3 and complete with gasketed joints.
- .2 Schedule 40 Steel – Grooved Coupling Joints
 - .1 Schedule 40 mild black carbon steel, ASTM A53, Grade B, complete with grooved ends and mechanical fittings and couplings equal to Victaulic "FireLock" fittings and Victaulic Style 009N, 107H, and 107N QuickVic and 005 rigid coupling joints. Strap type outlet fittings such as Victaulic "Snap-Let" are not acceptable.
- .3 Schedule 40 Steel – Screwed and Welded Joints
 - .1 Schedule 40 mild black carbon steel, ASTM A53, Grade B. Screwed piping complete with Class 125 cast iron screwed fittings to ANSI/ASME B16.4. Welded piping complete with factory made seamless carbon steel butt welding fittings to ASTM A234, Grade WPB, long sweep pattern wherever possible.
- .4 Schedule 10 Steel – Grooved Coupling Joints
 - .1 Schedule 10 mild black carbon steel, ASTM A53, Grade B, complete with grooved ends and fittings and couplings equal to Victaulic "FireLock" fittings and Victaulic Style 009N, 107H, and 107N QuickVic and 005 rigid coupling joints.
- .5 Schedule 10 Steel – Screwed Joints
 - .1 Schedule 10 mild black carbon steel, ASTM A53, Grade B, complete with mill or site threaded ends, Class 125 cast iron screwed fittings to ANSI/ASME B16.4, and screwed joints.
- .6 Flexible Pipe – Equal to Victaulic "VicFlex"
 - .1 Drop system is to consist of a braided type 304 stainless steel flexible tube, zinc plated steel 25 mm (1") NPT male threaded nipple for connection to branch-line piping, and a zinc plated steel reducer with a 12 mm (1/2") or 20 mm (3/4") NPT female thread for connection to sprinkler head.
 - .2 Drop is to include a cULus/FM approved Series AH2 braided hose with a bend radius to 50 mm (2") to allow for proper installation in confined spaces.
 - .3 Hose is to be listed for following number of 50 mm (2") radius 90° bends:
 - .1 4 bends at 0.79 m (31") length;
 - .2 5 bends at 0.91 m (36") length;
 - .3 8 bends at 1.2 m (48") length;
 - .4 10 bends at 1.5 m (60") length;
 - .5 12 bends at 1.8 m (72") length.
 - .4 Union joints are to be provided for ease of installation, prevention of hose torque stresses and on site changing of factory 146 mm (5.75") straight reducing nipple in reduced spaces under obstructions.

- .5 On T-bar ceiling grid with drop in tile application, flexible drop is to attach to ceiling grid using a one-piece open gate Series AB1 bracket. Bracket is to allow installation before ceiling tile is in place.
- .6 On T-bar ceiling grid designed for hard lid drywall application, flexible drop is to attach to ceiling grid using a one-piece open gate Series AB2 bracket. Bracket is to allow for vertical adjustment of reducer/head from below drywall, post-drywall installation.
- .7 On hat furring channel grid with hard lid drywall application, flexible drop is to attach to ceiling grid using a one-piece open gate Series AB4 bracket. Bracket is to allow for vertical adjustment of reducer/head from below drywall, post-drywall installation.
- .8 Braided drop system is to be cULus listed for sprinkler services to 1206 kPa (175 psi).
- .7 Standard Mechanical Couplings: Equal to Victaulic
 - .1 Manufactured in two segments of cast ductile iron, conforming to ASTM A-536, Grade 65-45-12. Gaskets are to be pressure-responsive synthetic rubber, grade to suit intended service, conforming to ASTM D-2000. Mechanical coupling bolts are to be zinc plated (ASTM B-633) heat treated carbon steel track head conforming to ASTM A-449 and ASTM A-183. Couplings are to comply with ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications.
 - .2 Rigid Type: Coupling housings with offsetting, angle-pattern bolt pads are to be used to provide system rigidity and support and hanging in accordance NFPA-13. Couplings are to be fully installed at visual pad-to-pad offset contact. Couplings that require exact gapping of bolt pads at specific torque ratings are not permitted.
 - .3 Flexible Type: Use in locations where vibration attenuation and stress relief are required; Victaulic Style 177 (Quick-Vic™) flexible coupling.

2.02 SERVICE MAIN DOUBLE CHECK VALVE ASSEMBLY

- .1 Minimum 1205 kPa (175 psi) rated dual check valve backflow preventer assembly to CAN/CSA B64, complete with tight-closing resilient seated shut-off valves, test cocks, and strainer.
- .2 Assembly is to incorporate a metered by-pass to detect leaks and unauthorized water use. Where the municipality requires, coordinate water meter supply with the City water service otherwise include water meter as part of the assembly.
- .3 Acceptable manufacturers are:
 - .1 Watts Industries Canada;
 - .2 Zurn/Wilkins;
 - .3 Apollo Valves (Conbraco Industries).

2.03 SHUT-OFF VALVES

- .1 Minimum 2070 kPa (300 psi) rated full port brass or bronze body screwed ball valves and lug body or grooved end type butterfly valves.
 - .1 Butterfly valves are to include a pressure responsive seat, and stem is to be offset from disc centerline to provide complete 360° circumferential seating.
 - .2 Standard of Acceptance: Victaulic Style 705.
 - .3 Supervised closed applications standard of acceptance Victaulic Series 707C supervised closed butterfly valve.
- .2 OS&Y Gate Valves: 1725 kPa (250 psi), grooved ends with ductile iron body, yoke, and handwheel conforming to ASTM A-536, EPDM coated ASTM A-126-B cast iron disc, ASTM B16 brass rising stem, flanged and epoxy coated ductile iron bonnet, EPDM O-ring stem seals and body gasket. Equal to Victaulic Series 771H (Grooved ends) and Series 771F (Grooved x Flanged).

2.04 CHECK VALVES

- .1 Minimum 1725 kPa (250 psi) resilient seat check valves, suitable for vertical or horizontal installations. Standard of Acceptance: Victaulic Series 717.
- .2 Check valves associated with Fire Department connections and fire pump test connection are to be tapped for site installation of a 20 mm (¾") diameter ball drip.

2.05 BALL DRIPS

- .1 Equal to National Fire Equipment Ltd. Model #A58, 20 mm (¾") diameter automatic ball drip.

2.06 SHUT-OFF VALVE SUPERVISORY SWITCHES

- .1 Tamper-proof supervisory switches, each arranged to activate a fire alarm system trouble alarm condition if the valve is closed or tampered with, each suitable in all respects for the application, and each complete with all required mounting and connection hardware.
- .2 Actuator housings are to be weatherproof.

2.07 FIRE DEPARTMENT CONNECTION

- .1 Wall mounting polished brass clapper type dual inlet Fire Department connection with 2, 65 mm (2-½") diameter inlets threaded to Fire Department hose requirements and equipped with caps and chains, an outlet sized as shown, and a faceplate.
- .2 Faceplate is to be polished brass and complete with "AUTO-SPKR" "STANDPIPE" cast-in raised lettering.
- .3 Exposed metal parts of Fire Department connection are to be chrome plated.
- .4 For low point near each fire department connection, a 90° elbow with drain connection to allow for system drainage to prevent freezing. Standard of Acceptance: Victaulic #10-DR.

2.08 WATER FLOW ALARM SWITCH

- .1 Pipe mounting water flow alarm switch, minimum 1725 kPa (250 psi) rated, designed to actuate 2, 7 ampere rated (at 125/250 VAC) SPDT snap action switches when water flow exceeds 0.758 L/sec. (10 Imperial gpm), complete with a tamper-proof cover with conduit connection opening, a piping saddle and U-bolt, and an automatic reset pneumatic retard device with field adjustable (0 to 70 second) switch actuation delay to reduce false alarms caused by a single or series of transient water flow surges.

2.09 ZONE CONTROL RISER MODULES

- .1 Equal to Victaulic Co. "FireLock" Series 747M factory assembled zone control riser modules, each complete with a painted cast ductile iron grooved end body, a ball type shut-off valve, a test and drain combination with properly sized orifice, a flow alarm switch, a pressure gauge with cock, and a pressure relief valve kit.

2.10 SPRINKLER HEADS

- .1 Sprinkler heads, unless otherwise specified, are to be as scheduled in Part 3 of this Section.
- .2 Sprinkler body is to be die-cast, with a hex-shaped wrench boss integrally cast into sprinkler body to reduce risk of damage during installation. Wrenches are to be provided by sprinkler manufacturer that directly engages wrench boss.
- .3 For locations where corrosive resistant coatings are required, body is to be coated with ULC listed and FM approved anti-corrosion VC-250 coating (silver colouring).
- .4 Recessed sprinkler heads in finished areas are to be chrome plated unless otherwise specified. Concealed sprinkler head ceiling plates are to match ceiling colour.
- .5 Where exposed pendent heads occurs in areas with suspended ceilings, they are to be complete with chrome plated escutcheon plates. Similarly, sidewall heads with concealed piping are to be complete with chrome plated escutcheon plates.
- .6 Sprinkler heads which are exposed in areas where they may be subject to damage are to be complete with wire guards, chrome plated where in finished areas.
- .7 Escutcheons and guards are to be listed, supplied, and approved for use with sprinkler by sprinkler manufacturer.
- .8 Sprinkler heads located in areas or over equipment where high ambient temperature is present are to be, unless otherwise specified, 74°C (165°F) heads. All other heads, unless otherwise specified or required, are to be 57°C (135°F) rated.
- .9 Acceptable manufacturers are:
 - .1 Victaulic Co.;
 - .2 Tyco Fire Suppression & Building Products;
 - .3 The Viking Corporation;
 - .4 The Reliable Automatic Sprinkler Co.

2.11 SPARE SPRINKLER HEAD CABINET

- .1 Surface wall mounting, red enamelled steel, identified cabinet with hinged door, shelves with holes for mounting sprinkler heads, a wrench or wrenches suitable for each type of sprinkler head, and a full complement of spare sprinkler heads.
- .2 Cabinet is to be sized to accommodate a minimum of 4 spare heads for each type of head used on the project, however, each cabinet is to be full of spare heads.

3 EXECUTION

3.01 PIPING INSTALLATION REQUIREMENTS

- .1 Provide required sprinkler system piping.
- .2 Perform piping work in accordance with requirements of NFPA 13, governing regulations, and "Reviewed" shop drawings.
- .3 Piping, unless otherwise specified, is as follows:
 - .1 for underground piping inside or outside building – Class 200, DR14 rigid PVC, braced and secured at bends and tees with concrete blocks in accordance with Municipal standards and details;
 - .2 for piping inside building and above ground except as noted below – Schedule 40 grooved end black steel with Victaulic or equal fittings and coupling joints, or, for piping to and including 50 mm (2") diameter, screwed fittings and joints, or, for piping 65 mm (2-½") diameter and larger, welding fittings and welded joints;
 - .3 for wet system piping inside building and above ground – at your option, CPVC sprinkler pipe and fittings;
 - .4 for branch piping to heads in suspended ceilings, etc. – at your option, flexible piping installed in accordance with manufacturer's instructions;
- .4 Exceptions to piping requirements specified above are as follows:
 - .1 wet zone steel piping, fittings, unions, couplings and flanges for sprinkler work exposed to weather either inside or outside building (including parking garages), are to be galvanized;
 - .2 PVC piping is not to be used above grade;
 - .3 ferrous pipe hangers, supports, and similar hardware used for galvanized steel piping are to be electro-galvanized.
- .5 Pipe sizes, pipe routing, sprinkler head quantities and locations, and layout of work shown on drawings are to assist during tendering period. Ensure adequate head coverage, head quantities and pipe sizing as specified in Part 1 of this Section. Do not reduce size of sprinkler main or re-route main unless reviewed with and approved by Consultant.

- .6 Install grooved joints in accordance with manufacturer's latest installation instructions. Grooved ends are to be clean and free from indentations, projections and roll marks. Gaskets are to be moulded and produced by coupling manufacturer, and verified as suitable for intended service. Have factory-trained representative from mechanical joint manufacturer provide on-site training in proper use of grooving tools and installation of grooved piping products. Have factory-trained representative periodically review product installation and ensure best practices are being followed. Remove and replace any improperly installed products.
- .7 Clean pipe, fittings, couplings, flanges and similar components after erection is complete. Wire brush clean any ferrous pipe, fitting, coupling, flange, hanger, support and similar component which exhibit rust and carefully coat with suitably coloured primer.
- .8 When sprinkler work is complete, test system components and overall system(s) and submit completed test certificate and other documentation in accordance with Chapter 8 of NFPA 13.

3.02 INSTALLATION OF DOUBLE CHECK VALVE ASSEMBLY

- .1 Provide a double check valve assembly in sprinkler main inside the building.
- .2 Equip assembly with inlet and outlet shut-off valves with supervisory switches as specified below.
- .3 Support each end of assembly from floor by means of flanged pipe supports with saddles.

3.03 INSTALLATION OF SHUT-OFF VALVES AND CHECK VALVES

- .1 Provide shut-off valves and check valves in piping where shown and wherever else required.
- .2 Locate valves for easy operation and maintenance.
- .3 Confirm exact locations prior to roughing-in.

3.04 INSTALLATION OF SHUT-OFF VALVE SUPERVISORY SWITCHES

- .1 Equip each shut-off valve with a supervisory switch.
- .2 Identify each supervised valve with a 150 mm (6") square, engraved, laminated red-white plastic tag to correspond with supervised valve numbering specified and/or shown as part of the electrical work fire alarm system.
- .3 At low point near each fire department connection, install a 90° elbow with drain connection to allow for system drainage to prevent freezing.

3.05 INSTALLATION OF FIRE DEPARTMENT CONNECTION

- .1 Provide an exterior Fire Department connection. Confirm exact location prior to roughing-in. Confirm finish prior to ordering.
- .2 Equip connection with a check valve. Equip check valve with a ball drip to drain piping between Fire Department connection and check valve, and extend drainage piping from outlet of ball drip to nearest suitable floor drain.

3.06 INSTALLATION OF FLOW ALARM SWITCHES

- .1 Provide water flow alarm switches in accessible locations in zone piping.
- .2 Adjust to suit site water pressure conditions. Check and test operation.
- .3 Identify each switch with a 150 mm (6") square red-white laminated engraved plastic tag. Confirm wording prior to engraving.

3.07 INSTALLATION OF ZONE CONTROL RISER MODULES

- .1 Provide zone control riser modules with drain piping where required. Terminate drainage piping over a funnel floor drain unless otherwise shown or specified. Identify each assembly.

3.08 INSTALLATION OF ZONE CONTROL RISER MODULE CABINETS

- .1 Provide flush wall mounting cabinets for zone control and inspector's test connection assemblies where required in finished areas. Confirm exact locations prior to roughing-in.
- .2 Identify each cabinet with a nameplate in accordance with requirements of Section entitled Basic Mechanical Materials and Methods.

3.09 INSTALLATION OF SPRINKLER HEADS

- .1 Provide required sprinkler heads in accordance with following schedule:

APPLICATION	SPRINKLER HEAD TYPE
Rooms/areas with a suspended ceiling	Victaulic V38/V39 or Tyco Series RFII "Royal Flush II" concealed pendent Victaulic V27 or Tyco Series TY-FRB recessed pendent Victaulic V27 or Tyco Series TY-FRB pendent with escutcheon plates
Rooms/areas without a suspended ceiling	Victaulic V27 or Tyco Series TY-FRB pendent
Elevator shafts	Victaulic V27 or Tyco Series TY-FRB horizontal sidewall
Unheated exterior stairwells	Victaulic V36 or Tyco Series DS-1 dry pipe horizontal sidewall Victaulic V36 or Tyco Series DS-3 wet pipe horizontal sidewall
Air handling system outdoor air and relief air plenums (unheated)	Tyco Series DS-3 ECOH dry horizontal sidewalls in wet piping Victaulic V27 or Tyco Series TY-FRB upright or horizontal sidewall in dry pipe or anti-freeze piping

APPLICATION	SPRINKLER HEAD TYPE
Unheated and unfinished areas	Victaulic V36 or Tyco Series DS-3 ECOH dry horizontal sidewall in wet piping Victaulic V27 or Tyco Series TY-FRB upright or horizontal sidewall in dry pipe or anti-freeze piping
At non-rated windows in rated walls	Tyco Model WS horizontal and pendent vertical sidewall

- .2 Sprinkler head manufacturers indicated on schedule are for type indication purposes. Acceptable manufacturers are listed in Part 2 of this Section.
- .3 Coordinate sprinkler head locations with all drawings, including architectural reflected ceiling plan drawings, and, where applicable, electrical drawings. Coordinate sprinkler head locations in areas with suspended ceilings with the location of lighting, grilles, diffusers, and similar items recessed in or surface mounted on the ceiling as per the reflected ceiling plans. In areas with lay-in tile, centre the sprinkler head both ways in the lay-in tile wherever possible. Confirm locations prior to roughing-in.
- .4 Maintain maximum headroom in areas with no ceilings.
- .5 Provide guards for heads where they are subject to damage.
- .6 Provide high temperature heads in equipment rooms and similar areas over heat producing or generating equipment.

3.10 INSTALLATION OF SPARE SPRINKLER HEAD CABINET

- .1 Supply a full complement (to fill cabinet) of spare sprinkler heads of types used (minimum 4 of each type) and place in a wall mounting storage cabinet located adjacent to sprinkler system "head end" equipment where later directed.

END OF SECTION

1 GENERAL

1.01 SUBMITTALS

- .1 Submit product data sheets for all products specified in this Section.

1.02 QUALITY ASSURANCE

- .1 Fire extinguishers are to be in accordance with following Codes and Standards:
 - .1 National Fire Code of Canada;
 - .2 NFPA 10, Standard for Portable Fire Extinguishers;
 - .3 CAN/ULC S508, Standard for the Rating and Testing of Fire Extinguishers.

2 PRODUCTS

2.01 GENERAL

- .1 Fire extinguishers are to be pressurized (stored pressure) rechargeable type, in accordance with NFPA 10, and UL and/or ULC listed and labelled for the class of fires and hazard locations for which they are specified.
- .2 Each extinguisher is to be complete with:
 - .1 manufacturer's identification label indicating extinguisher model number, rating, and operating instructions;
 - .2 anodized aluminum or chrome plated forged brass valve with positive squeeze grip on-off operation and a pull-pin safety lock;
 - .3 discharge hose with nozzle or horn and hose securing clip;
 - .4 for wall mounting extinguishers, a wall mounting bracket.
- .3 Fire extinguishers in fire hose cabinets will be supplied with the cabinet and are specified in Section entitled Fire Protection Standpipe System.

2.02 3A10B:C RATED DRY CHEMICAL EXTINGUISHERS

- .1 Multi-purpose 3A10B:C dry chemical extinguishers are to be 100 mm (4") dia., 2.27 kg (5 lb.), each complete with a steel cylinder with a safety red baked enamel finish and a waterproof stainless steel pressure gauge.

2.03 WET CHEMICAL CLASS K COMMERCIAL KITCHENS

- .1 ULC listed portable wet chemical extinguisher suitable for Class K fires and commercial kitchen operation, 6 L cylinder with heavy-duty chrome plated brass valves, operator safe discharge hose, full stainless steel construction, mounting bracket.

2.04 FIRE EXTINGUISHER CABINETS

- .1 Surface Mounted: Rectangular break-glass type enclosures sized to suit the extinguishers to be housed, constructed of #18 gauge corrosion resistant steel with a baked white enamel finish, front glass panel, break-glass mechanism, and keyed alike cylinder lock.
- .2 Recessed: Rectangular cabinets sized to suit the extinguishers to be housed, with a #18 gauge corrosion resistant white enamelled steel tub, #14 gauge cleaned and prime coat painted steel door and adjustable trim assembly with rounded corners, semi-concealed piano hinge, safety glass panel, and flush stainless steel door latch.

2.05 FIRE BLANKETS

- .1 Equal to National Fire Equipment Ltd. Model #FB-6078-MC 300 mm x 400 mm (12" x 16") red enamelled #16 gauge surface mounting steel cabinet identified "FIRE BLANKET" and "PULL TAB TO REMOVE", complete with non-combustible glass fibre fire blanket pressure fit into the cabinet and equipped with pull-back release straps.

3 EXECUTION

3.01 INSTALLATION OF FIRE EXTINGUISHERS

- .1 Provide fire extinguishers of type(s) in accordance with requirements of NFPA 10.
- .2 Unless otherwise shown or specified, wall mount extinguishers using wall brackets supplied with extinguishers.
- .3 Do not install extinguishers until after wall finishing work is complete.
- .4 Be responsible for maintaining fire extinguishers until Substantial Completion of the Work.
- .5 If extinguishers are indicated adjacent to a door, locate extinguishers at the strike side of the door.

3.02 INSTALLATION OF FIRE EXTINGUISHER CABINETS

- .1 Provide wall cabinets for fire extinguishers where required.
- .2 Unless otherwise shown or specified, locate cabinets so centerline is approximately 1.2 m (4') above finished floor.
- .3 Confirm exact locations prior to installation.

3.03 INSTALLATION OF FIRE BLANKETS

- .1 Provide fire blankets in wall mounted cabinets in the Kitchen. Confirm exact locations prior to installation.

END OF SECTION

1 GENERAL

1.01 SUBMITTALS

- .1 Submit shop drawings/product data sheets for all products specified in Part 2 of this Section except for pipe, fittings, and chlorine.
- .2 Submit laboratory water purity test results indicating chlorine residual prior to application for Substantial Performance of the Work.
- .3 Submit signed test results and inspection and test log cards for each backflow preventer as specified in Part 3 of this Section.

1.02 QUALITY ASSURANCE

- .1 Domestic water piping and valves are to comply with following codes, regulations and standards (as applicable):
 - .1 applicable local codes and regulations;
 - .2 ASTM F1960, Standard Specification for Cold Expansion Fittings with PEX Reinforcing Rings for Use with Cross-linked Polyethylene (PEX) Tubing;
 - .3 CAN/CSA B125.1, Plumbing Supply Fittings;
 - .4 CAN/CSA B125.3, Plumbing Fittings;
 - .5 CAN/CSA B137 Series, Thermoplastic Pressure Piping Compendium;
 - .6 CAN/ULC S102.2, Standard Method of Test for Surface Burning Characteristics of Flooring, Floor Coverings, and Miscellaneous Materials and Assemblies;
 - .7 CAN/ULC S101, Fire Endurance Tests of Building Construction and Materials;
 - .8 NSF/ANSI 14, Plastics Piping System Components and Related Materials;
 - .9 NSF/ANSI 61, Drinking Water System Components – Health Effects;
 - .10 NSF/ANSI 372, Drinking Water System Components – Lead Content.

2 PRODUCTS

2.01 PIPE, FITTINGS AND JOINTS

- .1 Stainless Steel
 - .1 Schedule 10S type 304 stainless steel, ASTM A312, factory or site roll grooved, complete with Victaulic or equal type 304 stainless steel roll grooved end fittings and, unless otherwise specified, Victaulic Style 489 or equal lightweight rigid type 304L stainless steel couplings and coupling gaskets equal to Victaulic Grade E or Grade M.
- .2 Hard Copper - Solder Joint

- .1 Type "L" hard drawn seamless copper to ASTM B88, complete with copper solder type fittings to ASME/ANSI B16.18 and soldered joints using The Canada Metal Co. Ltd. "SILVABRITE 100" or equal lead-free solder for cold water pipe, and 95% tin/ 5% Antimony or "SILVABRITE 100" solder for other services.
- .3 Semi-Rigid Polyethylene Tubing
 - .1 Versa Fittings and Mfg. Inc. 12 mm (½") dia., high density, semi-rigid polyethylene tubing, 1380 kPa (200 psi) rated.

2.02 SHUT-OFF VALVES

- .1 Ball Valves
 - .1 Class 600, 4140 kPa (600 psi) WOG rated, lead-free, full port ball type valves, each complete with a forged brass body with solder ends, forged brass cap, blowout-proof stem, solid forged brass chrome plated ball, "Teflon" or "PTFE" seat, and a removable lever handle. Valves in insulated piping are to be complete with stem extensions.
 - .2 Acceptable products are:
 - .1 Toyo Valve Co. Fig. 5049A-LF;
 - .2 Milwaukee Valve Co. #UPBA485B;
 - .3 Kitz Corporation Code 859;
 - .4 Apollo Valves #77LF-200;
 - .5 Watts Industries (Canada) Inc. #LFFBVS-3C.

2.03 CHECK VALVES

- .1 Horizontal
 - .1 Lead-free, Class 125, bronze, 1380 kPa (200 psi) WOG rated horizontal swing type check valves with solder ends.
 - .2 Acceptable products are:
 - .1 Toyo Valve Co. Fig. 237A-LF;
 - .2 Milwaukee Valve Co. #UP1509;
 - .3 Kitz Corporation Code 823;
 - .4 Apollo Valves #61LF Series.
- .2 Vertical
 - .1 Equal to Kitz Corp. Code 826, lead-free, 1725 kPa (250 psi) WOG rated vertical lift check valve with soldering ends.

2.04 DRAIN VALVES

- .1 Minimum 2070 kPa (300 psi) water rated, 20 mm (¾") dia., straight pattern full port bronze ball valves, each complete with a threaded outlet suitable for coupling connection of 20 mm (¾") dia. garden hose, and a cap and chain.
- .2 Acceptable products are:
 - .1 Toyo Valve Co. Fig. 5046;
 - .2 Dahl Brothers Canada Ltd. Fig. No. 50. 430;
 - .3 Kitz Corporation Code 58CC;
 - .4 Apollo Valves #78-104-01;
 - .5 Watts Industries (Canada) Inc. #B6000.

2.05 DOMESTIC HOT WATER PIPING BALANCING VALVES

- .1 Solder or flanged end type as required, globe style, non-ferrous circuit balancing valves designed to facilitate precise flow measurement, precision flow balancing, and positive shut-off, complete with capped and valved drain connection, and valved ports for connection to a differential pressure meter.
- .2 Acceptable products are:
 - .1 S.A. Armstrong Model CBV Series;
 - .2 Tour and Andersson Model TBV Series;
 - .3 Watts Industries (Canada) Inc. Model CSM Series.

2.06 CHLORINE

- .1 Sodium hypochlorite to AWWA B300.

2.07 INTERIOR HOSE BIBBS

- .1 Flush-Concealed
 - .1 Recessed, 92 mm (3-5/8") deep, recessed, encased wall hydrant with lockable bronze or stainless steel box with hinged cover identified "WATER", bronze interior parts, a screwdriver operated stop in the supply, key operated control valve, 20 mm (¾") dia. hose connection, and a vacuum breaker.
 - .2 Acceptable products are:
 - .1 Watts Industries (Canada) Inc. #HY-330;
 - .2 Jay R. Smith #5509QT-CL-SAP;
 - .3 Zurn #Z1350;
 - .4 Mifab #MHY-55.
- .2 Semi-Recessed - Finished Areas

- .1 Anti-siphon type, 100 mm (4") deep hose bibb with stainless steel face with operating key, bronze interior parts, 20 mm ($\frac{3}{4}$ ") dia. solder inlet, 20 mm ($\frac{3}{4}$ ") dia. hose connection, and integral vacuum breaker.
- .2 Acceptable products are:
 - .1 Watts Industries (Canada) Inc. #HY-430;
 - .2 Jay R. Smith #5619-SAP-98;
 - .3 Zurn #Z1333 "ECOLOTROL";
 - .4 Mifab #MHY-30.
- .3 Surface – Exposed – Cold Water – Unfinished Areas
 - .1 Brass or bronze hose bibb with hose end vacuum breaker.
 - .2 Acceptable products are:
 - .1 Watts Industries (Canada) Inc. #SC8-1;
 - .2 Jay R. Smith #5609QT-SAP;
 - .3 Zurn/Wilkins # Z1341 with hose end vacuum breaker;
 - .4 Chicago Faucets #293-E27CP.
- .4 Exposed – Unfinished Areas – Hot and Cold Water
 - .1 Mixing faucet for surface mounting.
 - .2 Acceptable products are:
 - .1 Watts Industries (Canada) Inc. #HY-300-2-VB;
 - .2 Jay R. Smith #5560QT-LB-SAP;
 - .3 Zurn #Z841L1-RC;
 - .4 Delta Commercial #28T8083.

2.08 EXTERIOR NON-FREEZE WALL HYDRANTS

- .1 Flush-Concealed
 - .1 Recessed, encased, self-draining hydrants, each complete with a copper casing, operating rod assembly to suit wall thickness, polished nickel bronze box with hinged locking cover, 20 mm ($\frac{3}{4}$ ") dia. threaded hose connection outlet, vacuum breaker, and a loose tee handle operating key.
 - .2 Acceptable products are:
 - .1 Watts Industries (Canada) Inc. #HY-725;

- .2 Jay R. Smith #5519-98;
- .3 Zurn #Z1320;
- .4 Mifab #MHY-26.

2.09 FLOOR DRAIN TRAP SEAL PRIMERS

- .1 Primer Valve Type
 - .1 Precision Plumbing Products Inc. Model P2-500 trap primer valve, constructed of brass, adjustable to high or low water pressures and complete with "O" ring seals, 12 mm (½") threaded inlet and outlet connections, and, for priming two traps from the same primer, a DU-2 dual outlet distribution unit.
- .2 Primer Valve Type with Manifold
 - .1 Precision Plumbing Products Inc. Model P1-500 trap primer valve constructed as specified above for the Model P2-500 primer valve, complete with a Model DU-3 or DU-4, 3 or 4 outlet distribution unit for priming 3 or 4 traps, and at Model "YS-8" supply tube with combinations of Model DU-3 and DU-4 distribution units for priming from 5 to 6 traps.
- .3 Electronic Type
 - .1 Precision Plumbing Products #PT Series surface wall mounting, CSA certified, 115 volt, 1-phase, 60 Hz., electronic, automatic trap priming manifolds, each sized to suit the number of drain traps or interceptors serviced, and each complete with:
 - .1 galvanized steel cabinet with door;
 - .2 20 mm (¾") dia. NPT copper pipe inlet with shut-off valve and water hammer arrestor;
 - .3 solenoid valve, an atmospheric vacuum breaker, and a discharge manifold with 12 mm (½") dia. compression type copper tube connections on 40 mm (1-½") centres with quantity to suit the number of items to be primed;
 - .4 control panel with circuit breaker, 5 ampere fuse, 24 hour timer, and manual override toggle switch.
 - .2 Precision Plumbing Products #MP-500, CSA certified, 115 volt, 1-phase, 60 Hz., electronic, preset automatic trap priming unit. Provide DU unit for multiple floor drains.

2.10 SHOCK ABSORBERS

- .1 Type 304 stainless steel piping shock absorbers, each complete with a nesting type bellows and a casing of sufficient displacement volume to dissipate kinetic energy generated in piping system, and each sized to suit connecting potable water pipe and equipment it is provided for.
- .2 Acceptable products are:
 - .1 Watts Industries (Canada) Inc. "SG" Series;

- .2 Jay R. Smith 5000 Series "HYDROTROL";
- .3 Zurn #Z1700 "SHOKTROL";
- .4 Mifab "HAMMERGUARD" WHB Series.

2.11 WATER HAMMER ARRESTORS

- .1 Piston type, sealed, pressurized water hammer arrestors suitable for either horizontal or vertical installation, each complete with a hard drawn copper body, "O"-ring piston seals, an air charge, and an inlet opening equal to diameter of pipe in which arrestor is required.
- .2 Acceptable products are:
 - .1 Watts Industries (Canada) Inc.;
 - .2 Zurn #Z1705;
 - .3 Precision Plumbing Products Inc. #SC;
 - .4 Mifab MWH Series

2.12 LAVATORY SUPPLY FITTING TEMPERING VALVES

- .1 Equal to Lawler 310-SC1 12 mm ($\frac{1}{2}$ ") dia. or 20 mm ($\frac{3}{4}$ ") dia. as required, each CSA B125 certified, forged brass, tamper-proof thermostatic mixing valves, adjustable for water supply between 29°C and 49°C (85°F and 120°F), sized to suit number of lavatories in grouping, and complete with a stop and check valve and a lockable handle.

2.13 AIR VENTS

- .1 Equal to ITT Hoffman Specialty No. 78 cast brass, 1035 kPa (150 psi) rated, 20 mm ($\frac{3}{4}$ ") straight water main vent valves, each tapped at the top for a 3.2 mm ($\frac{1}{8}$ ") safety drain connection.

3 EXECUTION

3.01 DEMOLITION

- .1 Refer to demolition requirements specified in Section entitled Demolition and Revision Work.

3.02 PIPING INSTALLATION REQUIREMENTS

- .1 Provide required domestic water piping.
- .2 Piping, unless otherwise specified, is as follows:
 - .1 for pipe 100 mm (4") dia. and larger inside building and above ground – Schedule 10 stainless steel;
 - .2 for 12 mm ($\frac{1}{2}$ ") dia. trap seal primer tubing located underground or in concrete or masonry construction – semi-rigid polyethylene;

- .3 for pipe inside building and aboveground in sizes to 100 mm (4") dia. – Type "L" hard copper with solder joints
- .3 Slope piping so it can be completely drained.
- .4 Provide cast brass dielectric type adapters/unions at connections between ferrous and copper pipe or equipment.

3.03 INSTALLATION OF SHUT-OFF AND CHECK VALVES

- .1 Refer to Part 3 of Section entitled Basic Mechanical Materials and Methods.
- .2 For shut off valves installed on solder joint copper piping up to and including 75 mm (3") diameter, provide ball type valves, and for flanged joints copper or stainless steel piping larger than 75 mm (3") diameter provide butterfly type valves.

3.04 INSTALLATION OF DRAIN VALVES

- .1 Provide a drain valve at the bottom of domestic water piping risers, at other piping low points, and wherever else shown.
- .2 Locate drain valves so they are easily accessible.

3.05 INSTALLATION OF DOMESTIC HOT WATER PIPING BALANCING VALVES

- .1 Provide balancing valves in domestic hot water recirculation piping where shown or required.
- .2 Locate each valve so it is easily accessible.

3.06 INSTALLATION OF HOSE BIBBS

- .1 Provide hose bibbs.
- .2 Unless otherwise shown, specified, or required, mount hose bibbs approximately 1 m (3') above floor. Confirm exact locations prior to roughing-in.

3.07 INSTALLATION OF EXTERIOR NON-FREEZE WALL HYDRANTS

- .1 Provide non-freeze wall hydrants.
- .2 Install hydrants level and plumb such that hose outlets are approximately 600 mm (2') above grade level. Confirm exact locations prior to roughing-in.
- .3 Provide a shut-off valve inside building to each exterior non-freeze wall hydrant.

3.08 INSTALLATION OF TRAP SEAL PRIMERS

- .1 Provide required accessible trap seal primers to automatically maintain a water seal in floor drain traps, whether shown on drawings or not.
- .2 Provide trap primer valves to prime single or multiple (1 to 6) traps. Install trap primer valves in domestic cold water piping to frequently used plumbing fixtures. Where from 2 to 6 traps are to be primed from same primer valve, provide appropriate supply and distribution tube assemblies. Ensure primer valves are accessible.

- .3 Provide 115 volt, electronic, surface wall mounting trap primer assemblies for multiple (4 to 30) traps. Include for a 115 volt 15 ampere panel breaker and wiring in conduit from closest panelboards to primer assembly, all to wiring standards of Electrical Division. Adjust primer water flow and timing to suit number of traps served.
- .4 Ensure trap primer piping is secured to floor drain primer tapplings and not terminated through the tapping in the throat of the drain.

3.09 INSTALLATION OF SHOCK ABSORBERS

- .1 Provide accessible shock absorbers in domestic water piping.
- .2 Ensure size of each shock absorber is properly selected to suit size of domestic water pipe and equipment pipe is connected to.

3.10 INSTALLATION OF WATER HAMMER ARRESTORS

- .1 Provide accessible water hammer arrestors in domestic water piping in locations as follows:
 - .1 in headers at groups of plumbing fixtures;
 - .2 at top of risers;
 - .3 at ends of long horizontal runs of piping;
 - .4 in piping connecting solenoid valves or equipment with integral solenoid valves;
 - .5 wherever else shown or required by Code.
- .2 Install each unit in a piping tee either horizontally or vertically in the path of potential water shock in accordance with manufacturer's instructions and details.

3.11 INSTALLATION OF LAVATORY SUPPLY FITTING TEMPERING VALVES

- .1 Provide thermostatic water tempering valves for hot water supply to public washroom lavatory supply fittings. Conceal valves and piping.
- .2 Provide a flush wall mount panel for each valve. Confirm exact location prior to roughing-in.
- .3 Install in accordance with manufacturer's instructions and set mixing valves to deliver 32°C (90°F) tempered water.

3.12 INSTALLATION OF AIR VENTS

- .1 Provide accessible air vents in domestic water piping to prevent air binding.
- .2 Extend copper indirect drain piping from top drain connection of each vent to nearest suitable drain.
- .3 Locate exact vent locations on as-built record drawings.

3.13 FLUSHING AND DISINFECTING PIPING

- .1 Flush and disinfect all new and/or reworked domestic water piping after leakage testing is complete.
- .2 Isolate new piping from existing piping prior to flushing and disinfecting procedures.
- .3 Flush piping until all foreign materials have been removed and flushed water is clear. Provide connections and pumps as required. Open and close valves, faucets, hose outlets, and service connections to ensure thorough flushing.
- .4 When flushing is complete, disinfect the piping with a solution of chlorine in accordance with AWWA C601.
- .5 When disinfecting is complete, submit water samples to a certified laboratory for purity testing and, when testing indicates pure water in accordance with governing standards, submit a copy of test results and fill the systems.

END OF SECTION

1 GENERAL

1.01 SUBMITTALS

- .1 Submit shop drawings/product data sheets for all products specified in this Section except pipe and fittings.
- .2 Submit a copy of plumbing inspection certificate prior to application for Substantial Performance of the Work.

2 PRODUCTS

2.01 PIPE, FITTINGS AND JOINTS

- .1 PVC Sewer
 - .1 DR35 rigid, green PVC hub and spigot pattern sewer pipe and fittings to CAN/CSA B182.2, with gasket joints assembled with pipe lubricant.
 - .2 DR35 rigid, PVC sewer pipe and fittings, with solvent weld joints, all certified to CSA B182.1 and colour-coded as per local governing codes, regulations and standards.
- .2 Copper - Solder Joint
 - .1 Type DWV hard temper to ASTM B306, with forged copper solder type drainage fittings and 50% lead - 50% tin solder joints.
- .3 Cast Iron
 - .1 Class 4000 cast iron pipe, fittings, and mechanical coupling joints to CAN/CSA B70.
- .4 Copper - Victaulic Coupling Joint
 - .1 Type DWV hard temper to ASTM B306, with factory or site rolled grooved ends (with grooving rolls designed for copper) and Victaulic "Copper Connection" wrought copper or cast bronze fittings and Style 606 gasket type couplings.

2.02 VENT STACK COVERS

- .1 Equal to Lexcor Model "Flash-Tite" seamless, spun aluminum, insulated vent stack covers with caps and a factory applied asphalt primer coating on top and bottom of flange.
- .2 Each vent stack cover is to be complete with a vandal-proof cap.

2.03 CLEANOUTS

- .1 Horizontal Piping
 - .1 TY pipe fitting with an extra heavy brass plug screwed into the fitting.
- .2 Vertical Piping

- .1 Bronze or copper cleanout tees in copper piping, each complete with a bronze ferrule, and, for cast iron piping, "BARRETT" type cast iron cleanout tees, each gas and water-tight and complete with a bolted cover.
- .3 Urinal(s)
 - .1 Wall access cleanout assemblies, each complete with a tapered plug, threaded brass insert, urethane rubber seal, and polished stainless steel access cover with vandal-proof stainless steel securing screw.
 - .2 Acceptable products are:
 - .1 Watts Industries (Canada) Ltd. #CO-590-RD;
 - .2 Jay R. Smith #SQ4-1819;
 - .3 Zurn #ZSS-1666-1;
 - .4 Mifab #C1440-RD.

2.04 FLOOR CLEANOUT TERMINATIONS

- .1 Factory finished cast iron terminations, each adjustable and complete with a cast iron body with neoprene sleeve, solid, gasketed, polished nickel-bronze scoriated top access cover to suit floor finish, a seal plug, and captive, vandal-proof, stainless steel securing hardware.
- .2 Acceptable products are:
 - .1 Watts Industries (Canada) Ltd. # CO-200-R-1;
 - .2 Jay R. Smith #4020-F-C Series;
 - .3 Zurn # ZN-1602-SP Series;
 - .4 Mifab # C1100-XR-1 or #C1000-R-3.
- .3 Cleanout terminations in areas with a tile or sheet vinyl floor finish are to be as above but with a square top in lieu of a round top.

2.05 FLOOR DRAINS, FUNNEL FLOOR DRAINS AND HUB DRAINS

- .1 Unless otherwise specified or indicated, floor drains are to be vandal-proof drains in accordance with drawing symbol list, each complete with a cast iron body and a trap seal primer connection. Cast iron components are to be factory finished with latex based paint coating.
- .2 Floor drains in areas with a tile or sheet vinyl floor finish are to be as above but with a square grate in lieu of a round grate.
- .3 Acceptable manufacturers are:
 - .1 Watts Industries (Canada) Ltd.;
 - .2 Jay R. Smith Manufacturing Co.;

.3 Zurn Industries Ltd.;

.4 Mifab Inc.

2.06 ROOF DRAINS

.1 Unless otherwise specified or indicated, roof drains are to be cast iron body drains with aluminium domes, in accordance with the drawing symbol list. Cast iron components are to be factory finished with latex based paint coating.

.2 Acceptable manufacturers are:

.1 Watts Industries (Canada) Ltd.;

.2 Jay R. Smith Manufacturing Co.;

.3 Zurn Industries Ltd.;

.4 Mifab Inc.

3 EXECUTION

3.01 DEMOLITION

.1 Refer to demolition requirements specified in Section entitled Demolition and Revision Work.

3.02 DRAIN AND VENT PIPING INSTALLATION REQUIREMENTS

.1 Provide required drainage and vent piping. Pipe, unless otherwise specified, as follows:

.1 for underground pipe inside building and to points 1.5 m (5') outside building lines – rigid PVC sewer pipe, minimum 75 mm (3") dia.;

.2 for pipe inside building and aboveground in sizes less than or equal to 65 mm (2-½") dia. – type DWV copper;

.3 for pipe inside building and aboveground in sizes greater than or equal to 75 mm (3") dia. – Class 4000 cast iron;

.4 for drainage pump discharge pipe connections from pump to and including shut-off and check valve connections – Type "DWV" copper with Victaulic "Copper Connection" fittings and couplings, or Schedule 40 galvanized steel with Victaulic fittings and couplings.

.2 Unless otherwise specified, slope horizontal drainage piping aboveground in sizes to and including 75 mm (3") dia. 25 mm (1") in 1.2 m (4'), and pipe 100 mm (4") dia. and larger 25 mm (1") in 2.4 m (8').

.3 Install and slope underground drainage piping to inverts or slopes indicated on drawings to facilitate straight and true gradients between points shown. Verify available slopes before installing pipes.

.4 Unless otherwise specified, slope horizontal branches of vent piping down to fixture or pipe to which they connect with a minimum pitch of 25 mm (1") in 1.2 m (4').

- .5 Extend vent stacks up through roof generally where shown but with exact locations to suit site conditions and in any case a minimum of 3 m (10') from fresh air intakes. Terminate vent stacks a minimum of 330 mm (13") above roof (including roof parapets) in vent stack covers. Where not shown on drawings, route vent piping from source to building exterior as required in order to satisfy local governing codes and authority. Coordinate vent routing with other building services and ensure there is no architectural impact.
- .6 Provide cast brass dielectric unions at connections between copper pipe and ferrous pipe or equipment.
- .7 All drainage piping located above residential units is to be Class 4000 cast iron.

3.03 SUPPLY OF VENT STACK COVERS

- .1 Supply a properly sized vent stack cover for each vent stack penetrating roof.
- .2 Hand vent stack covers to roofing trade at site for installation and flashing into roof construction as part of roofing work. Coordinate installation to ensure proper locations. Provide waterproofing caps over vent stacks.

3.04 INSTALLATION OF CLEANOUTS

- .1 Provide cleanouts in drainage piping in locations as follows:
 - .1 in building drain or drains as close as possible to inner face of outside wall, and, if a building trap is installed, locate cleanout on downstream side of building trap;
 - .2 at or as close as practicable to the foot of each drainage stack;
 - .3 at maximum 15 m (50') intervals in horizontal pipe 100 mm (4") dia. and smaller;
 - .4 at maximum 30 m (100') intervals in horizontal pipe larger than 100 mm (4") dia.;
 - .5 in the wall at each new urinal or bank of urinals in a washroom;
 - .6 wherever else shown on drawings.
- .2 Cleanouts are to be same diameter as pipe in piping to 100 mm (4") dia., and not less than 100 mm (4") dia. in piping larger than 100 mm (4") dia.
- .3 Where cleanouts in vertical piping are concealed behind walls or partitions, install cleanouts near floor and so cover is within 25 mm (1") of the finished face of the wall or partition.

3.05 INSTALLATION OF FLOOR CLEANOUT TERMINATIONS

- .1 Where cleanouts occur in horizontal inaccessible underground piping, extend cleanout TY fitting up to floor, and provide a cleanout termination set flush with finished floor.
- .2 In waterproof floors, ensure each cleanout termination is equipped with a flashing clamp device. Cleanout terminations are to suit floor finish.
- .3 Where cleanout terminations occur in finished areas, confirm locations prior to rough-in and arrange piping to suit.

- .4 Ensure cleanout termination covers in tiled floor are square in lieu of round.

3.06 INSTALLATION OF FLOOR DRAINS, FUNNEL FLOOR DRAINS AND HUB DRAINS

- .1 Provide floor drains, funnel floor drains and hub drains.
- .2 Coordinate location of floor drains, funnel floor drains and hub drains with equipment provided by Mechanical Division and Owner's supplied equipment. Install in accordance with manufacturer's instructions.
- .3 Equip each drain with a trap.
- .4 In equipment rooms and similar areas, exactly locate floor drains to suit location of mechanical equipment and equipment indirect drainage piping. In washrooms, exactly locate floor drains to avoid interference with toilet partitions.
- .5 Confirm exact location of drains prior to roughing in. Where floor drains occur in washrooms coordinate locations with toilet partition installations.
- .6 Temporarily plug and cover floor drains during construction procedures. Remove plugs and covers during final clean-up work and when requested, demonstrate free and clear operation of each drain. Replace any damaged grates, and refinish any areas of the drain where cast iron finish has been damaged or removed, including rusted areas.

3.07 INSTALLATION OF ROOF DRAINS

- .1 Supply roof drains and place roof drain bodies in position for flashing into roof construction as part of roofing work. Connect with piping and provide accessories.
- .2 Protect roof drains from damage and entrance of debris until roofing work is complete, and refinish any areas where cast iron factory finish has been damaged or removed, including rusted areas.

END OF SECTION

1 GENERAL

1.01 SUBMITTALS

- .1 Submit product data sheets (fixture cuts) for all plumbing fixtures and fittings.

2 PRODUCTS

2.01 GENERAL RE: PLUMBING FIXTURES AND FITTINGS

- .1 Fixtures and fittings, where applicable, are to be in accordance with requirements of CAN/CSA B45 Series, General Requirements for Plumbing Fixtures, including supplements, ASME A112.1.18.1/CSA B125.1, Plumbing Supply Fittings, and CSA B125.3, Plumbing Fittings.
- .2 Barrier-free fixtures and fittings are to be in accordance with governing Code requirements.
- .3 Unless otherwise specified, vitreous china, porcelain enamelled, and acrylic finished fixtures are to be white.
- .4 Unless otherwise specified, fittings and piping exposed to view are to be chrome plated and polished.
- .5 Fittings located in areas other than private washrooms are to be vandal-proof.
- .6 Fixture carriers are to be suitable in all respects for the fixture they support and construction in which they are located.
- .7 Floor flanges for floor mounted water closets are to be cast iron or brass, secured to floor to prevent movement and complete with a wax seal and brass or stainless steel bolts, nuts, and washers. Plastic floor flanges will not be acceptable.
- .8 Proper seal to mate with fixture carrier flange and produce a water-tight installation.
- .9 Exposed traps for fixtures not equipped with integral traps, such as lavatories, are to be adjustable chrome plated cast brass "P" traps with cleanouts, minimum #17 gauge chrome plated tubular extensions, and chrome plated escutcheons, all to suit fixture type and drain connection.
- .10 Concealed traps for fixtures not equipped with integral traps, such as counter sinks, are to be adjustable cast brass with cleanout plugs, all to suit fixture type and drain connection.
- .11 Exposed supplies for fixtures which do not have supply trim/fittings with integral stops, i.e. lavatories, are to be solid chrome plated brass angle vales with screwdriver stops for public areas, wheel handle stops for private areas, flexible stainless steel risers, and stainless steel or chrome plated steel escutcheons, all arranged and sized to suit fixture.
- .12 Water piping as specified, complete with ball type shut-off valves as specified with water piping, or Dahl Bros. Canada Ltd. ¼ turn Mini Ball Valves.
- .13 All above grade drainage piping associated with waterclosets and showers are to be Class 4000 cast iron.

2.02 PLUMBING FIXTURES AND FITTINGS

.1 Plumbing fixtures and fittings are to be in accordance with the following:

.1 WC-1 TOILET

American Standard 3461001.020 Toilet - MADERA™ FloWise®, Toilet, Floor mounted with floor outlet, Toilet operates in the range of 4.2 to 6.0 LPF (1.1 - 1.6 GPF), Vitreous china, White finish, EverClean® antimicrobial surface, Elongated bowl, 419 mm (16-1/2") rim height, 254 mm (10") to 305 mm (12") rough-in from wall to the center of waste outlet, Direct-fed siphon jet flush action, 38 mm (1-1/2") top spud, Flush valve by others, 254 x 305 mm (10" x 12") water surface area, Fully-glazed 54 mm (2-1/8") trapway, Condensation channel, Toilet seat not included, Two (2) colour-matched bolt caps with retainers (481310-100), 356 mm (14") wide, 718 mm (28-1/4") from finished wall, ASME A112.19.2 compliant, CSA B45.1 compliant.

Centoco 500STSCCFE-001 Seat - FAST-N-LOCK Heavy-duty Open front Toilet seat Without cover, For elongated bowl, White, Polypropylene plastic, Color-matched plastic check hinges with one solid metal hinge pin and bolt, FAST-N-LOCK mounting system.

Sloan SL-ROYAL 111-1.28 Flush Valve - ROYAL® Manual Exposed Water closet flushometer, High Efficiency 4.8 LPF (1.28 GPF), 38 mm (1-1/2") spud coupling For top spud toilet, constructed from Semi-red brass, Polished chrome finish, Chloramine resistant PERMEX® synthetic rubber diaphragm, Metal oscillating handle with triple seal handle packing, Flush tube for 292 mm (11-1/2") rough-in, Adjustable tailpiece, 25 mm (1") I.P.S. screwdriver Bak-Chek® angle control stop with free spinning vandal-resistant stop cap, Dual-filtered fixed bypass, Sweat solder adapter kit with cover tube, High back pressure vacuum breaker, Inlet located right of valve, 25 mm (1") supply pipe, Cast wall flange with set screw, Non-hold-open, no external volume adjustment, fixed volume accuracy is controlled by CID™ technology, 103 - 552 kPa (15 - 80 PSI) operating water pressure, Requires less than 5 pounds of force to activate (push-button), cUPC compliant.

Franke Commercial CM-16104 Backrest - wall mounting, back rest, solid core plastic laminate panel back, Antique white, 305 mm (12") wide, 102 mm (4") high, 8" (204 mm), 18 gauge stainless steel bar with #4 gloss with flanges and covers, concealed snap flanges and mounting hardware included, Provide adequate backing in wall for support and comply to local codes for barrier free requirements

.2 L-1 (BF) LAVATORY -

American Standard 0954004EC.020 0059020EC.020 Basin - MURRO, Wall-hung Lavatory, Vitreous china, EverClean® antimicrobial surface, White finish, 102 mm (4") centerset, Rear overflow, Faucet ledge with recessed self-draining deck, For concealed arm or wall support, Vitreous china shroud/knee contact guard with EverClean (0059020EC), Soap dispenser, When installed with a below deck electronics faucet which has the control box, the accessories will not fit under the shroud and will need to be installed outside the shroud, Overall Dimensions: 545 mm (21-7/16") long, 540 mm (21-1/4") wide, 152 mm (6") high, Bowl Dimensions: 343 mm (13-1/2") long, 394mm (15-1/2") wide, 127 mm (5") deep.

Chicago Faucets 802-317E39VPABCP Faucet - Counter mounted, Manual, Two handles, Lavatory faucet, Polished chrome finish, 102 mm (4") centerset, Lead Free ANSI/NSF 61 compliant ECAST® brass construction, Quatern compression operating cartridge, 1.3 LPM (0.35 GPM) maximum flowrate, Pressure compensating Econo-Flo non-aerating outlet, Fixed Low-arc spout, 102 mm (4") spout reach, 108 mm (4-1/4") high, Vandal-resistant 102 mm (4") wrist blade handles with indexed buttons, 13 mm (1/2") NPSM supply inlet for 10 mm (3/8") or 13 mm (1/2") flexible riser.

Lawler 570-86820 Mixing Valve - Point of Use and Master controlled fixtures, Thermostatic master water mixing control valve, The temperature is adjusted with the help of Spindle.

McGuire 155A Fixture Drain - Straight drain, Cast brass, Chrome-plated finish, Open grid PO plug, 7/32" (5.5 mm) Ø holes size, 17 gauge 32 mm (1-1/4") Ø tailpiece, 17 gauge 152 mm (6") long, Brass locknut, Heavy rubber basin washer Fiber friction washer, ASME A112.18.2 CSA B125.2, CSA compliant

McGuire LFBV170 Supply - CONVERTIBLE™ Commercial Faucet Supply kit, consisting of (2) stop valves, (2) risers, (2) flanges (standard), Lead Free Brass body, Chrome-plated finish, 138 - 862 kPa (20 - 125 PSI) operating pressure, 4 to 60 °C (40 to 140 °F) operating temperature, Convertible loose key/triangle handle, Quarter turn ball valve, Angle stop, C.P. wrought steel deep bell wall flange (standard), C.P. prefabricated 127 mm (5") copper sweat tube extension nipple, 305 mm (12") C.P. lavatory flexible copper riser tubes (standard), 13 mm (1/2") Sweat inlet x 10 mm (3/8") O.D. outlet, 82 °C (180 °F) maximum during high-temperature system flush, AB 100 compliant, ASME A112.18.1 compliant, ASME A112.18.2-2 (risers), CSA B125.2 compliant (risers), Certified to NSF/ANSI 372, Certified to NSF/ANSI 61, UPC compliant.

Watts CA-411-CA-481 Carrier - Lavatory carrier, Floor mounted concealed arm lavatory carrier, concealed arm lavatory carrier, Epoxy coated cast iron concealed arms, Integral welded feet, Foot supports should be securely anchored to floor with 1/2" bolts and anchors by others, Heavy gauge steel uprights, Leveling screws and basin locking device, upper tie rod, and plated hardware., Wall mounted steel support plate with plated hardware.

McGuire 8872C P-Trap - Heavy cast brass, 32 mm (1-1/4") x 32 mm (1-1/4") size, With cleanout plug, 292 mm (11-1/2") distance, Steel shallow flange, Neoprene gasket, 17 gauge seamless tubular wall bend, Slipnuts, Codes and Compliances: ASME A112.18.2 CSA B125.2, CSA compliant.

.3 S-1 COUNTER MOUNTED SINGLE BOWL SINKS

Franke Commercial LBS6808P-1-3 Sink - Single compartment sink, 203 mm (8") centerset, Commercial sinks, with overall dimension 508 mm (20") long, 521 mm (20-1/2") wide, 203 mm (8") high, constructed from 18 gauge Type 304 Stainless steel, Bowl dimensions are Left bowl is 457mm (18") long and right bowl is 305mm (12") long, 406 mm (16") wide, 203 mm (8") deep, Polished to #4 satin finish, Factory installed EZ TORQUE™ fasteners, Factory applied rim seal, Center back waste location, 38 mm (1-1/2") (DN38) brass tailpiece, 89 mm (3-1/2") crumb cup strainer, Undercoated to reduce condensation and resonance, Compliances and certifications: ASME A112.19.3 compliant, CSA B45.4 compliant.

Chicago Faucets 1100-GN2AE35-317AB Faucet - Counter mounted, Manual, Two handles, Sink faucet, Polished chrome finish, 203 mm (8") centerset, Lead Free ANSI/NSF 61 compliant ECAST® brass construction, 1/4 turn compression cartridge, 5.7 LPM (1.5 GPM) maximum flowrate, Pressure compensating Softflo™ aerator, Rigid/swing Gooseneck spout, 133 mm (5-1/4") spout reach, 305 mm (12") high, Vandal-resistant 102 mm (4") wrist blade handles with indexed buttons, 13 mm (1/2") NPSM supply inlet for 10 mm (3/8") or 13 mm (1/2") flexible riser.

Lawler TMM-1070-87500 Mixing Valve - The point of use mechanical mixing valve with thermostatic limit stop, MECHANICAL MIXING VALVE, Compression Fitting.

McGuire LFCK165LK Supply - Faucet Supply kit, consisting of (2) stop valves, (2) risers, (2) flanges (standard), Lead Free Brass body, Chrome-plated finish, 138 - 862 kPa (20 - 125 PSI) operating pressure, 4 to 60 °C (40 to 140 °F) operating temperature, Loose key handle, Full turn, Angle stop, Spring actuated integral check valve, C.P. wrought steel shallow wall flange (standard), 305 mm (12") C.P. lavatory flexible copper riser tubes (standard), 10 mm (3/8") I.P.S. inlet x 10 mm (3/8") O.D. outlet, 82 °C (180 °F) maximum during high-temperature system flush, AB 100 compliant, ASME A112.18.3, ASME A112.18.2-2 (risers), CSA B125.2 compliant (risers), Certified to NSF/ANSI 372, Certified to NSF/ANSI 61, UPC compliant.

McGuire 8912C P-Trap - Heavy cast brass, 38 x 38 mm (1-1/2" x 1-1/2") size, With cleanout plug, 292 mm (11-1/2") length, Shallow steel flange, Neoprene gasket, Seamless tubular brass bend, Slipnuts.

.4 S-2 COUNTER MOUNTED DOUBLE BOWL SINKS

Franke Commercial LBD6408P-1-3 Sink - Double compartment sink, 203 mm (8") centerset, Commercial sinks, with overall dimension 794 mm (31-1/4") long, 521 mm (20-1/2") wide, 203 mm (8") high, constructed from 18 gauge Type 304 Stainless steel, Left bowl is 356 mm (14") long and right bowl is 356 mm (14") long, Left bowl is 406 mm (16") wide and right bowl is 406 mm (16") wide, Left bowl is 203 mm (8") deep and right bowl is 203 mm (8") deep, Polished to #4 satin finish, Factory installed EZ TORQUE™ fasteners, Factory applied rim seal, Center back waste location, 38 mm (1-1/2") (DN38) brass tailpiece, 89 mm (3-1/2") crumb cup strainer, waste fitting included, Undercoated to reduce condensation and resonance, Compliances and certifications: ASME A112.19.3 compliant, CSA B45.4 compliant.

Chicago Faucets 1100-GN8AE35-317AB Faucet - Counter mounted, Manual, Two handles, Sink faucet, Polished chrome finish, 203 mm (8") centerset, Lead Free ANSI/NSF 61 compliant ECAST® brass construction, 1/4 turn compression cartridge, 5.7 LPM (1.5 GPM) maximum flowrate, Pressure compensating Softflo™ aerator, Rigid/swing Gooseneck spout, 203 mm (8") spout reach, 343 mm (13-1/2") high, Vandal-resistant 102 mm (4") wrist blade handles with indexed buttons, 13 mm (1/2") NPSM supply inlet for 10 mm (3/8") or 13 mm (1/2") flexible riser.

Lawler TMM-1070-87500 Mixing Valve - The point of use mechanical mixing valve with thermostatic limit stop, MECHANICAL MIXING VALVE, Compression Fitting.

McGuire LFCK170LK Supply - ICV DEFENDER Faucet Supply kit, consisting of (2) stop valves, (2) risers, (2) flanges (standard), Lead Free Brass body, Chrome-plated finish, 138 - 862 kPa (20 - 125 PSI) operating pressure, 4 to 60 °C (40 to 140 °F) operating temperature, Loose key handle, Full turn, Angle stop, Spring actuated integral check valve, C.P. wrought steel deep bell wall flange (standard), C.P. prefabricated 127 mm (5") copper sweat tube extension nipple, 305 mm (12") C.P. lavatory flexible copper riser tubes (standard), 13 mm (1/2") Sweat inlet x 10 mm (3/8") O.D. outlet, 82 °C (180 °F) maximum during high-temperature system flush, AB 100 compliant, ASME A112.18.3, ASME A112.18.2-2 (risers), CSA B125.2 compliant (risers), Certified to NSF/ANSI 372, Certified to NSF/ANSI 61, UPC compliant.

McGuire 8912C P-Trap - Heavy cast brass, 38 x 38 mm (1-1/2" x 1-1/2") size, With cleanout plug, 292 mm (11-1/2") length, Shallow steel flange, Neoprene gasket, Seamless tubular brass bend, Slipnuts.

.5 DF-1 WALL MOUNTED - SURFACE INSTALLATION - DRINKING FOUNTAIN -

Haws 1311 wall-mounted vandal-resistant barrier-free drinking fountain shall include a white enameled-iron basin, vandal-resistant push-button operated stainless steel valve with front-accessible cartridge and flow adjustment, adult or child ADA mounting heights, 100% lead-free waterways, polished chrome-plated brass vandal-resistant bubbler head, polished chrome-plated brass vandal-resistant waste strainer, vandal-resistant bottom plate, and chrome-plated 1-1/4" NPT trap.

McGuire LFHST01 Stop Valves - Lead Free, Chrome-plated finish, 3/8" I.P.S x 3/8" O.D

McGuire 8872C P-Trap - Heavy cast brass, 32 mm (1-1/4") x 32 mm (1-1/4") size, With cleanout plug, 292 mm (11-1/2") distance, Steel shallow flange, Neoprene gasket, 17 gauge seamless tubular wall bend, Slipnuts, Codes and Compliances: ASME A112.18.2 CSA B125.2, CSA compliant.

Watts CA-311 Carrier - epoxy coated, Carrier, Floor Mounted Carrier, Wall Plate, welded feet, universal steel hangar support plate, Heavy gauge steel offset uprights, integral mounting brackets, Plated hardware.

.6 WF-1 WASHFOUNTAINS

Bradley MF2939-IR-NSD-TMA Terreon™ 3-Station, Terreon cast solid surface bowl, molded sprayhead, infrared controls, each stream former controlled by separate solenoid valve, plug in 110/24 VAC plug-in transformer, thermostatic mixing valve, stop valves, drain spud, flexible stainless steel supply hoses.

McGuire LFBV2165 Supply - CONVERTIBLE™ Commercial Faucet Supply kit, consisting of (2) stop valves, (2) risers, (2) flanges (standard), Lead Free Brass body, Chrome-plated finish, 138 - 862 kPa (20 - 125 PSI) operating pressure, 4 to 60 °C (40 to 140 °F) operating temperature, Convertible loose key/triangle handle, Quarter turn ball valve, Angle stop, C.P. wrought brass shallow wall flange, 305 mm (12") C.P. lavatory flexible copper riser tubes (standard), 13 mm (1/2") I.P.S. inlet x 10 mm (3/8") O.D. outlet, 82 °C (180 °F) maximum during high-temperature system flush, AB 100 compliant, ASME A112.18.1 compliant, CSA B125.2 compliant (risers), Certified to NSF/ANSI 372, Certified to NSF/ANSI 61, UPC compliant.

Watts CA-311-2 Carrier - epoxy coated, Carrier, Floor Mounted Carrier, Wall Plate, welded feet, universal steel hangar support plate, Heavy gauge steel offset uprights, integral mounting brackets, Plated hardware.

.7 PRESSURE BALANCING TUB AND SHOWER SYSTEM WITH SHOWER HEAD AND HAND SPRAY

Delta T13H302 Shower Trim - Polished chrome finish, Pressure balancing shower system with shower head, hand spray, and valve trim options, Delta #161011A vandal resistant shower head 5.7 LPM (1.5 GPM) maximum flowrate @ 80 PSI, With #, 5.7 LPM (1.5 GPM) flowrate, 1499 mm (59") long stainless steel hose, Hand spray with pause control, Wall elbow, In-line vacuum breaker, Wall mounted spray holder, Cold to hot cycle, Wall mounted, Round wall plate includes embossed and colour-coded temperature index, 171 mm (6-3/4") trim size, Lever handle, Pressure balancing valve, Integral service stops with checks to prevent cross-flow, 610 mm (24") wall-mounted grab bar/slide bar, Diverter valve with indexed wall flange, Pressure balancing valve cartridge, 13 mm (1/2") nominal Ø copper sweat inlet, 13 mm (1/2") nominal Ø copper sweat inlet, 138 - 862 kPa (20 - 125 PSI) operating pressure range, 4 °C - 60 °C (40 °F - 140 °F) operating temperature range, WaterSense® certified, Barrier-Free/ADA, ASME A112.18.1/CSA B125.1, ANSI/ICC A117.1, ASSE 1016/ASME A112.1016/CSA B125.16, cUPC certified

.8 SK-1 FLOOR MOUNTED - MOP SINKS

Fiat MSB2424100-MSGBRKT-MSG24-832AA-889CC-1453BB-E77AA Sink - Single compartment sink, Mop service sinks, with overall dimension 610 mm (24") long, 610 mm (24") wide, 254 mm (10") high, constructed from Molded stone, Bowl dimensions are White finish, A combination dome strainer and lint basket made from stainless steel shall be included with factory installed stainless steel drain body for caulked joint or QDC-3 joint to accept a 75 mm (3") drain pipe, Extra corner bracket one (1) extra corner bracket (MSGBRKT), 610 mm (24") wall guard one (1) extra 610 x 305 mm (24" x 12") stainless steel panel (MSG24), Hose and hose bracket (832AA), Mop hanger (889CC), Normal strainer (1453BB), Vinyl bumperguard (E77AA).

Chicago Faucets 897-RCF Faucet - Wall-hung, Manual, Two handles, Mop sink faucet, Rough chrome plated finish, 194 - 213 mm (7-5/8" to 8-3/8") adjustable centerset, Round wall escutcheons, Brass construction, Adjustable supply arms, 1/4 turn ceramic cartridge, No flow restrictor, Threaded hose end, Fixed Spout with pail hook, 146 mm (5-3/4") spout reach, 273 mm (10-3/4") high, Top brace, 60 mm (2-3/8") lever handle with indexed buttons, Atmospheric vacuum breaker is not intended for continuous pressure applications.

2.03 ACCEPTABLE MANUFACTURERS

- .1 Subject to compliance with requirements, manufacturers that may be incorporated into the Work include, but are not limited to, following:
 - .1 Flush Valves:
 - .1 Sloan;
 - .2 Delta Commercial;
 - .3 Zurn Industries;
 - .4 Moen Commercial.
 - .2 Plumbing Brass:
 - .1 Sloan;
 - .2 Acorn Engineering;
 - .3 American Standard;
 - .4 Delta Commercial;
 - .5 Chicago Faucet;
 - .6 Moen Commercial.
 - .3 Stainless Steel Sinks:
 - .1 Franke Commercial;
 - .2 Novanni Commercial;
 - .3 Aristaline;
 - .4 Arch Metal Ind.
 - .4 Mop Sinks:
 - .1 Stern Williams;
 - .2 Acorn Engineering;
 - .3 Zurn Industries.
 - .5 Drain Fittings, Angle Supplies, and Traps:
 - .1 McGuire;
 - .2 American Standard;
 - .3 Delta Commercial;

- .4 Zurn Industries.
- .6 Fixture Carriers:
 - .1 Watts Industries;
 - .2 Jay R. Smith;
 - .3 Zurn Industries.
- .7 Hose Bibbs:
 - .1 Jay R. Smith;
 - .2 Zurn Industries.
- .8 Water Closets, Lavatories, and Urinal:
 - .1 American Standard;
 - .2 Zurn Industries;
 - .3 Kohler.
- .9 Thermostatic Mixing Valves:
 - .1 Lawler;
 - .2 Delta Commercial;
 - .3 Leonard.
- .10 Shower and Associated Trim:
 - .1 American Standard;
 - .2 Delta Commercial;
 - .3 Zurn Industries;
 - .4 Moen Commercial.
- .11 Toilet Seats:
 - .1 Olsonite;
 - .2 Centoco;
 - .3 Bemis Commercial.

2.04 CAULKING

- .1 General Electric Series SCS-1200 Silicone Construction Sealant or Dow Corning 780 silicone rubber sealant with primers as recommended by sealant manufacturer. Caulking colour(s) for coloured fixtures other than white, if any, will be selected by Consultant from sealant manufacturer's standard colour range.

3 EXECUTION

3.01 DEMOLITION

- .1 Refer to demolition requirements specified in Section entitled Demolition and Revision Work.

3.02 INSTALLATION OF PLUMBING FIXTURES AND FITTINGS

- .1 Provide required plumbing fixtures and fittings.
- .2 Where new fixtures and fittings are to be connected to existing piping, include for required piping revisions.
- .3 Connect plumbing fixtures and fittings with piping sized in accordance with drawing schedule. Refer to manufacturer's published connection (rough-in) requirements. Where manufacturer requires piping connection larger than shown below, provide piping accordingly:

FIXTURE AND/OR FITTING	DRAIN SIZE MM (IN.)	VENT SIZE MM (IN.)	DHW SIZE MM (IN.)	DCW SIZE MM (IN.)	TEMP WATER SIZE MM (IN.)
Water Closets Flush Valve Type	100 (4)	38 (1-½)	-----	25 (1)	-----
Lavatories	32 (1-¼)	32 (1-¼)	12 (½)	12 (½)	-----
Lavatories (Electronic Faucet)	32 (1-¼)	32 (1-¼)	12 (½)	12 (½)	12 (½)
Counter Sinks	38 (1-½)	32 (1-¼)	12 (½)	12 (½)	-----
Shower Valves and Heads	-----	-----	12 (½)	12 (½)	12 (½)
Shower Stalls	50 (2)	38 (1-½)	12 (½)	12 (½)	12 (½)
Prefab. Mop Sinks with Drain	75 (3)	38 (1-½)	20 (¾)	20 (¾)	-----

- .4 Confirm exact location of plumbing fixtures and trim prior to roughing-in. Refer to architectural plan and elevation drawings.
- .5 When installation is complete, check, and test operation of each fixture and fitting. Adjust or repair as required.
- .6 For barrier-free fixtures, comply with mounting height and other requirements of governing Code(s).

- .7 Supply templates for counter mounted fixtures and trim and hand to trades who will cut the counter. Ensure openings in counter are properly located.
- .8 Locate control panels for electronic faucets under lavatories and recessed into wall. Coordinate panel installations with electrical trade who will provide 115 volt power wiring to panels. Install flexible conduit (supplied with box) and extend cord from faucet through the flexible conduit to control box. Connect hot and cold water piping to mixing valve in each box, and tempered water piping from each mixing valve to faucet. Set mixing valve maximum temperature limit stops to 43°C (110°F) after domestic water systems (hot and cold) are complete. Ensure each programmable controller is properly programmed and water off after deactivation is set for 3 seconds.
- .9 For electronic flush valves, locate transformer in ceiling space above electronic units to be served. Coordinate locations with electrical trade who will provide 120 volt line supply to transformers. Provide low voltage wiring from transformers to each electronic flush valve terminal point. Electrical line supply and low voltage wiring is to be concealed and access to transformer must be provided for servicing.
- .10 Protect shower bases from damage during construction and finishing work.
- .11 Confirm exact mixing valve and shower head locations prior to roughing-in.
- .12 Install refrigerated drinking fountains in accordance with manufacturer's instructions. Plug into a wall receptacle provided as part of electrical work. Coordinate receptacle installation with electrical trade on site.
- .13 Set mop service basins on floor over drain piping and connect to roughed-in service. Install wall supply trim and any accessories specified.

3.03 CAULKING AT PLUMBING FIXTURES AND FITTINGS

- .1 Caulk around plumbing fixtures and fittings where they contact walls, floors, and any other building surface.
- .2 Clean areas/surfaces to be caulked and prime in accordance with sealant manufacturer's instructions. Where damage to a building surface may occur, mask surface to prevent damage and ensure a clean exact edge to the caulking bead.
- .3 Apply caulking using a gun with proper size and shape of nozzle and force sealant into joints to ensure good surface contact and a smooth and even finished bead of sealant.
- .4 If joints have been masked sealant may be tooled in a continuous stroke to obtain complete void filling. Remove masking tape immediately after tooling and before sealant begins to skin.

3.04 DISHWASHER CONNECTIONS

- .1 Provide roughed-in water and drain connections for Owner supplied dishwasher consisting of:
 - .1 15 mm (½") dia. domestic hot water connection with a Dahl "Mini-Ball" valve with hose end and water hammer arrestor;
 - .2 40 mm (1-½") dia. DWV copper drain connection with "P" trap and cleanout plug.

3.05 CLOTHES WASHER CONNECTIONS

- .1 Provide roughed-in water and drain connections for Owner supplied clothes washer consisting of:
 - .1 15 mm (½") dia. piping connection for both hot and cold water, each terminated in a Dahl "Mini-Ball" Valve with hose end and water hammer arrestor;
 - .2 50 mm (2") dia. standing waste with a height to suit the washer drain and complete with a "P" trap.

END OF SECTION

1 GENERAL

1.01 SUBMITTALS

- .1 Submit shop drawings/product data for all products specified in Part 2 of this Section except for pipe, fittings, and unions. Indicate performance criteria, conformance to appropriate reference standards, and limitations.

1.02 QUALITY ASSURANCE

- .1 Gas system work is to be in accordance with requirements of CAN/CSA B149.1, Natural Gas and Propane Installation Code, as amended by local Gas Codes.
- .2 Gas system work is to be performed only by licensed gas pipe fitters (holding Gas Technician 1 Certificate) authorized under TSSA Act.
- .3 Apply for, on TSSA forms, approval of gas system design by TSSA prior to work beginning at site and prior to ordering any equipment. Submit completed TSSA Form and copies of shop drawings/product data sheets as required to TSSA and obtain an approval certificate. Pay costs for TSSA review and approval process. If TSSA requires revisions to the system and revisions result in an extra cost, a Notice of Change will be issued by Consultant for the revision.

2 PRODUCTS

2.01 PIPE, FITTINGS AND JOINTS

- .1 Uncoated Black Steel - Screwed Joints
 - .1 Schedule 40 mild black carbon steel, ASTM A53, Grade B, complete with malleable cast iron screwed fittings to ANSI B2.1, and screwed joints.
- .2 Uncoated Black Steel - Welded Joints
 - .1 Schedule 40 mild black carbon steel, ASTM A53, Grade B, mill or site bevelled, complete with factory made forged steel butt welding fittings and welded joints.
- .3 Copper - Uncoated
 - .1 Type "G" seamless copper tubing to ASTM B837, hard temper with wrought copper capillary brazed joint type fittings to ASTM B.61, and brazed joints made with "Sil-Fos" or "Sil-Fos 5" brazing alloy, or, soft temper with flared brass fittings of a single 45° flare type, forged or with a machined long nut and copper to copper threaded connectors, and, where required, flared brass copper to NPS adapters.
- .4 Flexible Stainless Steel
 - .1 Flexible, CSA certified, 860 kPa (125 psi) rated, gas-tight, convoluted stainless steel tubing factory jacketed with a bright yellow PVC coating which is continuously identified. Supply tubing in coils and complete with factory attached stainless steel end fittings, and adapter unions, protective plates, and steel clamps.
 - .2 Acceptable products are:
 - .1 Tru-Flex Metal Hose LLC. "Pro-Flex";

- .2 Titeflex Corp. "Gastite";
- .3 Omega Flex Canada "TracPipe".

2.02 PIPING UNIONS

- .1 Screwed Piping
 - .1 Malleable iron, ground joint, bronze or brass to iron or bronze to bronze seat screwed unions and union elbows with a minimum pressure rating of 1725 kPa (250 psi) steam at 260°C (500°F).
- .2 Flanged Piping
 - .1 Forged carbon steel slip-on type raised faced welding flange unions to ASTM A105, 150 lb. Class for steel pipe, and slip-on type 150 lb. Class bronze flanges for copper pipe.
- .3 Copper to Steel
 - .1 Equal to Kamco Products "Copper Stopper".

2.03 SHUT-OFF VALVES

- .1 Ball Type
 - .1 CSA certified, minimum 3100 kPa (450 psi) WOG rated, 1/4 turn, full port non-lubricated brass ball valves, each complete with a Teflon PTFE seat, chrome plated solid ball, removable lever handle, and screwed ends.
 - .2 Acceptable products are:
 - .1 Neo Valves Inc. #425;
 - .2 Kitz Corp. Code 58;
 - .3 Toyo Valve Co. Fig. 5044A.
- .2 Plug or Ball Type
 - .1 CSA certified, plain face flanged, Class 125, 1380 kPa (200 psi) rated, 1/4 turn, cast iron lubricated plug valves, each wrench operated and complete with cylindrical plug with lubricant grooves, lubricant screw, and lubricant receptacle, or full port carbon steel ball valves with flanged ends.
 - .2 Acceptable products are:
 - .1 Neo Valves Inc. #1AS40114 plug valve;
 - .2 Newman Hattersley #171M plug valve;
 - .3 Kitz Corp. Code No. 150 SCTAM-FS-CGA ball valve.

- .3 Shut off valves serving natural gas emergency generators are to be provided with valve position indicator and contact to initiate trouble alarm condition at the generator control panel.

2.04 PRESSURE REGULATORS

- .1 CSA certified pressure regulators as follows:
 - .1 vented type: spring-loaded self-operated design, tight closing, selected for facility gas pressure and piping pressure loss, and connected equipment load at full firing rate plus 20% spare, and complete with:
 - .1 1035 kPa (150 psi) rated cast iron body finished with corrosive resistant epoxy enamel;
 - .2 aluminum diaphragm and spring case with Nitrile diaphragm, disc, and body o-ring;
 - .3 throttling type, high flow rate, tight shut-off relief valve selected to protect equipment downstream of regulator in coordination with regulator capacity.
 - .2 Acceptable manufacturers are:
 - .1 Maxitrol Co.;
 - .2 Fisher Controls;
 - .3 Leslie Controls Inc.;
 - .4 Lakeside Process Controls.

3 EXECUTION

3.01 DEMOLITION

- .1 Perform required gas system demolition work. Refer to demolition requirements specified in Section entitled Demolition and Revision Work.

3.02 NATURAL GAS SERVICE

- .1 Make required arrangement with natural gas supply utility on behalf of Owner for installation of natural gas service piping with gas pressure regulator and meter assembly.
- .2 Provide 2 m (7') high minimum 200 mm (8") diameter Schedule 80 galvanized steel concrete filled bollards at meter-regulator location in a pattern to protect meter-regulator. Install pipe straight and plumb a 1.2 m (4') below grade in a continuous 600 mm (2') diameter reinforced concrete footing. Smoothly crown top of concrete above the top of the pipe.

3.03 NATURAL GAS PIPING INSTALLATION REQUIREMENTS

- .1 Provide required natural gas distribution piping and connect gas fired or operated equipment, and provide required vent piping to atmosphere, including vent piping from pressure regulators. Perform piping work in accordance with requirements of CAN/CSA B149.1, Natural Gas and Propane Installation Code, as amended by local Gas Codes.

- .2 Piping is to be as follows:
 - .1 for underground piping, coated Schedule 40 black steel, coated soft copper, or polyethylene;
 - .2 for aboveground piping, uncoated Schedule 40 black steel, hard temper or soft copper, or, if permitted, flexible stainless steel.
- .3 Install flexible stainless steel pipe in strict accordance with pipe manufacturer's instructions.
- .4 Slope gas piping in direction of flow to low points.
- .5 Ensure supports for roof mounted piping are sized (height) to accommodate roof slope and required piping slope, and to permit installation of low point dirt pockets.
- .6 Provide full pipe diameter 150 mm (6") long drip pockets at bottom of vertical risers, at piping low points, and wherever else shown and/or required.
- .7 Identify natural gas piping aboveground with 2 coats of safety yellow enamel applied over primer, and SMS Ltd. or equal coil type vinyl identification makers with arrows.
- .8 For underground gas piping, provide continuous 75 mm (3") wide yellow PVC warning tape with "CAUTION - GAS LINE BURIED BELOW" wording at 750 mm (30") intervals located above pipe approximately 250 mm (10") below grade.

3.04 INSTALLATION OF SHUT-OFF VALVES

- .1 Provide CSA approved ball type or lubricated plug type shut-off valves to isolate equipment, and wherever else shown.
- .2 Ensure valves are located for easy accessibility and maintenance.

3.05 INSTALLATION OF PRESSURE REGULATORS

- .1 Provide pressure regulators in gas distribution piping where indicated and/or required.
- .2 Use vented type pressure regulators for all other applications.
- .3 Install regulating stations in accordance with requirements of CAN/CSA B149.1.
- .4 Provide 6 mm (¼") diameter test ports upstream and downstream of each regulator assembly.
- .5 Locate outdoor regulating stations a minimum of 300 mm (12") away from walkways, and 3 m (10') away from equipment air intakes and building openings. Provide required vent piping and terminate vents in a turn-down elbow fitting with bronze bug screen secured in place.
- .6 Locate indoor regulating stations in locations accessible without use of ladders or lifts. Combine vents where permitted and increase vent pipe size accordingly. Extend vent piping up through roof 3 m (10') away from equipment air intakes and building openings and terminated in a turn-down elbow fitting with bronze bug screen secured in place.

- .7 Indicate operating set-points, relief settings and vent arrangements for each regulating station on as-built record drawings.

END OF SECTION

1 GENERAL

1.01 SUBMITTALS

- .1 Submit shop drawings/product data sheets for all products specified in this Section except shop fabricated ductwork and fittings.
- .2 Include capacity, throw and terminal velocity, noise criteria, and pressure drops with grille and diffuser shop drawing/product data sheet submission.
- .3 Submit duct leakage test data prior to ductwork being covered from view.
- .4 Include the following with fan & accessories shop drawing/product data sheet submission:
 - .1 certified fan performance curves at specified operating point with flow, static pressure and HP clearly plotted;
 - .2 certified sound power data that conforms to specified levels;
 - .3 product data sheets for all accessories;
 - .4 product data sheets for fan motors.

1.02 QUALITY ASSURANCE

- .1 Grilles and diffusers are to be tested and performance certified to ANSI/ASHRAE 70, Method of Testing the Performance of Air Outlets and Air Inlets.

2 PRODUCTS

2.01 GALVANIZED STEEL DUCTWORK

- .1 Galvanized steel sheet is to be hot dipped in accordance with requirements of ASTM A653. G60 galvanizing for bare uncovered duct to be finish painted. G90 for all other galvanizing.
- .2 Rectangular
 - .1 Lock forming grade hot dip galvanized steel, ASTM A653, shop fabricated, minimum #26 gauge.
- .3 Round
 - .1 Factory machine fabricated, spiral, mechanically locked flat seam, single wall duct, fittings and couplings.

2.02 RECTANGULAR ALUMINUM DUCTWORK

- .1 Alloy 3003 Temper H14 aluminum, ASTM B209, shop or factory fabricated, water-tight, with metal gauges and fabrication in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible to suit the duct working pressure classification, and type 316 stainless steel support hardware.

2.03 ROUND ALUMINUM DUCTWORK

- .1 Alloy 3003 Temper H14 aluminum, ASTM B209, factory fabricated, water-tight, smooth interior, single wall duct, and fittings of spiral lockseam construction with site sealed beaded sleeve (slip type) joints, all in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible to suit duct working pressure classification, and type 316 stainless steel sheet metal screws and support hardware.

2.04 FLEXIBLE CONNECTION MATERIAL

- .1 Waterproof, indoor-outdoor type flexible connection material meeting requirements of NFPA 90A, consisting of woven glass fibre fabric coated on both sides with synthetic rubber. Acceptable products are:
 - .1 Duro Dyne Canada Inc. "DUROLON";
 - .2 Dyn Air Inc. "HYPALON".
- .2 Waterproof, flameproof, high temperature flexible connection material meeting requirements of NFPA 90A, consisting of a woven glass fibre fabric coated on both sides with silicone rubber. Acceptable products are:
 - .1 Duro-Dyne Canada Inc. "THERMAFAB";
 - .2 Dyn Air Inc. "SILICON HI-T".

2.05 FLEXIBLE METALLIC DUCTWORK

- .1 Bare
 - .1 Spirally wound, semi-rigid, self-supporting corrugated aluminum duct with continuous triple lock seams, SMACNA Form "M-UN", ULC S110 listed and labelled as a Class 1 Air Duct, constructed of dead soft aluminum strip, and supplied in 3 m (10') lengths.

2.06 METAL DUCT SYSTEM JOINT SEALANT

- .1 ULC listed and labelled, premium grade, grey colour, water base, non-flammable duct sealer, brush, or gun applied, with a CAN/ULC S102 tested maximum flame spread rating of 5 and smoke developed rating of 0.
- .2 Acceptable manufacturers are:
 - .1 Johns Manville;
 - .2 Manson Insulation;
 - .3 Knauf Insulation.

2.07 ACOUSTIC LINING

- .1 Minimum 25 mm (1") thick acoustic lining material meeting 25/50 flame spread and smoke developed ratings tested in accordance with CAN/ULC S102, meeting NFPA 90A, ASTM C1071, and ASTM G21 requirements, not supporting microbial growth, flexible for round ducts, board type for rectangular ducts, consisting of a bonded fiberglass mat coated on inside (airside) face with a black fire-resistant coating.

- .2 Acceptable manufacturers are:

- .1 Johns Manville;
- .2 Manson Insulation;
- .3 Knauf Insulation.

2.08 CASING AND PLENUM MATERIAL AND ACCESSORIES

- .1 Unless otherwise specified, casing and plenum material is to be same as connecting duct material.
- .2 Accessories such as access doors and drain pans are to be constructed of same material as casing and plenum and are to be in accordance with Chapter 6 of SMACNA HVAC Duct Construction Standards Metal and Flexible.

2.09 PLENUM ACCESS DOORS

- .1 Factory fabricated, double wall insulated access doors, sized as indicated on drawings, and constructed of same material as connecting ductwork in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible to suit operating pressure of the system.

2.10 ROUND TO RECTANGULAR DUCT CONNECTIONS

- .1 Equal to Flexmaster Canada Ltd. galvanized steel, flared, flanged or notched "Spin-On" round duct take-off collars with locking dampers in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible.

2.11 SPLITTER DAMPERS

- .1 Minimum #20 gauge damper blade constructed of same material as duct, reinforced as required to suit blade size, system velocity, and to prevent "chatter", and complete with operating hardware equal to DynAir Inc. #Q-50 "DYN-A-QUAD S-S" quadrant regulator with RW-50 backup washers to prevent leakage, long square bearing pin, and slide pin.

2.12 AIR TURNING VANES

- .1 For square elbows, multiple-radius turning vanes interconnected with bars, adequately reinforced to suit pressure and velocity of system, constructed of same material as duct they are associated with, and in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible.
- .2 For short branch ducts at grille and diffuser connections, air extractor type each equipped with a matching bottom operated 90° opposed blade volume control damper, constructed of same material as duct it is associated with and in accordance with requirements and details in ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible.

2.13 MANUAL BALANCING (VOLUME) DAMPERS

- .1 Flanged and drilled, single or parallel blade (depending on damper size) manual balancing dampers, each constructed of same material as connecting ductwork unless otherwise specified, each designed to maintain internal free area of connecting duct, and each complete with:

- .1 hexagonal or square shaft extension through frame;
 - .2 non-stick, non-corrosive synthetic bearings for rectangular dampers, flange stainless steel bearings for round dampers;
 - .3 blade stops for single blade dampers, designed to prevent blade from moving more than 90°;
 - .4 linkage for multiple blade dampers;
 - .5 locking hand quadrant damper operator with, for insulated ducts 50 mm (2") standoff mounting.
- .2 Rectangular Dampers: Nailor Industries Inc. 1800 Series, maximum size 1.2 m x 1.2 m (4' x 4') for a single damper.
 - .3 Round Dampers: Nailor Industries Inc. Model 1890, maximum 600 mm (24") diameter, equipped with a minimum 200 mm (8") deep frame, and blade stiffeners where required.
 - .4 Multiple Rectangular Damper Section Assembly: Rectangular assembly supplied with the dampers or site constructed, of same material as damper and designed for tight and secure mounting of individual dampers.
 - .5 Acceptable manufacturers are:
 - .1 Nailor Industries Inc.;
 - .2 T.A. Morrison & Co. Inc. "TAMCO";
 - .3 NCA Manufacturing Ltd.;
 - .4 Greenheck Fan Corp.;
 - .5 Ruskin Co.

2.14 BACKDRAFT DAMPERS

- .1 Nailor Industries Model 1370CB counterbalanced backdraft dampers, vertical or horizontal mounting, 50 mm (2") wide, sized as shown and complete with:
 - .1 extruded 6063-T5 aluminum frame, 2.3 mm (0.090") nominal wall thickness, with mitred corners;
 - .2 extruded 6063-T5 aluminum blades, 1.3 mm (0.050") nominal wall thickness on 92 mm (3-5/8") centres, and with extruded PVC blade seals;
 - .3 corrosion-resistant synthetic bearings;
 - .4 adjustable plated steel counterweights mounted internally in the airstream;
 - .5 concealed blade linkage located out of the airstream.
- .2 Acceptable manufacturers are:
 - .1 Nailor Industries Inc.;

- .2 T.A. Morrison & Co. Inc. "TAMCO";
- .3 NCA Manufacturing Ltd.;
- .4 Greenheck Fan Corp.;
- .5 Ruskin Co.;
- .6 Alumavent.

2.15 FUSIBLE LINK DAMPERS

- .1 Curtain blade type, dynamic, galvanized steel (unless otherwise specified) fusible link dampers, ULC classified to CAN/ULC S112 and in accordance with NFPA 90A requirements, factory tested for closure under airflow, 1-1/2 hour or 3 hour rated as required, and complete with a constant force type 301 stainless steel closure spring, a blade lock assembly, a steel sleeve, retaining angles, and, unless otherwise specified, a 74°C (165°F) rated standard fusible link.
- .2 Fusible link dampers are to be Type "B" or Type "C" (as required) with folded curtain blade out of air stream except where damper size or location requires use of type "A" dampers with curtain blade in air stream.
- .3 Acceptable manufacturers are:
 - .1 Nailor Industries Inc.;
 - .2 Greenheck Fan Corp.;
 - .3 NCA Manufacturing Ltd.;
 - .4 Ruskin Co.;
 - .5 Price Industries (E.H. Price);
 - .6 Alumavent.

2.16 COMBINATION FIRE/SMOKE DAMPERS

- .1 Nailor Industries Series 1220, ULC listed to CAN/ULC S112 and CAN/ULC S112.1, meeting requirements of NFPA 80, 90A, 92, 101 and 105, consisting of type A, B, or C fusible link fire dampers as required and a fail-safe, opposed blade, normally closed, motor operated smoke damper complete with factory installed and tested 120 V electric actuator.
- .2 For applications where supply or return ducts terminate at a grille, at your option, provide:
 - .1 Nailor Industries 1221-OW "out of wall" high performance combination fire/smoke damper, ULC listed to CAN/ULC S112 and CAN/ULC S112.1, meeting requirements of NFPA 80, 90A, 92, 101 and 105, consisting of type A, B, or C fusible link fire dampers as required and a fail-safe, opposed blade, normally closed, motor operated smoke damper complete with factory installed and tested 120 V electric actuator accessible through the front supply/return grille, intumescent thermal insulation on all sides of sleeve.

- .2 Nailor Industries 1221G combination fire/smoke damper for grilles, ULC listed to CAN/ULC S112 and CAN/ULC S112.1, meeting requirements of NFPA 80, 90A, 92, 101 and 105, consisting of type A, B, or C fusible link fire dampers as required and a fail-safe, opposed blade, normally closed, motor operated smoke damper complete with factory installed and tested 120 V electric actuator accessible through the front supply/return grille, grille mounting flanges. Coordinate grille size and mounting with damper requirements.
- .3 ULC 1-1/2 hour fire rated and ULC Class I leakage rated for smoke, and equipped with a 74°C (165°F) ULC classified fusible link that will cause damper to close and lock independent of actuator when duct temperature reaches maximum temperature of damper assembly.
- .4 Supply damper with factory installed sleeves of minimum 400 mm (16") length, field verified by contractor dependent on wall thickness. Caulk sleeves to ULC requirements and constructed of 20 gauge for sizes up to 2.1 m (84") wide and 18 gauge for sizes greater than 2.1 m (84") wide.
- .5 Acceptable manufacturers are:
 - .1 Nailor Industries Inc.;
 - .2 Greenheck Fan Corp.;
 - .3 NCA Manufacturing Ltd.;
 - .4 Ruskin Co.;
 - .5 Price Industries (E.H. Price).

2.17 SMOKE DAMPERS

- .1 Multi-blade type, fail-safe, dynamic, galvanized steel (unless otherwise specified) smoke dampers, ULC classified to CAN/ULC S112.1, ULC Class I leakage rated for smoke, meeting requirements of NFPA 90A, 92, 101 and 105, normally closed, low pressure drop design, dynamically tested, each complete with jamb and blade seals, linkage concealed in the frame, a steel sleeve to suit the opening, and an electric actuator to automatically close damper upon receiving an external signal, and to automatically open damper when system is reset.
- .2 Acceptable manufacturers are:
 - .1 Nailor Industries Inc.;
 - .2 Greenheck Fan Corp.;
 - .3 NCA Manufacturing Ltd.;
 - .4 Ruskin Co.;
 - .5 Price Industries (E.H Price).

2.18 MOTORIZED DAMPERS

- .1 TAMCO Series 9000 BF low leakage/thermal break thermally insulated air foil damper capable of achieving a 6.7 cfm/sq. ft. (34 l/s/sq. m.) at -40°F (-40°C) leakage rate at 4" (1 kPa) differential pressure and bearing the AMCA certification seal for air leakage and complete with:
 - .1 0.080" (2.03 mm) thick 4" (100 mm) deep extruded aluminium insulated frame with extruded TPE thermoplastic seals on the sides of the frame. Entire frame shall be thermally broken by means of polyurethane resin pockets, complete with thermal cuts;
 - .2 extruded aluminium, broken frame damper blade internally insulated with non-CFC expanded polyurethane foam, with EPDM gasketed blade seals integrally secured to the damper blade;
 - .3 acetal copolymer (Celcon) and polycarbonate bearings with no metal-to-metal contact;
 - .4 out-of-airstream linkages and crank arms constructed of aluminium and corrosion resistant, zinc & nickel plated steel, complete with cup-point trunnion screws.
- .2 Dampers shall be sized for "flanged" installation (damper blade area to be equal to duct or plenum cross section area).
- .3 Acceptable damper manufacturer is TAMCO only.

2.19 ROOF DUCT SUPPORTS

- .1 Equal to PHP Systems Design Model PHP-D adjustable duct support assemblies sized to suit duct size, each assembly complete with injection moulded recycled plastic and carbon black bases and tubular hot dip galvanized steel framing.

2.20 DUCT ACCESS DOORS

- .1 In accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible, with sizes suitable in all respects for purpose for which they are provided, and, unless otherwise specified, constructed of same material as duct they are associated with.

2.21 DUCTWORK DRAIN POINTS

- .1 Equal to Ductmate Canada Ltd. "Moisture Drain", 20 mm ($\frac{3}{4}$ ") diameter moisture drains with galvanized sheet metal funnel, and chrome plated brass threaded drain, nut and cap.

2.22 INSTRUMENT TEST PORTS

- .1 Equal to Duro-Dyne of Canada Ltd. #IP1 or #IP2 (to suit insulation thickness where applicable) gasketed, leakproof instrument test ports for round or rectangular ducts as required, each complete with a neoprene expansion plug and a plug securing chain.

2.23 WIRE MESH (BIRDSCREEN)

- .1 Heavy-gauge galvanized steel or aluminum mesh, 12 mm x 12 mm ($\frac{1}{2}$ " x $\frac{1}{2}$ ") secured in a rigid galvanized steel or aluminum framework, sized as indicated on drawings, and constructed so as to be removable.

2.24 LOUVRES

- .1 Price Industries Inc. DE439 or DE635, 100 mm (4") or 150 mm (6") deep (to suit wall thickness) factory assembled stationary, drainable, storm-proof louvres sized as indicated on drawings, each AMCA water penetration and air performance certified, constructed of welded, extruded, alloy 6063-T5 aluminum with drainable blades, mounting and securing hardware to suit the application, and 12 mm (½") mesh aluminum birdscreen in an aluminum frame.
- .2 Louvres are to be factory finished with a finish equal to PPG Industries "Duranar" fluoropolymer powder coating over primer with colour as selected from manufacturer's standard colour range.
- .3 Acceptable manufacturers are:
 - .1 Price Industries Inc.;
 - .2 The Airolite Co. LLC;
 - .3 Construction Specialties;
 - .4 Nailor Industries Inc.;
 - .5 Greenheck Fan Corp.

2.25 LOUVRE BLANK-OFF PANELS

- .1 Insulated, framed, sandwich construction panels consisting of 40 mm (1-½") thick rigid insulation (meeting NFPA 90A requirements) between minimum #20 gauge galvanized sheet steel with exterior face of panels finished to match finish of exterior wall louvres.

2.26 SILENCERS

- .1 Vibro-Acoustics silencers per the drawing schedule and as specified hereinafter, each certified to latest ASTM E477 "Standard Method of Testing Duct Liner Materials and Prefabricated Silencers For Acoustical and Airflow Performance" completely prefabricated and as follows:
 - .1 Materials
 - .1 Rectangular type silencers shall be constructed with a 22 gauge (0.78 mm) galvanized steel outer casing and 26 gauge (0.47 mm) galvanized perforated steel.
 - .2 Elbow silencers shall be constructed with an 18 gauge (1.24 mm) galvanized steel outer casing and 22 gauge (0.78 mm) galvanized perforated steel. All acoustical splitters shall be internally radiused and aerodynamically designed for efficient turning of the air. Half and full splitters are required as necessary to achieve the scheduled insertion loss. All elbow silencers with a turning cross-section dimension greater than 48" (1200 mm) shall have at least two half splitters and one full splitter.
 - .2 Acoustic Media:

- .1 Film lined MoldBlock Media™ silencers shall be Vibro-Acoustics® MoldBlock Media™ containing 100% natural cotton fibers treated with an EPA registered, non-toxic borate solution, “flash dried” to provide resistance to mold, mildew and fungi. Media shall comply with UL181 and NFPA 90A. MoldBlock Media™ shall be packed with a minimum of 15% compression during silencer assembly. Media shall not cause or accelerate corrosion of aluminum or steel.
- .3 Acoustic Media Protection
 - .1 Film lined silencers shall be as above with acoustic media completely wrapped with Tedlar film to prevent shedding, erosion and impregnation of glass fibre. The wrapped acoustic media shall be separated from the perforated metal by a factory installed ½” (12 mm) thick acoustically transparent spacer. The spacer shall be flame retardant and erosion resistant. A mesh, screen or corrugated liner will not be acceptable as a substitute for the specified spacer.
- .4 HTL Casings
 - .1 Where indicated on the silencer schedule, silencers shall have a high transmission loss (HTL) walls externally applied and completely sealed to the silencer casing by the silencer manufacturer to assure quality controlled transmission loss. The HTL walls shall consist of media, airspace, mass and outer protective metal skin, as required to obtain the specified room noise criteria. Standard acoustical panels will not be accepted as HTL walls. Provide breakout noise calculations as part of the silencer shop drawing submissions for each air handling and fan system with HTL silencers. Breakout noise shall be based on the sound power levels of the specified equipment.
- .2 Manufacturer shall certify on shop drawings that silencer performance is per ASTM E477. Shop drawings submitted without same, will be rejected.
- .3 Acceptable manufacturers are Vibro-Acoustics, J.P. Environmental Products Inc., Vibron and EH Price.

2.27 GRILLES AND DIFFUSERS

- .1 Grilles and diffusers of type, size, capacity, finish, and arrangement as shown on drawings and in accordance with drawing schedule, each equipped with all required mounting and connection accessories to suit mounting location and application.
- .2 Acceptable manufacturers are:
 - .1 Price Industries Inc.;
 - .2 Anemostat;
 - .3 Krueger Division of Air System Components Inc.;
 - .4 Titus;
 - .5 Nailor Industries Inc.;
 - .6 Tuttle & Bailey;
 - .7 Metalaire.

2.28 RANGE HOODS

- .1 Reversomatic Htg. & Manufacturing Ltd., Series 4000 "Deluxe" ducted range hoods, each per the drawing schedule, CSA certified, rotary solid state speed control providing infinite range, rotary light control switch, backdraft damper, with light lens and permanent, washable aluminum mesh grease filter(s).
- .2 Acceptable manufacturers are:
 - .1 Reversomatic Htg. & Manufacturing Ltd.;
 - .2 Zonex;
 - .3 Broan.

2.29 DRYER BOOSTER FAN

- .1 Reversomatic Htg. & Manufacturing Ltd., TLD Series, each per the drawing schedule, CSA certified, self-cleaning, non-overloading backward inclined wheel, and hinged impeller for ease of cleaning and maintenance.
- .2 Acceptable manufacturers are:
 - .1 Reversomatic Htg. & Manufacturing Ltd.;
 - .2 Zonex;
 - .3 Broan.

3 EXECUTION

3.01 CLEANLINESS REQUIREMENTS FOR HANDLING AND INSTALLATION OF DUCTWORK

- .1 Handle and install ductwork in accordance with SMACNA's Duct Cleanliness for New Construction Guidelines at the Advanced Level.

3.02 FABRICATION AND INSTALLATION OF GALVANIZED STEEL DUCTWORK

- .1 Provide required ductwork, rectangular, round and/or flat oval. Where rectangular ductwork is shown, round or flat oval ductwork of equivalent cross-sectional area is acceptable.
- .2 It is to be understood that all duct dimensions shown on drawings are clear internal dimensions.
- .3 Variable air volume ductwork from supply fans to boxes is as above but rectangular duct take-offs are double side straight taper type with a take-off length equal to 0.5 times the branch duct width but minimum 150 mm (6") length, and double taper side is to have an included angle of minimum 60°.
- .4 Confirm routing of all ductwork at site and site measure ductwork prior to fabrication. Duct dimensions may be revised to suit site routing and building element requirements, if dimension revisions are reviewed with and approved by Consultant. Duct routing and/or dimension revisions to suit conditions at site are not grounds for a claim for an extra cost.

- .5 Refer to structural drawings. Where ductwork is to be run within or through open web steel joists, ductwork shown on mechanical drawings is schematic only and is to be altered as required to suit steel joist configuration, spacing, panel points, and cross-bridging at no additional cost.
- .6 Wherever ductwork is required at locations where sprayed fireproofing is applied to building construction, install ductwork only after fireproofing work is complete and do not compromise fire rating of sprayed fireproofing.
- .7 Install (but do not connect) duct system mounted automatic control components supplied as part of the automatic control work.
- .8 Where indicated, provide duct connections to fan powered heat transfer equipment with integral coils.
- .9 Flange connect ductwork to hot water reheat coils in accordance with requirements of ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible. Coils will be suspended independent of connecting ductwork as part of the heat transfer work.
- .10 Support horizontal rectangular ducts inside building in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible, but use trapeze hangers with, unless otherwise specified, galvanized steel channels, and galvanized steel hanger rods for exposed ducts and concealed ducts wider than 500 mm (20"). Support hardware constructed of same material as duct for metal duct, and, unless otherwise specified, type 316 stainless steel for non-metal duct. Supports for "heavy" duct such as cementitious core duct is to be suitable in all respects for the application and approved by Consultant.
- .11 Support round and flat oval ducts inside building in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible, but, unless otherwise specified, for both uninsulated and insulated ducts exposed in finished areas, use bands and secure at top of duct to a hanger rod, all similar to Ductmate Canada Ltd. type "BA". If duct is insulated, size strap to suit diameter of insulated duct. Unless otherwise specified, duct support hardware for metal duct is constructed of same material as duct, and for non-metal duct, type 316 stainless steel.
- .12 Where flanged duct joints are used, do not locate joints in wall or slab openings, or immediately at wall or slab openings. Do not use flanged joints for exposed uninsulated ducts in finished areas.
- .13 Where watertight horizontal ductwork is required, construct ducts without bottom longitudinal seams. Solder or weld joints of bottom and side sheets. Seal all other joints with duct sealer. Slope horizontal duct to hoods, risers, or drain points. Provide drain points. Provide watertight ductwork for:
 - .1 ductwork outside building or otherwise exposed to the elements;
 - .2 wherever else shown.
- .14 Seal all ductwork in accordance with SMACNA Seal Class "A", except for round duct with self-sealing gasketed fittings and couplings which does not require site applied sealant. Apply sealants by brush or gun to cleaned metal surfaces. Where bare ductwork is exposed apply neat uniform lines of sealant. Randomly brushed, sloppy looking sealant applications will be rejected and must be repaired or replaced with a neat application of sealant.

- .15 Apply sealants by brush or gun to cleaned metal surfaces. Where bare ductwork is exposed apply neat uniform lines of sealant. Randomly brushed, sloppy looking sealant applications will be rejected and must be repaired or replaced with a neat application of sealant.
- .16 Clean exterior exposed (uninsulated) ducts and coat with a heavy full coverage of Bakor #410-02 black metal paint.
- .17 Where dissimilar metal ducts are to be connected, isolate ducts by means of flexible duct connection material.
- .18 Round exposed ductwork in Gymnasium is to be 2 metal gauges heavier than standard metal gauge for same size duct, and duct hangers are to be pairs of 9.5 mm ($\frac{3}{8}$ ") diameter hanger rods secured to 40 mm (1- $\frac{1}{2}$ ") wide #12 gauge galvanized steel split clamps around full circumference of duct at maximum 1.8 m (72") centres. Provide double nuts and lock washers on each hanger rod above and below each clamp.

3.03 INSTALLATION OF ALUMINUM DUCTWORK

- .1 Provide aluminum ductwork, rectangular or round, where indicated.
- .2 Wherever bare aluminum ductwork comes in contact with ferrous metal or copper, paint ferrous metal or copper surface with a heavy, 100% covering coat of zinc chromate paint, asphalt paint or otherwise isolate direct contact with the bare aluminum.
- .3 Refer to "Commentary on Aluminum Ducts" in ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible, however, do not use drive and S cleats for joining waterproof aluminum ductwork. Use following SMACNA joining methods:
 - .1 T-21 - welded flange;
 - .2 T-22 - companion angle and gasket;
 - .3 T-24A - flanged.
- .4 Keep longitudinal joints at top surface of horizontal runs. Provide proper transverse supports to prevent deflection. Ensure duct is rigid.
- .5 When mastic is used for sealing such as sealing longitudinal joints, apply mastic to both surfaces before they are mated. When dry, apply mastic again for a water-tight seal.

3.04 INSTALLATION OF FLEXIBLE DUCTWORK

- .1 Provide maximum 3 m (10') long lengths of flexible ductwork for connections between galvanized steel duct mains and branches, and necks of ceiling grilles and diffusers. Do not install flexible ductwork through walls, even if shown on drawings.
- .2 At rectangular galvanized steel duct, accurately cut holes and provide flanged or "Spin-in" round flexible duct connection collars. Seal joints with duct sealer.
- .3 Install flexible ducts as straight as possible and support in accordance with requirements of ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible, and secure at each end with nylon or stainless steel gear type clamps, and seal joints. Provide long radius duct bends where they are required.

- .4 Do not penetrate fire barriers with flexible duct.

3.05 INSTALLATION OF ACOUSTIC LINING

- .1 Provide acoustic lining in ductwork in locations as follows:
 - .1 wherever shown and/or specified on drawings;
 - .2 supply ductwork downstream of air terminal boxes for a distance of 2.4 m (8') measured along duct and outward from box in all directions;
 - .3 all transfer air ducts.
- .2 Install lining in accordance with requirements of ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible, however, for all installations regardless of velocity, at leading and trailing edges of duct liner sections, provide galvanized steel nosing channel in accordance with detail entitled Flexible Duct Liner Installation found in the ANSI/SMACNA manual referred to above.

3.06 INSTALLATION OF CASINGS AND PLENUMS

- .1 Provide required shop or site fabricated casings and plenums. Unless otherwise specified or shown, construct casings and plenums of same material as connecting duct system.
- .2 Construct and install casings and plenums in accordance with Chapter 6 of ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible to suit systems' pressure classification. Ensure plenums and casings secured to building structure are gasketed air-tight and equipped with angle reinforcing.
- .3 Provide drain pans with accessible trapped drains for fresh air intake plenums, and wherever else shown.

3.07 INSTALLATION OF CASING AND PLENUM ACCESS DOORS

- .1 Provide access doors into all site or shop fabricated casings and plenums requiring access, and wherever shown.
- .2 Construct access doors to open in or out to suit positive and negative pressures of system.
- .3 Provide pitot tube openings in access doors where required for system air quantity balancing purposes.
- .4 Provide suitably sized, engraved, red-white laminated Lamacoid warning nameplates on access doors into casings and plenums where equipment is located, i.e. fans.

3.08 INSTALLATION OF ROUND TO RECTANGULAR DUCT CONNECTIONS

- .1 Cut round holes in rectangular ducts and provide round to rectangular lock-in fittings with dampers for connection of flexible round ductwork.

3.09 INSTALLATION OF SPLITTER DAMPERS

- .1 Provide splitter dampers in supply ductwork at branch duct connections off supply air mains, and wherever else shown and/or specified on drawings. Install splitter dampers so they cannot vibrate and rattle and so damper operation mechanisms are in an easily accessible and operable location. Ensure operators for dampers in insulated ducts are equipped with stand-off mounting brackets.

3.10 INSTALLATION OF TURNING VANES

- .1 Provide turning vanes in ductwork elbows where shown on drawings and wherever else required where, due to site installation routing and duct elbow radius, turning vanes are recommended in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible.
- .2 Provide volume extractor type turning vanes in short branch supply duct connections off mains to grilles and diffusers where shown and/or specified.

3.11 INSTALLATION OF MANUAL BALANCING (VOLUME) DAMPERS

- .1 Provide manual balancing dampers as required to provide a fully balanced system, including but not limited to in all open end ductwork, in all duct mains, and wherever else shown and/or specified.

- .2 Install dampers so operating mechanism is accessible and positioned for easy operation, and so dampers cannot move or rattle. Ensure operating mechanisms for dampers in insulated ducts are complete with stand-off mounting brackets.
- .3 Where a duct for which a balancing damper is required has dimensions larger than dimensions of maximum size volume damper available, provide multiple dampers bolted together in a properly sized assembly, or bolted to a heavy-gauge black structural steel angle or channel framework which is properly sized. Seal to prevent air by-pass, and provide connecting linkage.
- .4 Confirm exact damper locations with personnel doing air quantity balancing testing work and install dampers to suit. Include for providing 5 additional dampers at no additional cost.

3.12 INSTALLATION OF BACKDRAFT DAMPERS

- .1 Provide backdraft dampers.
- .2 Install and secure dampers so they cannot move or rattle.

3.13 INSTALLATION OF FUSIBLE LINK DAMPERS

- .1 Provide fusible link dampers. Ensure damper rating (1-½ or 3 hr.) is suitable for fire barrier it is associated with.
- .2 Install dampers with retaining angles on all 4 sides of sleeve on both sides of damper and connect with ductwork in accordance with damper manufacturer's instructions and details, and Code requirements.
- .3 Provide expansion clearance between damper or damper sleeve and opening in which damper is required. Ensure openings are properly sized and located, and all voids between damper sleeve and opening are properly sealed to maintain rating of fire barrier.
- .4 Where size of fire barrier opening requires use of a sectionalized fire damper assembly, provide multiple fusible link dampers (sized to CAN/ULC S112) bolted together in a properly sized assembly or bolted to a heavy-gauge black structural steel angle or channel framework.

3.14 INSTALLATION OF COMBINATION FIRE/SMOKE DAMPERS

- .1 Provide combination fire/smoke dampers. Install dampers with retaining angles on all 4 sides of each side of damper, and, where required, connect with ductwork, all in accordance with damper manufacturer's instructions and details, and Code requirements.
- .2 Coordinate damper installation with electrical work where electrical connections to damper actuators are specified.

3.15 INSTALLATION OF SMOKE DAMPERS

- .1 Provide smoke dampers. Install dampers with retaining angles on all 4 sides of sleeve on both sides of damper and connect with ductwork in accordance with damper manufacturer's instructions and details, and Code requirements.
- .2 Coordinate damper installation with electrical work where electrical connections to damper actuators are specified.

3.16 INSTALLATION OF FLEXIBLE CONNECTION MATERIAL

- .1 Provide a minimum of 100 mm (4") of flexible connection material where ducts, plenums, and/or easings connect to fans, and wherever else shown or specified.
- .2 Rigidly secure a minimum of 75 mm (3") of duct material (minimum #24 gauge) to each edge of flexible fabric and to fan, duct, plenum, etc., in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible. Ensure connections to flexible fabric material are arranged and supported so as to not impose any external forces on the fabric.

3.17 INSTALLATION OF ROOF MOUNTED DUCT SUPPORTS

- .1 Supply supports for roof mounted ductwork.
- .2 Accurately mark location and spacing of roof support assemblies. At each plastic base location, carefully scrape away loose roof ballast (gravel) and all other debris and dirt. Prime existing membrane with a primer which is compatible with existing roofing components. Set bases in adhesive in accordance with manufacturer's installation instructions. Scrape loose ballast back around and on bases. Install framing, and install ductwork on the cross-members. Secure ductwork to cross-members with galvanized steel banding.

3.18 INSTALLATION OF DUCT ACCESS DOORS

- .1 Provide access doors in ductwork for access to all components which will or may need maintenance and/or repair, including reheat coils. Install in accordance with requirements of ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible.
- .2 Identify access doors provided for fusible link damper maintenance with "FLD" stencil painted or marker type red lettering and ensure doors are properly located for damper maintenance.
- .3 When requested, submit a sample of proposed duct access doors for review.
- .4 Where sectionalized fusible link dampers and/or balancing dampers are provided in large ducts, provide a plenum type access door to suit, and adequately reinforce ductwork to suit access door installed.

3.19 INSTALLATION OF INSTRUMENTS TEST PORTS

- .1 Provide instrument test ports in all main ducts at connections to fans, plenums or casings, in all larger branch duct connections to mains, and wherever else required for proper air quantity balancing and testing.
- .2 Locate test ports where recommended by personnel performing air quantity testing and balancing work.

3.20 INSTALLATION OF WIRE MESH (BIRDSCREEN)

- .1 Provide framed, removable wire mesh panels over openings in ducts and/or walls where shown and/or specified on drawings. Rigidly secure in place but ensure panels are removable.

- .2 Provide wire mesh panels for open-end return air ducts in ceiling spaces whether shown on drawings or not.

3.21 INSTALLATION OF LOUVRES

- .1 Provide louvres for wall openings.
- .2 Install louvre assemblies and secure in place in accordance with manufacturer's instructions and details.
- .3 Confirm exact louvre sizes and finish prior to ordering.

3.22 INSTALLATION OF LOUVRE BLANK-OFF PANELS

- .1 Provide blank-off panels for inactive portions of exterior wall louvres.
- .2 Secure panels in place with non-ferrous hardware so they cannot move or rattle, yet are easily removable.
- .3 Confirm exact finish of panels prior to fabrication.

3.23 INSTALLATION OF ACOUSTIC LINING

- .1 Provide acoustic lining to the extent shown and/or specified on the drawings.
- .2 Install lining in accordance with requirements of SMACNA HVAC Duct Construction Standards Metal and Flexible.

3.24 INSTALLATION OF SILENCERS

- .1 Provide silencers where shown and as scheduled on the drawings.
- .2 Secure and support each silencer rigidly in place, independent of the ductwork or casings connected thereto.
- .3 Where silencers penetrate partition walls, seal the joint between the perimeter of the silencer and the wall, on both sides of the wall, with proper acoustic caulking.

3.25 INSTALLATION OF GRILLES AND DIFFUSERS

- .1 Provide grilles and diffusers. Wherever possible, grilles and diffusers are to be product of same manufacturer.
- .2 Unless otherwise specified connect grilles and diffusers in accordance with requirements of SMACNA HVAC Duct Construction Standards Metal and Flexible.
- .3 Exactly locate grilles and diffusers to conform to final architectural reflected ceiling plans and detailed wall elevations, and to conform to final lighting arrangement, ceiling layout, ornamental and other wall treatment.
- .4 Equip supply diffusers having a basic 4-way or all round air pattern for operation in 1-, 2-, or 3-way pattern where indicated on drawings.
- .5 Confirm grille and diffuser finishes prior to ordering.

3.26 INSTALLATION OF RANGE HOODS

- .1 Provide range hoods where shown.
- .2 Secure range housing in place from structure.
- .3 Installation fan-motor assemblies and plug motor cord into the fan housing receptacle. Install exhaust grilles and other accessories.

3.27 INSTALLATION OF DRYER BOOSTER FANS

- .1 Provide dryer booster fans where shown.
- .2 Suspend each fan with hanger rods and where shown and/or schedule, vibration isolation spring hangers, independent of ductwork connected hereto.
- .3 Provide amp sensor fan control interlocked with dryer operation and secondary dryer lint filtration installed within ductwork downstream of dryer exhaust duct connection all as per specifications and/or indicated on drawings.

3.28 DUCT SYSTEM PROTECTION, CLEANING AND START-UP

- .1 Temporarily cover all open ends of ducts during construction.
- .2 Remove all dirt and foreign matter from entire duct systems and clean duct system terminals and interior of air handling units prior to operating fans.
- .3 Prior to starting any supply air handling system provide 50 mm (2") thick glass fibre construction filters at fan equipment in place of permanent filters.
- .4 Provide cheesecloth over duct system inlets and outlets and run system for 24 hours, after which remove cheesecloth and construction filters, and install new permanent filters.
- .5 Include all labour for a complete site walk-through with testing and balancing personnel following route of all duct systems to be tested, adjusted and balanced for the purpose of confirming proper position and attitude of dampers, location of pitot tube openings, and any other work affecting testing and balancing procedures. Perform corrective work required as a result of this walk-through.

END OF SECTION

1 GENERAL

1.01 SUBMITTALS

- .1 Submit shop drawings/product data sheets for fans and accessories. Include following:
 - .1 certified fan performance curves at specified operating point with flow, static pressure and HP clearly plotted;
 - .2 certified sound power data that conforms to specified levels;
 - .3 product data sheets for all accessories;
 - .4 product data sheets for fan motors.
- .2 Submit with delivery of each unit a copy of the factory inspection report, and include a copy of each report with O & M Manual project close-out data.
- .3 Submit a site inspection and start-up report from manufacturer's representative as specified in Part 3 of this Section.
- .4 Supply reviewed copies of fan/curb assembly shop drawings or product data to trade who will cut roof openings for fans, and ensure openings are properly located.
- .5 Submit a signed copy of de-stratification fan manufacturer's 5 year extended parts and labour warranty.

1.02 QUALITY ASSURANCE

- .1 Fan manufacturers, as applicable, are to be current members of the Air Movement and Control Association International Inc. (AMCA), and fans are to be rated (capacity and sound performance) and certified in accordance with requirements of following standards:
 - .1 ANSI/AMCA Standard 210, Laboratory Method of Testing Fans for Certified Aerodynamic Performance Rating;
 - .2 AMCA Standard 211, Product Rating Manual for Fan Air Performance;
 - .3 ANSI/AMCA Standard 300, Reverberant Room Method for Sound Testing of Fans;
 - .4 AMCA Standard 311, Product Rating Manual for Fan Sound Performance;
 - .5 AMCA Standard 99-2408, Operating Limits for Centrifugal Fans.

2 PRODUCTS

2.01 ROOF MOUNTED EXHAUST FANS

- .1 Centrifugal, ULC listed, factory run tested roof mounted exhaust fans in accordance with drawing schedule.
- .2 Spun aluminium housing with deep venturi inlet, aluminium curb cap with continuously welded corners, pre-punched mounting holes, galvanized steel or aluminium birdscreen, and EMT conduit chase to the motor compartment.

- .3 Centrifugal, non-overloading aluminum wheel with backward inclined blades matched to inlet venturi, statically and dynamically balanced as an assembly.
- .4 For belt-drive fans only, hot rolled steel shaft, accurately turned, ground, and polished, and sized for a first critical speed of at least 1.25 times maximum rated speed for fan, and one-piece grease lubricated pillow block type bearings selected for an AFBMA L-50 minimum average life in excess of 500,000 hours at maximum catalogue operating speed and equipped with a lubrication fitting, and a heavy-gauge galvanized steel adjustable V-belt drive with guard conforming to requirements of Section entitled Basic Mechanical Materials and Methods.
- .5 Motors are to conform to requirements specified in Section entitled Basic Mechanical Materials and Methods, mounted on vibration isolation in a compartment outside of the airstream, and factory pre-wired to a NEMA 4 disconnect switch.
- .6 Prefabricated, minimum 300 mm (12") high heavy-duty aluminum roof mounting curb with factory installed wood nailer, 40 mm (1-½") thick insulation, continuously welded seams, and damper tray.
- .7 For fans as scheduled, factory supplied accessories as follows:
 - .1 gravity backdraft damper with #20 gauge galvanized steel frame and #26 gauge aluminum blades with felt edge blade seals;
 - .2 non-corrosive motorized damper with linkage, end switch, and motor with voltage to match fan motor;
 - .3 continuous non-corrosive piano type curb hinge to permit access to fan, damper and connecting duct, complete with retaining chain and a security hasp to prevent removal of unit from curb cap and prevent building entry through connecting ductwork;
 - .4 2-speed switch and 2-speed double winding 1-phase motor in accordance with Section entitled Basic Mechanical Materials and Methods;
- .8 Acceptable manufacturers are:
 - .1 Twin City Fan and Blower;
 - .2 Loren Cook Co.;
 - .3 Greenheck Fan Corp.;
 - .4 Carnes Company Inc.

2.02 CENTRIFUGAL INLINE FANS

- .1 Centrifugal, ULC listed, factory run tested rectangular inline fans in accordance with drawing schedule.
- .2 Heavy-gauge galvanized steel housing with removable side panels to permit removal of power assembly without disturbing duct connections, universal mounting brackets and hardware including spring vibration isolators to accommodate horizontal or vertical mounting as required, a flanged inlet panel with inlet venturi, a flanged outlet panel, both with duct connection collars, and galvanized steel wire grid fan inlet/outlet guard(s).

- .3 Non-overloading aluminium wheel with backward inclined blades with matching inlet venturi, statically and dynamically balanced as an assembly.
- .4 For belt-drive fans only, hot rolled steel shaft, accurately turned, ground, and polished, and sized for a first critical speed of at least 1.25 times maximum rated speed for fan, and heavy-duty, self-aligning pillow block type bearings selected for an AFBMA L-50 minimum average life in excess of 500,000 hours and equipped with lubrication line and fitting, and an adjustable V-belt drive with guard conforming to requirements of Section entitled Basic Mechanical Materials and Methods.
- .5 TEFC motor conforming to requirements specified in Section entitled Basic Mechanical Materials and Methods, mounted out of the airstream, complete with a cover, and factory pre-wired to a NEMA 4 disconnect switch.
- .6 For fans as scheduled, factory supplied accessories as follows:
 - .1 for fans as scheduled, housing insulation (lining), consisting of neoprene spray coated glass fibre semi-rigid insulation meeting NFPA 90A requirements and 25/50 flame spread/smoke developed ratings when tested in accordance with CAN/ULC S102, permanently secured in place with no exposed edges;
 - .2 for fans as scheduled, a galvanized steel filter box with frame suitable for 25 mm (2") thick disposable panel type filters;
- .7 Acceptable manufacturers are:
 - .1 Twin City Fan and Blower;
 - .2 Loren Cook Co.;
 - .3 Greenheck Fan Corp.;
 - .4 Carnes Company Inc.

2.03 CEILING MOUNTED FANS

- .1 ULC listed and labelled ceiling mounted centrifugal, AMCA rated and certified (capacity and sound to AMCA Standards 211 and 311), exhaust fans in accordance with drawing schedule, complete with:
 - .1 minimum #20 gauge galvanized steel housing equipped with duct connection collar(s), integral spring loaded aluminum backdraft damper, 12 mm (1/2") thick acoustic insulation meeting 25/50 flame spread/smoke developed ratings when tested in accordance with CAN/ULC S102, multi-position mounting brackets, and an integral CSA certified electrical receptacle in an outlet box for plug-in connection of fan motor;
 - .2 low RPM, resiliently mounted, direct connected fan wheel and motor assembly with a forward curved, statically and dynamically balanced galvanized steel or calcium carbonate filled polypropylene centrifugal wheel direct connected to a 1-phase motor conforming to requirements specified in Section entitled Basic Mechanical Materials and Methods and equipped with a length of power cord and plug;
 - .3 factory supplied accessories in accordance with drawing schedule, as follows:

- .1 rectangular to round duct transitions;
 - .2 roof cap with backdraft damper and birdscreen;
 - .3 wall cap with backdraft damper and birdscreen.
- .2 Acceptable manufacturers are:
- .1 Twin City Fan and Blower;
 - .2 Loren Cook Co.;
 - .3 Greenheck Fan Corp.;
 - .4 Carnes Company Inc.

3 EXECUTION

3.01 INSTALLATION OF ROOF MOUNTED EXHAUST FANS

- .1 Provide roof mounted exhaust fans.
- .2 Supply a roof mounting curb with each fan and hand curbs to roofing trade on roof for mounting and flashing into roof construction as part of roofing work. Secure fans in place on curbs.
- .3 Install dampers in curb damper tray and secure in place.
- .4 Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system manufacturer certification requirements.
- .5 Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system start-up requirements.
- .6 Include for a 4 hour on-site operation demonstration and training session. Training is to be a full review of all components including but not limited to a full operation and maintenance demonstration, with abnormal events.

3.02 INSTALLATION OF CENTRIFUGAL INLINE FANS

- .1 Provide inline centrifugal fans.
- .2 Secure each fan in place from structure with vibration isolation, independent of connecting ductwork and in accordance with fan manufacturer's instructions.
- .3 Ensure duct connections are made using flexible connection material.
- .4 Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system manufacturer certification requirements.
- .5 Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system start-up requirements.

- .6 Include for a 4 hour on-site operation demonstration and training session. Training is to be a full review of all components including but not limited to a full operation and maintenance demonstration, with abnormal events.

3.03 INSTALLATION OF CEILING FANS

- .1 Provide ceiling exhaust fans.
- .2 Secure suspended units in place from structure, level, and plumb, by means of vibration isolation spring hangers and galvanized steel hanger rods.
- .3 Supply exterior wall/roof discharge caps as indicated.
- .4 Hand roof caps to roof trade for installation and flashing into roof construction as part of roofing work.
- .5 Install wall caps and secure in place. Caulk perimeter of each wall cap in accordance with caulking requirements specified in Division 07.
- .6 Connect fan housings and discharges with ductwork.
- .7 Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system start-up requirements.

END OF SECTION

1 GENERAL

1.01 SUBMITTALS

- .1 Submit shop drawings/product data sheets for air terminals. Include following:
 - .1 capacity and pressure drop;
 - .2 sound power data to verify conformance with specified sound power levels;
 - .3 leakage and dimensions;
 - .4 mounting details to suit locations shown, indicating methods and hardware to be used;
 - .5 control components and a control wiring schematic.
- .2 Submit with shop drawings/product data, a test report in accordance with ANSI/AMCA 210 requirements and ISO 3741, published test data on DIN (Direct Internal Noise) made by an independent testing agency for 2.5 and 6 m/s (8.2 and 19.7 ft/min) branch velocity or inlet velocity, sound power levels with a minimum inlet pressure of 0.25 kPa (0.036 psi) in accordance with ISO 3741 for the 2nd through 7th octave bands, and confirmation pressure loss through a silencer will not exceed 60% of inlet velocity pressure maximum.
- .3 Submit a site inspection and start-up report from manufacturer's representative as specified in Part 3 of this Section.

1.02 QUALITY ASSURANCE

- .1 Air terminals manufacturers are to be current members of Air-Conditioning, Heating and Refrigeration Institute (AHRI), and terminals are to be in accordance with requirements of following standards:
 - .1 ANSI/AHRI Standard 880, Performance Rating of Air Terminals;
 - .2 ANSI/AMCA Standard 210, Laboratory Method of Testing Fans for Certified Aerodynamic Performance Rating;
 - .3 International Organization of Standardization (ISO) Standard 3741, Acoustics-Determination of Sound Power Levels of Noise Sources Using Sound Pressure-Precision Methods for Reverberation Rooms.
- .2 Acceptable manufacturers are:
 - .1 Price Industries Inc.;
 - .2 Titus;
 - .3 Nailor Industries Inc.;
 - .4 Krueger Division of Air System Components Inc.

2 PRODUCTS

2.01 VARIABLE AIR VOLUME (VAV) TERMINAL BOXES

- .1 Single duct, controller type, pressure independent variable air volume boxes in accordance with drawing schedule, each individually field adjustable to minimum and maximum air volumes, and complete with:
 - .1 #22 gauge galvanized steel housing, sealed and gasketed, internally lined with 25 mm (1") thick glass fibre duct lining material with a neoprene coating meeting NFPA 90A and 25/50 flame spread/smoke developed ratings when tested in accordance with CAN/ULC S102, and complete with:
 - .1 exposed cut edges of the liner material factory coated with NFPA 90A and CAN/ULC S102 approved sealant;
 - .2 50 mm (2") long, round inlet duct connection;
 - .3 rectangular discharge opening with slip and drive cleat duct connection facilities;
 - .4 protective galvanized steel shroud for controller and damper actuator.
 - .2 air valve damper, normally open, galvanized steel blade with peripheral gasket, pivoting in self-lubricating bearings and with air leakage past a closed damper of 2% or less of rated capacity at 750 Pa (3" wc) inlet static pressure;
 - .3 air flow sensor located at box inlet, complete with gauge taps, multiple pressure sensing ports, and an averaging chamber designed to accurately average the flow across the inlet of box with an accuracy of within 5% with a 90° sheet metal elbow located directly at inlet, and amplify the sensed air flow signal;
 - .4 controller/actuator supplied as part of controls work specified in Section entitled Automatic Control Systems, shipped to box manufacturer's plant by controls supplier, and factory installed, connected, tested, calibrated and set by box manufacturer;
 - .5 galvanized steel attenuators, lined as per box housings, each factory supplied loose and with a length in accordance with drawing schedule;
 - .6 for boxes as scheduled, AHRI performance rated and certified, CSA certified electric reheat coils in accordance with drawing schedule, each factory mounted, wired and tested and complete with:
 - .1 galvanized steel coil frame and cabinet with 20 mm ($\frac{3}{4}$ ") thick neoprene coated glass fibre insulation meeting NFPA 90A and 25/50 flame spread/smoke developed ratings when tested in accordance with CAN/ULC S102;
 - .2 hinged access door for electrical enclosure;
 - .3 low watt density coil consisting of minimum Grade 80/20 nickel-chromium wire elements insulated from frame by floating ceramic bushings;
 - .4 pre-wired safety devices and controls including:
 - .1 automatic reset primary thermal cut-out and a manual reset secondary thermal cut-out;

- .2 differential pressure switch to shut-down coil upon sensing a no air flow condition;
 - .3 door interlock disconnect switch;
 - .4 mercury contactors.
- .2 Terminal box to be complete with attenuator or lined discharge duct in place. Maximum sound power levels in decibels and specific static pressure are scheduled on drawings for each size of box.

2.02 CONSTANT VOLUME TERMINAL BOXES

- .1 Single duct constant volume by-pass boxes in accordance with drawing schedule, each complete with:
 - .1 #22 gauge galvanized steel housing, sealed and gasketed, internally lined with 25 mm (1") thick glass fibre duct lining material with a neoprene coating meeting NFPA 90A and 25/50 flame spread/smoke developed ratings when tested in accordance with CAN/ULC S102, and complete with:
 - .1 exposed cut edges of the liner material factory coated with NFPA 90A and CAN/ULC S102 approved sealant;
 - .2 round inlet collar and a rectangular by-pass discharge collar for connection to return air ductwork;
 - .3 integral inlet and by-pass balancing dampers;
 - .4 field adjustable minimum air volume stop;
 - .5 protective galvanized steel shroud for controller and damper actuator.
 - .2 sliding gate type supply/by-pass air valve equipped with polyethylene linear bearings which slide in stainless steel tracks, and adjustable end stops;
 - .3 air valve actuator, factory installed, electronic, 24 volt, direct connected, tri-state, reversible floating actuator suitable in all respects for the application;
 - .4 galvanized steel attenuators, lined as per box housings, each factory supplied loose and with a length in accordance with drawing schedule;
 - .5 actuator supplied as part of controls work specified in Section entitled Automatic Control Systems, shipped to box manufacturer's plant by controls supplier, and factory installed, connected, tested, calibrated and set by box manufacturer;

3 EXECUTION

3.01 INSTALLATION OF TERMINAL BOXES

- .1 Provide ceiling mounted terminal boxes.
- .2 Secure each box in place from structure by means of galvanized steel angles and hanger rods, independent of connecting ductwork.

- .3 Coordinate provision of transformers, actuators and controllers with Controls Contractor.
- .4 Connect each box with ductwork as indicated. Provide straight inlet duct same size as box inlet and of a length equal to a minimum of 4 duct diameters. Refer to drawing detail. Coordinate final box adjustments and settings with personnel doing system testing and balancing work.
- .5 Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system start-up requirements.
- .6 Include for a 1/2 day on-site operation demonstration and training session. Training is to be a full review of all components including, but not limited to, a full operation and maintenance demonstration, and setting and adjusting controls.

END OF SECTION

1. GENERAL

1.01 SUBMITTALS

- .1 Submit shop drawings/product data sheets for all rooftop units. Include following:
 - .1 certified fan performance curves;
 - .2 certified sound power data;
 - .3 computer generated psychrometric chart for each cooling coil;
 - .4 hardware for section-to-section site connections;
 - .5 dimensioned layouts, including dimensioned curb layouts as applicable;
 - .6 product data for fan motors.
- .2 Submit with delivery of each unit a copy of the factory inspection and fire test report as specified in Part 2 of this Section, and include a copy of each report with O & M Manual project close-out data.
- .3 Submit a site inspection and start-up report from manufacturer's representative as specified in Part 3 of this Section.
- .4 Submit spare air filters as specified in Part 2 of this Section.

1.02 QUALITY ASSURANCE

- .1 Rooftop units and installation are to be in accordance with requirements of following:
 - .1 all applicable Provincial Codes and Standards;
 - .2 CAN/CSA B149, Natural Gas and Propane Installation Codes;
 - .3 CSA or ETL listed and labelled electrical components.
- .2 Unit installation tradesmen are to be journeyman and licensed gas fitters.

1.03 WARRANTY

- .1 The warranty period shall commence at the date of initial start up and shall continue for a period of one (1) year not to exceed eighteen (18) months from shipment. Manufacturer's warranty shall include parts only.
- .2 Manufacturer shall furnish a factory trained service technician to perform the unit start-up assistance to the installing contractor with licensed gas personnel. Factory technician to provide copy of start-up log to owner and to demonstrate operation and maintenance to owner's representative.

2. PRODUCTS

2.01 PACKAGED ROOFTOP UNITS

- .1 Trane Horizon Model OA packaged rooftop units in configuration and performances as indicated on drawings and drawing schedules. Unit shall be factory assembled, internally wired, fully charged with R-454B, and 100% run tested to check cooling operation, fan and blow rotation, and control sequence before leaving the factory. Unit to have field convertible airflow. Units shall include all specified components installed and tested at the factory. Field fabrication of units and their components will not be accepted.

.2 CABINET

- .1 Cabinet panels: 2" double-wall foamed panel with thermal break construction throughout the indoor section of unit to provide nonporous, cleanable interior surfaces. All interior seams exposed to airflow shall be sealed.
- .2 Insulation: 2" polyisocyanurate or 2" polyurethane injected foam metal encapsulated with no exposed edges. Initial R value of 6.6 per inch of thickness.
- .3 Cabinet base shall be double wall construction designed to prevent trapping or ponding of water within the unit base. Cabinet base pan shall be insulated with 2" thick polyisocyanurate foam. Foam insulation shall be fully enclosed with galvanized steel insulation cover. Insulation shall not be applied to underside of unit base.
- .4 Cabinet Base Rails: Side and end base rails shall include openings for forklift and tie-down access. To protect unit base from fork damage side rails shall include removable heavy gauge fork pockets.
- .5 Shipping anchors attach to and/or through unit base rails. Straps over unit shall not be used to secure unit for shipping.
- .6 Cabinet material interior and base rails: shall be G-90 zinc-coated galvanized steel. Material gauge shall be a minimum of 14-gauge for base rails, 16-gauge for structural members and 20-gauge for access doors and cabinet panels.
- .7 Exterior Corrosion Protection: Exterior cabinet panels shall be a base coat of G-90 galvanized steel with both exterior and interior surfaces cleaned, phosphatized, and finished with a weather-resistant baked enamel finish. Unit's surface shall be in compliance with ASTM B117 salt spray testing at a minimum of 672-hour duration.
- .8 Cabinet construction shall provide hinged panels providing easy access for all parts requiring routine service.
- .9 Cabinet top cover shall be one piece construction or where seams exist, it shall be double-hemmed and gasket-sealed.
- .10 Hinged Access Panels: Water- and air-tight hinged access panels shall provide access to all areas requiring routine service including air filters, heating section, electrical and control cabinet sections, optional ERV and power exhaust fan section, supply air fan section, evaporator and reheat coil sections. Insulated doors shall be constructed to allow the hinges to be reversed in the field.
- .11 Hold-open devices shall be factory installed on all hinged front access doors. Chains shall not be used as hold-open devices.
- .12 Latches with locking hasps or tool operated closure devices shall be factory installed on all hinged access panels.
- .13 Drain Pan material shall be Type 304 Stainless steel drain and constructed to sloped in two directions to ensure positive drainage with corners exposed to standing water and drain fittings welded liquid tight to prevent leaks. Pan shall have a minimum depth of 2". Base of drain pan shall be insulated with 1" thick foam insulation.
- .14 Provide openings either on side of unit or through the base for power, control, and gas connections.

- .15 Cabinet shall include optional interior liner constructed of Type 304 stainless steel with sealed seams.
- .16 Unit shall be equipped with a 6" filter rack upstream of the evaporator. Frame shall be field-adjustable to match any filter combination specified in the following section.

.3 FANS AND MOTORS

- .1 Indoor fans shall be high efficiency backward curved impeller.
- .2 Indoor fans shall be direct drive with premium efficiency motors, statically and dynamically balanced, draw through.
- .3 Outdoor fans shall be direct drive with premium efficiency motors, statically and dynamically balanced, draw through in the vertical discharge position with either internal or external thermal protection.
- .4 Provide shafts constructed of solid hot rolled steel, ground and polished, with keyway, and protectively coated with lubricating oil.

.4 AIR FILTERS

- .1 The Evaporator Inlet shall include a full complement of pleated media air filters. Filters shall be:
 - .1 2" deep MERV 13.

.5 DAMPERS

- .1 Unit shall include a motor operated outdoor air damper constructed of galvanized steel.
- .2 Damper blades shall be air foil design with rubber edge seals designed not to exceed a 4 CFM/SQ FT leakage rate exceeding ASHRAE 90.1 damper leakage requirements. Airfoil design Class 1A rated dampers are optional.
- .3 Damper actuator shall be factory mounted and wired sealed spring return and either two-position or fully modulating.
- .4 Dampers air velocity shall not exceed 2000 fpm.
- .5 Return Air damper shall be of same material, construction and leakage rate as outdoor air damper. Return air damper actuator shall be factory mounted and wired sealed spring fully modulating and operate based on outdoor air damper feedback signal to properly regulate RA airflow.

.6 COOLING

.1 COMPRESSORS:

- .1 All units shall have direct-drive, scroll type compressors.
- .2 Digital Scroll Compressor: Circuit One
- .3 Motor shall be suction gas-cooled and shall have a voltage utilization range of plus or minus 10 percent of unit nameplate voltage.
- .4 Internal overloads shall be provided with the scroll compressors.

- .5 Each compressor shall have a crankcase heater to minimize the amount of liquid refrigerant present in the oil sump during off cycles.
- .6 Each compressor shall be mounted on rubber vibration isolators, to reduce the transmission of noise.
- .7 Provide each unit with hermetically sealed refrigerant circuit(s) factory-supplied completely piped with liquid line filter-drier, liquid line charging port, suction and liquid line pressure ports, sight glass, and thermal expansion valve.
- .8 Provide each circuit with automatic reset high and low pressure and high temperature switches for safety control.

.2 COILS:

- .1 Evaporator, Condenser and Hot Gas Reheat coils shall be constructed with copper tubes mechanically bonded to configured aluminum plate fins.
- .2 Casings to be constructed with 18- or 16-gauge G90 galvanized steel or 16- or 14-gauge 304 L stainless steel.
- .3 Copper tube shall be C12200, ASTM B75, that is 050 light annealed tubing, with a minimum grain size of 0.015 to 0.035 mm. Tensile strength shall be a minimum of 34KSI, with a yield strength of 9-13KSI.
- .4 Aluminum fin shall be of the Series 1100, ASTM B209, with an H112 Temper.
- .5 Coils shall be factory leak tested in accordance ANSI/ASHRAE 15-1992 at a minimum pressure of 500 PSIG.
- .6 The condenser coil shall have a fin designed for ease of cleaning.
- .7 Evaporator coil shall include (six / four) rows of cooling interlaced for superior sensible and latent cooling with a maximum of 12 FPI for ease of cleaning.
- .8 Reheat coil shall be fully integrated into the supply airstream and be capable of delivering design supply air temperature.
- .9 To prevent re-hydration of condensate from evaporator coil, the evaporator coil face and the hot gas reheat coil face shall be separated by a minimum of six inches.
- .10 Condenser coil hail guards shall be factory installed.

.3 CONDENSER SECTION:

- .1 Outdoor Fans: Shall be direct drive vertical discharge design with low-noise corrosion resistant glass reinforced polypropylene props, powder coated wire discharge guards and electro-plated motor mounting brackets.
- .2 Fans shall be statically and dynamically balanced.

.4 COMPRESSOR CAPACITY CONTROL:

- .1 Electronic Control: Compressor output capacity shall be controlled by the Main Control Module

.7 HEATING

.1 MODULATING INDIRECT GAS FIRED HEATING SYSTEM:

- .1 Completely assembled and factory installed heating system shall be in the primary heating position located beneath the indoor fan assembly and be integral to unit and approved for use downstream from refrigerant cooling coils in units mounted outdoors. Threaded gas connection shall terminate at field provided manual shut-off valve. Provide capability for sidewall gas piping.
- .2 Heaters shall include high turn-down burners firing into individual stainless steel tubular heat exchangers. Heat exchangers shall be constructed of type 439 stainless steel and be a high efficiency dimpled tubular design capable of draining internal condensate. Units with multiple heaters shall include one fully modulating high turndown heater with additional on-off heater sections. Total heater turndown shall be based on heater gas input capacity 5:1 when <150 MBH or a minimum of 10:1 when ≥ 150 MBH.
- .3 Heater outdoor air inlet shall be hooded and include internal baffle system to prevent rain blow through. To prevent recirculation of flue gas and to prevent flue gas condensate from draining onto and obstructing the heater air inlet the inlet shall be hooded and shall be located a minimum of 11" beneath the flue outlet. Inlet hood shall include bird screen.
- .4 Heater flue outlet(s) shall include hooded outlet with wire cloth all constructed of Type 430 stainless steel. Hooded outlet shall be sealed to prevent flue gas recirculation.
- .5 Gas Burner Safety Controls: Provide safety controls for the proving of combustion air prior to ignition, continuous air proving monitoring following ignition and continuous electronic flame supervision.
- .6 Unit controls shall monitor heat output and shall discontinue all heating attempts and/or unit operation in the event the heating section fails to ignite or fails to maintain programmed supply air temperature/time.
- .7 Inducer fan shall be direct drive high pressure centrifugal type with two speeds and shall include built- in thermal overload protection.
- .8 Limit controls: High temperature automatic reset limits shall be located on blower wall and in indoor fan chamber to shut off gas flow in the event of excessive temperatures resulting from restricted indoor airflow, or loss of indoor airflow.
- .9 Flame roll-out safeties shall provide continuous monitoring of proper burner operation.

.8 ELECTRICAL RATINGS AND CONNECTIONS

- .1 All high voltage power components such as fuses, switches and contactors shall include a service personnel protection barrier or shall be a listed as touch-safe design.
- .2 Field wiring access to be provided thru unit base into isolated enclosure with removable cover.
- .3 Power wiring to be single point connection.
- .4 Wiring internal to the unit shall be colored and labeled for identification.
- .5 Unit shall be factory wired to field wiring terminal block mounted in isolated enclosure.
- .6 Factory wired main power disconnect and overcurrent device shall be rated for total unit connected power.
- .7 Unit SCCR rating shall be a minimum of 5kA.
- .8 Factory wired Voltage/Phase monitor shall be included as standard. In the event of any of the following, the units will be shut down and a fault code will be stored in the monitor for the most recent 25 faults. Upon correction of the fault condition the unit will reset and restart automatically.
 - .1 Phase Unbalance Protection: Factory set 3%.
 - .2 Over/Under/Brown Out Voltage Protection: +/-10% of nameplate voltage.
 - .3 Phase Loss/Reversal.
- .9 Factory to mount and wire optional 115-volt convenience outlet. Field wiring of convenience outlet not acceptable.
- .10 All low voltage field wiring connections shall be made at factory installed low voltage terminal strip.

.9 UNIT CONTROLS

- .1 Unit to be supplied with a terminal block for a 3rd party controls integration. Any ancillary sensors and sequencing is the responsibility of the controls provider.
- .2 Refrigerant Detection System (RDS):
 - .1 Systems with refrigerant classified as A2L shall include RDS.
 - .2 RDS shall engage mitigation measures at 12% of LFL.
 - .3 Mitigation will continue for 5 minutes once the alarm is cleared.
 - .4 Detection of refrigerant leak(s) in the airstream shall:
 - .1 De-energize compressors, UV Lights, heaters, and fan motors, excluding Indoor Fan Motor(s).
 - .2 Run indoor fan motor(s) at minimum Hz.
 - .3 For building comfort, to avoid freezing or overheating the space, the damper command will not change, and the unit will still provide full dilution of any leaked refrigerant.
 - .4 Except for units with 2 position dampers and no return duct. In which case the damper shall be commanded open.
 - .5 24VAC status terminal will energize on OAUTS.
 - .5 Detection of refrigerant leak(s) in a non-airstream compartment shall:
 - .1 De-energize all loads including: compressors, motors and heaters.

- .2 Energize the mechanical ventilation fans internal to the unit.
- .6 E-stop shall be given priority control of the unit over that of the RDS.
- .10 POWER EXHAUST – BAROMETRIC RELIEF
 - .1 Provide a factory installed power exhaust assembly that shall be designed to ventilate return air to atmosphere.
 - .2 Plenum mounted direct drive airfoil design exhaust wheel material shall be heavy gauge aluminum, welded construction and rated for up to Class II speed/pressure performance. Belt-drive and/or forward curve plenums fans shall not be used.
 - .3 Exhaust to discharge through gravity dampers located on each side of unit cabinet.
- .11 ENERGY RECOVERY WHEEL
 - .1 GENERAL REQUIREMENTS:
 - .1 The energy recovery cassette shall incorporate a rotary wheel in a non-insulated cassette frame complete with energy transfer media, seals, drive motor and drive belt.
 - .2 Energy recovery wheel performance shall be AHRI 1060 certified and bear the AHRI certified label. Components that are independently tested or “rated in accordance with” shall not be acceptable. Manufacturer membership in AHRI is not an acceptable substitute. Certified components must be listed as active in the AHRI Directory. (www.ahridirectory.org)
 - .3 The energy recovery cassette shall be an Underwriters Laboratory UR recognized component for fire, smoke and electrical safety and bear the UR symbol. Recognized components shall be listed in the UL directory (<http://database.ul.com>).
 - .4 The energy recovery cassette shall comply with NFPA 90A by virtue of UL standard 1812 and UL900 or UL723 fire test for determination of flammability and smoke density.
 - .5 The energy recovery cassette shall carry a 2-Year standard warranty on the entire cassette assembly (excluding the motor) from the date of shipment. Motors shall carry the manufacturer’s standard 18-month warranty from the date of manufacture.
 - .2 CASSETTE FRAME AND WHEEL CONSTRUCTION:
 - .1 Cassette frame and structural components shall be constructed of G90 galvanized steel for corrosion resistance.
 - .2 Wheel structure shall consist of a welded hub, spoke and continuous rolled rim assembly of stainless steel, and shall be self-supporting without energy transfer media present.
 - .3 Wheel structure shall be connected to the shaft by means of taper lock bushings.
 - .4 Wheel bearings shall be permanently sealed and selected for a minimum 30-year L-10 life of 400,000 hours. Bearings requiring external grease fittings or periodic maintenance are not acceptable.
 - .5 Standard cassettes may be affixed within the cabinet in any orientation without the need for factory modification.

.3 ENERGY TRANSFER MEDIA:

- .1 The energy transfer media shall be made of aluminum.
- .2 All media surfaces shall be coated with a non-migrating solid absorbent layer prior to being formed into the flat plate separated media structure to ensure that all surfaces are coated, and that adequate latent capacity is provided.
- .3 The media shall have a flame spread index of less than 25 and a smoke developed index of less than 50 as required by NFPA 90A and UL 1995.
- .4 Media shall be wound continuously with one flat and one structural layer in an ideal parallel plate geometry. Airflow across heat exchanger surface shall remain laminar.
- .5 Energy transfer media shall not exceed 4" in depth.

.4 COATINGS AND DESICCANT:

- .1 The desiccant shall be inorganic and specifically developed for the selective adsorption of water vapor.
- .2 The desiccant shall utilize a 3A molecular sieve certified by the manufacturer.
- .3 Desiccant shall be non-migrating, nor shall it dissolve or deliquesce in the presence of water or high humidity.

.5 SEALS:

- .1 All diameter and perimeter seals shall be provided as part of the cassette assembly and shall be factory set.
- .2 Seals shall be non-contact nylon pile brush seal orientated in a labyrinth style configuration.
- .3 Diameter Seals shall be fully adjustable and easily accessible and set to within 0.05 inch of the rotor surface.
- .4 Perimeter seals shall be permanently mounted to the wheel rim and not require adjustment. Seals that mount to the frame are not acceptable.

.6 DRIVE SYSTEM:

- .1 The wheel drive motor shall be an Underwriters Laboratory Recognized Component and shall be mounted in the cassette frame and supplied with a service connector or junction box.
- .2 Three phase motors shall be suitable for use in both standard and inverter rated applications.
- .3 The drive system shall be easily accessible and visible for inspection and maintenance and have a minimum life expectancy of 90,000 hours.

.7 MOTOR:

- .1 Inverter rated AC motor.
- .2 Provides with shaft grounding rings similar to AEGIS.
- .3 Wheel drive system shall not require periodic adjustment.

.8 MAINTENANCE:

- .1 The media shall be cleanable by vacuuming the media surface, without degrading the latent recovery.

.9 PURGE:

- .1 A mechanical purge shall be available as an optional accessory.
- .2 When required the mechanical purge sector shall be factory installed and field adjustable.
- .3 Purge settings shall be calculated using AHRI certified data and adjusted per the wheel manufacturer's selection software.
- .4 Purge shall be capable of limiting Exhaust Air Transfer Ratio (EATR) values to 0.4% through proper fan and purge adjustment.

.12 ROOF CURB

- .1 Contractor shall provide factory supplied roof curb, 16 gauge perimeter made of zinc coated steel with supply and return air gasketing and wood nailer strips. Ship knocked down and provided with instructions for easy assembly.
- .2 Curb shall be manufactured in accordance with the National Roofing Contractors Association guidelines.

.13 ACCEPTABLE MANUFACTURERS

- .1 Trane;
- .2 Daikin;
- .3 Johnson Controls;
- .4 AAON.

3. EXECUTION

3.01 INSTALLATION OF PACKAGED ROOFTOP UNITS

- .1 Provide rooftop units on roof.
- .2 Provide required rigging and hoisting/moving equipment required to move units to required locations. Perform rigging/hoisting/moving in accordance with unit manufacturer's directions and details.
- .3 Locate curbs on roof where required for installation and flashing into roof construction as part of roofing work of Division 07. Secure units in place, level, and plumb, on gasketing material.
- .4 Remove fan base hold-down clamps and other shipping restraints and protective packaging.
- .5 Carefully coordinate installation of each unit with other trades making connections to unit, in particular, control connections.
- .6 Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system start-up requirements.

- .7 Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system manufacturer certification. Submit a copy of the letter prior to Substantial Performance.
- .8 Include for a one half day on-site operation demonstration and training session. Training is to be a full review of all components including but not limited to a full operation and maintenance demonstration, with abnormal events.

END OF SECTION

1 GENERAL

1.01 SUBMITTALS

- .1 Submit shop drawings/product data sheets for electric heaters, including accessories.
- .2 Submit a site start-up report from manufacturer's representative as specified in Part 3 of this Section.

2 PRODUCTS

2.01 GENERAL RE: ELECTRIC HEATERS

- .1 Electric heaters are to be certified and labelled in accordance with CSA C22.2 No. 46, Electric Air-Heaters, and are to be complete with automatic reset high limit temperature control, baked epoxy/polyester powder coat white or almond finish as selected, and in accordance with drawing schedule.
- .2 Acceptable manufacturers are:
 - .1 Ouellet Canada Inc.;
 - .2 Chromalox Inc.;
 - .3 Stelpro Design Inc.

2.02 BASEBOARD HEATERS

- .1 Low profile wall mount baseboard heaters, each approximately 150 mm (6") high, 65 mm (2-½") deep, complete with:
 - .1 #22 gauge steel body with #20 gauge steel connection box at both ends of heater, 2 rows of mounting holes, single screw built-in wire holder, and #20 gauge steel removable front panel with rounded upper corners;
 - .2 standard watt density (900 W/m) tubular steel heating element with aluminium fins, noise free and floating on high temperature nylon bushings;
 - .3 factory installed, tamperproof, adjustable bi-metal thermostat;
 - .4 factory supplied enclosure accessories as indicated on drawings and/or heater schedule;

2.03 MOTORIZED CABINET HEATERS

- .1 Surface mounted or recessed cabinet heaters as shown, each complete with:
 - .1 #18 gauge steel cabinet and removable front panel with integral louvers and grille with rounded corners;
 - .2 tubular steel heating element with aluminium fins;
 - .3 steel fan wheel, direct driven by means of a motor conforming to requirements of Section entitled Basic Mechanical Materials and Methods, and complete with a fan delay to purge heater of residual heat;

- .4 factory installed, tamperproof, adjustable thermostat;
- .5 factory supplied enclosure accessories as indicated on drawings and/or heater schedule;

2.04 MOTORIZED UNIT HEATERS

- .1 Horizontal surface mounting unit heaters, each complete with:
 - .1 #20 gauge die-formed steel with individually adjustable discharge louvers, and mounting brackets for either ceiling or wall swivel mounting;
 - .2 tubular steel heating element with fins;
 - .3 resiliently mounted totally enclosed motor in accordance with requirements specified in Section entitled Basic Mechanical Materials and Methods, direct connected to a statically and dynamically balanced aluminium fan and complete with guard;
 - .4 factory installed, tamperproof, adjustable thermostat;

3 EXECUTION

3.01 INSTALLATION OF ELECTRIC HEATERS

- .1 Supply electric heaters, complete with all required accessories. Hand heaters, in original packaging, to electrical trade at site in room/area where they are to be installed.
- .2 Locate electric heaters for electrical trade so accurate electrical rough-in can be made. Confirm exact locations prior to electrical rough-in.
- .3 Ensure heaters are properly installed.
- .4 Where remote thermostats are indicated, provide thermostats and required control wiring and accessories. Unless otherwise indicated, locate thermostats in accordance with requirements of local governing authority and, where applicable, barrier-free requirements. Review exact thermostat locations with Consultant prior to roughing-in.
- .5 Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system start-up requirements.
- .6 Include for a 4 hour on-site heater operation demonstration and training session. Training is to be a full review of all components including but not limited to construction details, operation, and maintenance.

END OF SECTION

PROJECT NAME: Halton District School Board
Paul A. Fisher Public School
Interior Renovations

RDZ PROJECT NUMBER: 24122

Following Supplementary Controls Bid Form is submitted by:

.....
(Bidding Company)

.....
(Street Address or P. O. Box No.)

.....
(City, Province and Postal Code)

Dated and which is an integral part of Bid Form.

In accordance with Instructions to Bidders, we provide the Supplementary Controls Bid Form. We understand that the information provided to be considered an integral part of Bid Form and is to be completed in full.

Where instructions are not provided, submit Supplementary Controls Bid Form by time of Bid closing, via e-mail addressed to:

RDZ Engineers Ltd.
Attention: Giovanni Rea
e-mail: Giovanni@rdzeng.ca

Supplementary Bid Form Signature:

.....
(Signature of Authorized Representative)

.....
(Print Name)

.....
(Title)

LIST OF MANUFACTURERS/SUPPLIERS

We submit, herein, typed or neatly printed, the names of the manufacturers upon whose products our Bid Price is based and which we will supply. If no name is indicated, or if name identified is not listed in issued documents, or if more than one name is indicated for a particular product, we will if requested, provide the base specified manufacturer's product. Where products are named in the specifications with only one (1) manufacturer/supplier, or are not listed herein, we are also prepared to provide the base specified named product. We will provide Canadian manufactured products if costs and quality are similar.

We understand that the first manufacturer specified for any product is the manufacturer upon whose product the design is based, and that the other manufacturers specified for a particular product are manufacturers acceptable to the Owner and whose product produces equivalent quality, performance and size. We further understand if we indicate a manufacturer other than the manufacturer whose product is the basis of the design, we are responsible for ensuring that the product supplied is equivalent in quality, performance and size to the base design product, and that any additional costs incurred as a result of use of such products will be borne by us. Acceptance of non-base specified manufacturers with respect to their equivalency shall be as sole discretion of Consultant.

We also acknowledge that failure to submit this list as specified or failure to submit within time defined may result in provision of base specified manufacturer's product, at discretion of Consultant.

SECTION	PRODUCT	MANUFACTURER/SUPPLIER & CATALOGUE NUMBER
25 09 23	Motorized Dampers	
25 09 23	Motorized Damper Actuators	
25 09 23	Temperature Sensors	
25 09 23	Room Sensors	
25 09 23	Pressure Transmitters	
25 09 23	Outside Air Sensors	

END OF SECTION

1. GENERAL

1.01 SUMMARY

- .1 The approved Building Automations System Contractor per 2.1, referred to herein as the Contractor, shall provide a Direct-Digital Control System as indicated on the project documents in accordance with the drawings and as described in these specifications.
- .2 Where existing legacy controls exist, the Contractor shall be responsible for the removal and preservation of existing controls and accessories, and to engineer, permit, provide and install a fully functioning Building Automation System which meets the requirements detailed herein.
- .3 Where an Owner or Owner's representative provided points / object and equipment list is not provided as part of the bid package, the Contractor shall be responsible to verify existing site conditions and/or review all available drawings so to ensure all existing and/or currently proposed equipment at the facility is identified in accordance with 1.3.2, and is made part of the complete Direct-Digital Control System.
- .4 The work administered by this Section of the technical specifications shall include all engineering, programming, labor, materials, special tools, equipment, enclosures, power supplies, software, software licenses, project specific software configurations and database entries, interfaces, wiring, tubing, installation, labeling, calibration, documentation, submittals, testing, verification, training services, permits and licenses, transportation, shipping, handling, administration, supervision, management, insurance, warranty, specified services and items required for a complete and fully functional Controls Systems.

1.02 DESIGN INSTRUCTIONS

- .1 Design shall meet the functional intent of an "open", and interoperable Building Automation System, comprised of a network of stand-alone digital controllers. Incorporating the Niagara 4 Framework®.
- .2 The Building Automation System is to include, but not limited to, the monitoring and/or control of **ALL** of the following equipment instances at each specified site:
 - .1 Boilers
 - .2 Fluid Cooler
 - .3 Air handling units
 - .4 Make up air units
 - .5 HVAC Equipment
 - .6 Energy recovery units
 - .7 Heat-pumps
 - .8 Exhaust fans
 - .9 Variable Frequency Drives
 - .10 Pumps
 - .11 Motors
 - .12 Valves
 - .13 Unit Heaters
 - .14 Radiant Heaters
 - .15 Electric Duct Heaters
 - .16 Exterior Lighting
 - .17 Utility Consumption and Demand Metering

- .3 The system shall be modular in nature and designed for future flexibility so to accommodate the addition of functionality, control points or expansion of facility.
- .4 The control systems shall be designed such that each mechanical system shall operate under stand-alone mode. The contractor administered by this Section of the technical specifications shall provide controllers for each mechanical system. In the event of a network communication failure, or the loss of any other controller, the control system shall continue to operate independently. Failure of the B-BC shall have no effect on the field controllers, including those involved with global strategies.
- .5 Coordinate the specifications and equipment schedules in related sections for manufacturer furnished DDC systems to ensure the minimal hardwired points and sequences can be met. OEM DDC Systems, that meet the minimum hardwired points are preferred and approved for use with the following equipment ONLY; boilers, main air handling equipment, heat pumps and, fluid cooler. The supplier of the equipment is responsible for the configuration, programming, start-up, and testing of that product to meet the sequence of operation and specifications. The supplier shall also provide any licensing, hardware, and software required for interface to the DDC system.

1.03 DEFINITIONS

- .1 Definitions of terms used in this section may differ from those given in general and supplementary conditions and take precedence over them.

BAS	Building Automation System
B-BC	BACnet Building Controller
B-AAC	BACnet Advanced Application Controller
B-ASC	BACnet Application Specific Controller
BACnet / BACnet Standard	Building Automation and Controls Network - ANSI/ASHRAE Standard 135-2012
BACnet/IP	BACnet Annex J – describes how BACnet devices can make use of IP directly for communicating across IP-based terminals
BBMD	BACnet Broadcast Management Device, see BACnet Annex J
BIBB	BACnet Interoperability Building Blocks: A BIBB defines a small portion of BACnet functionality that is needed to perform a particular task
BTL	BACnet Testing Laboratory: A recognized, independent third party laboratory certified to test product for compliance to BACnet standards. BTL Certified products are indicated by a registered seal affixed to the product.
B/I	Binary Input
B/O	Binary Output
COV	Change of Value
cUL	Underwriters Laboratory Canada
DDC	Direct Digital Control
D/I	Digital Input
D/O	Digital Output
Embedded Control	Some OEM's (Original Equipment Manufacturer) equipment have a factory installed controller. These controllers must follow these standards. Examples can be found in chillers, boilers, variable frequency drives, etc. Proprietary communication protocols will not be allowed.
Gateway	A device, which contains two or more dissimilar networks/protocols, permitting information exchange between them (ASHRAE/ANSI 135-2004). Gateways are NOT to be included unless approved by the Owner.

GUI	Graphical User Interface
HVAC	Heating, Ventilation and Air-Conditioning
IEEE	Institute of Electrical and Electronics Engineers
I/O	Input / Output
LAN	Local Area Network (an individual school or site)
MS/TP	Master Slave Token Passing: Data link protocol as defined by the BACnet Standard. Operates over a serial field bus network (RS485)
NEMA	National Electrical Manufacturers Association
PICS	Protocol Implementation Conformance Statement: All devices conforming to the BACnet protocol shall have a documented statement that identifies all portions of BACnet that are implemented in the device.
P.I.D.	Proportional Integral Derivative
Shall	indicate a requirement that, in the view of the Board, must be complied with
UPS	Uninterruptible Power Supply Unit
VFD	Variable Frequency Drive
VLAN	Virtual Local Area Network: Dedicated for Facilities Services equipment
WAN	Wide Area Network (board wide)

1.04 REFERENCE STANDARDS

- .1 Where edition date is not specified, consider that references to the manufacturer's data, and published codes, standards and specifications are made to the latest edition or revision, approved by the issuing organization.
- .2 Reference Standards and specifications are quoted to establish minimum standards. Work in which quality exceeds the specified minimum will be considered to conform.
- .3 The requirements of the Contract Documents govern over the requirements of reference standards and specifications.
- .4 Standards, specifications, associations and regulatory agencies are generally referred to throughout the Contract Documents by their abbreviated designations, as listed below:
 - .1 AMCA American Movement and Air Control Association
 - .2 ANSI American National Standards Institute
 - .3 ARI Air Conditioning and Refrigeration Institute
 - .4 ASME American Society of Mechanical Engineering
 - .5 ASTM American Society for Testing and Materials
 - .6 ASHRAE American Society of Heating, Refrigeration and Air Conditioning Engineers
 - .7 CGA Canadian Gas Association
 - .8 CGSB Canadian General Standards Board
 - .9 CSA Canadian Standards Association
 - .10 NFPA National Fire Protection Association
 - .11 SMACNA Sheet Metal and Air Conditioning Contractors' National Association
 - .12 ULC Underwriters' Laboratories of Canada

1.05 SYSTEM ARCHITECTURE AND DESCRIPTION

- .1 The Building Automation System as detailed in this Section shall be based on a hierarchical architecture incorporating the Niagara 4 Framework® through Tier 1 and 2 inclusive. Systems not developed on the Niagara 4 Framework® platform are unacceptable.
- .2 All Niagara 4 Framework® components shall have an unrestricted interoperability license with a Niagara Compatibility Statement (NICS) following the Tridium Open NiCS Specification.
- .3 All devices supplied under this specification, excluding sensors, shall be connected to the site LAN and shall communicate natively using the following BACnet/IP, BACnet MS/TP, Peer to Peer, or Ethernet (ISO 8802-3), as defined in the ANSI/ASHRAE Standard 135, latest or Peer-to-Peer using Niagara's Fox Protocol or SNMP.
- .4 Program databases, data acquisition and all control sequence logic shall reside in the respective B-BC, B-AAC and B-ASC controller. Each device shall, to the greatest extent possible, perform its programmed sequence. Operation of each device shall not be dependent on a connection to a server or master controller.
- .5 The B-BC and any B-AAC or B-ASC shall be capable of updating firmware without the replacement of any hardware, microprocessors or chips.
- .6 Each school / site shall be furnished with a single B-BC, which is responsible for and capable of providing fully distributed control including user access control and all necessary site computations at the site, independent of or under the Enterprise Management System and it must be stand-alone, multi-tasking, multi-user with a real-time digital processor. All controlled objects, sequences and associated operational parameters shall be both operator definable and modifiable through the embedded User Interface.
- .7 The B-BC shall provide a web-based graphical user interface for programming, monitoring, and control, independent of any Enterprise Management System, be accessible remotely from a central site(s) and locally. The web-enabled user interface shall operate on an industry standard web-browser without the requirement of additional plugins.
- .8 Each Mechanical or Electrical System and/or major piece of mechanical or electrical equipment shall have 1 dedicated B-AAC controller with sufficient I/O capacity such that it shall be connected to ALL field devices and points associated with that system, space and/or piece of equipment. B-ASC use shall be limited to VAV box applications provided the full functional intent can be met within the singular device.
- .9 Mechanical and Electrical Systems i.e., VFD's, fluid cooler, boilers, unitary equipment, etc. units that are equipped with manufacturers furnished controls shall be BTL certified. Gateways are not to be used unless prior written approval has been acquired. A single B-AAC can be used in combination with the manufacturer supplied controls, only where the manufacturer's controls are unable to meet the functional intent, it shall be implemented in accordance with Section 25 09 93.
- .10 The use of multiple application controllers used to control a single piece of equipment is strictly prohibited, except those specifically noted in 1.6.9.
- .11 The system shall include real time monitoring of the following utilities; electricity (main feed), natural gas (main), and water (main). Meters supplied under this division shall communicate BACnet Natively. For existing meters, utility owned, coordinate integration requirements with the respective utility provider.
- .12 The B-BC shall be connected to the HDSB Facilities VLAN, , to be supplied by the School Board at the School Board's expense.
- .13 Site workstations, otherwise referred to as Caretaker PC, will be provided by the School Board.

1.06 HARDWARE AND SOFTWARE LICENSING

- .1 The School Board shall be named license holder of all controllers and components, software and firmware supplied under this specification. The School Board shall receive ownership of all project specific configuration documentation, data files, and application-level software developed for the site.
- .2 The School Board shall have unrestricted access rights for all network management, operating system server, engineering and programming software required for the ongoing maintenance and operation of the building automation system
- .3 All software provided shall be full featured and not limited or trial version.

1.07 USER CONTROL OVER CONFIGURATION

- .1 The intent of this specification is to provide a system which shall allow the Board to independently do its own modifications to all objects, operational parameters and sequences.

1.08 INTELLECTUAL PROPERTY AND PROPRIETARY MATERIAL

- .1 The Board shall sign a software and hardware licensing agreement, upon review and agreement of terms and conditions, as a condition of contract. Such license will grant use of all programs and application software to the Board and its representatives, as defined by the agreement, and shall protect the manufacturer's rights to disclosure of intellectual property contained within such software.

1.09 SYSTEM PERFORMANCE

- .1 The System shall conform to the following minimum:
 - .1 The system shall report values with minimum end-to-end accuracy listed in Table 1.

Table 1 - Reporting Accuracy	
Measured Variable	Reported Accuracy
Space Temperature	1% of range
Ducted Air Temperature	1% of range
Outside Air Temperature	±1°C (±2°F)
Water Temperature	1% of range
Water Flow	±2% of full scale
Airflow (terminal)	±10% of full scale (see note 1)
Airflow (measuring stations)	±5% of full scale
Airflow (pressurized spaces)	±3% of full scale
Air Pressure (ducts)	±25 Pa (±0.1 in. w.g.)
Air Pressure (space)	±3 Pa (±0.01 in. w.g.)
Water Pressure	±2% of full scale (see note 2)
Carbon Dioxide (CO ²)	±50 ppm
Electrical (kW, kVA, kWh, A, V, pF)	±1% of reading (see note 3)

Note 1: 10% - 100% of scale

Note 2: For both absolute and differential pressure

Note 3: Not including utility-supplied meters

- .2 Control Stability and Accuracy shall maintain measured variable at set-point within tolerances listed in Table 2.

Table 2 – Control Stability and Accuracy		
Controlled Variable	Control Accuracy	Range of Medium Accuracy
Air Pressure	±50 Pa (±0.2 in. w.g.) ±3 Pa (±0.01 in. w.g.)	0-1.5 kPa (0-6 in. w.g.) -25 to 25 Pa (-0.1 to 0.1 in. w.g.)
Airflow	±10% of full scale	
Space Temperature	±1°C (±2°F)	
Duct Temperature	±1.5°C (±3°F)	
Fluid Pressure	±10 kPa (±1.5 psi) ±250 Pa (±1 in. w.g.)	MPa (1-150 psi) 0-12.5 kPa (0-5 in. w.g.) differential

1.10 WORK COVERED BY THE CONTRACT DOCUMENT

- .1 The Scope of Work for the Building Automation Systems Contractor shall include, but is not limited to the following:
 - .1 Furnish and install all necessary controllers, control and/or ancillary devices, sensors, wiring, software, licenses, and programming to deliver a complete and functional building automation system, which meets the functional intent of the systems design.
 - .2 The naming and addressing of all objects and devices to be in accordance with the specifications.
 - .3 Configure the web-based user interface embedded in the B-BC in accordance with the specifications.
 - .4 Coordinate equipment specifications for related sections necessary to meet the functional intent including variable frequency drives, dampers, valves, actuators, and peripheral devices considered to have wet surfaces such as pressure taps, thermal wells, flow switches, flow meters, etc. Preference is given to these devices being furnished by the Original Equipment Manufacturer, where applicable.
 - .5 Review and coordinate with other related sections so to ensure all mechanical and electrical systems and components to be integrated have the necessary hardware and software to meet the points and sequences specified.
 - .6 Coordinate with the School Board, the setup and communication of the B-BC on the School Board's supplied VLAN, in accordance with the specifications.
 - .7 Coordinate with the School Board and the respective utility provider, the installation and setup of utility metering equipment or the integration of any existing meters, in accordance with the specifications.
 - .8 Identify and label all controllers and associated devices including but not limited to connected I/O points, address', network id, etc.
 - .9 Attain, where required, all necessary permits and inspections
 - .10 Commissioning of new BAS.
 - .11 Submit the required documentation as described herein, including, but not limited to submittals, project record, start-up, commissioning, testing, acceptance documentation and system warranty.
 - .12 Operator Training.

1.11 PRODUCTS FURNISHED BUT NOT INSTALLED BY THE BUILDING AUTOMATION CONTRACTOR

- .1 Hydronic Piping:
 - .1 Control Valves
 - .2 Flow Switches
 - .3 Temperature Sensor Wells and Sockets
 - .4 Flow Meters.
- .2 Ductwork Accessories:
 - .1 Automatic Dampers
 - .2 Air Flow Switches

1.12 PRODUCTS NOT FURNISHED OR INSTALLED BUT INTEGRATED BY THE BUILDING AUTOMATION CONTRACTOR

- .1 Fire Alarm Systems
- .2 Utility Monitoring Systems
- .3 Variable Frequency Drives
- .4 Boiler, Fluid Cooler, Heat Pumps Equipment and Controls (BACnet Points necessary to meet specifications for monitoring and history only)
- .5 Packaged Equipment and Controls (BACnet Points necessary to meet specifications for monitoring and history only)

1.13 RESPONSIBILITY MATRIX BY DIVISION CONTRACTOR

Work / Item / System	Furnish	Install	Control Wiring	Power
Control System Communication Wiring	25 09 23	25 09 23	25 09 23	n/a
Controls Equipment, panels, enclosures, and accessories	25 09 23	25 09 23	25 09 23	26
Interface to OEM furnished controllers supplied under Division 23	23	23	25 09 23	26
DOAS, Air Handling, HVAC Manufacturer furnished space mounted control (i.e., thermostat)	n/a	n/a	n/a	n/a
Fluid Cooler Level, Make-up Water and Sump Heater Control Devices (local control only)	23	23	23	23
Starters, operator switches	23	26	25 09 23	26
Automatic Damper (not OEM installed)	25 09 23	23	23 09 23	n/a
Automatic Damper Actuators	25 09 23	25 09 23	25 09 23	n/a
Hydronic Valves	25 09 23	23	25 09 23	n/a
Hydronic Valve Actuators	25 09 23	25 09 23	25 09 23	n/a
Thermo-wells (including accessories considered "wet")	25 09 23	23	n/a	n/a
Hydronic Flow Switches and	25 09 23	23	25 09 23	n/a

Transducers				
Variable Frequency Drives not OEM Furnished	23	26	25 09 23	26
Fire Alarm control monitoring relay	28	28	25 09 23	26
Power Distribution Monitoring System	Utility	Utility	25 09 23	26
Natural Gas Utility Monitoring System	Utility	26	25 09 23	n/a
Water Meter Monitoring System	Owner	25 09 23	25 09 23	n/a
Fume Hood Controls (to be local control only)	23	23	23	26

1.14 QUALITY ASSURANCE

- .1 The Controls Contractor shall be responsible for inspection and quality assurance for all materials and workmanship provided.
- .2 The Controls Contractor shall have an established working relationship with the proposed BAS manufacturer of not less than 3 years.
- .3 The Controls Contractor shall have successfully completed all control system training and certification as required by the manufacturer.

1.15 PERMITS, INSPECTIONS AND TESTING

- .1 Contractor will arrange for submission to the Electrical Safety Authority (ESA) for review of this project, and pay all associated fees. Provide Certificate(s) of Acceptance from ESA and other Authorities having jurisdiction upon completion of the Work.
- .2 Where modification to mechanical or electrical equipment control wiring is necessary to meet the requirements of the specifications, the contractor is responsible for arranging any testing required by the Authority Having Jurisdiction to maintain the required certification and ensure the safe operation of the equipment modified.

1.16 PERFORMANCE VERIFICATION OF INSTALLED EQUIPMENT

- .1 Installed equipment may be subject to performance verification as specified herein if required by Owner or Owner's Representative(s).
- .2 When performance verification is requested, equipment shall be tested to determine compliance with specified performance requirements.
- .3 If requested, Contractor shall arrange for services of independent testing agency.
- .4 Maintain building comfort condition when equipment removed from service or testing purposes.
- .5 Promptly provide School Board, or School Board's Representative(s) with test reports.
- .6 Should test results reveal that originally installed equipment meets specified performance requirements, School Board will pay costs resulting from performance verification procedure.
- .7 Should test results reveal equipment does not meet specified performance, equipment will be rejected and the following shall apply:
 - .1 Remove rejected equipment. Replace with equipment that meets requirements of Contract Documents, including specified performance requirements.

- .2 Replacement equipment may be subject to performance verification as well; use same testing procedures as performed on originally installed equipment.
- .3 Contractor shall pay costs resulting from performance verification procedure.

1.17 SUBMITTALS

- .1 All submittals and documentation including complete BAS System Engineering Design Submittal & Drawings, Project Record Documents, Application Engineering Documents and Owner's & Maintenance Manuals shall be submitted electronically in the form of an Adobe Portable Document Format (.pdf). All Control Schematics, Wiring Diagrams, Riser Diagrams, &c. shall be formatted for A3 11" x 17". Floor Plans shall be submitted in CAD format (.dwg). All other documentation may be formatted for 8.5" x 11".
- .2 Submit in writing and so delineated at the beginning of each submittal, known substitutions and deviations from requirements of Contract Documents.
- .3 Complete BAS Engineering Design Submittal & Drawings shall be prepared in accordance with Section 1.20 using the following guidelines:
 - .1 Submittal documentation and drawings shall consistently use the same abbreviations, symbols, nomenclature and identifiers. Each control system element shall be assigned a unique identifier pursuant with the Contract Documents
Submit the following:
 - .2 A complete bill of materials of all equipment, controllers, devices, sensors, actuators, valves, etc., necessary to meet the requirements detailed herein is to be provided, indicating unique equipment identifier/tag, unique device/controller identifier/tag, manufacturer and model number.
 - .3 Riser diagram of Local Area Network (LAN) shall outline execution and details of all network cabling, BAS & Network Hardware including the following:
 - .1 All BAS/DDC Hardware with controller number, MAC Addresses where required, unique identifier/tag, location, equipment and service.
 - .2 All Network Hardware with unique identifier, location and service
 - .3 Network cabling configuration and execution specification
 - .4 Location of all cabling termination points and End of Line (EOL) terminators
 - .5 Location of all network interface jacks
 - .6 A separate riser diagram shall be provided for each network segment
 - .4 Provide manufacturers cut sheets for major system components. When manufacturer's cut sheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Include for every BAS component including but not limited to the following:
 - .1 Gateways or BBMD associated networking peripherals
 - .2 Control Valves
 - .3 Dampers
 - .4 Actuators
 - .5 Variable Frequency Drives

1.18 SUBSTANTIAL COMPLETION REQUIREMENTS

- .1 Contractor shall provide checklist for completion before Substantial Completion Field Review. Provide written declaration that work is complete. The following items shall be complete before Substantial Completion Field Review:
 - .1 Mechanical and Electrical systems capable of operation with Building Automation System, in operation with alarms functional.
 - .2 Tests on systems and equipment completed and certificates of approval obtained from regulating Authorities.

- .3 Fire stopping completed, if required.
- .4 Valve tagging completed and equipment, ductwork and piping identified.
- .5 Escutcheons installed.
- .6 Extended warranty form mailed to manufacturer and copy provided to Owner.
- .7 Ensure access doors suitable located and equipment accessible.
- .8 Ensure electrical connections to mechanical equipment are complete and motor rotation correct.
- .9 Equipment cleaned inside and out, lubricated and paint touched-up.
- .10 Commissioning, Testing, Demonstration and Acceptance.
- .11 Complete program back-up and system files provided and verified for functionality.

1.19 PROJECT RECORD

- .1 Upon completion of installation and systems commissioning, submit record documents for review. "As-Built" Project Record Documents should include:
 - .1 Project Record Application Engineering Drawings shall include all BAS System Engineering Design Submittal with Drawings updated to reflect actual field conditions, architecture and execution.
 - .2 Electronic Operating & Maintenance (O&M) Manual including:
 - .1 Operator's Manual with Manufacturers' complete operating instructions.
 - .2 Documentation of all project specific Application and DDC programs.
 - .3 All necessary system Administrator-Level passwords and/or required access credentials.
 - .4 Information required for programming BAS.
 - .5 Complete Final Point Schedule including all hardware and software data points and documentation of calibration and configuration values for all Inputs, Outputs, Variables and PID Loops at the conclusion of systems commissioning and functional testing.
 - .6 Routine preventative maintenance procedures, corrective diagnostic troubleshooting procedures and calibration processes.
 - .7 Final Bill of Material with all installed parts, manufacturers, manufacturers' part numbers and ordering information.
 - .3 Sequence of Operation shall be submitted for every piece of equipment being controlled by and/or associated with the BAS. No operational deviation from specified Sequences of Operation as outlined in Contract Documents shall be permitted without prior written approval. Sequences of Operation shall include and conform to the following:
 - .1 Refer to equipment and control devices by their specific unique identifiers/tags pursuant with the Contract Documents and BAS Submittal package.
 - .2 Clearly represent actual Application Programming methodology and functional control operation. Do not merely provide a copy of Contract Document specified Sequence of Control.
 - .3 Include description of functional system operation under normal and failure conditions.
 - .4 BAS Control Schematics and Wiring Diagrams shall be submitted for every piece of equipment being controlled by and/or associated with the BAS. BAS Control Schematics and Wiring Diagrams shall include and conform to the following:
 - .1 Floor plan showing exact location, MAC addresses where required, including unique identifiers of all hardware supplied under this section.
 - .2 Control Schematic flow diagram of each system (air, water, gas, & etc.) being controlled showing actual physical configuration and control device/sensor location of all fans, coils, dampers, valves, pumps, heat exchangers, control devices, &c. including each hardware point type, controller and associated ancillary devices.

- .3 Controller termination details showing every controller point termination.
- .4 Wiring Diagrams of all packaged equipment, motor starters, relay wiring, equipment interlock, safety circuits, & etc. clearly indicating all interconnecting wiring and termination of all conductors and cables including labels of all cables and points.
- .5 Control Enclosure details for every enclosure including panel identifier, location, physical lay-out, dimensions, instrumentation, labels, & etc. Also include detail wiring (I/O, network and power) and power source for each panel, transformer and controller.

2. PRODUCTS

2.01 APPROVED MANUFACTURERS

- .1 The following controls hardware and software, in no particular order of preference, are approved for use:

Manufacturer	Tier 2 Product Line	Manufacturer Assigned Vendor
Alerton	AIE Niagara 4	HTS Engineering Ltd (115 Norfinch Drive, North York, ON)
Distech Controls	EC-BOS Niagara 4	Energy Controls & Mechanical Services Inc. (Kitchener)

2.02 SOLE VENDOR SITE DESIGNATION

- .1 Any minor site additions or upgrades, requiring manufacturer specific products as detailed herein will be that of the Approved Manufacturer for the site, per 2.3.
- .2 The Board reserves the right to change the status of an Approved Manufacturer at any time should they not meet the performance or requirements detailed herein.

2.03 BUILDING CONTROLLER (B-BC)

- .1 The B-BC shall be BTL certified, communicate BACnet Natively and incorporate the Niagara 4 Framework®.
- .2 The B-BC shall have an unrestricted interoperability license with a Niagara Compatibility Statement (NiCS) following the Tridium Open NiCS Specification and have a value of “*”, it shall be understood to mean that parameter is open to all possible values. Note that this will result in the following entries in the license.dat file:

Specific Feature	license.dat file entry value
Owner	“HDSB”
Project	“HDSB”
BrandId	“*” preferred, “Distech” or “Alerton” acceptable
accept.station.in	“*”
accept.station.out	“*”
accept.wb.in	“*”
accept.wb.out	“*”
Expiration	
All expiration instances	“never”
Limit	
¹ All .limit instances	“none”
Export	
BACnet	“true”
obix	“true”
Import	
rdbSqlServer	“true”
web	
ui	“true”
ui.wb	“true”
ui.wb.admin	“true”

¹ With the exception of limitations defined by hardware configuration

- .3 The B-BC shall function in a real-time, multi-tasking networked operating environment. It must complete all necessary site computations based on information from any object in the internetwork and locally execute global strategies and supervisory control for all field devices supplied under this specification, without additional hardware or software and independent of or under a B-AWS. It shall be capable of executing application control programs to provide the following:
 - .1 Calendar Functions
 - .2 Scheduling
 - .3 Trending and Data Management
 - .4 Alarm Monitoring and Routing
 - .5 Real-Time Clock and Network Time Synchronization
 - .6 Network and User Management functions for all devices on the LAN
- .4 The B-BC shall be equal to a JACE 8000 and be supplied with the following hardware features as a minimum:
 - .1 two (2) Ethernet ports
 - .2 two (2) RS-485 BACnet MS/TP port
 - .3 one (1) USB port
 - .4 Wi-Fi connectivity
 - .5 expansion capability
 - .6 a battery backup and/or non-volatile memory. If battery backup or non-volatile memory is not available an Uninterruptable Power Supply must be provided to maintain program file and data base for a minimum 24 hours.
- .5 The B-BC shall contain sufficient memory to support its own operating system, User Interface, all specified control strategies and objects, energy management applications, data storage and trending, alarm annunciation, and network management.
- .6 The system shall be capable of supporting an unlimited number of clients using a standard Web browser such as Google Chrome™. Systems requiring additional software (to enable a standard Web browser) to be resident on the client machine, or manufacturer-specific browsers shall not be acceptable.
- .7 The B-BC must enable access to the complete BAS system installed under this section, via web-browser. Access includes but is not limited to comprehensive programming capabilities for all controllers and real-time operational values via an embedded web-browser Graphical User Interface (GUI). The GUI shall support the latest version of standard web-browsers, without the requirement of additional plugins or software, and must be configured in accordance with these specifications.
- .8 The B-BC shall provide alarm management to monitor, buffer, and direct alarms and messages to operator devices and memory files, to be assigned in accordance with these specifications. Each B-BC shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic, and prevent alarms from being lost.
- .9 The B-BC shall have the ability to collect and archive any data, for any property of any object on the LAN, in accordance with these specifications. The embedded UI shall be capable of configuring the collection of data. The data shall be accessible in either the following formats, XML or CSV from the WAN Server Supervisory Software or through a standard web-browser.
- .10 The B-BC shall be capable of maintaining an Audit log that tracks and archives all activities performed.
- .11 The B-BC shall provide, a minimum of four (5) levels of local access privileges. The highest level, Administrator Level, shall allow the BAS administrator to perform application, database, and user management functions. Each login credentials shall be assigned to a pre-defined level of access.

- .12 The B-BC shall provide WAN access privileges, including a comprehensive list of accessibility/functionality items, to be enabled or disabled for each user according to the level of access granted. Operators shall be able to perform only those commands available for the access level assigned to their login credentials. Login credentials are to be looked up using the Lightweight Directory Access (LDAP) through the BAS server.

2.04 ADVANCED APPLICATION CONTROLLERS (B-AAC)

- .1 B-AAC's shall be BTL Certified.
- .2 B-AAC objects, sequences and operational parameters must be configurable via the B-BC's embedded graphical user interface.
- .3 Each B-AAC shall contain sufficient memory to support its own operating system, data storage and programming requirements.
- .4 The B-AAC shall share and use data between all controllers on the network and shall manage the input and output communication signals to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms.
- .5 Controllers that perform scheduling shall have a real-time clock.
- .6 The B-AAC shall continuously check the status of its processor and memory circuits and in the event an abnormal operation is detected, the controller shall initiate a predetermined failure mode and generate an alarm notification.
- .7 Each B-AAC shall be supplied with a minimum 3 spare Universal I/O's.

2.05 APPLICATION SPECIFIC CONTROLLERS (B-ASC)

- .1 B-ASC use is limited to VAV box and will not be accepted for use in any other application.
- .2 B-ASC's shall be BTL Certified.
- .3 B-ASC objects, sequences and operational parameters must be configurable via the B-BC's embedded graphical user interface.
- .4 Each B-ASC shall contain sufficient memory to support its own operating system, data storage and programming requirements.
- .5 The B-ASC shall share and use data between all controllers on the network and shall manage the input and output communication signals to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms.
- .6 Controllers that perform scheduling shall have a real-time clock.
- .7 The B-ASC shall continuously check the status of its processor and memory circuits and in the event an abnormal operation is detected, the controller shall initiate a predetermined failure mode and generate an alarm notification.
- .8 Each B-ASC shall be supplied with a minimum 3 spare Universal I/O's.

2.06 AUTOMATIC CONTROL VALVES AND OPERATORS

- .1 Each control valve must be suitable in all respects for the application, including system pressure, and must have design output and flow rates with maximum pressure drops as follows:
 - .1 condenser water valves: 5 psi;
 - .2 heating water valves: 2.5 psi.

- .2 Unless otherwise indicated, control valves for proportional operation are to have equal percentage characteristics, and control valves for open/shut 2-position operation are to have straight line flow characteristics. All valves are to have position indicators. Valves for outdoor applications must be suitable in all respects for the application.
- .3 Heating valves are to be normally open unless otherwise specified.
- .4 Cooling valves are to be normally closed unless otherwise specified.
- .5 Unless otherwise specified, control valves in hydronic piping systems are to conform to requirements specified in Section entitled HVAC Piping and Pumps.
- .6 Unless otherwise specified, valves in steam/condensate piping are to generally conform to requirements specified in Section entitled Steam and Condensate Piping and Pumps but must be equipped with stainless steel plugs and stems, removable screwed stainless steel seat rings, and spring loaded Teflon V-ring packing.
- .7 All control valve operators are to be spring return type for fail safe operation, sized to tightly shut the control valves against differentials imposed by system, equipped with position indicators, and suitable in all respects for environment in which they are located.
- .8 Electric valve operators are to be equal to Belimo "EF Series" enclosed reversible gear type operators that can accept modulating control signals as required. Each is to be 1-phase AC, 120 or 24 volt as required or indicated, overload protected, and complete with an enclosure to suit the mounting location.

2.07 CONTROL DAMPERS AND OPERATORS

- .1 T. A. Morrison & Co. Inc. "TAMCO" 100 mm (4') deep, flanged, AMCA low leakage certified aluminium dampers. Dampers for modulating and mixing applications are to be parallel blade type. Dampers for open-shut service are to be opposed blade type. Maximum blade length is to be 1 m (4'). Dampers greater than 2 sections wide are to be complete with a jackshaft. Each damper is to be complete with:
 - .1 extruded 6063T5 aluminum frame and airfoil blades, each with an integral slot to receive a gasket;
 - .2 extruded TPE frame gaskets and extruded EPDM blade gaskets;
 - .3 slip-proof aluminium and corrosion resistant plated steel linkage of a metal thickness to prevent warping or bending during damper operation, concealed in frame, equipped with seal-sealing and self-lubricating bearings consisting of a Celcon inner bearing fixed on hexagonal blade pin and rotating in a polycarbonate outer bearing inserted in frame.
- .2 For standard damper(s), Series 1000 as above.
- .3 For insulated damper(s), Series 9000 as above but with all 4 sides of frame insulated with polystyrene, and blades thermally broken and insulated with expanded polyurethane foam.
- .4 For stainless steel dampers, as above but constructed of type 316 stainless steel and equipped with Teflon blade bearings.
- .5 Each damper motor is to be shaft mounted, spring return, fail safe in the normally open or normally closed position, sized to control damper against maximum pressure or dynamic closing pressure, whichever is greater, to suit sizes of dampers involved, and to provide sufficient force to maintain damper rated leakage characteristics. Each operator is to be complete with a damper position indicator, and external adjustable stops to limit length of stroke in either direction, and is to be mounted on a corrosion resistant adjustable bracket. Operating arms are to have double yoke linkages and double set screws for fastening to damper shaft. Operators for dampers to be connected to building fire alarm system or to freeze protection devices are to be equipped with additional relays to permit dampers to respond and go to required position in less than 15 seconds upon receipt of a signal. Operator enclosures are to be suitable in all respects for environment in which they are located.

- .6 Electric damper operators are to be equal to Belimo EF Series 24 volt or 120 volt AC spring return, direct coupled electric motor operators for either modulating or 2-position control as required. Each operator is to be overload protected and complete with an enclosure to suit the mounting location.

2.08 CONTROL SYSTEM COMPONENTS

- .1 Components specified below are required for control of equipment and systems in accordance with drawing control diagrams and sequences of operation. Not all required components may be specified.
- .2 Sensor/transmitter input devices must be suitable in all respects for the application and mounting location. Devices are as follows:

- .1 unless otherwise specified, temperature sensors are to be resistance type, either 2-wire 1000 ohm nickel RTD or 2-wire 1000 ohm platinum RTD with accuracy (includes errors associated with sensor, lead wire, and A to D conversion), equipped with type 316 stainless steel thermowells for pipe mounting applications;
- .2 room sensors, associated with each "Room Controller" detailed in Section 25 09 93, are to be communicating type complete with integral override button, configurable set-point / offset adjustment and without a display. Only the following room sensors, associated with occupant comfort, are approved for use:

DisTech Controls - Allure EC-Smart-Comfort-SO
Alerton - Microtouch Wall Sensor

- .3 outside air sensors designed and constructed for ambient temperatures and to withstand environmental conditions to which they are exposed, complete with a NEMA 3R enclosure, solar shield, and a perforated plate surrounding sensor element where exposed to wind velocity pressure;
- .4 insertion duct mounting sensors type with lock nut and mounting plate, designed to mount in an electrical box (weather-proof with gasket and cover where outside) through a hole in duct;
- .5 for ducts greater than 1.2 m (4') or for ducts where air temperature stratification occurs, averaging type sensors with multiple sensing points, and for plenums for applications such as mixed air temperature measurement to account for air turbulence and/or stratification, an averaging string of sensors with capillary supports on the sides of duct/plenum;
- .6 factory solid-state relative humidity sensors with an element that resists contamination, weather-proof with a NEMA 3R enclosure for outside air applications, supplied with a type 304 stainless steel probe with mounting bracket and hardware for duct mounting, each complete with a factory calibrated humidity transmitter which is accurate (including lead loss and analog to digital conversion) to 3% between 20% to 80% RH at 25°C (77°F) and equipped with non-interactive span and zero adjustments, and a 2-wire isolated loop powered, 4-20 mA, 0 to 100% linear proportional output;
- .7 carbon dioxide sensors for air quality control purposes having a maximum 20 second response time, suitable for operating conditions from 0°C to 50°C (32°F to 122°F) and 0 to 100% RH non-condensing, complete with a calibration kit (to be handed to Owner) and characteristics as follows:
 - .1 measurement range: 0 to 2000 ppm;
 - .2 accuracy: per article 1.9 of this section;
 - .3 repeatability: ±20 ppm;
 - .4 drift: ±100 ppm per year;
 - .5 output signal: 0 to 10 VDC proportional over the 0 to 2000 ppm range.

- .8 Pressure transmitters are to be constructed to withstand 100% pressure over-range without damage and to hold calibrated accuracy when subject to a momentary 40% over-range input. Pressure transmitters are to transmit a 0 to 5 VDC, 0 to 10 VDC, or 4 to 20 mA output signal. Differential pressure transmitters used for flow measurement are to be sized to the flow sensing device and supplied with a tee fitting and shut-off valves in the high and low sensing pick-up lines to allow permanent ease of use connection for balancing, etc. Transmitter housing is to suit mounting location. Standalone pressure transmitters are to be mounted in a minimum NEMA 1 (NEMA 2 in sprinklered area) by-pass valve assembly panel with high and low connections piped and valved, air bleed units, by-pass valves, and compression fittings. Transmitters are to be as follows:
- .1 low differential water pressure, 0 to 5 kPa (0 to 20" wc): equal to Setra or Mamac industrial quality transmitter capable of transmitting a linear 4 to 20 mA output in response to variation of flow meter differential pressure or water pressure sensing points, each complete with non-interactive zero and span adjustments adjustable from outside the cover, and performance as per article 1.9 of this section.
 - .2 medium to high differential water pressure, over 5 kPa (20" wc): equal to Setra or Mamac transmitters as specified above for low pressure transmitters but with a pressure range of from 2.5 kPa (10" wc) to 2070 kPa (300 psi), a reference accuracy of $\pm 1\%$ of full span (includes non-linearity, hysteresis, and repeatability);
 - .3 building differential air pressure: equal to Setra or Johnson Controls Inc. industrial quality transmitter with a range suitable for the application, capable of transmitting a linear 4 to 20 mA output in response to variation of differential pressure or air pressure sensing points, each complete with non-interactive zero and span adjustments adjustable from outside the cover, and performance as per article 1.9 of this section.
 - .4 low differential air pressure, 0 to 1.25 kPa (0" to 5" wc): equal to Setra or Johnson Controls Inc. industrial quality transmitter with a range suitable for the application, capable of transmitting a linear 4 to 20 mA output in response to variation of differential pressure or air pressure sensing points, each complete with non-interactive zero and span adjustments adjustable from outside the cover, and performance as per article 1.9 of this section.
 - .5 medium differential air pressure, over 1.5 kPa (5" wc): equal to Setra or Johnson Controls Inc. transmitters as specified above for low pressure air transmitters but performance requirements as follows:
 - .1 zero and span: (c/o F.S./Deg. F); .04% including linearity, hysteresis, and repeatability;
 - .2 accuracy: 1% F.S. (best straight line); static pressure effect: 0.5% F. S.;
 - .3 thermal effects: $< +0.33$ F.S./°F over 40°F to 100°F (calibrated at 70°F).
- .9 Air and water flow monitoring stations and probes are to be Air Monitor Corp., Tek-Air Systems Inc., Ebtron, or Dietrich Standard products as follows:
- .1 Fan Inlet Air Flow Measuring Station: At fan inlet and near exit of inlet sound trap, air flow traverse probes are to continuously monitor fan air volume and system velocity pressure, and traverse probes are to be as follows:
 - .1 each probe is to be of a dual manifold, cylindrical, anodized type 3003 extruded aluminium construction probe with sensors located along the stagnation plane of approaching air flow, and the static pressure manifold is to incorporate dual offset static taps on opposing sides of averaging manifold so as to be insensitive to flow angle variations for as much as $\pm 20^\circ$ in approaching air stream;

- .2 each probe is not to introduce a measurable pressure drop, nor is sound level within duct to be amplified by its singular or multiple presence in air stream, and each probe is to contain multiple static and total pressure sensors placed at equal distances along its length in accordance with ASHRAE Standards for duct traversing.
- .2 Single Probe Air Flow Measuring Sensor: Duct mounting hot wire anemometer type which utilizes 2 temperature sensors, one is a heater element temperature sensor and the other is to measure downstream temperature, with temperature differential related directly to air flow velocity. Sensor insertion length is to be adjustable up to 200 mm (8"), and transmitter is to produce a 4 to 20 mA or 0 to 10 VDC signal linear to air velocity.
- .3 Duct Flow Measuring Stations: #14 gauge galvanized steel casing with duct connection flanges of a size to mate with connecting ductwork, and complete with an air directionalizer and a 98% free area parallel cell 20 mm ($\frac{3}{4}$ ") honeycomb profile suppressor across entering air stream to equalize velocity profile and eliminate turbulent and rotational flow from the air stream prior to measuring point, mechanically fastened to casing so as to withstand velocities of up to 1828 m (6000') per minute. Additional requirements as follows:
 - .1 total pressure measurement side (high side) is to be designed and spaced to requirements of Industrial Ventilation Manual, 16th Edition, page 9-5, and self-averaging manifolding is to be constructed of brass and copper components;
 - .2 static pressure sensing probes (low side) is to be bullet-nose shaped, per detailed radius, as illustrated in Industrial Ventilation Manual referred to above, page 9-5;
 - .3 main take-off point from both total pressure and static pressure manifolds is to be symmetrical, and manifolds are to terminate with external ports for connection to control tubing;
 - .4 each station is to be equipped with a label on casing indicating unit model number, size, area, and specified air flow capacity;
 - .5 each station is to have a self-generated sound rating of less than NC 40, and sound level within duct is not to be amplified nor is additional sound to be generated.
 - .6 Static Pressure Traverse Probe: Duct mounting, complete with multiple static pressure sensors located along exterior surface of cylindrical probe.
 - .7 Shielded Static Air Probe: Indoor type or outdoor type as required, each with multiple sensing ports, an impulse suppression chamber, and air flow shielding.
 - .8 Water Flow Monitoring: Equal to Onicon microprocessor-based electromagnetic water flow meters with an accuracy of 0.25%.
- .10 Power (amps) monitoring is to be performed by a combination of a current transformer and a current transducer with transformer sized to reduce full amperage of monitored circuit to a maximum 5 ampere signal which will be converted to a 4 to 20 mA DDC compatible circuit for use by building automation system. Current transformer and current transducer are as follows:
 - .1 equal to Veris Industries split core current transformer with an operating frequency of from 50 to 400 Hz, 0.6 Kv class, 10 Kv BIL insulation, and 5 ampere secondary;

- .2 equal to Veris Industries current to voltage or current to mA transducer with an accuracy of $\pm 5\%$, a minimum load resistance of 30 kOhm, an input of 0 to 20 amperes and an output of 4 to 20 mA, and a 24 VDC regulated power supply.
- .11 Duct mounting smoke detectors supplied as part of electrical work for mounting as part of control system work.
- .12 Double contact switches to monitor equipment status and safety conditions, and generate alarms when a failure or abnormal condition occurs. Status and safety switches are to be as follows:
 - .1 current sensing switches: equal to Veris Industries self-powered dry contact output switches for sensing run status of motor loads, each calibrated to indicate a positive run status only when motor is operating under load, and each consisting of a current transformer, a solid-state current sensing circuit, adjustable trip point, solid-state switch, SPDT relay, and a LED to indicate on or off status;
 - .2 air filter status switches: equal to Johnson Controls Inc. or Cleveland Controls automatic reset type differential pressure switches, each complete with SPDT contacts rated for 2 amperes at 120 VAC, a scale range and differential pressure adjustment appropriate for the service, and an installation kit which includes static pressure taps, tubing, fittings, and air filters;
 - .3 air flow switches: equal to Johnson Controls Inc. or Cleveland Controls pressure flow switches, bellows actuated mercury switch or snap-acting micro-switch type with an appropriate scale range and pressure adjustment;
 - .4 air pressure safety switches: equal to Johnson Controls Inc. or Cleveland Controls manual reset switches, each complete with SPDT contacts rated for 2 amperes at 120 VAC and an appropriate scale range and pressure adjustment;
 - .5 water flow switches: equal to Johnson Controls Inc. Model P74;
 - .6 low temperature limit switches: manual reset type equal to Johnson Controls Inc. Model A70, each complete with DPST snap acting contacts rated for 16 amperes at 120 VAC, a minimum 4.5 m (15') sensing element for mounting horizontally across duct/plenum with sensing reaction from coldest 450 mm (18") section of element, and where sensing element does not provide full coverage of air stream, additional switches are to be supplied as required.
- .13 Control relays as follows:
 - .1 control pilot relays: equal to Johnson Controls Inc. or Lectro modular plug-in design with snap-mount mounting bases, retaining springs or clips, DPDT, 3 PDT or 4 PDT as required for the application, with contacts rated for 10 amperes at 120 VAC;
 - .2 lighting control relays: latching type with integral status contacts rated for 20 amperes at 120 VAC, each complete with a split low voltage coil that moves the voltage contact armature to On or Off latched position, each controlled by a pulsed tri-state output (preferred) or pulsed paired binary outputs, and each designed so power outages will not result in a change-of-state and so multiple same state commands will simply maintain commanded state.
- .14 Electronic signal isolation transducers equal to Advanced Control Technologies for installation whenever an analog output signal from building automation system is to be connected to an external control system as an input (i.e. equipment control panel), or is to receive as an input signal from a remote system, and to provide ground plane isolation between systems.

- .15 Each manual override station is to be complete with contacts rated minimum 1 ampere at 24 VAC and is to provide following:
 - .1 integral H-O-A switch to override controlled device pilot relay;
 - .2 status input to building automation system to indicate whenever switch is not in the Auto position;
 - .3 status LED to illuminate whenever output is On;
 - .4 override LED to illuminate whenever H-O-A switch is in either the Hand or Off position.
- .16 Electronic transducers equal to Johnson Controls Inc. transducers with an output of from 3 to 15 psig, an input of from 4 to 20 mA or 10 VDC, manual output adjustment, a pressure gauge, and an external replaceable supply air filter.
- .17 Thermostats:
 - .1 Wall mounting adjustable set-point thermostats, each suitable in all respects for equipment (and operating sequence) they are provided for, equipped with a thermometer, a cover and any required mounting and connection accessories.
 - .2 Line voltage thermostats are to be 115 volt.
 - .3 Low voltage thermostats are to be 24 volt electronic type.
 - .4 Set-point adjustment for thermostats in public spaces is to be concealed behind cover. Set-point adjustment for other thermostats is to be accessible through cover.
 - .5 Covers are to be removable, tamper-proof covers with temperature set-point and thermometer displays.
 - .6 Guards for thermostats are to be clear, ventilated polycarbonate covers with allen key locking hardware.
- .18 Humidistats:
 - .1 Direct or reverse acting (to suit system), proportional type, adjustable humidity controllers, each corrosion resistant, suitable in all respects for the application and complete with a nylon element, replaceable cartridge type air filter, internally adjustable limit stops for maximum and minimum settings, a cover, and required mounting and connection accessories.
 - .2 Electric humidistats are to be line voltage (115 volt), or 24 volt electronic type.
 - .3 Wall mounting humidistats are to be complete with a tamper-proof display type cover.
 - .4 Duct mounting humidistats are to be complete with a display type cover, duct sampling chamber with 300 mm (12") long extruded pick-up tube for duct mounting, a moulded mounting base, and a ventilated cover.
 - .5 Hardware to permit building automation system control and monitoring of input/output points in accordance with Section entitled Building Automation System, points schedule, and drawing control diagrams and operation sequences. All such hardware is to be suitable in all respects for interface with the building automation system.

2.09 SYSTEM WIRING MATERIALS

- .1 System wiring, conduit, boxes, and similar materials are to be in accordance with requirements specified in appropriate Section(s) of Electrical Work specification.

3. EXECUTION

3.01 INSTALLATION

- .1 The BAS contractor is responsible to verify that equipment can be installed in accordance with the manufacturer's instructions and as detailed within these specifications, as such the contractor shall inspect the site and report any discrepancies, conflicts or omissions to the Owner or it's representative, for resolution prior to the commencement of work.
- .2 Unless otherwise specified, meet manufacturer's latest printed instructions for materials, planned maintenance and installation methods.

3.02 OBJECT AND POINT NAMING

- .1 Where the first four segments of the object / point name are configured by virtue of the Niagara Network Device Addressing, only the 5th segment shall be defined as the Object / Point Name herein and must be programmed in accordance with Schedule A of Section 23 09 93. It must be demonstrated, by way of the Niagara Enterprise Software instance, that the individual points are searchable by the School's Unique Identifier, or Controller/Equipment Identifier, or Point Name Abbreviation, or any combination of, across the Board's WAN, without interruptions and/or collisions.
- .2 All BACnet objects and points programmed under these specifications, shall conform to the following case sensitive convention:
 - .1 First five characters = School's unique identifier
 - .2 Sixth character = Network number
 - .3 Seventh and eighth characters = Device number
 - .4 Ninth up to required not to exceed nineteen characters = Controller / Equipment Identifier
 - .5 Last segment = Point name abbreviation
Example: S1156_2_15_HP10_RmTemp (S1156 = Forest Trail, 2 = Network 2, 15 = 15th device on network, HP10 = heat-pump 10, RmTemp = Room Temperature)
- .3 Object name segment shall be delimited by () character, however must be consistent by Vendor across all Board sites
- .4 Where a BACnet object or point name is not explicitly detailed in Schedule A of these Specifications, the Owner shall supply the required information including, but not limited to, device name, instance number, point name, units, meta tag, etc.,

3.03 CONTROLLER AND DEVICE ADDRESSING

- .1 Where the first four segments of the Controller and Device Addressing are configured by virtue of the Niagara Network Device Addressing, only the 4th segment shall be defined as the Object / Point Name herein and must be programmed in accordance with Schedule A of Section 23 09 93. It must be demonstrated, by way of the Niagara Enterprise Software instance, that the individual points are searchable by the School's Unique Identifier, or Controller/Equipment Identifier, or Point Name Abbreviation, or any combination of, across the Board's WAN, without interruptions and/or collisions.

- .2 Each device or network installed and programmed under these specifications, shall be addressed and/or named as follows:

Device Instance

- .1 First five characters = School's unique identifier
- .2 Sixth character = Network number
- .3 Seventh and Eighth character = Device number
- .4 Ninth up to required not to exceed nineteen characters = Controller / Equipment Identifier
Example: S1156_2_15_HP10 (S1156 = Forest Trail, 2 = Network 2, 15 = 15th device on network, HP10)

BACnet Network Number

- .1 First five characters = School's unique identifier
- .2 Sixth character = Network number
- .3 Seventh = Network and Type
Example: S1156_2_1 (S1156 = Forest Trail, 2 = Network 2, 1 = 1st MS/TP network)

MAC Addresses

- 0. B-BC
 - 1. Maintenance Connection
 - 2. Reserved
 - 3. – 127. Master Range
 - 128. – 254. Slave Range
 - 255. Broadcast
- .3 Object name segment shall be delimited by () character, however must be consistent by Vendor across all Board sites

3.04 CONTROLLER / DEVICE NAMING

- .1 Each device or network installed and programmed under these specifications, shall be addressed and/or named as follows:

Device Instance

- .1 First five characters = School's unique identifier
- .2 Sixth character = Network number
- .3 Seventh and Eighth character = Device number
- .4 Ninth up to required not to exceed nineteen characters = Controller / Equipment Identifier
Example: S1156_2_15_HP10 (S1156 = Forest Trail, 2 = Network 2, 15 = 15th device on network, HP10)

BACnet Network Number

- .1 First five characters = School's unique identifier
- .2 Sixth character = Network number
- .3 Seventh = Network and Type
Example: S1156_2_1 (S1156 = Forest Trail, 2 = Network 2, 1 = 1st MS/TP network)

MAC Addresses

- 4. B-BC
- 5. Maintenance Connection
- 6. Reserved

7. – 127. Master Range

129. – 254. Slave Range

256. Broadcast

- .2 Object name segment shall be delimited by () character, however must be consistent by Vendor across all Board sites

3.05 SCHOOL'S UNIQUE IDENTIFIER

- .1 The School's Unique Identifier will be provided by Owner and must be used in the first segment, for all device, network, object, and point names.

3.06 CONTROLLER / EQUIPMENT IDENTIFIER

- .1 The Controller / Equipment Identifiers are restricted to dedicated B-AAC and B-ASC controllers. Identifiers are limited those listed below. Where an identifier is not listed below the Owner shall supply the required information.
- .1 AC# = Air Conditioning Unit
 - .2 AHU# = Air Handling Unit
 - .3 Blr# = Boiler
 - .4 BPB# = By-Pass Box (constant volume)
 - .5 Chiller# = Chiller
 - .6 CU# = Condensing Unit
 - .7 HVAC# = HVAC Unit
 - .8 HVAC#VAV# = HVAC Unit (associated with) Variable Air Volume Box
 - .9 HP# = Heat pump
 - .10 HWLoop# = Heating Water Loop
 - .11 HpLoop# = Heat-pump Loop
 - .12 HX# = Heat Exchanger
 - .13 MAU# = Make-up Air Unit
 - .14 Tower# = Cooling Tower
 - .15 UV# = Unit Ventilator
 - .16 VRF# = Variable Refrigerant Flow Condensing Unit
 - .17 VRF#AC# = Variable Refrigerant Flow Unit (associated with) Air Conditioning Unit
 - .18 VRF#AC# = Variable Refrigerant Flow Unit (associated with) Air Conditioning Unit
- .2 Where a dedicated B-AAC or B-ASC is not configured specific to a system or unit, controller identifier is to be approved by Owner.

3.07 POINT NAME ABBREVIATION

- .1 The Object / Point Name convention must be followed for the objects / points as listed in Schedule A of this Section, note abbreviations are case sensitive.
- .2 Where an identifier is not listed below the Owner shall supply the required information.

3.08 PROGRAMMING

- .1 Sequences of Operation are to be programmed in accordance with Section 25 09 93
- .2 Programs for like equipment i.e, heat-pump, unit heater, etc. shall be consistent by controls vendor across the facility and all Board sites.

3.09 HISTORY AND TRENDING

- .1 A minimum of 7 days history shall be maintained within the B-BC for the points identified in Schedule A of this Section.
- .2 Data stored in the B-BC shall be uploaded to the B-AWS..
- .3 Default Graphical trends, Navigation button per 3.9, shall be pre-configured.

3.10 SCHEDULING

- .1 Scheduling feature shall include seven-day schedule, plus holiday or event schedule, each with start time and stop time. Schedules shall be individually editable for each day and holiday.
- .2 The scheduling feature shall allow for each individual equipment to be assigned to one of the Schedule Groups which includes, but is not limited to:
 - .1 Administration
 - .2 Gymnasium
 - .3 First Floor Classrooms
 - .4 Second Floor Classrooms
 - .5 Kindergarten
 - .6 Library
 - .7 Daycare
 - .8 Theatre
 - .9 Cafeteria
 - .10 Refuge
- .3 The Areas, associated schedule, and equipment grouping will be provided by Owner.
- .4 Timed override feature shall allow a temporary change of the scheduled equipment. An override command shall be selectable by an individual unit, all units assigned to a given schedule group, or to all units in a building. Timed override shall terminate at the end of the event. Timed override feature shall be allowed by a password level.

3.11 DEMAND LIMITING

- .1 Programming or schedules shall incorporate a delay such that there is a delay between the start-up of each Schedule Group.
- .2 Equipment within the Schedule Group shall incorporate a delay such that there is a delay between the start-up of individual equipment within the Schedule Group.

3.12 ALARMS

- .1 Logical and consistent alarm strategy must be used as defined within these specifications. The alarm strategy detailed herein applies to those objects identified in Schedule A of this section. It is expected that additional alarms be added when applicable, Owner to determine class.
- .2 Alarms, not classified as Emergency or Communication / Network, shall have the following values adjustable: threshold, limit and time delay.
- .3 Alarm actions, defined by Alarm Class, shall be annunciated as follows:
 - .1 Emergency (E): email, header button red, graphic with flashing alarm object, Alarm Portal B-BC record
 - .2 High Priority (H): graphic with flashing alarm object, header button red, Alarm Portal B-BC record
 - .3 General (G): Alarm Portal B-BC Record

- .4 The complete object / point name shall be included in every alarm message, refer to "Object and Point Naming" within this specification section.
- .5 The minimum shall be recorded by the B-BC for each alarm:
 - .1 Time and Date
 - .2 Complete object / point name
 - .3 Acknowledge time, date, and user who issued acknowledgement

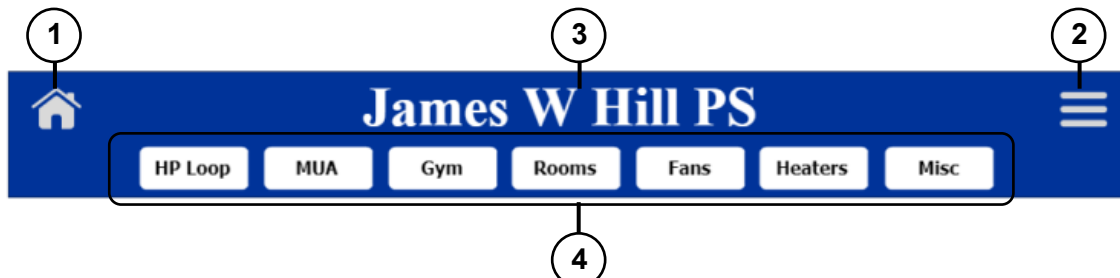
3.13 USER ACCESS

- .1 Set up the following 5 password levels to include the specified capabilities.
 - .1 Level 1: (The Board's BAS Administrator)
 - .1 Level 2 capabilities.
 - .2 All administrative rights
 - .3 View, add, change and delete user names, passwords, password levels.
 - .4 All unrestricted system capabilities including all network management functions.
 - .2 Level 2: (TBD)
 - .1 Level 3 capabilities.
 - .2 Configure system software.
 - .3 Modify control unit programs.
 - .4 Modify graphic software.
 - .5 Unrestricted except for viewing or modifying user names, passwords, password levels.
 - .3 Level 3: (Approved Facilities Staff and Board's HVAC Maintenance Technicians)
 - .1 Level 4 capabilities.
 - .2 Temporary override of designated objects and/or points.
 - .3 Temporary set-point value change.
 - .4 Change selected equipment schedules.
 - .4 Level 4: (Approved Facilities Staff)
 - .1 Level 5 capabilities.
 - .2 Acknowledge alarms.
 - .3 Change selected equipment schedules.
 - .5 Level 5: (Read Only)
 - .1 Display all graphic data.
 - .2 Trend point data.
- .2 Level 1 and 5 will be accounts which reside locally within the B-BC.
- .3 Level 2 through 4 will be will use LDAP for login credential authentication.

3.14 GRAPHICAL USER INTERFACE

- .1 Provide a colour graphic home screen, floor plans, system flow diagrams for each system and summary screens, designed and sized for iPad, with all points indicated on the points list in Schedule A of this Section, and in accordance with these specifications.
- .2 All graphics shall be rendered as N4 HTML 5 views. Any graphic page that depends on JAVAbased animated widgets, or in any way depends on any browser-side-applet shall not be acceptable.

- .3 The Graphical User Interface shall not use Red as graphical representation for any of the following: stop, alarm, or fault. Red is used explicitly for graphical representation of heat command and/or enable, with the only exception in text format in charts, the word “fault” can be coloured red.
- .4 Graphics not explicitly detailed within this section shall be reviewed and approved by Owner.
- .5 Common for all Graphics:
 - .1 The Header is one PX file for the entire project. All links, labels, etc. shall be edited from only one instance of the Header. The following aspects of the Header should appear exactly the same across all Board Facilities: Dimensions, Font Size, Colour(s), Equipment Navigation Buttons' Size, Font, and Colour(s). The following shall be exactly the same 1 - Home Button, 2 - Three Line Menu Navicon. The following aspects are dynamic: 3 - Page title, and 4 - Equipment Navigation Buttons (function and name).



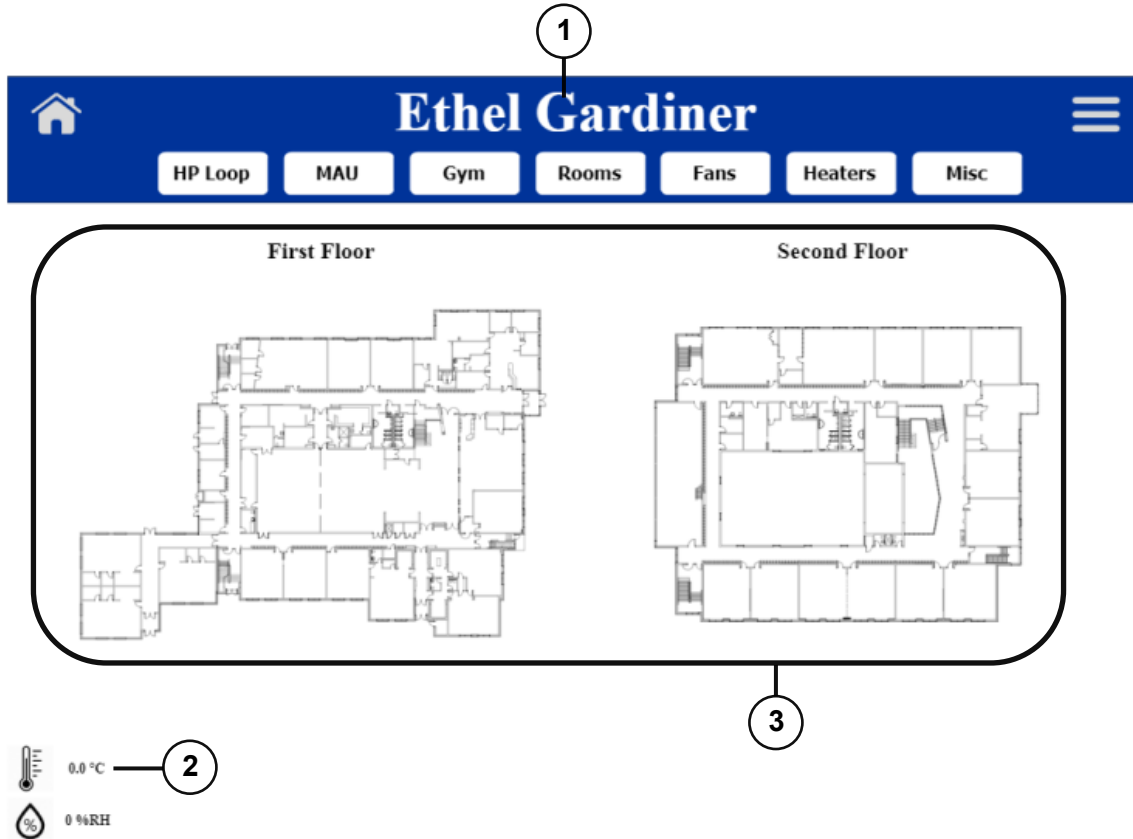
- .2 Flashing Alarm graphic (a standard Niagara graphic white triangle with red boarder and black exclamation mark) shall be consistent for all alarm annunciations, across all Board facilities, regardless of vendor.



- .3 Page Title shall be representative of the Navigation name used to link to the page and is to include information identifying area or equipment.

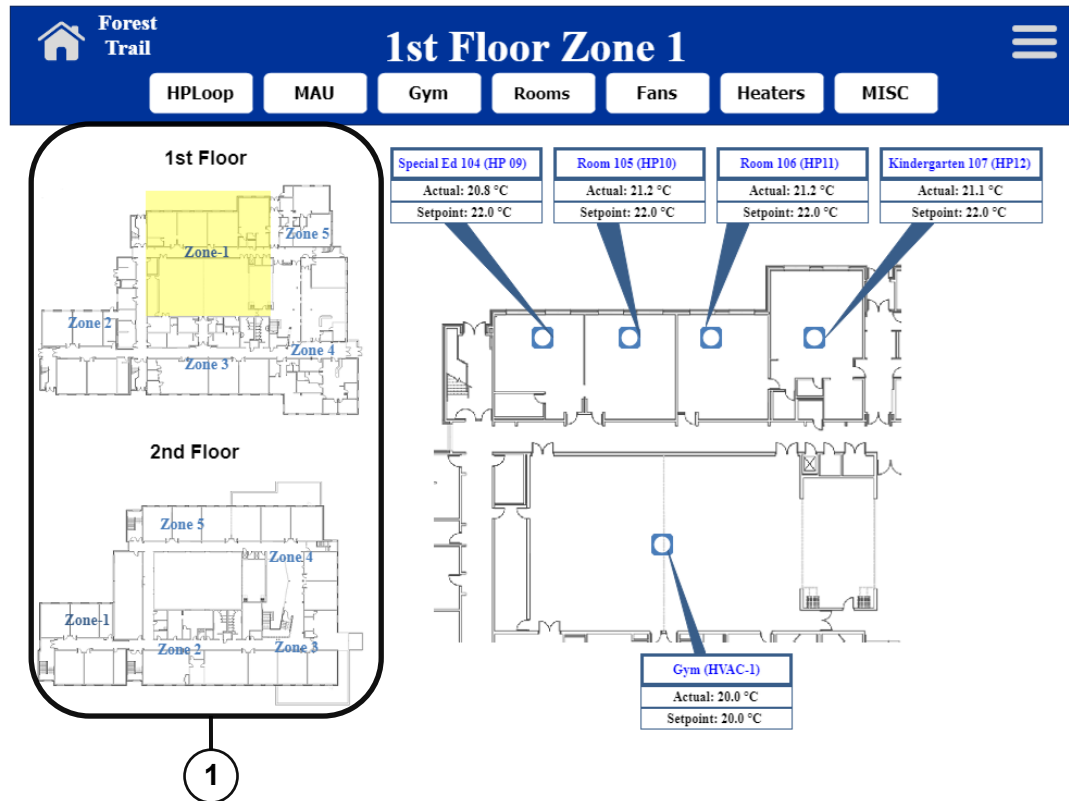
.6 Home Page

The Home Page shall be comprised of the following: 1 – School / Facility name as page title, 2 - Outdoor Air Temperature, 3 - Complete Facility Floor Map (individual floors labelled accordingly).



.7 Zone

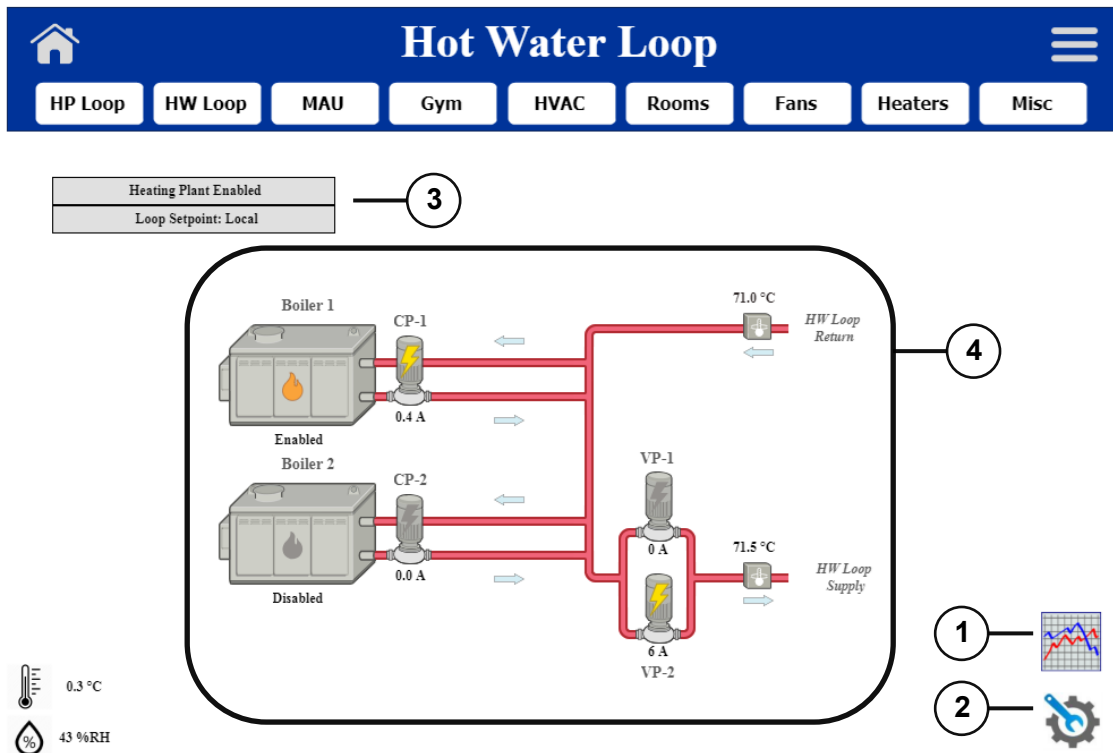
The Zone Page(s) which are scaled portions of the floor plan shall be comprised of 1 – Keyplan indicating respective zone, individual space temperatures and set-points, navigation button to respective equipment.



.8 HWLoop Page

Only include HWLoop Navigation button on Header where Heating Water Loop is present at facility.

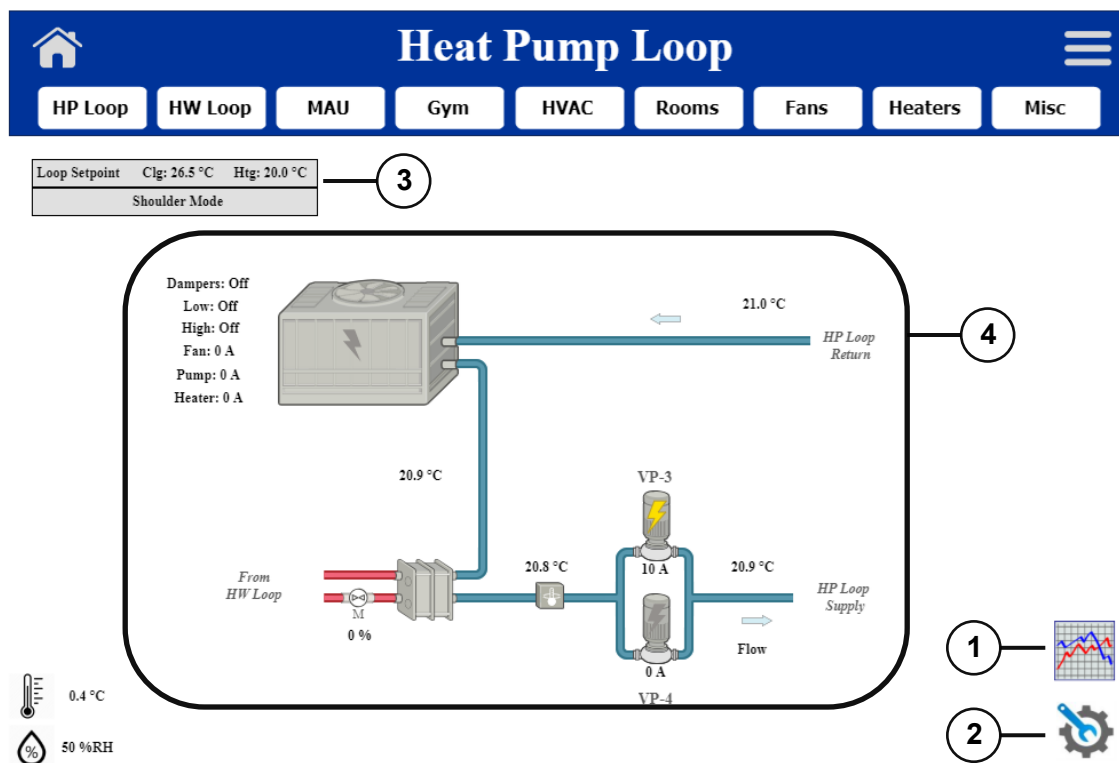
The HWLoop (Heating Water Loop) Page shall be comprised of the following: 1 - Trend navigation button (trend defaulted to include 7 days history of loop return water temperature (°C), loop supply water temperature (°C), boiler(s) supply water temperature (°C), and loop set-point (°C), 2 - Settings button to be linked to settings page, 3 - a chart with the loop water temperature set-point, and 4 – graphic depicting all associated the equipment and controlled zones. The following shall be graphically presented on the equipment: pump(s) command (green = on, white or no colour = idle), boiler command (red = on, white or no colour = idle). The following status values shall be presented: pump(s) status (amperage), valve(s) position, boiler command and reset signal value or status, boiler supply water temperature (°C), loop return water temperature (°C), loop supply water temperature (°C), zone supply water temperature (°C), zone return water temperature (°C).



.9 HPLoop Page

Only include HPLoop Navigation button on Header where Heat-pump Loop is present at facility.

The HpLoop (Heat-pump Loop) Page shall be comprised of the following: 1 - Trend navigation button (trend defaulted to include 7 days history of loop return water temperature (°C), loop supply water temperature (°C), cooling tower leaving water temperature (°C), and set-point (°C), 2 - Settings button to be linked to settings page, 3 - a chart with the mode, and return water temperature set-point (°C), and 4 – graphic depicting all associated the equipment and controlled zones. The following shall be graphically presented on the equipment: pump(s) command (green = on, white or no colour = idle), boiler command for dedicated Heat-pump loop boilers only (red = on, white or no colour = idle), damper(s) position. The following status values shall be presented: fan status (Amperage), cooling tower pan heater status (Amperage), pump(s) status (Amperage), valve(s) position, boiler command and reset signal value or status, boiler supply water temperature (°C), loop return water temperature (°C), loop supply water temperature (°C), cooling tower leaving water temperature (°C), cooling tower damper(s) status (open or closed), cooling tower low speed fan command, cooling tower high speed fan command, cooling tower percentage speed command where VFD installed.



.10 Rooms Page

The Rooms page shall be comprised of the following: 1 - Navigation Buttons (left side of Chart) to include but not limited to: equipment by floor (example VAV Boxes 1st Floor), Comfort Heat, By-Pass Boxes, Unit Ventilators, HVAC Units. 2 – Navigation to respective equipment. Chart with live data under the following headers: Unit# (navigation to unit referenced), Area Served, Space Temp, Set-point, Offset, Status, DATemp, Mode, Occupancy, Fault.

1st Floor Heat Pumps

HPLoop
MAU
Gym
Rooms
Fans
Heaters
MISC

≡

1st Floor Heat Pumps

2nd Floor Heat Pumps

Bypass Boxes

Comfort Heat

Unit#	Area Served	Space Temp	Setpoint	Offset	Status	DATemp	Mode	Occupancy	Fault
HP01	Staff Room	21.3 °C	22.0 °C	0.0 °C	4.0 A	22.8 °C	Idle	Occupied	Normal
HP02	Principal/Admin	21.0 °C	22.0 °C	0.0 °C	4.0 A	22.8 °C	Idle	Occupied	Normal
HP03	Meeting	22.0 °C	22.0 °C	0.0 °C	1.7 A	23.3 °C	Idle	Occupied	Fault
HP04	Comp. 101	22.0 °C	23.8 °C	0.0 °C	11.5 A	22.3 °C	Heat	Occupied	Normal
HP05	Room 102	23.2 °C	23.4 °C	0.0 °C	2.8 A	23.2 °C	Idle	Occupied	Normal
HP06	Music Room 103	21.3 °C	22.0 °C	0.0 °C	5.7 A	22.1 °C	Idle	Occupied	Normal
HP07	Counseling	20.3 °C	22.0 °C	0.0 °C	0.8 A	21.1 °C	Idle	Occupied	Normal
HP08	Workroom	21.3 °C	22.4 °C	0.0 °C	1.5 A	21.3 °C	Idle	Occupied	Normal
HP09	Special Ed 104	21.5 °C	22.0 °C	0.0 °C	2.5 A	22.8 °C	Idle	Occupied	Normal
HP10	Room 105	21.5 °C	22.0 °C	0.0 °C	2.5 A	21.8 °C	Idle	Occupied	Normal
HP11	Room 106	21.1 °C	22.0 °C	0.0 °C	2.8 A	21.7 °C	Idle	Occupied	Normal
HP12	Kindergarten 107	21.6 °C	22.0 °C	0.0 °C	2.6 A	23.6 °C	Idle	Occupied	Normal
HP13	Kindergarten 108	21.4 °C	22.0 °C	0.0 °C	10.7 A	39.9 °C	Heat	Occupied	Normal
HP14	Kindergarten 109	21.8 °C	22.0 °C	0.0 °C	2.6 A	22.0 °C	Idle	Occupied	Normal
HP15	Community	20.9 °C	22.0 °C	0.0 °C	2.4 A	21.6 °C	Idle	Occupied	Fault
HP16	Forum	20.9 °C	22.0 °C	0.0 °C	2.2 A	21.8 °C	Idle	Occupied	Fault
HP17	Room 110	21.5 °C	21.9 °C	0.0 °C	3.6 A	22.5 °C	Idle	Occupied	Normal
HP18	Library	21.2 °C	21.2 °C	0.0 °C	4.0 A	21.9 °C	Idle	Occupied	Normal
HP37	Room 116	21.9 °C	22.0 °C	0.0 °C	2.6 A	22.7 °C	Idle	Occupied	Normal
HP38	Room 114	21.4 °C	22.0 °C	0.0 °C	2.7 A	22.4 °C	Idle	Occupied	Normal
HP39	Room 115	22.3 °C	22.0 °C	0.0 °C	2.7 A	23.2 °C	Idle	Occupied	Normal
HP40	Room 113	22.0 °C	22.9 °C	0.0 °C	2.6 A	23.3 °C	Idle	Occupied	Normal

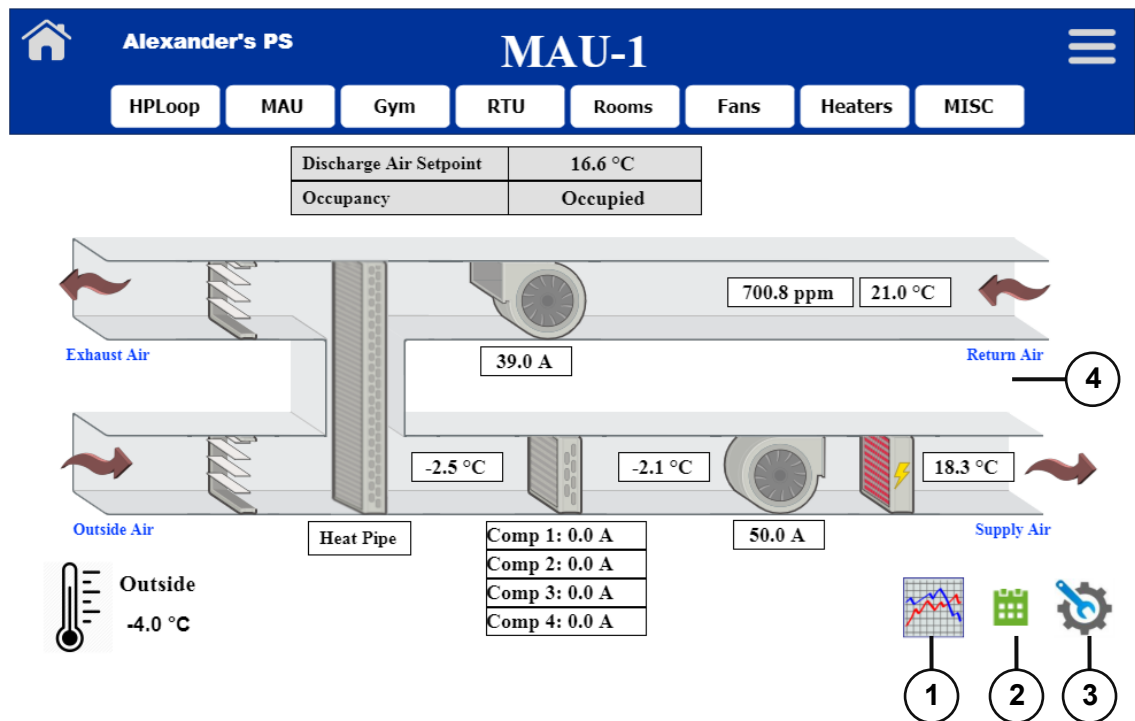
1

2

.11 MAU Page

The MAU (make-up air unit) page shall be comprised shall be comprised of: 1 - Trend navigation button (trend defaulted to include 7 days history of return air temperature, discharge air temperature, set-point), 2 - Calendar button to be linked to the respective calendar, 3 - Settings button to be linked to settings page, a chart with the discharge air set-point and occupancy, and 4 – template graphic depicting the equipment. The following shall be graphically presented on the equipment: fan(s) command (fan spinning = on, not spinning = idle), heat command (red coil = on, gray coil = idle), cooling command (blue coil = on, gray coil = idle), damper(s) position. The following status values shall be presented: fan(s) status (amperage), exhaust air temperature (°C), discharge air temperature (°C), downstream HRV/ERV air temperature (°C), heating command reset signal value or status, compressor(s) status (amperage), outdoor air damper position (where mechanically linked to return air and/or exhaust air damper(s) value to be outdoor air damper position), HRV/ERV command, HRV/ERV status

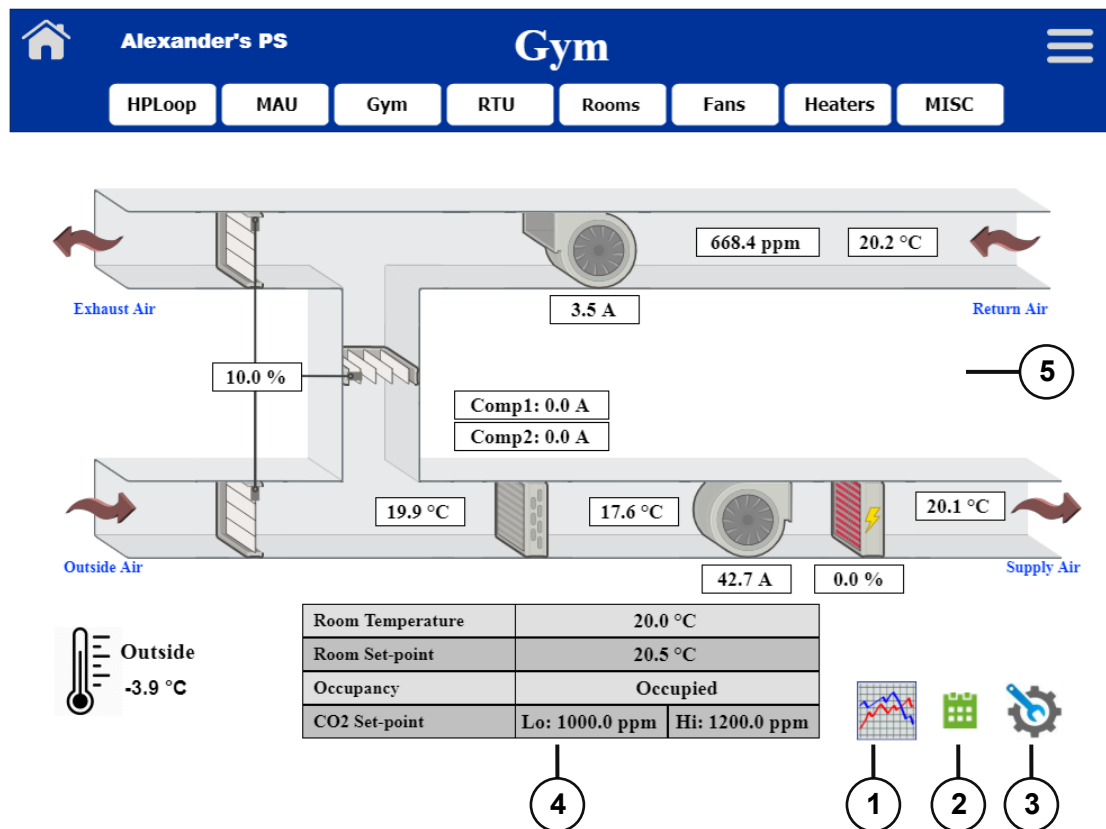
Where more than one make-up air unit exists in a facility, navigation buttons located on the left side of the graphic shall be incorporated, labelling to be determined by Owner.



.12 Gym Page

The Gym page shall be comprised of: 1 - Trend navigation button (trend to include 7 days history of return air temperature, discharge air temperature, set-point), 2 - Calendar button to be linked to the respective calendar, 3 - Settings button to be linked to settings page, 4 - a chart with the Room Temperature, Room Set-point and Occupancy, and 5 - template graphic depicting the equipment type servicing the space. The following shall be graphically presented on the equipment graphic: fan(s) command (fan spinning = on, not spinning = idle), heat command (red coil = on, gray coil = idle), cooling command (blue coil = on, gray coil = idle), damper(s) position. The following status values shall be presented: fan(s) status (amperage), return air temperature (°C), discharge air temperature (°C), mixed air temperature (°C), heating command reset signal value or status, compressor(s) status (amperage), outdoor air damper position (where mechanically linked to return air and/or exhaust air damper(s) value to be outdoor air damper position), HRV/ERV command, HRV/ERV status, Where more than one piece of equipment conditions a single gymnasium, the Room Temperature, Room Set-point and Occupancy shall be a single object and programmed as such.

Where more than one gymnasium exists in a facility, navigation buttons located on the left side of the graphic shall be incorporated, labelling to be determined by Owner.

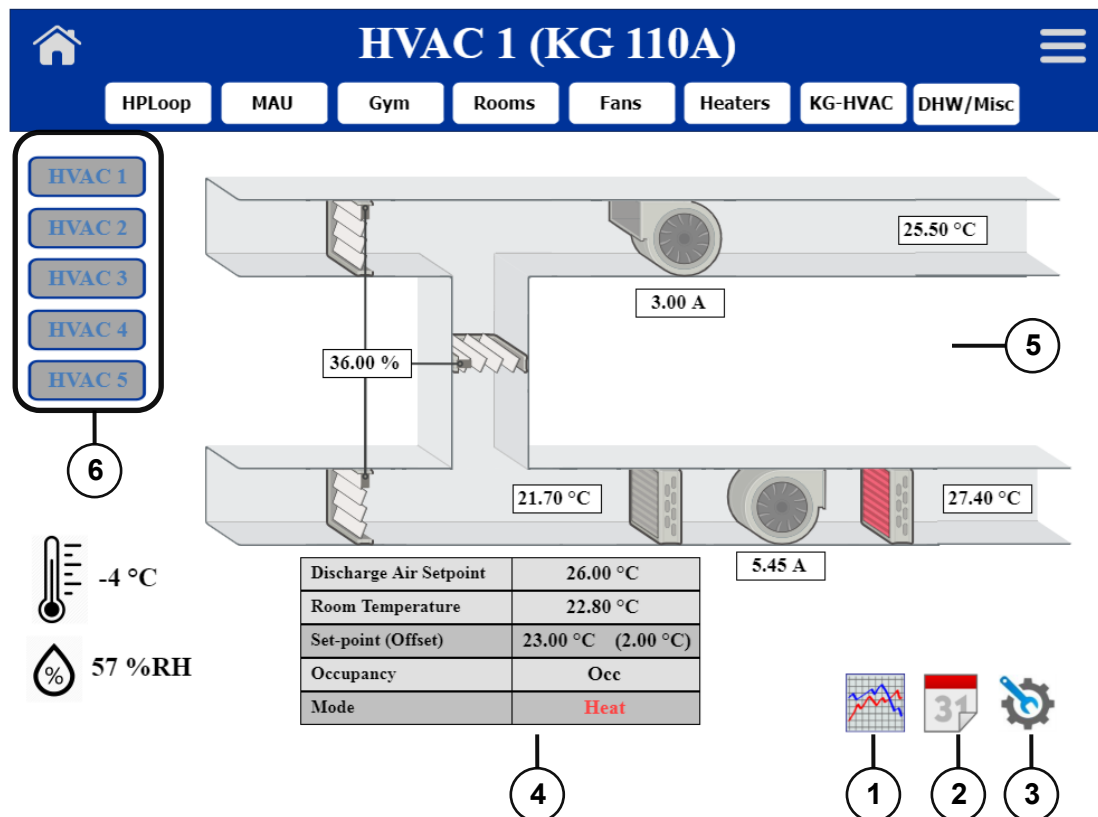


.13 HVAC Page

Where an HVAC Unit serves a classroom or office (which can include 1 by-pass box), an HVAC Header navigation button is not required and the unit operational information can be presented on the Rooms Page. The individual unit, navigation from chart, is to be configured per below.

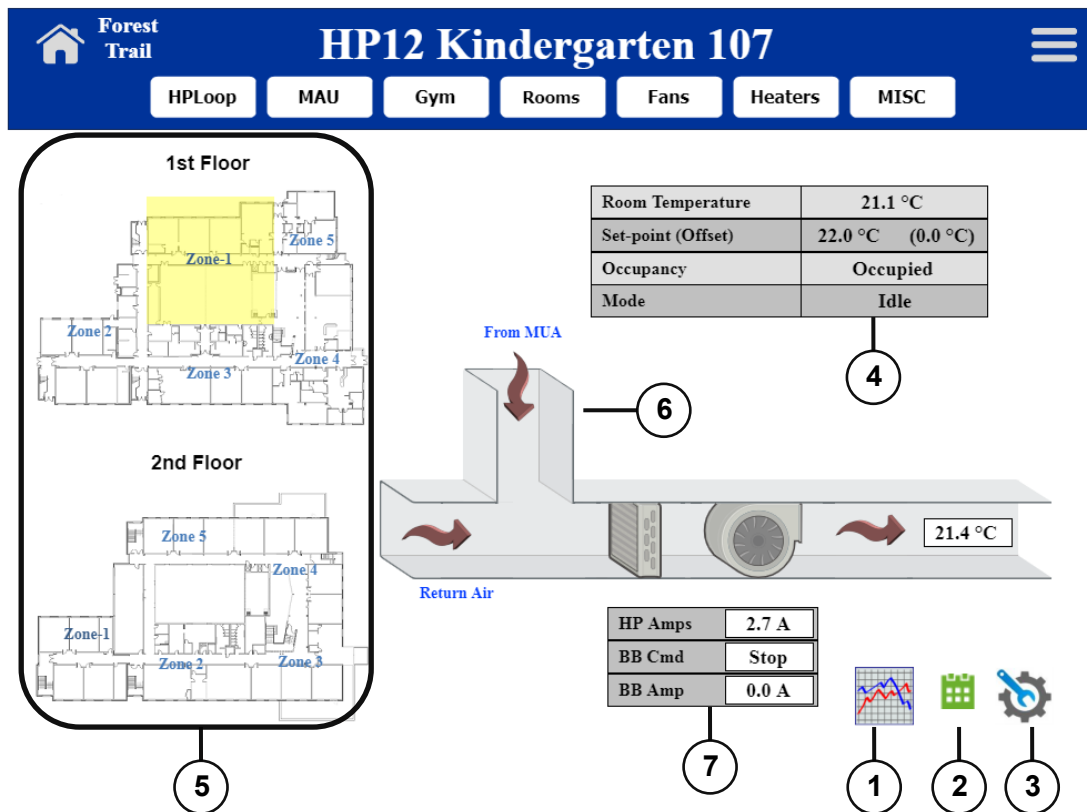
Where is more than one HVAC Unit serving multiple common spaces, i.e., Library, Shop, etc., there is to be a HVAC Header navigation button used.

The HVAC page shall be comprised of: 1 - Trend navigation button (trend to include 7 days history of return air temperature, discharge air temperature, set-point, 2 - Calendar button to be linked to the respective calendar, 3 - Settings button to be linked to settings page, 4 - a chart with the Room Temperature, Room Set-point and Occupancy, and 5 - template graphic depicting the equipment type servicing the space. The following shall be graphically presented on the equipment graphic: fan(s) command (fan spinning = on, not spinning = idle), heat command (red coil = on, gray coil = idle), cooling command (blue coil = on, gray coil = idle), damper(s) position. The following status values shall be presented: fan(s) status (amperage), return air temperature (°C), discharge air temperature (°C), mixed air temperature (°C), heating command reset signal value or status, compressor(s) status (amperage), outdoor air damper position (where mechanically linked to return air and/or exhaust air damper(s) value to be outdoor air damper position), HRV/ERV command, HRV/ERV status, Where more than one HVAC Unit exists in a facility, 6 - navigation buttons located on the left side of the graphic shall be incorporated, labelling to be determined by Owner.



.14 Heat-pump Page (individual equipment)

A Heat-pump page shall be comprised of: 1 - Trend navigation button (trend to include 7 days history of room temperature, set-point offset value, discharge air temperature (°C), and unit status (amperage), 2 - Calendar button to be linked to the respective calendar, 3 - Settings button to be linked to settings page, 4 - a chart with the Room Temperature, Set-point (offset), Occupancy, and Mode, 5 – keyplan indicating zone the respective unit is located, and 6 - template Heat-pump graphic. The following shall be graphically presented on the equipment graphic: fan(s) command (fan spinning = on, not spinning = idle), heat command (red coil = on, gray coil = idle), cooling command (blue coil = on, gray coil = idle). The following status values shall be presented: 7 - unit status including auxiliary heat (amperage), return air temperature (°C), discharge air temperature (°C), auxiliary heat status (amperage).



- .15 Fans and Heaters Page
The Fans and Heaters page(s) shall be comprised of a Chart with live data under the following headers: Unit Number, Area Served, RmTemp, Set-point, Command, Status, and Occupancy.
- .16 Misc Page
The Misc page shall comprise operational information for: exterior lighting, domestic hot water status, trap flushing urinal flushing, grouped schedules, network comfort set-point.

3.15 LOW-VOLTAGE ELECTRICAL AND CONTROL WIRING

- .1 It shall be the System Contractor's responsibility to complete and/or coordinate all wiring, less than 600 V, in accordance with 1.15, required for a complete Control System, including but not limited to:
 - .1 All raceways, boxes, cables, circuit breakers, grounding, relays, motors, starters and wirings from existing panel boards or switchgear through splitters, starters and field disconnect switches to complete power supply required for equipment supplied under this Contract not indicated on the electrical plans and specifications.
 - .2 Power to all actuators and sensors.
 - .3 Provide all wiring and cabling for network communications except for owner provided LAN(s)/WAN(s).
 - .4 All sensor and control device input and output wiring.
 - .5 All interconnecting cabling between and amongst network devices
 - .6 Interlock wiring between devices, and between motor starters.
 - .7 All other necessary wiring for fully complete and functional system as specified.
 - .8 Install piping, wiring/cabling routed parallel to or at right angles with the structure, properly supported every six (6) feet at a minimum and installed in a workmanlike manner.
- .2 Control system wiring and cabling installed for this project shall be performed by professionals in a workmanlike manner and in accordance with National Electric Code (NFPA 70), CSA C22.2 and latest NEMA standards, FCC, and any/all applicable local codes and/or Authorities Having Jurisdiction (AHJ).
- .3 All materials must be CSA and NEMA approved. Where this is not possible, arrange and pay for unconditional Electrical Safety Authority approval.
- .4 The following cabling shall be installed as continuous links, including shielding. Field splices are strictly prohibited.
 - .1 Network / Communication
 - .2 Signal (input / output control wiring)
- .5 Maximum allowable voltage for control wiring shall be 120-volts.
- .6 The Contractor shall terminate all control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site. This Section includes wiring, circuit breakers and accessories rated 600 V and less.

3.16 POWER WIRING AND CABLING

- .1 Power wiring for all enclosures and equipment, including branch circuit wiring from circuit breaker panels shall be the responsibility of the System Contractor unless specifically shown on the Plans or Specifications.
- .2 The B-BC panel shall be served from isolated ground receptacle via UPS by dedicated branch circuits.
- .3 Power shall NOT be obtained by tapping into miscellaneous circuit that could inadvertently be switched off.

- .4 Transformers and power supplies for controllers and field devices shall be supplied in accordance with manufacturers recommendations and shall be located within the designated control enclosure.
- .5 Power for controls equipment shall be from a dedicated circuit. Where a controller is dedicated to controlling a single piece of equipment, power may be obtained directly from that equipment.
- .6 All other enclosures, sensor and control devices shall be fed from separate circuits in the electrical distribution panels and shall not be served from the typical floor receptacle or lighting circuits.

3.17 NETWORK AND COMMUNICATION CABLING

- .1 Network installation shall strictly adhere to the manufacturer's network installation instructions and procedures.
- .2 All data cabling shall use stranded conductors. Solid core conductors shall not be accepted.
- .3 Data cabling shall be run separately from power and signal wiring
- .4 All communications wire shall be externally identified as "Building Automation System Network" in accordance with the HDSB's Building Automation Systems Standards and Design, latest revision.
- .5 Network installation shall conform to standards for the LAN types and cabling types selected. Specific network rules inherent to the ANSI/AHRAE Standard 135, latest will be followed. Those include but are not limited to:
 - .1 Only one path can exist from any BACnet device to another
 - .2 The maximum length and cabling type of an MS/TP segment shall be in accordance with manufacturers specifications and shall comply with EIA-485.
 - .3 Each internetwork LAN must have a unique Network Number (1 - 65,545).
 - .4 The maximum number of nodes per segment shall be 32, as specified in the EIA 485 standard.
 - .5 Wire type used for MSTP, RS-485 twisted pair communications must be balanced twisted pair with 100 to 120 Ohms Characteristic Impedance. The wire shall be less than 30 pF per foot, and preferred 20 AWG or lower. A shield wire shall be included for ground connection.
- .6 Primary LAN Network wire and cable shall be run separately from all other wiring.
- .7 Other LAN Network wire and cabling shall be installed separate from any wiring over thirty (30) volts.
- .8 All communications shielding shall be grounded as per Networked System manufacturer's recommendations.

3.18 BACNET ETHERNET COMMUNICATION CABLING

- .1 Data cable shall Category 5 or better Ethernet cable.
- .2 Data cable shall be four twisted pair 24 AWG solid copper, Plenum Rated FT-6 / CMP or Riser Rated FT-4 / CMR (as required by local codes) unshielded twisted cable meeting EIA / TIA 568B.1 Category 5e classification.
- .3 The maximum cable length for each run shall be limited to 90 meters.
- .4 All cables must be Power Sum accepted and recognized by the manufacturer.
- .5 Cable Skew must be specified as 20Ns or less per 100 meters.

- .6 Cables must display the manufacturer's stamp stating that the cable is included in the latest UL verified publication for respective Category standards.

3.19 SIGNAL (INPUT/OUTPUT CONTROL) WIRING

- .1 Minimum #20 AWG stranded copper conductors (larger gauge wire/cable shall be provided where required by BAS equipment and where applications warrant (e.g. rated load, long runs, etc.).
- .2 All BMS input/output point wire/cable and communication cable shall be shielded.
 - .1 Non-shielded cables may be approved for BAS input and output field point wiring following certification from the BAS manufacturer that non-shielded cables will function satisfactorily for the life of the building and that the use of non-shielded cables will not negatively affect other building systems/cabling.
 - .2 The manufacturers certification shall guarantee to the Board that should it be determined that BAS system performance is negatively affected or another building system or equipment is negatively affected due to the non-shielded cable, the BAS manufacturer shall replace the cable at no cost to the Board.
- .3 All cabling shall be installed in a neat and workman like manner. Follow manufacturer's installation recommendations for all communication cabling.
- .4 Free air cabling installed in non-combustible rated buildings shall be fire rated cable with a minimum rating of FT-6.
- .5 Wiring located in combustible rated buildings above T-bar ceiling shall be run in free air using fire rated cable with a minimum rating of FT-6.
- .6 Note: all free air cabling used in combustible rated buildings to interface to security or fire alarm systems shall be FT-6 rated.
- .7 Install plenum wiring in sleeves where it passes through walls and floors. Maintain fire rating at all penetrations.
- .8 Cables shall follow building lines and be installed in bundles resting in a cabling support system (J-hooks).
- .9 Cable supports shall be attached to the wall or ceiling of the area they are running through. Cable supports shall not be attached to:
 - .1 Electrical raceways,
 - .2 Duct work,
 - .3 Ceiling suspension systems,
 - .4 Piping,
 - .5 Wilson joists.
 - .6 All wire/cable terminations shall be made at screw type terminal strips. Wire nut terminations and butt splices shall not be acceptable. Wiring runs shall be continuous runs without splices.
- .10 All BAS equipment and components shall be grounded to building ground facilities.
- .11 BAS shall only be capable of controlling electric motors when the associated hand/off/auto (HOA) motor control switches are in the "auto" position. BAS control shall be wired into the auto circuit of the hand/off/auto motor control circuit only. Where hand/off/auto switches do not exist they shall be provided by the Controls Contractor.
- .12 Life safety and equipment protection interlocks shall be wired to override equipment whenever it is in operation.
- .13 Existing interlocks and override control should typically not be removed or overridden by the application of new BAS control without the specific instruction and/or approval of the Owner.

3.20 UTILITY MONITORING

- .1 The metered systems include the electrical power, natural gas distribution, and water systems. The Controls Contractor is responsible for the integration and/or supply of metering equipment necessary to provide the following:
Electricity – real time and historical kWh and KW
Gas – real time and historical m3
Water – real time and historical L
- .2 The Controls Contractor is responsible for coordination with the respective Electricity Provider for integration and/or installation.
- .3 The Board will coordinate with Union Gas the installation of the Utility provided signal output. The Controls Contractor is responsible for connection, integration and programming.
- .4 The Controls Contractor is responsible to integrate the water the existing Utility Provider's (Region of Halton) meter.

3.21 COMMISSIONING, TESTING, DEMONSTRATION, AND ACCEPTANCE

- .1 The system shall be commissioned in its entirety. All commissioning and tested shall be documented and submitted prior to Demonstration and Acceptance testing. Commissioning and Testing shall include, but not limited to the following:
 - .1 Verify all programming, naming, identification, and....conforms to the HDSB's Building Automation Systems Standards and Design, latest revision.
 - .2 A point-to-point check of the location, installation, and labeling
 - .3 Calibrate all analogue inputs and devices using actual versus the embedded UI
 - .4 Control loops are to be fully set-up and tuned
 - .5 Each control program and sequence shall be fully commissioned and confirmed by an end-to-end test, for the complete design intent compliance and functionality.
 - .6 Verify failsafe conditions.
- .2 The naming and identification of all points, networking instances, objects, meta tags, etc. is to be extracted from the site controls electronically and sent to the Owner or its Authorized representative in one of the following formats .csv, .xls or.xlsx, for review and acceptance. The values are not to be edited or formatted prior to sending.
- .3 Pursuant to 3.8.1, assist and cooperate with the Owner approved third party commissioning provider in the following manner: using a skilled technician who is familiar with the building, assist in the functional performance testing of the control system as per test requirements developed in the commissioning check sheets (prepared by the commissioning provider).
- .4 When Commissioning, Testing, Demonstration and Acceptance process has been completed and approved and/or verified by the Owner, and within ten (10) days, the contractor will be provided with a signed letter from the owner indicating acceptance.

3.22 TRAINING

- .1 Subsequent to the acceptance, per 3.9., and part of this contract, 1 day of training is to be provided to a maximum 6 individuals responsible for the operation of the site at the sole discretion of the Owner. The training shall provide instruction and demonstration on the operation, adjustment and maintenance of the BAS inclusive of all hardware and software supplied under this and other related specifications necessary to meet the functional intent.
- .2 The training is to include, but not limited to, the following:
 - .1 Location of all controllers, devices, sensors, peripherals, etc.
 - .2 Equipment layout and dependencies
 - .3 Sequence of operation
 - .4 Preventative maintenance

3.23 WARRANTY, MAINTENANCE, AND SERVICE

- .1 Provide warranty under provisions of these specifications.
- .2 At no cost to the Owner, during the warranty period, the Contractor shall provide maintenance services for software and hardware components as specified below:
 - .1 Normal Service: Any malfunction, failure, or defect in any hardware component or failure of any control programming that would not result in property damage or loss of comfort control shall be corrected and repaired. Response to any request for service shall be provided within eight (8) working hours of the Owner's initial request for service. In the event that the malfunction, failure, or defect cannot be corrected through telephone support to the Owner, or its representatives, the next step is to attempt to correct the issue through remote site access. In the event the problem persists, a service technician, trained in the system to be serviced, shall be dispatched to the Owner's site within forty-eight (48) hours of the Owner's initial request for service, as specified.
 - .2 Emergency Service: Any malfunction, failure, or defect in any hardware component or failure of any control programming that would result in property damage or loss of comfort control shall be corrected and repaired. Response to any request for service shall be provided within two (2) working hours of the Owner's initial request for service. In the event that the malfunction, failure, or defect cannot be corrected immediately through telephone support or remote site access, a service technician, trained in the system to be serviced, shall be dispatched to the Owner's site within eight (8) hours of the Owner's initial telephone request for service, as specified.
 - .3 Owners Request for Service: Contractor shall specify three telephone numbers and email addresses, including order of contact and procedure in the event a contact fails to respond, for the Owner to use in the event of a need for service.
- .3 Provide all labour, associated travel and expenses, materials and equipment necessary for the successful operation of this system for a period of 12 months from the date of final acceptance, per 3.9. In addition, provide three (3) visits for testing and evaluating the performance of the hardware and software installed per this specification, to be coordinated with the HDSB's Building Automation Manager. One visit shall be during the cooling season, one visit shall be during the heating season, and one visit shall be during a shoulder season, either spring or fall. Provide a written report after each visit is complete. This service visit shall include, but not be limited to, the following:
 - .1 Check calibration and re-calibrate if needed instrumentation sensors for air flow, liquid flow, pressure, humidity, temperature, and transducers. Written records shall be kept indicating the performance of such calibrations along with pertinent data.

- .2 Check the operation of dampers and damper actuators to assure no lock up has occurred and stroke is proper. Written records shall be kept indicating the performance of such calibrations along with pertinent data.
- .3 Check the overall system field operations by performing a review of all points. Verify that all monitoring and command points are valid and active. Written records shall be kept indicating the performance of such exercises.
- .4 If a problem develops at any time during the warranty/service period, the affected BAS point/object shall be monitored and logged for the remainder of the warranty/service period. "A problem" in the above statement will refer to an incident in which any of the following occur:
 - .1 An alarm occurs due to a defective control system component(s), improper installation or programming.
 - .2 Overall performance of the system is compromised due to a defective control component(s), improper installation or programming.
 - .3 Major recalibration (by greater than 5 times the catalogued accuracy) is required for a sensor during one of the service visits.
- .5 Pursuant to 3.3, changes required to meet design, compliance, and functionality, that were not part of the Demonstration and Acceptance process, will be made at no cost to the Owner.
- .6 Any changes to programming, inclusive of but not limited to set-points, schedules, sequences, alarms, history, network addressing, object naming, etc. are to be performed in accordance with the Change Management Procedures outlined in the HDSB's Building Automation Systems Standards and Design, latest revision.

3.24 SCHEDULE A

- .1 Objects / Points identified in Schedule A as Mandatory ('Y' in Mandatory column) must be included in program of the respective system or equipment. Where an Object or Point is not listed as Mandatory, inclusion within Schedule A does not dictate the requirement for use within a program, and are listed for information purposes only where equipment differs from standard and program variations must be made to meet the sequences per 23 09 93.
- .2 Objects / Points identified as Mandatory must be adjustable, in accordance with 3.12 of this Section
- .3 Where a 'G' and/or 'V' is indicated in the User Interface column, the Object or Point shall be represented on the respective graphic page, in accordance with 3.9 of this Section. Mandatory points without a 'G' and/or 'V' indicated in the User Interface column shall be presented in the settings page.
- .4 Where an Object or Point is identified as a software point with a 'B' in the Software Point column of the table, BACnet value will be an accepted means of data source provided change of value requirements are met. BACnet shall not be used as a writeable point or as a data source for Alarms classified as Emergency.

3.25 SUPPLY OF CONTROL AIR DAMPERS AND OPERATORS

- .1 Unless otherwise specified, supply required control dampers. Hand dampers to sheet metal trade at site in location where they are required for installation as part of sheet metal work. Ensure each damper is correctly located and mounted.
- .2 Provide linkage and operators for dampers. Wherever possible locate damper operators so they are accessible from outside duct, plenum, and equipment casings. Bracket mount operators on ducts or plenums clear of insulation where applicable.

- .3 Where sequence operation is indicated, or where multiple operators drive a series of dampers, provide pilot positioners to couple their action.
- .4 Ensure dampers located in ductwork other than galvanized steel are constructed of type 316 stainless steel.

3.26 SUPPLY OF AUTOMATIC CONTROL VALVES AND OPERATORS

- .1 Unless otherwise specified, supply required automatic control valves. Hand valves to appropriate piping trades at site in locations they are required for installation as part of piping work. Ensure each valve is properly located and installed.
- .2 Provide an operator for each valve.

3.27 INSTALLATION OF THERMOSTATS

- .1 Unless otherwise noted, provide required thermostats.
- .2 Provide a ventilated clear polycarbonate cover for each thermostat located in finished areas, and a wire type guard for each thermostat located in unfinished areas and in areas such as mechanical rooms where thermostat is subject to damage.
- .3 Unless otherwise indicated, mount room thermostats in accordance with requirements of local governing authority and, where applicable, barrier-free requirements. Review exact location of thermostats with Consultant prior to roughing-in.
- .4 Provide stand-off mounting and an insulated sub-base for thermostats on outside walls.
- .5 Perform control wiring associated with installation of electric or electric-electronic thermostats.

3.28 INSTALLATION OF CONTROL SYSTEM COMPONENTS

- .1 Provide required control system components and related hardware. Refer to drawing control diagrams and sequences.
- .2 Where components are pipe, duct, or equipment mounted supply components at proper time, coordinate installation with appropriate trade, and ensure components are properly located and mounted.

3.29 IDENTIFICATION AND LABELLING OF EQUIPMENT AND CIRCUITS

- .1 Refer to identification requirements specified in Section entitled Basic Mechanical Materials and Methods.
- .2 Identify equipment as follows:
 - .1 enclosures and components: engraved laminated nameplates with wording listed and approved prior to manufacture of nameplates;
 - .2 wiring: numbered sleeves or plastic rings at both ends of conductor, with numbering corresponding to conductor identification on shop drawings and "as-built" record drawings.

END OF SECTION

DIVISION 26	ELECTERICAL
SECTION 26 05 00	FORM OF SUPPLEMENTARY ELECTRICAL TENDER
SECTION 26 05 01	ELECTRICAL WORK GENERAL INSTRUCTIONS
SECTION 26 05 05	ELECTRICAL COMMISSIONING
SECTION 26 05 21	WIRES AND CABLES
SECTION 26 05 28	GROUNDING
SECTION 26 05 31	SPLITTERS, JUNCTION, PULL BOXES AND CABINETS
SECTION 26 05 32	OUTLET BOXES, CONDUIT BOXES AND FITTINGS
SECTION 26 05 34	CONDUITS, CONDUIT FASTENINGS AND CONDUIT FITTINGS
SECTION 26 05 40	DUAL HANGER SYSTEM
SECTION 26 08 10	ACCESS PANELS
SECTION 26 08 20	ELECTRIC HEATING SYSTEM
SECTION 26 08 30	PIPE TRACING SYSTEM
SECTION 26 08 40	BUILDING AUTOMATION SYSTEM
SECTION 26 08 50	HAND DRYERS
SECTION 26 09 23	DIGITAL METERING SYSTEM
SECTION 26 09 24	LIGHTING CONTROL DEVICES
SECTION 26 12 17	DRY TYPE TRANSFORMERS
SECTION 26 24 02	SWITCHBOARD
SECTION 26 24 05	COORDINATION AND SHORT CIRCUIT STUDY
SECTION 26 24 06	CALIBRATION AND VERIFICATION
SECTION 26 24 07	THERMOGRAPHY
SECTION 26 24 16	PANEL BOARDS
SECTION 26 24 17	POWER PANELS
SECTION 26 24 18	DISTRIBUTION PANELS
SECTION 26 27 19	CLASSROOM CONTROL PANEL MODULE
SECTION 26 27 26	WIRING DEVICES
SECTION 26 28 13	FUSES
SECTION 26 28 23	DISCONNECT SWITCHES-FUSED AND NON-FUSED
SECTION 26 29 01	CONTACTORS
SECTION 26 29 10	MOTOR STARTERS
SECTION 26 50 00	LIGHTING
SECTION 26 50 10	LIGHTING FIXTURE SCHEDULE
SECTION 26 52 00	EMERGENCY LIGHTING
SECTION 26 53 00	EXIT SIGNS

DIVISION 27 COMMUNICATIONS

SECTION 27 11 19	STRUCTURED CABLING FOR COMMUNICATIONS SYSTEMS
SECTION 27 51 16	PUBLIC ADDRESS SYSTEM
SECTION 27 51 20	TELEPHONE SYSTEM
SECTION 27 53 13	CLOCK SYSTEM
SECTION 27 53 20	CABLE TV SYSTEM

DIVISION 28 ELECTRONIC SAFETY AND SECURITY

SECTION 28 13 00	ACCESS CONTROL SYSTEM
SECTION 28 23 00	VIDEO SURVEILLANCE SYSTEM
SECTION 28 31 00	INTRUSION DETECTION SYSTEM
SECTION 28 31 01	FIRE DETECTION AND ALARM SYSTEM REMOTE MONITORING
SECTION 28 46 00	FIRE DETECTION AND ALARM SYSTEM
SECTION 28 46 01	FIRE DETECTION AND ALARM SYSTEM VERIFICATION

END OF SECTION

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PROJECT NAME: Paul A. Fisher Public School – Renovation & Alteration
2175 Cavendish Drive, Burlington ON

RDZ PROJECT NUMBER: 24122

Following Supplementary Electrical Bid Form is submitted by:

.....

(Bidding Company)

.....

(Street Address or P. O. Box No.)

.....

(City, Province and Postal Code)

Dated And which is an integral part of Bid Form.

In accordance with Instructions to Bidders, we provide the Supplementary Electrical Bid Form. We understand that the information provided to be considered an integral part of Bid Form and is to be completed in full.

Where instructions are not provided, submit Supplementary Electrical Bid Form by time of Bid closing, via e-mail addressed to:

RDZ Engineers Ltd.
Attention: Fei Han
e-mail : fei@rdzeng.ca

Supplementary Bid Form Signature:

.....

(Signature of Authorized Representative)

.....

(Print Name)

.....

(Title)

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A. LIST OF MANUFACTURERS/SUPPLIERS

We submit, herein, typed or neatly printed, the names of the manufacturers upon whose products our Bid Price is based and which we will supply. If no name is indicated, or if name identified is not listed in issued documents, or if more than one name is indicated for a particular product, we will if requested, provide the base specified manufacturer's product. Where products are named in the specifications with only one (1) manufacturer/supplier, or are not listed herein, we are also prepared to provide the base specified named product. We will provide Canadian manufactured products if costs and quality are similar.

We understand that the first manufacturer specified for any product is the manufacturer upon whose product the design is based, and that the other manufacturers specified for a particular product are manufacturers acceptable to the Owner and whose product produces equivalent quality, performance, and size. We further understand if we indicate a manufacturer other than the manufacturer whose product is the basis of the design, we are responsible for ensuring that the product supplied is equivalent in quality, performance, and size to the base design product, and that any additional costs incurred as a result of use of such products will be borne by us. Acceptance of non-base specified manufacturers with respect to their equivalency shall be as sole discretion of consultant.

We also acknowledge that failure to submit this list as specified or failure to submit within time defined may result in provision of base specified manufacturer's product, at discretion of consultant.

SECTION	PRODUCT	MANUFACTURER/SUPPLIER & CATALOGUE NUMBER
26 09 24	Lighting Control Devices	
26 24 02	Switchboard	
26 24 16	Panel Boards	
26 24 17	Power Panels	
26 24 18	Distribution Panels	
26 27 26	Wiring Devices	
26 28 23	Disconnect Switches-Fused and Non-Fused	
26 29 01	Contactors	
26 50 00	Lighting	
26 52 00	Emergency Lighting	
26 53 00	Exit Signs	
28 46 00	Fire Detection and Alarm System	

B. SUBCONTRACTORS

We enclose herewith a list of Subcontractors to the Electrical Building Services which is an integral part of the Bid. We agree that the Subcontractors shall not be changed without good reason and permission for same must be obtained from the Owner.

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<u>Section</u>	<u>Subcontractor</u>
26 24 05 – Coordination and Short Circuit Study	_____
26 24 07 – Thermography	_____
27 11 19 – Structure Cabling for Communications Systems	_____
27 51 16 – Public Address System	_____
28 13 00 – Access Control System	_____
28 23 00 – Video Surveillance System	_____
28 31 00 – Intrusion Detection System	_____
28 46 00 - Fire Detection and Alarm System	_____

C. UNIT PRICES AND LABOUR RATES

We enclose herewith Unit Prices and Labour Rates which are an integral part of the Bid. Unit prices and labour rates are in effect for the duration of this Project's construction period. Owner is not obligated to accept unit prices and labour rates quoted.

1. Labour Rates:

Labour at the following rates shall be applied for additions or deletions to the work not covered by unit prices. The prices consist of salary, all agreed local union benefits. The rate quoted represents the net cost to the Contractor, exclusive of overhead and profit.

Journeyman \$/hour _____

Foreman \$/hour _____

2. Unit Prices:

The following unit costs will apply to all additional or deleted work from the Contract and should include their proportional share of all labour equipment, materials, accessories, profits, overhead and taxes for a job completely installed. Applications of unit prices will be to the net difference of quantities of individual products and materials in each contemplated Change Notice or Revision Notice.

3. The unit prices will be used for additions and deletions. Credit rate for deletions shall be at 80%

4. Conduit and Cable:

Supply and install the following conduit and cables including fastenings, clips, connectors, coupling boxes, etc. as required based on length as shown.

27mm Empty Conduit for length of 3500mm	\$ _____
2#12-16mmC for length of 3500mm	\$ _____
3#12-16mmC for length of 3500mm	\$ _____
2#10-21mmC for length of 3500mm	\$ _____
3#10-21mmC for length of 3500mm	\$ _____
3#8-21mmC for length of 3500mm	\$ _____

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5. Receptacles:
Supply and installation of one duplex receptacle, shall include the receptacle box, cover plate, 3000mm of conduit and wiring, including connection to adjacent receptacle and/or outlet box.
\$ _____
6. Light Switches:
Supply and installation of one light switch shall include the switch box, cover plate, conduit, wiring and connection to box containing the lighting circuit.
\$ _____
7. Fire Alarm System:
Supply and installation of one fire alarm pull station, including conduits, wiring and connections, to the nearest fire alarm pull station based on 15000mm conduit and wiring length.
\$ _____
- Supply and installation of one fire alarm cone speaker complete with strobe lights including, conduit, wiring and connections to nearest fire alarm cone speaker based on 15000mm conduit and wiring length.
\$ _____
8. Light Fixtures:
Supply and installation of the following lighting fixtures. The supply and installation of lighting fixtures shall include the fixtures, flexible conduit, wiring and connection to nearest outlet box containing 347 and/or 120volt circuits and the supply and installation of built-in drivers, 0-10V dimmers, etc. (Base conduit and wiring on 4500mm length).
- .1 Supply and installation of one type 'AB' fixture. \$ _____
- .2 Supply and installation of one type 'BA' fixture. \$ _____
- .3 Supply and installation of one type 'BB' fixture. \$ _____
- .4 Supply and installation of one type 'BC' fixture. \$ _____
- .5 Supply and installation of one type 'C' fixture. \$ _____
- .6 Supply and installation of one type 'D' fixture. \$ _____
- .7 Supply and installation of one type 'R' fixture. \$ _____
- .8 Supply and installation of one type 'RA' fixture. \$ _____

D. ALTERNATIVES

The bid is based on the suppliers, subcontractors and manufacturers listed in the specifications and in the Supplementary Tender Form.

The following alternatives are for equipment and materials of manufacturers other than those named and offered, for consideration.

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(Note that equipment offered as an alternative must be equivalent to the base bid equipment in respect to capacity, performance, quality, maintenance and must fit into space allocated.)

<u>Equipment</u>	<u>Alternative Manufacturer</u>	<u>Reduction in Tender Price</u>
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

E. ITEMIZED PRICES

These Itemized Prices will be used to identify the cost of components within the total Bid Sum required for the Owner's own internal auditing.

- .1 Supply and installation of Fire Detection and Alarm System complete with associated components, conduit, and wiring, as shown on Drawing and described in Specification.

_____ Dollars (\$ _____)

- .2 Supply and installation of Intrusion Detection System complete with associated components, conduit, and wiring, as shown on Drawing and described in Specification.

_____ Dollars (\$ _____)

- .3 Supply and installation of Structured Cabling for Communication System complete with associated components, conduit, and wiring, as shown on Drawing and described in Specification.

_____ Dollars (\$ _____)

- .4 Supply and installation of Video Surveillance System complete with associated components, conduit, and wiring, as shown on Drawing and described in Specification.

_____ Dollars (\$ _____)

- .5 Supply and installation of Public Address System complete with associated components, conduit, and wiring, as shown on Drawing and described in Specification.

_____ Dollars (\$ _____)

END OF DOCUMENT

1. General

1.1 GENERAL

- .1 This Section covers items common to Sections of Division 26, Division 27, and Division 28. The General Conditions, Supplementary Conditions and Division 1 are a part of this Specification and shall apply to this Division. This section also supplements requirements of Division 1, Division 23, Division 27, Division 28, Division 33, and Division 34.
- .2 Issued for Construction documents are issued for Contractors' convenience for reference only and are a consolidation of issued drawings, specifications, and addenda. Consultant makes no representation of their completeness. Exact construction requirements to be based on official Bid issued drawings, specifications, and issued separate addenda. Contact Consultant for any clarifications.

1.2 APPLICATION

- .1 This Section specifies requirements that are common to Electrical Divisions work Sections, and it is a supplement to each Section and is to be read accordingly. Where requirements of this Section contradict requirements of Divisions 00 or 01, conditions of Division 00 or 01 to take precedence.
- .2 Mention herein, or indication on the Drawings of articles, materials, operations, or methods requires that all such items shall be provided in the quality and quantity required, and that the operations shall be performed according to the methods prescribed, complete with all necessary labour and incidentals.
- .3 These Specifications shall be considered as an integral part of the accompanying Drawings. Any item or subject omitted from either the Specifications or the Drawings, but which is mentioned or reasonably specified in the other shall be considered as properly and sufficiently specified and shall be provided.

1.3 REFERENCES

- .1 All work shall conform to the latest Codes, requirements and approval of the Authorities having jurisdiction and shall be subject to acceptance by the Consultant, and the following codes and standards:
 - OBC, Latest Edition and Local Building Department requirements.
 - Ontario Fire Marshall latest requirements.
 - OESC – Latest Edition
 - Electrical Safety Authority – Latest Inspection Bulletins
 - CSA C22.1, Canadian Electrical Code, Part 1 - Latest Edition

1.4 DEFINITIONS

- .1 The following are definitions of words found in Electrical Divisions of the Specification and on associated drawings:
 - .1 "concealed" – means hidden from normal sight in furred spaces, shafts, ceiling spaces, walls, and partitions.
 - .2 "exposed" – means work normally visible, including work in equipment rooms, service tunnels, and similar spaces.
 - .3 "finished" - means when in description of any area or part of an area or a product which receives a finish such as paint, or in case of a product may be factory finished.
 - .4 "provision" or "provide" (and tenses of "provide") – means supply and install complete. Include labour, materials, and services necessary to supply and install items or work referred to.

- .5 "install" (and tenses of "install") – means secure in position, connect complete, test, adjust, verify, and certify.
 - .6 "As instructed" or "where instructed" – means as instructed by the Consultant including supplementary instruction notices and job site instruction notices.
 - .7 "listed" - means that the materials or equipment has been tested in accordance with applicable standards and methods and has been approved and listed for the intended use by a testing company approved by the Authorities having jurisdiction.
 - .8 "supply" – means to procure, arrange for delivery to site, inspect, accept delivery, and administer supply of products; distribute to areas; and include manufacturer's supply of any special materials, standard on site testing, initial start-up, programming, basic commissioning, warranties, and assistance to Contractor.
 - .9 "delete" or "remove" (and tenses of "delete" or "remove") – means to disconnect, make safe, remove obsolete materials and patch and repair/finish surfaces to match adjoining similar construction; include for associated re-programming of systems and/or change of documentation identifications to suit deletions, and properly dispose of deleted products off site unless otherwise instructed by consultant.
 - .10 "BAS" – means building automation system; "BMS" – means building management system, "FMS" – means facility management system; and "DDC" means direct digital controls; references to "BAS", "BMS", "FMS" and "DDC" generally mean same.
 - .11 "Governing authority" and/or "authority having jurisdiction" and/or "regulatory authority" and/or "Municipal authority" – means government departments, agencies, standards, rules, and regulations that apply to and govern work and to which work must adhere.
 - .12 "Mechanical Divisions" – refers to Divisions 20, 21, 22, 23, 25 and other Divisions as specifically noted, and which work as defined in Specifications and/or on drawings is responsibility of Mechanical Contractor, unless otherwise noted.
 - .13 "Electrical Divisions" – refers to Divisions 26, 27, 28 and other Divisions as specifically noted, and which work as defined in Specifications and/or on drawings is responsibility of Electrical Contractor, unless otherwise noted.
 - .14 "Approved" or "Approval" - means approved by Authorities having jurisdiction as conforming to Codes, Standards, By-Laws, etc.
 - .15 "Acceptable" or "Acceptance" – means acceptable to the Consultant as conforming together to the requirements of the contract documents.
 - .16 "Submit for Review" or "Submit Notice" – means submit to the Consultant.
 - .17 "Subject to Review" – means work shall be laid out for review by the Consultant. No work shall proceed until instructions have been obtained from the Consultant. Submit further information, shop drawings, samples etc. as specified and as may be requested by the Consultants.
 - .18 "Accessible" - means reachable by person with tools as required and where obstacles may be removed and replaced without cutting or breaking out materials.
 - .19 "board", "owner" - means School board.
- .2 Wherever words "indicated", "shown", "noted", "listed", or similar words or phrases are used in Contract Documents they are understood, unless otherwise defined, to mean product referred to is "indicated", "shown", "listed", or "noted" on Contract Documents.
- .3 Wherever words "reviewed", "satisfactory", "as directed", "submit", or similar words or phrases are used in Contract Documents they are understood, unless otherwise defined, to mean that work or product referred to is "reviewed by", "to the satisfaction of", "submitted to", etc., Consultant.

1.5 DOCUMENTS

- .1 Documents for bidding include but are not limited to issued Drawings, Specifications and Addenda.

- .2 Drawings and Specifications are portions of Contract Documents and identify labour, products, and services necessary for performance of work and form a basis for determining pricing. They are intended to be cooperative. Perform work that is shown, specified, or reasonably implied on the drawings but not mentioned in Specification, or vice-versa, as though fully covered by both.
- .3 Read Drawings and Specifications in conjunction with documents of other Divisions and, where applicable, Code Consultant's report.
- .4 Unless otherwise specifically noted in Specifications and/or on Drawings, Sections of Electrical Divisions are not intended to delegate functions nor to delegate work and supply of materials to any specific trade, but rather to generally designate a basic unit of work, and Sections are to be read as a whole.
- .5 Drawings are performance drawings, diagrammatic, and show approximate locations of equipment and connecting services. Any information regarding accurate measurement of building is to be taken on site. Do not scale Drawings, and do not use Drawings for prefabrication work.
- .6 Drawings are intended to convey the scope of work and do not show architectural and structural details. Provide, at your cost, offsets, fittings, transformations, and similar products required as a result of obstructions and other architectural and/or structural details but not shown on Drawings.
- .7 Locations of equipment and materials shown may be altered, when reviewed by consultant, to meet requirements of equipment and/or materials, other equipment or systems being installed, and of building, all at no additional cost to Contract.
- .8 Specification does not generally indicate specific number of items or amounts of material required. Specification is intended to provide product data and installation requirements. Refer to schedules, Drawings (layouts, riser diagrams, schematics, details) and Specification to provide correct quantities. Singular may be read as plural and vice versa in Specification.
- .9 Starter/motor control centre (MCC)/variable frequency drive (VFD) schedule drawings are both mechanical and electrical and apply to work of Mechanical Divisions and Electrical Divisions. Be responsible for reviewing starter, MCC, VFD, and motor specification requirements prior to Bid submission and confirm exact scope of work and responsibility of work between Mechanical Divisions and Electrical Divisions.
- .10 Drawings and Specifications have been prepared solely for use by party with whom Consultant has entered a contract and there are no representations of any kind made by consultant to any other party.
- .11 When scale and date of Drawings are the same, or when discrepancy exists within Specification, include most costly arrangement to take precedence.
- .12 Unless otherwise specified in Division 00, Division 01, or "General Conditions", in the case of discrepancies or conflicts between Drawings and Specification, documents will govern in following order:
 - .1 Specification.
 - .2 Drawings of larger scale.
 - .3 Drawings of smaller scale.
 - .4 Drawings of later date when scale of Drawings is same.

1.6 IMPERIAL AND METRIC MEASUREMENTS

- .1 Generally, both metric and imperial units of measurement are given in Sections of Specification governed by this section. Measurement conversions may be generally "soft" and rounded off. Exact measurements to be confirmed based on application. Where measurements are related to installation and onsite applications, confirm issued document measurements with applicable local code requirements, and/or as applicable, make accurate measurements onsite. Where significant discrepancies are found, immediately notify Consultant for direction.

1.7 EXAMINATION OF DOCUMENTS AND EXISTING SITE CONDITIONS

- .1 Carefully examine Documents and visit site to determine and review existing site conditions that will or may affect work and include for such conditions in Bid Price.
- .2 Carefully examine electrical, structural, mechanical, and architectural drawings, and fully understand the functioning of the system described and specified under this Section. If in doubt, contact the engineer before submitting the Bid Price.
- .3 Report to Consultant, prior to Bid Submittal, any existing site condition that will or may affect performance of work as per Documents. Failure to do so will not be grounds for additional costs.
- .4 Upon finding discrepancies in, or omissions from Documents, or having doubt as to their meaning or intent, immediately notify Consultant, in writing.

1.8 WORK STANDARDS

- .1 Where any code, regulation, bylaw, standard, contract form, manual, printed instruction, and installation and application instruction are quoted it means, unless otherwise specifically noted, latest published edition at time of submission of Bids adopted by and enforced by local governing authorities having jurisdiction. Include for compliance with revisions, bulletins, supplementary standards, or amendments issued by local governing authorities.
- .2 Where regulatory codes, standards and regulations are at variance with Drawings and Specification, more stringent requirement will apply unless otherwise directed by consultant.
- .3 Supplementary mandatory specification and requirements to be used in conjunction with project include but are not limited to following:
 - .1 Ontario Building Code (OBC)
 - .2 Electrical Safety Authority (ESA)
 - .3 Ontario Electrical Safety Code (OESC)
 - .4 Canadian Standards Association (CSA)
 - .5 Underwriters' Laboratories of Canada (ULC)
 - .6 National Standards of Canada (CAN)
 - .7 National Building Code of Canada (NBC)
 - .8 National Fire Protection Association (NFPA)
 - .9 American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc., (ASHRAE)
 - .10 National Electrical Manufacturers Association (NEMA)
 - .11 Electrical and Electronic Manufacturers Association of Canada (EEMAC)
 - .12 American National Standards Institute (ANSI)
 - .13 Illuminating Engineering Society (IES)
 - .14 Building Industry Consulting Services, International (BICSI)
 - .15 Electronic Industries Association (EIA)
 - .16 Canadian General Standards Board (CGSB)
 - .17 Institute of Electrical and Electronic Engineers (IEEE)

- .18 Occupational Health and Safety Act (OHSA)
 - .19 Technical Standards and Safety Authority (TSSA)
 - .20 Workplace Hazardous Materials Information System (WHMIS)
 - .21 International Standards Organization (ISO)
 - .22 Material Safety Data Sheets by product manufacturers.
 - .23 Local utility inspection permits.
 - .24 Codes, standards, and regulations of local governing authorities having jurisdiction.
 - .25 Additional codes and standards listed in Trade Sections.
 - .26 Owner's standards.
-
- .4 Provide applicable requirements for barrier free access in accordance with latest edition of local governing building code.
 - .5 Where any governing Code, Regulation, or Standard requires preparation and submission of special details or drawings for review they are to be prepared and submitted. Pay associated costs associated with these submittals.
 - .6 Unless otherwise specified, equipment is to be installed in accordance with the equipment manufacturer's recommendations and instructions, and requirements of governing Codes, Standards, and Regulations. Governing Codes, Standards, and Regulations take precedence over manufacturer's instructions.
 - .7 Work is to be performed by journeyperson tradesmen who perform only the work that their certificates permit, or by apprentice tradesmen under direct on-site supervision of an experienced journeyperson tradesman. Journeyperson to apprentice ratio is not to exceed ratio determined as stated in Ontario College of Trades and Apprenticeship Act.
 - .8 Journeyperson tradesmen are to have a copy of valid trade certificates available at site for review by consultant at any time.
 - .9 Experienced and qualified superintendent is to be on-site at times when work is being performed.
 - .10 Coordinate work inspection reviews and approvals with governing inspection department to ensure that construction schedule is not delayed. Be responsible for prompt notification of deficiencies to consultant and submission of reports and certificates to consultant.
 - .11 Properly protect equipment and materials on site from damage due to elements and work of trades, to satisfaction of consultant. Equipment and materials are to be in new condition upon Substantial Performance of the Work.
 - .12 Electrical equipment and devices shall be certified and bear stamp or seal of a recognized testing agency such as CSA, UL, ULC, ETL, etc., or bear a stamp to indicate special electrical utility approval.
 - .13 Makes and quality of the materials used shall be approved by the Consultants and authority having jurisdiction.
 - .14 Products and materials provided shall be new and free from all defects. Related materials shall be of the same manufacturer throughout the Project.
 - .15 Products and materials called for on the drawings or in the specifications by trade names, manufacturer names and catalogue reference are those which shall be used based on the Tender.
 - .16 Alternative products and materials to those specified shall only be considered if they are shown in the Tender as a material variation with an appropriate price adjustment. The Consultant reserves the right to accept or reject any alternative without explanation.

- .17 Assume full responsibilities for ensuring that when providing alternative products or materials, all space, weight, connections, power, and wiring requirements, etc., are considered. Any costs incurred for additional components, changes to services, structural or space requirements, layouts, and plans, etc., that may be necessary will be borne by this Division.
- .18 Materials or equipment rejected by the Consultants shall be immediately removed from the project and suitable materials shall be provided.

1.9 PERMITS, CERTIFICATES AND FEES

- .1 Contact and confirm with local authorities having jurisdiction including utility providers, requirements for approvals from such authorities. Obtain and pay for permits, certificates, and approvals required to complete Work.
- .2 Be responsible for ensuring that authorities having jurisdiction which require on-site inspection of work, have ample notification to perform inspection, with sufficient lead time to correct deficiencies in a manner that will not impede schedule of completion of Work.
- .3 Submit to Consultant, approval/inspection certificates issued by governing authorities to confirm that Work as installed is in accordance with rules and regulations of local governing authorities.
- .4 Include in each copy of operating and maintenance instruction manuals, copies of approvals and inspection certificates issued by regulatory authorities to certify that completed Work is in accordance with regulations of regulatory authorities and is acceptable to them.

1.10 REQUIREMENTS FOR CONTRACTOR RETAINED ENGINEERS

- .1 Professional engineers retained to perform consulting services with regards to Project work, i.e., seismic engineer, fire protection engineer, structural engineer, are to be members in good standing with local Association of Professional Engineers and are to carry and pay for errors and omissions professional liability insurance in compliance with requirements of governing authorities in Place of the Work.
- .2 Retained engineer's professional liability insurance is to protect Contractor's Consultants and their respective servants, agents, and employees against any loss or damage resulting from professional services rendered by aforementioned Consultants and their respective servants, agents, and employees in regard to the Work of this Contract.
- .3 Liability insurance requirements are as follows:
 - .1 coverage is to be a minimum of \$1,000,000.00 inclusive of any one occurrence.
 - .2 insurance policy is not to be cancelled or changed in any way without insurer giving Owner minimum thirty days written notice.
 - .3 liability insurance is to be obtained from an insurer registered and licensed to underwrite such insurance in the Place of the Work.
 - .4 retained Consultants are to ascertain that Sub-Consultants employed by them carry insurance in the form and limits specified above.
 - .5 evidence of the required liability insurance in such form as may be required is to be issued to Owner, Owner's Consultant, and Municipal Authorities as required prior to commencement of aforementioned Consultant's services.

1.11 WORKPLACE SAFETY

- .1 Comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage, and disposal of hazardous materials. Submit WHMIS MSDS (Material Safety Data Sheets) for products where required and maintain one copy at site in a visible and accessible location available to personnel.

- .2 Comply with requirements of Occupational Health and Safety Act and other regulations pertaining to health and safety, including worker's compensation/insurance board and fall protection regulations. When working in confined spaces, comply with requirements of Occupational Health and Safety Act - Ontario Regulation 632, "Confined Spaces".

1.12 PLANNING AND LAYOUT OF WORK

- .1 Base installation layout, design, terminations, and supply of accessories, on Contract Documents with specific coordination with reviewed shop drawings.
- .2 Plan, coordinate, and establish exact locations and routing of services with affected trades prior to installation such that services clear each other as well as other obstructions. Generally, order of right of way for services to be as follows:
 - .1 large ducts (main runs)
 - .2 cable tray and bus duct
 - .3 conduit 100 mm (4") dia. and larger
 - .4 smaller branch ductwork
 - .5 conduit less than 100 mm (4") dia.
- .3 Unless otherwise shown or specified, conceal work in finished areas, and conceal work in partially finished and/or unfinished areas to extent made possible by the area construction. Install services as high as possible to conserve headroom and/or ceiling space. Notify Consultant where headroom or ceiling space appears to be inadequate prior to installation of the work.
- .4 Do not use Contract Drawing measurements for distribution equipment layout, conduit installation work and such other work. Locations and routing are to generally be in accordance with Contract Drawings, however, prepare layout drawings for such work. Use established benchmarks for both horizontal and vertical measurements. Coordinate with and make allowances for work of other trades. Accurately layout work and be entirely responsible for work installed in accordance with layout drawings. Where any grade or size is at variance with Contract Drawings, notify Consultant prior to proceeding with work.
- .5 Prepare plan and interference drawings (at a minimum drawing scale of 1:50 or 1/4"=1' 0") of the work for coordination with General Contractor. Arrange for preparation of detailed section drawings of ceiling spaces of corridors and any other congested areas. Sections are to be cross referenced with plan drawings so that trades may make use of section drawings. Section drawings to indicate lateral and elevation dimensions of major services within ceiling space. Lateral dimensions are to be from grid lines and elevations from top of floor slab. Obtain from Consultant, disks of engineering drawings for this use. Prints and/or disks of Contractors' interference drawings are to be distributed among other Trade Contractors and General Contractor. Submit drawings to consultant for review. Failure of General Contractor to prepare and coordinate overall interface drawings of trades does not relieve respective Division Contractor of responsibility to ensure that work is properly planned and coordinated.
- .6 Carry out alterations in arrangement of work that has been installed without proper coordination, study, and review, even if in accordance with Contract Documents, in order to conceal work behind finishes, or to allow installation of other work, without additional cost. In addition, make necessary alterations in other work required by such alterations, without additional cost.
- .7 Junction boxes for lighting, power, fire alarm, power packs, lighting controllers and such other systems devices and products located above suspended ceilings must be located for easy access for servicing and/or removal. Products which do not meet this location requirement are to be relocated to an accessible location at no additional cost.

- .8 Be responsible for making necessary changes, at no additional cost, to accommodate structural and building conditions that were missed due to lack of coordination by this Division.

1.13 COORDINATION OF THE WORK

- .1 Fully understands the functions of the systems specified and have no doubts regarding the extent of the Contract.
- .2 Examine the Architectural, Structural, Mechanical and Electrical drawings and become fully familiar with the work of other Divisions.
- .3 Co-ordinate with all Divisions providing equipment and services and ensure that there is no confliction. Coordination requirements are to include but not be limited to following:
 - .1 requirements for openings, sleeves, inserts and other hardware necessary for installation of work.
 - .2 concrete work such as housekeeping pads, sumps, bases, etc., required for work, and including required dimensions, operating weight of equipment, location, etc.
 - .3 depth and routing of excavation required for work, and requirements for bedding and backfill.
 - .4 wiring work required for equipment and systems but not specified to be done as part of mechanical work, including termination points, wiring type and size, and any other requirements.
- .4 Ensure materials and equipment are delivered to site at proper time and in such assemblies and sizes to enter building and be moved into spaces where they are to be located without difficulty.
- .5 Wherever possible, coordinate equipment deliveries with manufacturers and/or suppliers so equipment is delivered to site when it is required, or so it can be stored within building and protected from elements.
- .6 Ensure proper access and service clearances are maintained around equipment, and, where applicable, access space for future equipment removal or replacement is not impeded. Comply with code requirements with regards to access space provision around equipment. Remove and replace any equipment which does not meet this requirement.
- .7 Arrange equipment in proper relation with other apparatus, the building construction, the Architectural finish and with all work specified.
- .8 Where space is shown for future equipment leave such space clear and ensure that the necessary connections can be made to the future equipment.
- .9 Where work is to be integrated or is to be installed in close proximity with work of other trades, coordinate work prior to and during installation.
- .10 Failures to fully understand Drawings and allow for the work of other Divisions or where relocations are necessary due to lack of co-ordination between Divisions shall be remedied at the expense of this Division.

1.14 WORKMANSHIP

- .1 All work shall be executed in a workmanlike manner and present a neat mechanical appearance.

1.15 EQUIPMENT AND MATERIALS

- .1 Be responsible for ordering of products (equipment and materials) in a timely manner to meet project-scheduling timelines. Failure to order products to allow manufacturers sufficient production/delivery time to meet project-scheduling timelines is an unacceptable reason to request for other suppliers or substitutions.
- .2 Provide Canadian manufactured products wherever possible and where required quality and performance is obtainable. Unless otherwise specified, all materials and apparatus shall be new and shall comply with applicable Canadian Standards Association (CSA) Standards and/or Underwriters Laboratories of Canada (ULC) Standards and the requirements of the authorities having jurisdiction.
- .3 Materials and equipment scheduled and/or specified, have been selected to establish a performance and quality standard, and, in some instances, a dimensional standard. In most cases, base specified manufacturers are stated for material and equipment, specified by manufacturer's name and model number. Unless otherwise noted, the Bid Price may be based on materials and equipment supplied by any of the manufacturers named as acceptable for the particular material or equipment. If acceptable manufacturers are not stated for a particular material or piece of equipment, base the Bid Price on material supplied by the base specified manufacturers.
- .4 Documents have been prepared based on product available at time of Bidding. If, after award of Contract, and if successful manufacturer can no longer supply a product that meets base specifications, notify Consultant immediately. Be responsible for obtaining other manufacturers product that complies with base specified performance and criteria and meets project timelines. Proposed products are subject to review and consideration by consultant and are considered as substitutions subject to a credit to Contract. In addition, if such products require modifications to room spaces, mechanical systems, electrical systems, etc., include required changes. Such changes are to be submitted in detail to consultant for review and consideration for acceptance. There will be no increase in Contract Price for revisions. Note that above conditions supplement and are not to supersede any specification conditions with regards to substitutions or failure to supply product as per issued documents.
- .5 If materials or equipment supplied by a manufacturer named as acceptable are used in lieu of the manufacturer specified, be responsible for ensuring that the substituted material or equipment is equivalent in quality, performance and operating characteristics (including energy consumption if applicable) to the specified materials or equipment, and, it shall be understood that any additional costs, and changes to associated or adjacent work resulting from provision of materials supplied by a manufacturer other than the specified manufacturer is included in the Bid Price. In addition, in equipment spaces where equipment named as acceptable is used in lieu of specified equipment and the dimension of such equipment differs from the specified equipment, prepare, and submit for review, accurately dimensioned layouts of rooms affected.
- .6 In addition to the manufacturers specified or named as acceptable, other manufacturers of materials or equipment may be proposed to the Consultant for acceptance, listing in each case a corresponding credit for each alternative proposed, however, the Bid Price must be based on equipment or materials specified or named as acceptable. Certify in writing to the Consultant that the proposed alternative meets all space, power, design, energy consumption, and all other requirements of the specified or acceptable material or equipment. In addition, it shall be understood that there will be no increase in the contract Price by reason of any changes to associated equipment, mechanical and/or electrical, required by acceptance of proposed alternatives. The Consultant has sole discretion in accepting any such proposed alternative material or equipment.

- .7 Where products you intend to provide are proposed as "an equal" and/or "or approved equal", to specified products, certify in writing that the proposed product to be used in lieu of specified product, at least meets space, power, design, energy consumption, noise criteria and other requirements of the specified product and thus shall be equivalent to or better than the specified product. When requested by the Consultant, provide full design detail drawings and specifications of proposed products. Acceptance of these "or equal" and/or "or approved equal" products shall be at the sole discretion of the Consultant. The Consultant's decision shall be final and shall not require explanation. There shall be no increase in the contract Price due to the Consultant's rejection of a proposed equivalent product.
- .8 Only base specified products specified acceptable products or equipment listed as alternate will be considered for acceptance by the owner. No proposed substitutions will be accepted.
- .9 Indicate in Form of Supplementary Electrical Tender, names of manufacturers for proposed products to be supplied, and which were based specified or scheduled with a manufacturer's name. Names of proposed manufacturers on list must be one of names stated as acceptable for products unless prior approval from Owner has been given for use of products by other manufacturers. Submit to Consultant for review as directed.

1.16 SHOP DRAWINGS

- .1 At start-up meeting, confirm with consultant products to be included in shop drawing submission. Prepare and submit list of products to consultant for review.
- .2 Submit for review, drawings showing in detail design, construction, and performance of equipment and materials as requested in Specification. Submit shop drawings to consultant for review prior to ordering and delivery of product to site. Include minimally for preparation and submission of following, as applicable:
 - .1 Product literature cuts.
 - .2 Equipment data sheets.
 - .3 Equipment dimension drawings.
 - .4 System block diagrams.
 - .5 Sequence of operation.
 - .6 Connection wiring schematic diagrams.
 - .7 Functionality with integrated systems.
- .3 Each shop drawing or product data sheet is to be properly identified with project name and product drawing or specification section reference. Shop drawing or product data sheet dimensions are to match dimension type on drawings.
- .4 Where any item of equipment is required by Code or Standard or By-Law to meet a specific energy efficiency level, or any other specific requirement, ensure this requirement is clearly indicated on submission.
- .5 Ensure proposed products meet each requirement of Project. Endorse each shop drawing copy "CERTIFIED TO BE IN ACCORDANCE WITH ALL REQUIREMENTS". Include company name, submittal date, and sign each copy. Shop drawings that are received and are not endorsed, dated, and signed will be returned to be resubmitted. Submit electronic copies of shop drawings unless otherwise directed by consultant. Confirm exact requirements with consultant.
- .6 Approval of a drawing by this Division implies the following:
 - 1. The drawing has been checked by the person making the approval.
 - 2. The equipment or material complies in all respects with the requirements of the specifications and drawings.

3. The quantities, if indicated on the drawing, are correct.
4. The physical dimensions of the components are such that they can be installed without interference with the building structure or other equipment, and that, after installation, there are sufficient clearances on all sides for the maintenance, servicing, and operation of the equipment.
- .7 Consultant will review shop drawings and indicate review status by stamping shop drawing copies as follows:
 - .1 "REVIEWED" or "REVIEWED AS NOTED" (appropriately marked) – If Consultant's review of shop drawing is final, Consultant to stamp shop drawing.
 - .2 "REVISE AND RESUBMIT" – If Consultant's review of shop drawing is not final, Consultant to stamp shop drawing as stated above, mark submission with comments, and return submission. Revise shop drawing in accordance with Consultant's notations and resubmit.
- .8 Following is to be read in conjunction with wording on Consultant's shop drawing review stamp applied to each shop drawing or product data sheet submitted:

"THIS REVIEW BY CONSULTANT IS FOR THE SOLE PURPOSE OF ASCERTAINING CONFORMANCE WITH GENERAL DESIGN CONCEPT. THIS REVIEW DOES NOT MEAN THAT CONSULTANT APPROVES DETAIL DESIGN INHERENT IN SHOP DRAWINGS, RESPONSIBILITY FOR WHICH REMAINS WITH CONTRACTOR, AND SUCH REVIEW DOES NOT RELIEVE CONTRACTOR OF RESPONSIBILITY FOR ERRORS OR OMISSIONS IN SHOP DRAWINGS OR OF CONTRACTOR'S RESPONSIBILITY FOR MEETING REQUIREMENTS OF CONTRACT DOCUMENTS. BE RESPONSIBLE FOR DIMENSIONS TO BE CONFIRMED AND CORRELATED AT JOB SITE, FOR INFORMATION THAT PERTAINS SOLELY TO FABRICATION PROCESSES OR TO TECHNIQUES OF CONSTRUCTION AND INSTALLATION, AND FOR COORDINATION OF WORK OF SUB-TRADES."
- .9 Resubmit any drawing on which notations have been made, after it has been modified or corrected.
- .10 Drawings that are re-submitted shall have a distinct notation of the fact made on each drawing.
- .11 Works shall not proceed on any equipment, material or installation until the drawings have been reviewed by the Consultant.
- .12 Each system and each major component are to be separate shop drawing submissions. Shop drawings for common devices such as devices of each system are to be submitted together.
- .13 Obtain shop drawings for submission from product manufacturer's authorized representatives and supplemented with additional items specified herein.
- .14 Where extended warranties are specified for equipment items, submit specified extended warranty with shop drawing submittal.
- 1.17 EQUIPMENT LOADS
 - .1 Supply equipment loads (self-weight, operating weight, housekeeping pad, inertia pads, etc.) to consultant, via shop drawing submissions, prior to construction.
 - .2 When choice of specific equipment is made by Contractor, actual weight, location, and method of support of equipment may differ from those initially given to consultants and thus from those assumed for design. Consequently, it is necessary to back-check equipment loads, location, and supports.

- .3 Where supporting structure consists of structural steel framing, it is imperative that equipment loads, location, and method of support be confirmed prior to fabrication of structural steel. Be responsible for confirming locations of equipment with consultant prior to construction.

1.18 OPENINGS

- .1 Supply opening sizes and locations to consultant to allow verification of their effect on design, and for inclusion on structural drawings where appropriate.
- .2 No openings are permitted through completed structure without written approval of consultant. Show required openings on a copy of structural drawings. Identify exact locations, elevations, and size of proposed openings and submit to consultant for review, well in advance of doing work.
- .3 Chases, openings, cutting, patching, etc. shall be provided by this Division in accordance with those sections of the specification detailing the requirements.
- .4 Flashing required for openings in walls, floors and roofs shall, unless otherwise noted, be provided by this Division.
- .5 Electrical conduit roof flashing shall be similar to National Roofing supply product code# ECP-PVCH (electrical conduit post PVCH), Gooseneck S.S.A ARPGN2 (2")/ ARPGN3 (3").
- .6 Drilling for hangers, rods, inserts and work of a similar nature shall be provided by this Division.
- .7 Provide all necessary sleeves, inserts, anchor bolts, etc., prior to pouring of concrete or building of walls, roofs, etc.
- .8 Advise the extent of such work and supply all information and details as to sizes and locations within thirty days after the award of the Contract.
- .9 Failures to comply with the above requirements shall be remedied at this Division's expense.
- .10 Where conduits pass through fire rated walls/ areas, proper fire stop material shall be used by Division 26. Submit shop drawings for review before installation.

1.19 SCAFFOLDING, RIGGING, AND HOISTING

- .1 Unless otherwise specified or directed, supply, erect and operate scaffolding, rigging, hoisting equipment and associated hardware required for work, and subject to review by and coordination with consultant.
- .2 Immediately remove from site scaffolding, rigging and hoisting equipment when no longer required.
- .3 Do not place major scaffolding/hoisting equipment loads on any portion of structure without approval from consultant.

1.20 TEMPORARY CRANES

- .1 Submit following to consultant for review:
 - .1 Propose details showing existing structures and surfaces being used for lifting locations.
 - .2 Copies of approvals of authorities for work.
 - .3 Copies of approvals of property management of buildings affected by hoisting work, allowing for work.
 - .4 Copies of required insurance for work.

1.21 CHANGES OR REVISIONS TO THE WORK

- .1 Whenever Consultant proposes in writing to make a change or revision to design, arrangement, quantity, or type of work from that required by Contract Documents, prepare, and submit to consultant for approval, a quotation being proposed cost for executing change or revision.
- .2 Quotation is to be a detailed and itemized estimate of product, labour, and equipment costs associated with change or revision, plus overhead and profit percentages and applicable taxes and duties.
- .3 If overhead and profit percentages are not specified in Division 00 or 01, but allowable under Contract as confirmed with consultant prior to contract signing, then allowable maximum percentages for overhead and profit are to be 7% and 5% respectively.
- .4 Unless otherwise specified in Divisions 00 or 01, following requirements apply to all quotations submitted:
 - .1 When change or revision involves deleted work as well as additional work, cost of deleted work (less overhead and profit percentages but including taxes and duties) is to be subtracted from cost of additional work before overhead and profit percentages are applied to additional work.
 - .2 Material costs are not to exceed those published in local estimating price guides.
 - .3 Electrical material labour unit costs are to be in accordance with National Electrical Contractors Association Manual of Labour Units.
 - .4 Costs for journeyman and apprentice labour must not exceed prevailing rates at time of execution of Contract and must reflect actual personnel performing work.
 - .5 Cost for site superintendent must not exceed 10% of total hours of labour estimated for change or revision and change or revision must be such that site superintendent's involvement is necessary.
 - .6 Costs for rental tools and/or equipment are not to exceed local rental costs.
 - .7 Overhead percentage will be deemed to cover quotation costs other than actual site labour and materials, and rentals.
 - .8 Quotations, including those for deleted work, to include a figure for any required change to Contract time.
- .5 Quotations submitted that are not in accordance with requirements specified above will be rejected and returned for re-submittal. Failure to submit a proper quotation to enable Consultant to expeditiously process quotation and issue a Change Order will not be grounds for any additional change to Contract time.
- .6 Make requests for changes or revisions to work to Consultant in writing and, if Consultant agrees, will issue Notice of Change.
- .7 Do not execute any change or revision until written authorization for the change or revision has been obtained from consultant.

1.22 BREAKDOWN OF ELECTRICAL WORK COST

- .1 Prior to submittal of first progress payment draw, submit a detailed breakdown of work cost to assist Consultant in reviewing and approving progress payment claims.
- .2 Payment breakdown is subject to Consultant's approval and progress payments will not be processed until an approved breakdown is in place. Breakdown is to include one-time claim items such as mobilization and demobilization, insurance, bonds (if applicable), shop drawings and product data sheets, commissioning including system testing and verification, and project closeout submittals.

- .3 Indicate equipment, material, and labour costs for site services (if applicable) and indicate work of each trade in same manner as indicated on progress draw.

1.23 NOTICE FOR REQUIRED FIELD REVIEWS

- .1 Whenever there is a requirement for consultant to perform a field review prior to concealment of any work, to inspect/re-inspect work for deficiencies prior to Substantial Performance of the Work, for commissioning demonstrations, and any other such field review, give minimum 5 working days' notice in writing to consultant.
- .2 If Consultant is unable to attend a field review when requested, arrange an alternative date and time.
- .3 Do not conceal work until consultant advises that it may be concealed.
- .4 When Consultant is requested to perform a field review and work is not ready to be reviewed, reimburse Consultant for time and travel expenses.

1.24 PRELIMINARY TESTING

- .1 When directed by consultant, promptly arrange, pay for, and perform site tests on any piece of equipment or any system for such reasonable lengths of time and at such times as may be required to prove compliance with Specification and governing Codes and Regulations, prior to Substantial Performance of the Work.
- .2 When, in Consultant's opinion, tests are required to be performed by a certified testing agency, arrange, and pay for such tests.
- .3 These tests are not to be construed as evidence of acceptance of work, and it is agreed and understood that no claim for delays or damage will be made for injury or breakage to any part or parts of equipment or system due to test where such injuries or breakage were caused by faulty parts and/or workmanship of any kind.
- .4 When, in Consultant's opinion, tests indicate that equipment, products, etc., are defective or deficient, immediately remove such equipment and/or products from site and replace them with acceptable equipment and/or products, at no additional cost.

1.25 PROVISIONS FOR SYSTEMS/EQUIPMENT USED DURING CONSTRUCTION

- .1 Confirm with Consultant what equipment can be used during construction.
- .2 Any system or piece of equipment that is specified to be provided under requirements of Documents and is required to be used during construction stages of work prior to issuing of Certificate of Substantial Performance of the Work, are to be provided with special interim maintenance and service to cover systems/equipment during time of use during construction period of project until project has been certified as substantially performed and such systems/equipment are turned over to Owner.
- .3 During this period of construction, such systems/equipment to not become property of Owner or be Owner's responsibility for maintenance or service. Systems/equipment are to remain property of respective manufacturers/suppliers or Contractor, who are responsible for full maintenance and servicing of systems/equipment in order to maintain validity of warranties after turning over to Owner.
- .4 Prior to application for a Certificate of Substantial Performance of the Work and turn over to Owner, such systems/equipment to be cleaned, restored to "new" condition, paint finishes "touched up" etc.

1.26 MAINTAINING EQUIPMENT PRIOR TO ACCEPTANCE

- .1 Maintain equipment in accordance with the manufacturer's printed instructions prior to start-up, testing, and commissioning.

1.27 PROTECTION

- .1 Protect all finished and unfinished work from damage due to carrying out the work specified.
- .2 Repair all damage resulting from execution of the work to the satisfaction of the Consultant.
- .3 Should the project be stopped for any cause, provide all necessary protection to prevent damage by weather or other causes while such stoppage exists.

1.28 HANDLING AND STORAGE

- .1 Materials and equipment shall be handled and stored in such a manner so that no damage shall be done to the materials, the structure of the building or surrounding property.
- .2 Packaged or bundled materials and equipment shall be stored in dry weathertight secure enclosures in original undamaged condition with manufacturer's seals and labels intact.
- .3 All metals shall be protected against corrosion and bending.
- .4 Storage of materials, equipment etc. in the building structure shall not be permitted unless otherwise noted.

1.29 MINOR FIELD CHANGES

- .1 The location, arrangement and connection of equipment and materials as shown on the drawings represents a close approximation to the intent and requirements of the Contract.
- .2 The right is reserved to make reasonable changes required to accommodate conditions arising during the progress of the work. Such changes, if made prior to the installation, shall be done at no additional cost, unless the location, arrangement or connection is more than six feet from that shown on the drawings.

1.30 CLEANING UP

- .1 During construction, and daily, keep the site reasonably clear of rubbish and waste material resulting from electrical work to the satisfaction of the Consultant. Before applying for a Certificate of Substantial Performance of the Work, remove all rubbish and debris, and arrange for and pay for the repair of any damage caused as a result of electrical work.
- .2 Clean the interior and exterior of all equipment and remove any debris during construction.
- .3 Inspect and clean all systems and equipment prior to energizing and ensure that they are safe.

Perform a complete and thorough clean-up to the exterior and interiors of all systems and equipment before the final inspection. The interiors shall be cleaned using an industrial vacuum cleaner.

1.31 ELECTRICAL CONDUCTOR FIRE PROTECTION

- .1 Fire rated enclosures shall be provided to form service spaces for conduits containing electrical conductors for emergency power, elevators, and life safety equipment in accordance with the requirements of the Authorities having jurisdiction.
- .2 Fire rated access panels shall be provided in the enclosures where required.

- .3 The fire rated enclosures required by this Division shall, unless otherwise noted, be provided by this Division and shall be in accordance with the sections of the specification detailing the fire rated enclosures requirements.
- .4 Advise the extent of the fire rated enclosures required and supply all information and details as to size and locations within thirty days after the award of the contract.
- .5 Failures to comply with the above requirements shall be remedied at this Division's expense.
- .6 Where fire rated cables, that comply with the requirements of the Authorities having jurisdiction, are provided it shall not be required that they be installed in fire rated enclosures.

1.32 SPRINKLER PROOF EQUIPMENT

- .1 Where sprinklers are installed; electrical equipment shall be constructed so that water from the sprinkler heads shall not impair the effectiveness of the equipment.
- .2 A separate and complete roof shall be provided on free standing or surface mounted equipment. An overhang at the front, rear and sides shall prevent the entrance of water either at the top or through projecting face plates, meters, etc. Provide complete gaskets to suit.
- .3 Where openings are required in the roofs or sides of incoming and outgoing conduits and cables, removable gasketed plates shall be provided and the conduits and cables shall be installed using waterproof fittings. The plates are to be grounded by a separate copper strap to the equipment.
- .4 Distribution and power panels, panel boards, etc. and switchboards shall be complete with gaskets and doors.

1.33 EQUIPMENT AND MATERIAL COLOURS

- .1 Where materials and equipment are specified to be a specific colour, a sample of the colour proposed by the manufacturer shall be submitted with the shop drawing.
- .2 Where materials and equipment are specified to be of colours as selected by the Consultant, these shall be determined during the Contract. Obtain the colour requirements from the Consultant prior to submitting shop drawings so that the appropriate sample of the colour can be submitted with the shop drawings.

1.34 SLEEVES

- .1 Provide sleeves of galvanized steel pipe with machine cut ends of ample size to accommodate conduits passing through walls, partitions, ceilings, floors, etc.
- .2 For wall partitions and ceilings, the ends of the sleeves shall be flush with the finish on both sides. For floors they shall extend 50mm above and below finished floor level.
- .3 The space between the sleeve and the conduit and spare sleeves shall be filled with Dow Corning silicone RTV foam for fire stop. Caulk around the top and bottom with approved permanently resilient, non-flammable and weatherproof silicone base compound.

1.35 EXCAVATION AND BACKFILL

- .1 The excavation and backfill required by this Division shall, unless otherwise noted, be provided by this Division and shall be in accordance with the Sections of the Specification detailing the excavation and backfill requirements.

- .2 Advise the extent of the excavation and backfill work required by this Division and supply all information and details as to size and locations within thirty days after the award of the Contract.
- .3 Failures to comply with the above requirements shall be remedied at this Division's expense.

1.36 HOUSEKEEPING PAD

- .1 All floor mounted electrical equipment installed by this Division shall be mounted on concrete housekeeping pads which shall, unless otherwise noted, be provided by this Division.
- .2 Advise the extent of the housekeeping pads required by this Division and supply all information and details as to size and location within thirty days after the award of the Contract.
- .3 Failures to comply with the above requirements shall be remedied at this Division's expense.

1.37 CONCRETE

- .1 The concrete and reinforcing required by this Division shall, unless otherwise noted, be provided by this Division and shall be in accordance with the Sections of the Specifications detailing the concrete and reinforcing requirements.
- .2 Advise the extent of the concrete and reinforcing work required by this Division and supply all information and details as to size and locations within thirty days after the award of the Contract.
- .3 Failures to comply with the above requirements shall be remedied at this Division's expense.

1.38 PAINTING

- .1 All equipment shall be supplied with manufacturer's standard finish coat, unless otherwise noted.
- .2 All supports, hangers, etc. provided or fabricated by this Division shall be painted with two coats of zinc chromate primer.
- .3 Where the finish on any materials or equipment installed by this Division is damaged, it shall be touched up, completely repainted or replaced to the satisfaction of the Consultant.

1.39 IDENTIFICATIONS

- .1 Identify each item of equipment installed by this Division, whether supplied by it or not.
- .2 Metal surfaces shall be thoroughly cleaned before application of identification.
- .3 Identifications shall be installed after painting has been completed and shall be secured with self-tapping screws or rivets except when installed on the inside of doors when gluing will be acceptable.
- .4 Manufacturer's nameplates shall be affixed to each item supplied showing the size, name of equipment, serial number and all information usually provided including voltage, cycle, phase, horsepower, etc., and the name of the Manufacturer and his address. Ensure that all stamped, etched, or engraved lettering on plates is perfectly legible. Do not paint over nameplates and where equipment is to be concealed attach the nameplates in an accessible location.
- .5 Panels and all other equipment which have exposed faces in finished areas shall not have any visible trademarks or other identifying symbols. Nameplates shall be mounted on the inside of the doors.
- .6 Each lighting panel shall have a directory mounted on the inside of the door behind a protective plastic screen. The directories shall be typewritten and shall identify each branch circuit used. Spares and spaces shall be noted in pencil.

- .7 The nameplates for switchboards, distribution panels, power panels, etc. shall be Lamicoid with 13mm high letters with typical identification of e.g., "PP'AA, 600V 3 PH., 4W, fed from Switchboard 'A'".
 - .8 The nameplates for panel boards shall be Lamicoid with 9.5mm high letters with typical identification of: e.g., "LP'B', 208V, 3Ph, 4W, fed from PP'A".
 - .9 Each breaker, switch, instrument, meter, etc. in switchboards, distribution panels, power panels, etc. shall have a Lamicoid nameplate with 6.4mm high letters with typical identification of: e.g., "Elevator #1" or "Pump-1A".
 - .10 The nameplates for disconnect switches, starters, time clocks, dimmers etc. shall be Lamicoid with 6.4mm high letters with typical identification of: e.g., "Supply Fan "S4", 5 HP, 600V, 3Ph., 3W, fed from 'PP-1".
 - .11 Each feeder cable and feeder conduit shall be identified with 25mm high letters with typical identification of "208V, 3Ph, 4W to LP'B". The identification shall be provided at each access door, each change of direction, each junction box, at each floor or platform for vertically exposed conduits or cables at 2 metres above floor, at not more than 15 metres apart in straight runs, and on both sides of sleeves through walls.
 - .12 The interior, exterior and lids of all junction boxes and outlet boxes shall be neatly identified with different colours of paint. The colours shall be consistent throughout the project for the following systems:
 - .1 347/600 Volt System – Black
 - .2 120/208 Volt System – Blue
 - .3 120/208 Volt Lighting – Yellow
 - .4 120/208 Volt Emergency Lighting System – Orange
 - .5 Intrusion Detection System – Purple
 - .6 Computer System – Pink
 - .7 Fire Detection and Alarm System – Red
 - .8 Telephone System – Brown
 - .9 P.A./Telephone System – Green
 - .10 Cable TV – White (Co-ordinate with the Board)
 - .13 Provide all signs and marking of equipment as required by the Authorities having jurisdiction.
 - .14 Outlet boxes for light switch(es) and receptacle(s) and junction boxes provided for lighting or power connections shall be identified on the box cover with circuits contained in the box, the panels from which they are fed, the voltage and the purpose of the outlet.
 - .15 Each power switch and receptacle shall be complete with permanent printed adhesive label installed on faceplate, identifying panel and circuit from which it is fed.
- 1.40 MOCK-UP
- .1 A mock-up of the ceiling shall be provided by another Division of the Specification.
 - .2 Provide samples of the lighting fixtures, fire alarm devices and all other items of equipment mounted in or on the ceiling and obtain acceptance for the samples and their installation.
- 1.41 TEMPORARY AND TRIAL USAGE
- .1 When it is claimed that a portion of the work is completed and in accordance with the Drawings and Specifications, the Owner shall have the privilege of temporary and trial usage for a reasonable length of time for making a complete and thorough test of the portion of the work completed.

- .2 Temporary or trial usage by the Owner of any electrical device, machinery, apparatus, equipment or any other work or materials supplied under this Contract before final completion and written acceptance, is not to be construed as evidence of acceptance of same.

1.42 RECORD (AS-BUILT) DRAWINGS

- .1 Drawings for this project have been prepared on a CAD system using AutoCAD software of release version confirmed with consultant. For purpose of producing record "as built" drawings, copies of Contract Drawings can be obtained from consultant by paying \$3,500. Drawings may also to be used for preparation of layouts and interference drawings.
- .2 As work progresses at site, clearly mark in red in a neat and legible manner on a set of bound white prints of Contract Drawings, changes, and deviations from routing of services and locations of equipment shown on Contract Drawings, daily. Changes and deviations include those made by addenda, change orders, and site instructions. Use notes marked in red as required. Maintain white print red line as-built set at site for exclusive use of recording as-built conditions, keep always set up to date, and ensure set is always available for periodic review. As-built set is also to include the following:
 - .1 Dimensioned location of inaccessible concealed work.
 - .2 Locations of control devices with identification for each.
 - .3 Location of all pull boxes and junction boxes.
 - .4 Locate, with dimensions to the building grid and datum lines, all buried and concealed services, pull boxes, junction boxes, etc. for all systems.
 - .5 Location of all conduits, ducts, wiring, and conductor runs for all systems including sizes, types of components, circuit numbers, etc. exactly as installed.
 - .6 Location of concealed services terminated for future extension.
 - .7 Room names and numbering, equipment names, etc. shall be in accordance with the Owner's designation and may not necessarily be those shown on the drawings.
- .3 Before applying for a Certificate of Substantial Performance of the Work, update a clean copy of Contract Drawing set in accordance with marked up set of "as-built" white prints including deviations from original Contract Drawings, thus forming an "as-built" drawing set. Submit "as-built" site drawing prints to consultant for review. Make necessary revisions to drawings as per Consultant's comments, to satisfaction of consultant.
- .4 Reviews of the record drawings by the Consultant shall be for general conformance only and is not an approval of the accuracy of the drawings. Electrical Division shall be responsible for the accuracy of the record drawings.
- .5 Submit final reviewed "as-built" drawing set to consultant to produce final "as-built" CAD drawings for submission to the School Board.
- .6 Transfer all recorded information from marked-up set of As-Built condition to AutoCAD.
- .7 Unless otherwise noted in Divisions 00 or 01, failure to maintain accurate record drawings will incur additional 5% holdback on progress claims until drawings are brought up to date to satisfaction of consultant.

1.43 TESTING AND COMMISSIONING

- .1 All systems, equipment and installation shall be inspected, tested, adjusted, and commissioned to ensure compliance with the Drawings, Specifications and the Requirements of the Authorities having jurisdiction.
- .2 Provide testing equipment, instruments, material and labour for all testing and commissioning.
- .3 Submit reports of all testing and commissioning for review by the Consultants.

- .4 This Division 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 Owner for a total of 60 hours 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 serviceman shall ensure continuity of their function by having only one such person assigned to the commissioning team.
- .5 The actual performance of this work will be scheduled and coordinated by the Owner.

1.44 SYSTEM ACCEPTANCES

- .1 Prior to requesting final inspection, submit, for review by the Consultant, letters from the manufacturers of equipment and systems indicating that their Technical Service Representatives have inspected and tested the equipment and systems and are satisfied with the methods of installation, connections, and operation.
- .2 Acceptance letters shall be submitted for the following, when applicable:
 - .1 Switchboard
 - .2 Distribution Panels
 - .3 Power Panels
 - .4 Panel Boards
 - .5 Fire Detection and Alarm System
 - .6 Emergency Lighting System
 - .7 Intrusion Detection System
 - .8 Video Surveillance System
 - .9 Public Address System
 - .10 Lighting Control System

1.45 INSTRUCTIONS AND DEMONSTRATIONS

- .1 Instruct the Owner's designated personnel during construction and prior to requesting final inspection so that they are fully familiar with all aspects in the function, installation, operation and maintenance of all systems and equipment.
- .2 Arrange for and pay for the services of manufacturer's service technicians, engineers and other personnel required for instruction on specialized systems or installation.
- .3 After commissioning of the systems, equipment, and installation they shall be fully demonstrated by this Division and representatives of the manufacturers to the Authorities having jurisdiction.
- .4 Prior to requesting final inspection submit, for each system, the following:
 - .1 Dates and durations of instructions given to designated personnel and the names of persons instructed.
 - .2 Signature of each person instructed stating that they understand and are familiar with the function, installation, operation, and maintenance of the system.
 - .3 Dates and durations of demonstrations to Authorities having jurisdiction and names of all persons present.

1.46 OPERATING AND MAINTENANCE INSTRUCTION MANUALS

- .1 Supply one hard copy of operating and maintenance (O&M) manuals consolidated in hardcover three "D" ring binders with each binder sized to include approximately 25% spare space for future data. Confirm exact quantity of manuals with consultant. Each binder to include:
 - .1 On front cover: project name; wording – "Electrical Systems Operating and Maintenance Manual"; and date.
 - .2 Introduction sheet listing Consultant, Contractor, and Subcontractor names, street addresses, telephone and fax numbers, and e-mail addresses.

- .3 Equipment manufacturer's authorized contact person name, telephone number and company website.
 - .4 Table of Contents sheet, and corresponding Index tab sheets for all electrical specification sections.
 - .5 Copy of each "Reviewed" or clean, updated "Reviewed As Noted" shop drawing or product data sheet, with manufacturer's/supplier's name, telephone and fax numbers, email address, company website address, and email address for local source of parts and service; when shop drawings are returned marked "REVIEWED AS NOTED" with revisions marked on shop drawing copies, they are to be revised by equipment supplier to incorporate comments marked on "reviewed" shop drawings and a clean updated copy is to be included in operating and maintenance manuals;
 - .6 Testing and commissioning reports, and certificates issued by governing authorities.
 - .7 Operating data is to include:
 - .1 Demonstration and instruction certificate.
 - .2 Description of each system and its controls.
 - .3 Control schematics for equipment/systems.
 - .4 Description of operation of each system.
 - .5 Operation instruction for each system and each component.
 - .6 Description of actions to be taken in event of emergencies and/or equipment failure.
 - .7 Testing procedures.
 - .8 Trouble finding procedure.
 - .8 Maintenance data is to include:
 - .1 Servicing maintenance, operation, and trouble-shooting instructions for each item of equipment and each system.
 - .2 Schedules of tasks, frequency, tools required, and estimated task time.
 - .3 Complete spare parts lists with numbers.
 - .4 Catalogue sheets for all components.
 - .5 Approved shop drawings.
 - .6 Wiring diagram.
 - .9 Copies of warranties.
 - .10 Items requested specifically in Section Articles.
- .2 Operating and maintenance instructions are to relate to job specific equipment supplied under this project and related to Owner's building. Language used in manuals is to contain simple practical operating terms and language easy for in-house maintenance staff to understand how to operate and maintain each system.
 - .3 Before applying for a Certificate of Substantial Performance of the Work, assemble one copy of O&M Manual and submit to consultant for review prior to assembling remaining copies. Incorporate Consultant's comments into final submission.
 - .4 Provide 1 digital copies of contents of operating and maintenance manuals and load onto separate USB type flash drives and submit to consultant. Prepare digital copies using version of Adobe Acrobat Portable Document Format or equal as confirmed with consultant and enhanced with bookmarks and internal document links. Each PDF file name shall be the same as that indicated in the binder. The contents in each PDF file shall be searchable.

1.47 COMMISSIONING

- .1 A commissioning Authority will be appointed by the Board/Owner to oversee the commissioning activities of the electrical contract. Cooperate and coordinate with the Authority. Perform all commissioning activities for all aspects of work provided in Electrical Divisions. Perform all corrective work identified by the Authority.

- .2 Comply with the requirements of sections 20 05 40 and 25 05 15, prepared by Commissioning consultant.

1.48 WARRANTY

- .1 Unless otherwise specified in Divisions 00 and 01, warrant electrical work to be in accordance with Contract Documents and free from defects for a period of one (1) year from date of issue of a Certificate of Substantial Performance of the Work.
- .2 Where equipment includes extended warranty period, e.g., five (5) years, first year of warranty period is to be governed by terms and conditions of warranty in Contract Documents, and remaining years of warranty are to be direct from equipment manufacturer and/or supplier to Owner.
- .3 Warranty to include parts, labour, travel costs and living expenses incurred by manufacturer's authorized technician to provide factory authorized on-site service.
- .4 Repair and/or replace any defects that appear in Work within warranty period without additional expense to Owner. Be responsible for costs incurred in making defective work good, including repair or replacement of building finishes, other materials, and damage to other equipment. Ordinary wear and tear and damage caused wilfully or due to carelessness of Owner's staff or agents is exempted.
- .5 Do not include Owner deductible amounts in warranties.
- .6 It is understood that warranties are to commence from time of Substantial Performance of the Work, regardless of what is noted within following Sections of Specification. Be responsible for providing whatever "bridging" or additional extended warranty period is required from time that material is purchased until this time.
- .7 Submit signed and dated copies of extended warranties to consultant which clearly states herein specified requirements.
- .8 Visit building during warranty period with Owner representatives. Owner to organize these visits. At these meetings, Owner representatives are to review performance of systems. If performance is satisfactory, then no further action needs to be taken. If unsatisfactory, then correct deficiencies, as directed by Owner representatives, to satisfaction of Owner's representatives. These site visits to occur:
 - .1 once during first month of building operation.
 - .2 once during third month of building operation.
 - .3 once between fourth and tenth month in a season opposite to first- and third-month visits.
- .9 The following table indicates the warranty period that shall be provided for the following equipment:

EQUIPMENT	ITEMS	WARRANTY
LIGHTING	All types of lighting fixtures including LED lamps, drivers, and other associated components.	5 YEARS
LIGHTING CONTROLS	Lighting controls components including occupancy sensors, power packs, dimming switches, room controllers, control	5 YEARS

EQUIPMENT	ITEMS	WARRANTY
	wiring and other associated components	
DISTRIBUTION	Electrical distribution including switchboard, power panels, panel boards, contactors, transformers, relays, cables, wiring etc.	1 YEAR
FIRE ALARM SYSTEM	Fire alarm system completes with all components, devices etc.	1 YEAR

- .10 The Owner/Board reserves the right to initiate a service contract for all equipment with one of the boards approved certified service companies. This shall not affect any of the above extended warranties provided by the manufacturers.

1.49 EQUIPMENT AND SYSTEM MANUFACTURER'S CERTIFICATION

- .1 When equipment/system installation is complete, but prior to start-up procedures, arrange and pay for equipment/system manufacturer's authorized representative to visit site to examine installation, and after any required corrective measures have been made, to certify in writing to consultant that equipment/system installation is complete and in accordance with equipment/system manufacturer's instructions.

1.50 EQUIPMENT AND SYSTEM START-UP

- .1 When installation of equipment/systems is complete but prior to commissioning, perform start-up for equipment/systems as specified in electrical work Sections in accordance with following requirements:
- .1 Submit a copy of each equipment/system manufacturer's start-up and verification report sheet to consultant for review and incorporate any comments.
 - .2 Under direct on-site supervision and involvement of equipment/system manufacturer's representative, start-up equipment/systems, make any required adjustments, document procedures, leave equipment/systems in proper operating condition, and submit a complete set of start-up and verification documentation sheets signed by manufacturer/supplier and Contractor, to consultant.

1.51 PROJECT CLOSEOUT SUBMITTALS

- .1 Prior to application for Substantial Performance of the Work, submit required items and documentation specified, including following:
- .1 Operating and Maintenance Manuals.
 - .2 As-built record drawings and associated data.
 - .3 Extended warranties for equipment as specified.
 - .4 Operating test certificates, i.e., Fire alarm verification Certificate.
 - .5 Final commissioning report.
 - .6 Identified keys for equipment and/or panels for which keys are required, and other items required to be submitted.
 - .7 Other data or products specified.

1.52 INSTRUCTIONS TO OWNER

- .1 Refer to equipment and system operational and maintenance training requirements specified in Division 01.

- .2 Train Owner's designated personnel in aspects of operation and maintenance of equipment and systems as specified. Demonstrations and training are to be performed by qualified technicians employed by equipment/system manufacturer/supplier. Supply hard copies of training materials to each attendee.
- .3 Unless where specified otherwise in trade Sections, minimum requirements are for manufacturer/suppliers of each system and major equipment, to provide minimum two separate sessions each consisting of minimum 4 hours on site or in factory training (at Owner's choice), of Owner's designated personnel (for up to 6 people each session), on operation and maintenance procedures of system.
- .4 For each item of equipment and for each system for which training is specified, prepare training modules as specified below. Use Operating and Maintenance Manuals during training sessions. Training modules include but are not limited to:
 - .1 Operational Requirements and Criteria – equipment function, stopping and starting, safeties, operating standards, operating characteristics, performance curves, and limitations.
 - .2 Troubleshooting – diagnostic instructions, test, and inspection procedures.
 - .3 Documentation – equipment/system warranties, and manufacturer's/supplier's parts and service facilities, telephone numbers, email addresses, and the like.
 - .4 Maintenance – inspection instructions, types of cleaning agents to be used as well as cleaning methods, preventive maintenance procedures, and use of any special tools.
 - .5 Repairs – diagnostic instructions, disassembly, component removal and repair instructions, instructions for identifying parts and components, and review of any spare parts inventory.
 - .6 The training sessions shall be scheduled and co-ordinated by the Commissioning Agent. The Commissioning Consultant shall video tape the sessions. Refer to Section 20 05 40 for further requirements.
- .5 Before instructing Owner's designated personnel, submit to consultant for review a preliminary copy of training manual and a proposed schedule of demonstration and training dates and times. Incorporate Consultant's comments in final copy.
- .6 Obtain in writing from consultant a list of Owner's representatives to receive instructions. Submit to Consultant prior to application for a Certificate of Substantial Performance of the Work, a complete list of systems for which instructions were given, stating for each system:
 - .1 Date instructions were given to Owner's staff.
 - .2 Duration of instruction.
 - .3 Names of persons instructed.
 - .4 Other parties present (manufacturer's representative, consultants, etc.).
- .7 Obtain signatures of Owner's staff to verify they properly understood system installation, operation, and maintenance requirements, and have received operating and maintenance instruction manuals and "as-built" record drawings.
- .8 Submit to Consultant, copy of electronic version of training materials used to train Owner's designated personnel. Include in operating and maintenance manuals submission.

1.53 FINAL INSPECTION

- .1 Submit to Consultant, written request for final inspection of systems. Include written certification that:
 - .1 Deficiencies noted during job inspections have been completed.
 - .2 Field quality control procedures have been completed.
 - .3 Systems have been tested and verified, adjusted, and are ready for operation.
 - .4 Maintenance and operating data have been completed and submitted to, reviewed, and accepted by consultant.

- .5 Tags and nameplates are in place and equipment identifications have been completed.
- .6 Clean-up is complete.
- .7 Spare parts and replacement parts specified have been provided and acknowledged by consultant.
- .8 As built and record drawings have been completed and submitted to, reviewed, and accepted by consultant.
- .9 Owner's staff has been instructed in operation and maintenance of systems.
- .10 Commissioning procedures have been completed.

1.54 SUB-CONTRACTORS TO THE ELECTRICAL CONTRACTOR

- .1 The Electrical Contractor agrees to employ those sub-contractors proposed in the Electrical Form(s) of Tender and accepted by the Board/Owner at the signing of the Contract with the General Contractor.
 - .1 The Board/Owner may, for reasonable cause object to the use of a proposed Sub-Contractor and consequently, may require the Electrical Contractor to employ one of the other Sub-Contractors or Bidders.
- .2 If the Board/Owner requires a change from a proposed Sub-Contractor originally proposed by the Electrical Contractor, the Contract Price shall be adjusted by the difference in cost.
- .3 The Electrical Contractor shall not be required to employ as a Sub-Contractor, a firm to whom he may reasonably object.

END OF SECTION

1. General

1.1 GENERAL REQUIREMENTS

- .1 Conform to the requirements of Division 01.
- .2 Conform to the requirements of Section 20 05 01.
- .3 Provide labour and tools / equipment to conduct the commissioning process as outlined in this specification section.
- .4 Where “Contractor” is referenced herein this section, it shall be understood to mean “Electrical Division Contractor”.

1.2 COMMISSIONING QUESTIONS/QUERIES

- .1 Questions or queries related to this Section of the Specification shall be directed to Board’s Commissioning Consultant/Agent.

2. Products

2.1 PRODUCTS

- .1 The Contractor and manufacturers shall provide all instrumentation and equipment necessary to conduct the tests specified. The Contractor shall advise the Consultants of instrumentation to be used and the dates the instruments were calibrated.

3. Execution

3.1 THE COMMISSIONING PROCESS

- .1 The commissioning process consists of:
 - .1 Shop Drawings and Record Drawings
 - .2 Installation inspection and equipment verification
 - .3 Independent testing contractor
 - .4 Testing of equipment and systems
 - .5 Commissioning Consultant performance testing
 - .6 Commissioning meetings and reporting
 - .7 Operating and maintenance manuals
 - .8 Operator Training
 - .9 Systems Demonstration and turnover
 - .10 Testing forms
 - .11 Warranties

3.2 SHOP DRAWINGS AND RECORD DRAWINGS

- .1 Conform to articles entitled “Shop Drawings” and “Record (As-built) Drawings” of section 20 05 01 for requirements for shop drawings and record drawings.

3.3 INSTALLATION INSPECTION AND EQUIPMENT VERIFICATION

- .1 The Contractor shall co-ordinate with the Consultant who will inspect the electrical installation.
- .2 The Contractor shall complete the equipment verification forms for each piece of equipment. The forms shall be included in the operating and maintenance manual. The equipment data shall include:
 - .1 Manufacturer's name, address, and telephone number.
 - .2 Distributor's name, address, and telephone number.
 - .3 Make, model number and serial number.
 - .4 Electrical - volts, amps, fuse size, overload size.
 - .5 Any other special characteristics.

3.4 TESTING OF EQUIPMENT AND SYSTEMS

- .1 General
 - .1 The Contractor shall be responsible for all tests detailed in the electrical specification and those tests required by a manufacturer as part of their installation requirements.
 - .2 The Contractor shall, with the services of the manufacturer's technicians, test the equipment and associated systems. The technician shall record the results of the tests on the testing forms. The Consultant or the Commissioning Consultant shall witness the tests. When the tests have been completed satisfactorily the technician and witnessing authority shall sign the forms. A copy of the forms shall be forwarded to the Consultant. The original shall be inserted into the operating and maintenance manual.
 - .3 Should equipment or systems fail a test, the test shall be repeated after repairs or adjustments have been made. The additional tests shall be witnessed.
 - .4 Tests, which have not been witnessed, shall not be accepted, and shall be repeated.
 - .5 When all testing has been completed, and all mechanical and electrical systems are operational; Electrical Contractor shall conduct system load balance measurements, infrared test, and harmonics tests.
 - .6 The equipment and systems to be tested shall include:
 - .1 Power feeder cables
 - .2 Power panels and panel boards
 - .3 Fire detection and alarm system
 - .4 Intrusion detection system
 - .5 Video surveillance system
 - .6 Specialty equipment

3.5 COMMISSIONING MEETINGS AND REPORTING

- .1 The Contractor shall include the schedule for all tests in the construction schedule.
- .2 The commissioning process and results shall be reviewed during the regular construction meetings. Separate commissioning meetings may be scheduled at the discretion of the Consultant.
- .3 All testing forms and reports associated with the electrical systems shall be directed to the Consultant with copies to the Consultant, Commissioning Consultant and The Board.
- .4 The forms and reports to be issued shall include:
 - .1 Shop drawings issued and accepted.
 - .2 Equipment verification forms.
 - .3 Testing forms.
 - .4 Reports resulting from tests.
 - .5 Testing schedule.

3.6 OPERATING AND MAINTENANCE MANUAL

- .1 Conform to section 20 05 01 for requirements for the O&M Manuals.

3.7 OPERATOR TRAINING

- .1 Conform to this section and any pertinent sections of the electrical specification for the requirements of Instructions to the building Operating Staff for each system and equipment.
- .2 The training shall be conducted either in a organize room or at the equipment or system.
- .3 Training will begin when the operating and maintenance manuals have been delivered to The Board and approved by the consultant.
- .4 Each training session shall be structured to cover:
 - .1 Design intent of each system.
 - .2 Operating procedures.
 - .3 Maintenance procedures.
 - .4 Trouble-shooting procedures.
 - .5 The use of the operating and maintenance (O&M) manuals.
 - .6 System start-up, normal operation, shutdown, manual operation, and alarms.
 - .7 Spare parts required and parts sources.
 - .8 Relevant health and safety issues.
- .5 Submit a course outline to the Consultant before training commences. Provide course documentation for up to four people.
- .6 The training sessions shall be scheduled and co-ordinated by the Commissioning Agent. The Commissioning Consultant shall video tape the sessions.
- .7 Training shall be provided for the following systems:

System	Minimum Training Time
Electrical system and distribution	8 hours
Fire detection and alarm system	8 hours
Intrusion detection system	8 hours
Video surveillance system	8 hours
Public address system	8 hours

- .8 The training requirement for the electrical system shall include a walk-through of the building by the Contractor. During the walk through the contractor shall:
 - .1 Identify equipment.
 - .2 Identify electrical panels.
 - .3 Identify starters and disconnects.
 - .4 Review electrical power distribution.
 - .5 Identify maintenance items.
 - .6 Review general equipment maintenance and procedures.
- .9 When each training session has been completed The Board, or the Commissioning Consultant shall sign the associated form to verify completion.

3.8 COMMISSIONING CONSULTANT

- .1 The Board shall hire a Commissioning Consultant (CC).

- .2 The CC responsibilities shall include:
 - .1 Preparing the commissioning plan.
 - .2 Co-ordinating with the contractor to schedule tests.
 - .3 Preparing a test form manual.
 - .4 Witnessing selected tests.
 - .5 Receiving all test forms.
 - .6 Co-ordinating the contractors training.
 - .7 Chair commissioning meetings.
- .3 The contractor shall co-operate with the CC.
- .4 The contractor shall provide assistance to the CC and have personnel available during the performance testing procedure. Each electrical system shall be tested in the operational mode.

3.9 ELECTRICAL SYSTEM DEMONSTRATION AND TURNOVER

- .1 Refer to article entitled “Instructions to Owner” of specification section 20 05 01.
- .2 The system demonstration and turnover to The Board shall occur when:
 - .1 The installation is complete.
 - .2 Training has been completed.
 - .3 Shop-drawings have been updated.
 - .4 As-built drawings have been completed.
 - .5 Operating and Maintenance Manuals have been accepted.
 - .6 The acceptance test conducted by the Consultant has been completed successfully.
 - .7 The commissioning process has been completed successfully and system operation accepted by the Consultant and Commissioning Agent.
- .3 The Contractors and manufacturers shall conduct the systems demonstration. The demonstration shall cover a demonstration of equipment installation and operation.

3.10 TESTING FORMS

- .1 The Contractor and manufacturers shall fill out the forms listed in this section or provide other forms. The Consultant and The Board must approve the forms before they are used.

3.11 WARRANTIES

- .1 Equipment and system warranties shall not begin until the system demonstration and turnover has been conducted successfully and accepted by The Board.
- .2 The Contractor shall fill out the warranty form listing the equipment and systems and the start and finishing dates for warranty.
- .3 Comply with section 20 05 01 for requirements during the warranty period.

3.12 COMMISSIONING PROCESS ALLOCATION

- .1 The commissioning process shall be allocated a value equal to 4% of the electrical contract. The contractors may draw from this allocation as the commissioning process is completed.
- .2 The contractors shall submit all test and verification forms. The Consultant will use these forms to calculate percentage complete.

END OF SECTION

1. General

1.1 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA)
 - .1 CAN/CSA-C22.2 No. 131, Type TECK 90 Cable.
 - .2 CSA-C22.2 No. 51 (latest edition), Armoured Cables.
 - .3 CSA C22.2 No. 38 (latest edition), Thermoset-Insulated Wires and Cables.
 - .4 CSA C22.2 No. 75 (latest edition), Thermoplastic-Insulated Wires and Cables.
 - .5 CSA C22.2 No .0.3 (latest edition), Test Methods for Electrical Wires and Cables.

2. Products

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 Low voltage wires and cables up to 4/0 shall, unless otherwise noted, have copper conductors with T90 Nylon, 600-volt insulation.
- .3 Low Voltages wires and cables 250 MCM and larger shall, unless otherwise noted, have copper conductors with RW90 X-Link minus 40 degrees F, 1000-volt insulation.
- .4 Aluminium sheathed feeder cables shall, unless otherwise noted, have a corrugated seamless aluminium sheath, copper conductors, RA90 X-Link minus 40 degrees F, 1000-volt insulation and without P.V.C. jacket.
- .5 M.I.C.C. cables shall have solid copper conductors insulated with magnesium oxide and enclosed in a seamless copper sheath with a protective jacket where required.
- .6 All outdoor and underground wiring shall have copper conductors with RWU-90, X-Link, minus 40 degrees F, 1000-volt insulation.

3. Execution

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical.
- .2 Wires and cables shall be selected so that their current carrying capacity conforms to the standards of the Authorities having jurisdiction.
- .3 Feeders and branch circuits shall be as indicated on the drawings. Supporting of wires and cables with tie wires, perforated straps, etc., shall not be permitted. Electrical Contractor shall use approved clips.
- .4 Unless otherwise indicated on the drawings no wire smaller than #12 AWG shall be used except for internal wiring of lighting fixtures which can be #14.
- .5 BX90 aluminium sheathed cable, unless otherwise noted, may be used in accessible ceiling space and where concealed only. Install BX cables with anti-short bushings.

- .6 Aluminium sheathed and M.I.C.C. cables shall be installed with horizontal supports at not more than 1220mm intervals and shall be spaced, bonded, and grounded in accordance with the requirements of the Authorities having jurisdiction.
- .7 Aluminium sheathed and M.I.C.C. cables shall be terminated with moisture proof connectors.
- .8 Where single conductor cables enter a ferrous box, provide the required non-ferrous plates. Slotting between the knockouts shall not be accepted.
- .9 Aluminium sheathed and M.I.C.C. cables shall be suitably protected, when installed within 5 feet of the floor and in all locations where they might be subject to mechanical injury.
- .10 Joints in feeder cables shall not be permitted.
- .11 Joints in branch circuit wiring shall only occur where such circuits divide at a junction box and shall be mechanically and electrically sound and shall be securely fastened by means of "Ideal" 600V special service wire nut connectors.
- .12 Conductors shall be colour coded and the colour coding shall be consistent throughout the project.
- .13 Conductors shall be identified with self-sticking wire markers, indicating circuit number at all terminations and joints, at panels, pull boxes, junction boxes, etc.
- .14 Termination lugs for feeder cables shall be compression type.
- .15 All outdoor and underground wiring shall have copper conductors with RWU-90, X-Link, minus 40 degrees F, 1000-volt insulation.
- .16 Wiring terminated in an outlet box for future lighting or power shall have 250mm of slack and each cable shall be terminated in a connector.
- .17 Exposed cable runs shall be installed parallel to, or horizontally on, the walls of the building.
- .18 Loads shall be circuited to provide fully balanced feeders.
- .19 Only lubricants approved by the Authorities having jurisdiction shall be used and they shall be suitable for the type of cables installed.

END OF SECTION

1.1 GENERAL

1.2 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.

1.3 REFERENCES

- .1 Canadian Standards Association (CSA)
 - .1 OESC – Latest Edition.
 - .2 Electrical Safety Authority – Latest Inspection Bulletins.
 - .3 CSA C22.1, Canadian Electrical Code, Part 1 – Latest Edition.
 - .4 CAN/CSA Z32, Electrical Safety and Essential Electrical Systems in Health Care Facilities, where applicable.

2. Products

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 The grounding equipment shall be in accordance with CSA C22.2 and the copper grounding conductors in accordance with ASA G7.1.
- .3 Provide non corroding accessories necessary for the grounding system.
- .4 Building ground system to consist of a grid of copper welded ground rods (minimum 4' to 10' (1.2m to 3m) long spaced minimum of 10' (3m) apart, interconnected with bare minimum No. 3/0 AWG copper loop. Ground rods shall be driven sufficiently to contact permanent water table. Provide minimum No. 3/0 AWG copper ground loop inside electrical room and vaults for grounding of equipment enclosures and connect to ground grid. Connect building water service pipes (both street and building sides), gas service pipes and sprinkler system pipes, supply and return hot water heating pipes to ground system with minimum No. 3/0 AWG copper ground conductor in conduit. Perform resistivity test on soil to determine exact quantity of rods (minimum of 4).
- .5 All buried ground connections shall be Thermit welded type.
- .6 Provide one (1) No. 3/0 AWG insulated green copper ground conductor in conduit from the main building ground to the main Telephone/LAN Room. Provide a minimum 24" (600mm) long x 2" (50mm) high x 3/8" (10mm) thick copper ground bus and install on wall with standoff isolators and connect to 3/0 cable. Ground bus to have eight drilled taps. Provide one (1) #6 AWG green ground conductor in conduit from this ground bus and extend to each satellite LAN Room and coil for future connection to computer cable termination rack.
- .7 Where cable trays are used for the data cabling pathways, ensure that they are grounded and bonded in accordance with the Ontario Electrical Safety Code.
- .8 Continuous rows of fluorescent/LED fixtures shall be equipped with No. 12 bare copper ground wire for the full length of fixture row.
- .9 The accessories shall be as manufactured by Burndy, Erico, Amp or Caldwell.

3. Execution

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical.
- .2 Provide complete permanent and continuous, system and equipment grounding systems including, ground rods, conductors, connectors, accessories, to conform to requirements of the Authorities having jurisdiction.
- .3 Install connectors to manufacturer's instructions.
- .4 Protect exposed grounding conductors from mechanical injury.
- .5 All non-current carrying metal parts shall be bonded in accordance with ESA, CSA, and provincial inspection department standards.
- .6 The neutrals of the dry-type transformer shall be connected by a separate copper ground wire to the ground bus in the switchboard.
- .7 A separate copper ground wire to the ground bus in the switchboard shall be provided for each isolation transformer and isolated ground lighting panel.
- .8 Separate copper wire shall be installed in all flexible conduits, in all rigid conduits, in wall or below slab conduits, EMT conduits and all non-metallic conduits.
- .9 Connect the ground bus in the main switchboard to the main ground and incoming water main ahead of the water meter and provide a water meter shunt.
- .10 The grounding system in the main switchboard shall be suitable for use with the ground fault system.
- .11 Install separate grounding/bonding systems for telephone system, fire detection and alarm system, public address system, video surveillance system and intrusion detection system, in accordance with the systems suppliers' requirements.
- .12 Install grounding system for pad mounted transformer in accordance with ESA and Local Hydro requirements.
- .13 All grounding conductors run inside of building, except in electrical and LAN rooms, shall be run in EMT conduit.
- .14 Install separate ground conductor for outdoor lighting standards.
- .15 Install grounding connections to typical equipment included in, but not necessarily limited to following list: Service equipment, transformers, switchgear, duct systems, motor frames, motor control centres, starters, control panels, building steel work, generators, elevators and escalators, distribution panels, outdoor lighting etc.
- .16 Install electrode interconnections where metal parts, circuits, or grounding conductors and/or electrodes are in proximity to lightning rod conductors.
- .17 Perform ground continuity and resistance tests using method appropriate to site conditions and to approval of Owner's Representative and local authority having jurisdiction over installation.

END OF SECTION

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1. General

1.1 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.

1.2 SUBMITTALS

- .1 Submit shop drawings for all products specified in Part 2.

2. Products

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 Type 'C', 'D', 'T' and 'E' pull boxes, junction boxes and cabinets shall be made of code gauge steel with corners lapped and welded and shall be painted and identified as noted in this specification.
- .3 Cabinets shall provide proper space for conduits, wires and connections and their size shall be in accordance with the requirements of the Authorities having jurisdiction.
- .4 The trim and cover shall be as required by the service and location.
- .5 Splitters shall be sheet metal enclosure complete with welded corners and formed hinged cover suitable for locking in closed position.
- .6 Splitters main and branch lugs/connection bars shall match the required size and number of incoming and outgoing conductors as indicated on drawings.
- .7 At least three spare terminals shall be provided on each set of lugs in splitters less than 400A.
- .8 The metal cabinets shall be as manufactured by Eaton, Square-D, Siemens, or Hammond.

3. Execution

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical.
- .2 Pull boxes, junction boxes and cabinets shall be independently supported from the conduit connected to them.
- .3 Pull boxes shall be installed in inconspicuous but accessible locations.
- .4 The cabinets shall be suitable for the installation and location.
- .5 Cabinets shall be mounted with top not higher than 2m above finished floor.
- .6 All electrical pull boxes above drywall ceilings shall be accessible via a properly sized access door installed directly below the respective pull box in drywall ceilings. Temporary removal of electrical light fixtures will not be considered safe access to above ceiling electrical boxes and shall not be permitted and acceptable.

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- .7 Install splitters and mount plumb, true and square to the building lines.
- .8 All pull boxes, cabinets, equipment shall be identified in accordance with Section 26 05 01, Electrical Work General Instructions.
- .9 Identification labels shall be provided indicating system name voltage and phase.

END OF SECTION

May 2025

1. General

1.1 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA)
 - .1 CSA C22.1, Canadian Electrical Code, Part 1.
 - .2 OESC – Latest Edition.
 - .3 Electrical Safety Authority – Latest Inspection Bulletins.

2. Products

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 Size boxes in accordance with latest edition of OESC and/or CSA C22.1.
- .3 102 mm square or larger outlet boxes shall be provided as required for special devices.
- .4 Blank cover plates shall be provided for all outlet boxes without wiring devices.
- .5 347 V outlet boxes shall be provided for 347 V switching devices.
- .6 Barriers shall be provided for outlet boxes where more than one system are grouped.
- .7 Outlet boxes used with rigid steel conduit shall be 'FS' or 'FD' Feraloy condulets.
- .8 Outlet boxes used with EMT conduit shall be electro-galvanized and made of code gauge steel except when they are surface mounted on walls and then they shall be 'FS' or 'FD' Feraloy condulets.
- .9 Outlet boxes installed outside the building shall be weatherproof type, with neoprene gasket and cast cover.
- .10 Electro-galvanized steel masonry single and multi-gang boxes shall be provided for devices flush mounted in exposed block walls.
- .11 Electro-galvanized sheet steel concrete type boxes shall be provided for flush mount in concrete with matching extension and plaster rings as required.

3. Execution

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical.
- .2 All outlet boxes shall be supported independently of connecting conduits.
- .3 Outlet boxes shall have adequate knockouts, but only those knockouts actually required shall be opened.

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- .4 Outlet boxes shall be securely fastened to the surface on which they are mounted. If the boxes are not mounted on a surface, then adequate and independent supports must be provided.
- .5 Outlet boxes shall be provided for each surface mounted lighting fixture.
- .6 Outlet boxes shall be provided for each recessed mounted lighting fixture.
- .7 Multi-gang outlet boxes with single cover plate shall be used where switches are grouped.
- .8 Unused opened knockouts shall be closed with steel knockout plugs.
- .9 Correct size of openings shall be provided in boxes for conduit, mineral insulated and armoured cable connections. Installation of reducing washers will not be acceptable and allowed.
- .10 All electrical outlet boxes above drywall ceilings shall be accessible via a properly sized access door installed directly below the box in drywall ceilings. Temporary removal of electrical light fixtures will not be considered safe access to above ceiling electrical boxes and shall not be permitted and acceptable.

END OF SECTION

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1. General

1.1 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA)
 - .1 CSA C22.2 No. 45, Rigid Metal Conduit.
 - .2 CSA C22.2 No. 83, Electrical Metallic Tubing.
 - .3 CSA C22.2 No. 211.2, Rigid PVC (Un-plasticized) Conduit.
 - .4 CSA C22.2 No. 56, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
 - .5 CAN/CSA C22.2 No. 227.3, Flexible PVC conduit. Non-metallic Mechanical Protection Tubing (NMPT), a National Standard of Canada.

1.3 SUBMITTALS

- .1 Submit shop drawings for all products specified in Part 2.
- .2 Submit the following to the Consultant for review:
 - .1 Location drawings for all required sleeves and formed openings in poured concrete or precast concrete construction.
 - .2 Samples of materials and any other items as specified in succeeding Sections of this Division of the Specification.

2. Products

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 Rigid metal conduits shall be electro-galvanized and made of standard weight steel pipe and connected with electro-galvanized threaded couplings.
- .3 Electrical metallic tubing shall be a metal raceway which has a wall thinner than that of rigid metal conduit and an outside diameter sufficiently different from that of rigid metal conduit to render it impracticable for anyone to thread it with a standard pipe thread.
- .4 Rigid PVC conduits shall be a rigid non-metallic conduit of un-plasticized polyvinyl chloride.
- .5 Rigid Type I shall be similar to rigid PVC duct, Type EB1, to CSA Standard B196.1 requiring encasement in concrete.
- .6 Rigid Type II shall be similar to Type I except of heavier construction and suitable for direct burial.
- .7 Flexible conduits shall be liquid-tight flexible metal conduit.
- .8 Rigid metal conduits entering boxes in dry locations shall be secured with galvanized steel locknuts and nylon insulated steel bushings.
- .9 Rigid metal conduits entering boxes in wet locations shall be secured with steel bullet hub connectors, nylon insulated with neoprene 'O' ring.

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- .10 Connectors for EMT surface mounted conduit shall be steel, set screw and nylon insulated.
- .11 Connectors for EMT conduit in concrete shall be steel, raintight, concrete tight and nylon insulated.
- .12 Couplings for EMT conduit surface mounted shall be steel set screw type.
- .13 Couplings for EMT conduit in concrete shall be steel, rain tight and concrete tight.
- .14 Connectors for flexible conduit shall be steel, liquid-tight, nylon insulated with neoprene 'O' ring.

3. Execution

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical.
- .2 Install all conduit, conduit fittings and accessories in accordance with the latest edition of the Canadian Electrical Code in a manner that does not alter, change, or violate any part of the installed system components or the CSA/UL certification of these components.
- .3 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.
- .4 Raceways shall be as shown on the Drawings and as detailed in the Specification.
- .5 The size of conduit shall be in accordance with the requirements of the Authorities having jurisdiction.
- .6 All conduits inside the building shall, unless otherwise noted, be electrical metallic tubing.
- .7 Unless otherwise noted branch circuit conduits shall be concealed in wall and ceilings or exposed in unfinished areas and shall not be installed below or in any concrete slab unless otherwise approved by the owner/consultant. Where it is noted that branch circuit conduits can be installed in a concrete slab that is not on grade the conduit shall be electrical metallic tubing with a copper ground wire.
- .8 Conduits exposed to the weather, in wet locations, subject to mechanical injury or in any hazardous locations, shall be rigid metal conduit.
- .9 Conduits in plenums shall be rigid metal conduit.
- .10 Telephone zone conduits shall be PVC conduit when installed in concrete and EMT in other locations.
- .11 Telephone distribution conduits shall be rigid P.V.C. conduit when installed in concrete or underground and EMT conduit in other locations.
- .12 Motor feeder drops shall be in rigid conduit with a maximum 910mm of flexible metal conduit. Rigid conduit for the drops shall start at least 910mm ahead of the actual bend and have two additional clips over normal requirements. The minimum conduit size for the drops shall be 19mm.
- .13 Liquid tight flexible metal conduit shall be used for connection to motors or vibrating equipment in damp, wet or corrosive locations.
- .14 Explosion proof flexible connection shall be used for connection to explosion proof motors.

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- .15 Conduit sealing fittings shall be installed complete with compound in hazardous areas.
- .16 Conduits in finished areas shall be concealed and those in unfinished areas shall be surface mounted unless otherwise noted.
- .17 Feeder conduits shall not be installed in or below any concrete slab, unless approved by the Consultant.
- .18 Conduits shall be installed so that the conductors can be drawn in without strain or injury.
- .19 Expansion fittings shall be installed in conduits crossing expansion joints.
- .20 Conduits shall be installed to provide for expansion and expansion fittings shall be provided where required.
- .21 Conduits shall not be installed within 75mm of water, sprinkler, drain or waste piping.
- .22 Exposed conduits shall run parallel to or horizontally on the walls of the building.
- .23 Conduit ends shall be carefully plugged during construction with steel capped bushings.
- .24 The use of running threads shall not be permitted. Ericson couplings shall be used where required.
- .25 Conduits shall not pass-through structural members without the approval of the Consultants.
- .26 Powder activated fastenings can only be used if approved by the Consultant.
- .27 Conduits shall be fastened with approved clips. Supporting of conduits with tie wires, perforated straps, etc. shall not be permitted. If a conduit rests on structural steel, etc., this will not be considered as a support. Provide proper supports, hangers, etc. and supports conduits from the top of structural beams/joists.
- .28 Conduits shall not be attached or suspended from the metal deck unless approved by the Consultant.
- .29 Conduit supports shall be spaced in accordance with the requirements of the Authorities having jurisdiction.
- .30 An adequate number and size of pull boxes shall be installed where required in all conduits runs to facilitate the installation of the conductors.
- .31 Fish wires shall be installed in all empty conduits, including telephone conduits.
- .32 Excessive lengths of flexible conduit shall not be accepted. Maximum 10'-0" of length will be acceptable.
- .33 Proper metallic contacts shall be made between conduit, boxes, etc.
- .34 Maximum size of conduit on which ground bushings can be used is 32mm.
- .35 A separate ground wire shall be installed in all flexible conduits, EMT conduits, underground conduits, in wall or below a concrete slab, underground parking lot lighting and in all non-metallic conduits or ducts.
- .36 Installation of conduit in oversize knockouts shall not be accepted.

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- .37 Joints in conduits installed underground, in concrete slab on grade or in a concrete duct bank shall be pitched on the outside and made completely watertight.
- .38 Minimum concrete thickness over a conduit in a concrete slab where applicable shall be 50mm.
- .39 Spare or unused conduits that terminate in an enclosure shall be capped.
- .40 Conduits passing through concrete and/or masonry floors, walls, roof and any other such construction shall be provided with sleeves.
- .41 Electrical conduit roof flashing shall be similar to National Roofing supply product code# ECP-PVCH (electrical conduit post PVCH), Gooseneck S.S.A ARPGN2 (2")/ ARPGN3 (3").
- .42 Protect conduits from damage where they stub out of concrete. Use rigid steel conduit for stub-up and adapt to in floor rigid PVC conduit.

END OF SECTION

1. General

1.1 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.

1.2 SUBMITTALS

- .1 Submit shop drawings for all products specified in Part 2.
- .2 Submit manufacturer's instructions, printed product literature and data sheets. Include product characteristics, performance criteria, physical size, finish, and limitations.

2. Products

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 Provide dual hanger system as described below and as shown on drawings.
- .3 Hangers where noted are to be complete with the following features:
 - .1 4" J-Hook; Legrand cat. # CJ64H.
 - .2 Approximately 150 mm (6") high by 50 mm (2") wide.
 - .3 Constructed from steel.
 - .4 Pre-galvanized finish.
 - .5 Suitable for wall or suspended mounting.
 - .6 J-Hooks shall be installed as per details as shown on drawings.
 - .7 Mono systems; J-Hook/Steel Cat. #H-433-S shall be considered equivalent.
- .4 As an alternate to the hanger system detailed, the contractor may use as an equal, one run of 50 mm (2") x 150 mm (6") wire mesh cable management system equal to Cablofil Cat. #CF 54/150 EZ complete with Cat. #FAS L 150 universal wall bracket where, noted shall be wall mounted and Cat. #FAS C 200 where, noted shall be hung. The hangers shall be installed at intervals as recommended by the manufacturer but not greater than 2.4 m (8'-0") on centre.
- .5 Cable Tray/ Management System:
 - .1 The system, where noted, shall be a continuous, rigid, welded steel wire mesh cable management system with the following features:
 - .1 Permits continuous ventilation of cable and maximum dissipation of heat.
 - .2 Continuous safety edge T-welded wire lip.
 - .3 Welded at all intersections.
 - .4 Straight sections 4" x 12" (100 mm x 300 mm) in configurations noted on the drawings.
 - .5 Constructed of carbon steel wire, ASTM A 510, Grade 1008. Wire welded, bent and surface treated after manufacture.
 - .6 Post fabrication finish of electro-plated zinc galvanizing:
 - .1 ASTM B 633, Type III, SC-1.
 - .7 Fittings:
 - .1 Field fabricated in accordance with manufacturer's instructions for straight sections.

- .2 The support system shall be Cablofil FAS CH hanger.
- .3 The necessary hardware, including splice connectors and support components furnished by manufacturer.
- .4 The product shall be Cablofil Cat. #CF105/300 EZ complete with Cat. #FAS P300 CH at intervals as recommended by the manufacturer.
- .5 The manufacturer shall be Cablofil Inc.
- .6 Flextray, Cat. #FT4x12x10 complete with 12 CTR HGR shall be considered equivalent.

3. Execution

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical
- .2 Cable Management Hangers:
 - .1 Install hangers as per details in configuration noted.
 - .2 Prior to installation co-ordinate location with other services within the ceiling space.
 - .3 Co-ordinate with noted sub-contractors to install cables noted to be utilizing these hangers. Cables are to be installed such that the maximum sag between hangers does not exceed 25 mm (1"). This electrical contractor is to coordinate.
 - .4 Attaching cable to any T-bar support rods is not acceptable.
- .3 Cable Tray/ Management System:
 - .1 Install cable management system at locations indicated on the drawings and in accordance with manufacturer's instructions.
 - .2 Support system every 2.4 m (8'-0") unless system is used within a telecommunication room. In that situation, support every 1.5 m (5'-0").
 - .3 Cut wires in accordance with manufacturer's instructions.
 - .4 Cut wires with side action bolt cutters to ensure integrity of galvanic protective layer. Cut using side action bolt cutters (Cablofil Cat. #Coupfil).
 - .5 Cut each wire with 1 clean cut to eliminate grinding or tough-up.
 - .6 Install cable management system using hardware, splice connectors, support components, and accessories furnished by manufacturer.
 - .7 Suspend from structure or intermediate Unistrut channel spanning across the corridor where access to structure is not available due to the concentration of mechanical ductwork and/or piping.

END OF SECTION

1. General

1.1 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.

2. Products

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 Access panels for walls and ceiling shall be of the flush type with concealed flanges constructed from 12 gauge minimum bonderized steel and shall be complete with anchor straps, rust resistant concealed hinges and positive locking, self-opening screwdriver operated lock. Coordinate with Division 23.
- .3 Access panels in tiled walls shall be stainless steel with recessed door panel to accept wall finish and shall be of a size to suit tile pattern.
- .4 Access panels installed in fire rated walls, partitions or ceilings shall have a fire resistance rating equal to the materials in which they are installed.
- .5 Access panels shall be as manufactured by LeHage, SMS, Pedlar or approved equal.

3. Execution

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical.
- .2 All parts of the installation including, but not limited to, pull-in, junction and outlet boxes, cabinets, gutters, etc. shall be accessible.
- .3 Supply access panels as required to provide complete access to all equipment and connections. The access panels shall be installed by other Sections of the specification.
- .4 Provide drawings showing size, type and location of all access panels and submit for review by the Consultant.

END OF SECTION

1. General

1.1 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.

2. Products

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 Electric supplementary heaters and controls shall, unless otherwise noted, be supplied by Division 23.

3. Execution

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical.
- .2 Install all electric heaters and remote electric thermostats supplied by Division 23.
- .3 Electric duct heaters shall be installed by another Division of Specification.
- .4 Provide all conduit, wiring, etc. and connect to the electric heaters, electric duct heaters and remote electric thermostats to provide a complete Electric Heating System.
- .5 Install filler pieces as shown on the drawings between baseboard heaters to form a continuous length.
- .6 All L.V. control wiring shall be by Division 23.

END OF SECTION

1. General

1.1 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.

2. Products

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 The pipe tracing cables, and controls shall, unless otherwise noted, be provided by Division 23.

3. Execution

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical.
- .2 Provide all conduit, wiring, pipe tracing cables, etc., and connect to the pipe tracing cables and controls to provide a complete pipe tracing system.

END OF SECTION

1. General

1.1 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.

2. Products

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 This Section is for provisions for Building Automation System only.
- .3 Divisions 23 will supply and install a Computerized Building Automation System complete with the distribution boxes, control sequencing and all interfacing.
- .4 Division 26 shall provide individual lighting relays and/or contactors for each individual circuit and associated relay boxes and connect to load side of relays, as shown on the drawings. All control wiring by Division 23.
- .5 Contactors used in conjunction with building automation system shall be electrically operated, electrically held type. Refer to Section 26 29 01.
- .6 Coordinate all work with Division 23.

Execution: NOT USED

END OF SECTION

1. General

1.1 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.

1.2 SUBMITTALS

- .1 Submit shop drawings for all products specified in Part 2.
- .2 Drawings to include electrical detail of hand dryer complete with voltage, ampacity, dimensions etc.

2. Products

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 The hand dryers shall be Dyson - 'airblade V', with brushless motor, polycarbonate fascia, anti-tamper screws, Nickel finish and 120v input voltage.

3. Execution

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical.
- .2 Provide backboxes complete with conduit and wiring and connect to circuits as shown on the drawings. Coordinate all associated work with Architectural drawings.
- .3 Hand dryers shall be installed in accordance with manufacturer's recommendations.

END OF SECTION

1. General

1.1 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.

2. Products

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 Supply and install an integrated micro-processor-based metering package. The system shall measure R.M.S. values and display voltage and current for each phase as well as kVA, kVAR, kW, PF, Hz. It shall also measure and accumulate MWHR and monitor and store minimum values of volts and PF and the maximum values of Amps, kW, kVA and kVAR. The unit shall be field programmable. Accumulated and programmed parameters shall be stored in non-volatile memory and shall not be lost in case of control power failure. Digital metering package shall be Similar to Square-D PM5563RD or approved equal.
- .3 System shall utilize a DMS panel mounted three phase digital AC meter for use on a 208V, 3-phase system, a control module located in the interior of the switchboard, together with all other accessories required for system operation.
- .4 The unit shall provide 4-20ma Analog output to interface with the HVAC control system. Use 8 channel POD-8 programmable output adapter.
- .5 Digital metering system shall be complete with BacNet/IP and Modbus communication modules for remote communications.

3. Execution

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical.
- .2 Employ the services of a factory trained technician to initially program the system. Train the Owner's staff.
- .3 Measure all parameters during a one-week period prior to take-over by the Owner. Record all readings. Use an approved record sheet. Provide a clipboard in the electrical room and use for recording data. Leave sufficient blank sheets for 12 months use by the Owner.

END OF SECTION

1. General

1.1 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.

1.2 SUBMITTALS

- .1 Submit shop drawings for all products specified in Part 2.
- .2 Submit the following to the Consultant for review:
 - .1 Drawings to include electrical detail of lighting control devices including occupancy sensor complete with associated power pack etc., quantity, control schematic wiring diagram and coverage area etc.

2. Products

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 Provide lighting control device(s) including occupancy sensors, room controllers, daylight sensors, dimmers, etc. as specified on the drawings:
 - .1 Provide associated power and relay packs.
 - .2 Provide all associated mounting accessories.
- .3 Electrical Contractor shall include in tender price for installation, testing, time adjustment, functional testing and commissioning of occupancy sensors, room controllers, daylight sensors, and programming of Auto-On sequence of all lighting control devices for light fixtures on a room-by-room basis in entire building by manufacturer. Submit verification/commissioning report after completion of work.
- .4 Lighting Control Devices Commissioning:
 - .1 Functional testing: Lighting control devices and control systems shall be tested to ensure that control hardware and software are calibrated, adjusted, programmed, and in proper working condition in accordance with the construction documents and manufacturer's installation instructions. Where occupancy sensors, time switches, programmable schedule controls, or photo sensors are installed, the following procedures shall be performed.

Occupancy sensors:

- .1 Certify that the sensor has been located and aimed in accordance with manufacturer recommendations.
- .2 For each sensor to be tested, verify the following:
 - .1 Status indicator (as applicable) operates correctly.
 - .2 Controlled lights turn 'off' or down to the permitted level within the required time.
 - .3 For auto-on occupancy sensors, the lights turn 'on' to the permitted level when someone enters the space.
 - .4 For manual-on sensors, the lights turn 'on' only when manually activated.
 - .5 The lights are not incorrectly turned 'on' by movement in nearby areas or by HVAC operation.

- .6 Simulate occupied condition. Verify and document the following:
 - .1 All lights can be turned 'on' and 'off' by their respective area control switch.
 - .2 The switch only operates lighting in the enclosed space in which the switch is located.
 - .7 Simulate unoccupied condition. Verify and document the following:
 - .1 All non-exempt lighting turns 'off'.
 - .2 Manual override switch (where applicable) allows only the lights in enclosed space where the override switch is located to turn 'on' or remain 'on' until the next scheduled shut off occurs.
 - .8 Daylight controls
 - .1 All control devices (photocontrols) have been properly located, field-calibrated, and set for appropriate setpoints and threshold light levels.
 - .2 Daylight controlled lighting loads adjust to appropriate light levels in response to available daylight.
 - .3 The location where calibration adjustments are made is readily accessible only to authorized personnel.
 - .2 Functional testing report/documentation shall certify that the installed lighting control of each respective space in entire building meets all requirements as specified in the contract documents.
 - .5 All occupancy sensors must be installed as per manufacturer's recommended location and wiring diagram.
 - .6 Occupancy sensors time delay settings must be adjusted and co-ordinated to suit the Owner requirements.
 - .7 Cooper lighting, Current lighting, Acuity and Wattstopper shall be considered equivalent for lighting control system.
3. Execution
- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical.
 - .2 Install all lighting control devices as shown on electrical drawings. Provide all components to suit.
 - .3 Exact location of occupancy sensors shall be co-ordinated on site and shall comply with the manufacturer's recommendations.
 - .4 Occupancy sensors shall turn off the corresponding light fixture when light switches are in the "On" position and the space is not occupied.
 - .5 Adjust occupancy detection sensitivity to match the level of activity for each space.
 - .6 Install power packs and associated relays to suit the number of circuits in the respective spaces. Installation shall comply with the manufacturer's recommendations. Coordinate all work with manufacturer.

END OF SECTION

1. General

1.1 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA)
 - .1 CAN/CSA C22.2 No. 47, Air Cooled Transformer (Dry Type).
 - .2 CSA C9, Dry Type Transformers.
- .2 National Electrical Manufacturers Association (NEMA).

1.3 SUBMITTALS

- .1 Submit shop drawings for all products specified in Part 2.
- .2 Provide manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish, and limitations.

2. Products

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 Dry type transformers shall, unless otherwise noted, be of the indoor air-cooled dry type of the size, rating and capacities as shown on the drawings and shall be sprinkler-proof.
- .3 Transformers shall be of the 1.2 KV Class 10 KV B.I.L. 220°C insulation, copper wire, temperature rise above a maximum ambient temperature of 150 degrees C.
- .4 Transformers shall have 4 - 2½% full capacity taps, 2 above and 2 below normal.
- .5 Ample ventilation openings at top, bottom, front, and sides shall be provided but these shall be shielded to prevent access to the live parts.
- .6 Transformers shall be equipped as required with eye bolts, braces, etc. to enable them to be wall mounted, floor mounted or suspended. Units shall be braced to block walls to suit seismic requirements.
- .7 External anti-vibration isolation mountings shall be supplied and installed for all transformers.
- .8 Transformers shall have two coats of primer and two finish coats of ASA 61 grey paint.
- .9 Transformer nominal efficiency of different KVA ratings must follow ASHRAE Standard 90.1-2010. Transformers shall be Harmonic Mitigator and similar to Powersmiths Model T1000-C3, Delta Mitigator e-silver, Marcus Supreme, or approved equal by the Consultant.

3. Execution

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical.

- .2 Locate the dry type transformers where shown on the drawings and ensure that there is adequate ventilation so that they operate as specified and that there is no transfer of heat to adjacent surfaces or equipment.
- .3 Prior to energizing or commissioning any transformer it shall be fully inspected, tested, checked, and adjusted to include, but not limited to the following:
 - .1 Grounding.
 - .2 Ratio.
 - .3 Polarity.
 - .4 Insulation resistance.
 - .5 Taps adjusted to give rated voltage specified at rated capacity.

END OF SECTION

1. General

1.1 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA)
 - .1 CSA C22.2 No. 31, Switchgear Assemblies.

1.3 SUBMITTALS

- .1 Submit shop drawings for all products specified in Part 2.
- .2 Drawings to include electrical detail of switchboard, cable entry location, bus bar size, branch breaker types, quantity, ampacity, KAIC rating and overall enclosure length, height, and depth dimensions etc.

2. Products

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 Switchboard shall be of the free standing totally enclosed sprinkler-proof design and shall consist of individual dead front type cells bolted together to form a complete switchgear assembly as shown on the drawings.
- .3 Switchboard shall be constructed of formed dished steel panels on the front with flat steel covers on the sides, rear and top. A suitable channel base shall be supplied along the entire length of the switchboard assembly.
- .4 Switchboard shall be complete with provision for the incoming service as shown on the drawings.
- .5 The main breaker shall be 208volt, 3 phase, quick make, quick break manually operated circuit breaker with an interrupting capacity of 50 KAIC symmetrical. Co-ordinate with Hydro and Coordination Study. The breaker shall be trip free in operation. The breaker shall be equipped with 3 phase solid state overcurrent relay with instantaneous, short time and long-time elements, each working independently of the others. Relay pick-up and time delay settings shall be field adjustable and shall be adjusted according to coordination study. Breaker shall be also complete with ground fault protection and adjusted to suit coordination study.
- .6 Provide auxiliary contacts for building automation system.
- .7 The branch devices/ breakers rated 400A and above shall be breaker(s) with electronic trip(s) (LSI).
- .8 All bussing shall be copper and shall extend the full length of the Switchboard with provision for future extension. Full capacity rated horizontal bussing shall be provided between each section of the service entrance board.
- .9 A full-length ground bus shall be provided.

- .10 Switchboard shall be constructed so that, if necessary, it can be shipped in sections for reassembly on site by this Division.
- .11 Cable lugs for outgoing feeder cables shall be two-hole compression type.
- .12 Openings in the Switchboard are to be cut or punched. Burning of holes will not be permitted.
- .13 Each breaker, instrument, meter, etc. shall be identified with a black Lamicoid nameplate with engraved white letters.
- .14 Switchboard shall be supplied complete with all necessary and required identifications and warning signs.
- .15 Switchboard shall have two coats of primer and two finish coats of ASA 61 grey paint.
- .16 Switchboard shall be designed, manufactured, and tested in accordance with C.S.A. and C.E.M.A. standards and shall meet all requirements of Authorities having jurisdiction.
- .17 Switchboard shall be as manufactured by Siemens, Eaton, or Square-D. The specification and layouts shown have been based upon Square-D equipment. However, it shall be the responsibility of this Division to ensure that, prior to submission of the tender, the equipment proposed can fit in the allocated space.

3. Execution

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical.
- .2 Install Switchboard in accordance with the manufacturer's requirements and recommendations and the requirements of the Authorities having jurisdiction and local Hydro.
- .3 Cable lugs for outgoing feeder cables shall be two-hole compression type.
- .4 Openings in the distribution panels are to be cut or punched. Burning of holes will not be permitted.
- .5 Provide necessary plates for the outgoing aluminum sheathed and MICC cables.
- .6 Prior to energizing or commissioning the distribution panels, they shall be fully inspected, tested, checked, and adjusted to include, but not limited to, the following:
 - .1 Grounding.
 - .2 Continuity of feeder cables.
 - .3 Breaker settings and fuses.
 - .4 Ground fault system operation.
 - .5 Breaker and switches operation.
 - .6 Phase resistance of feeder cables.
 - .7 Insulation resistance of feeder cables.
 - .8 Proper phasing of incoming and feeder cables.
 - .9 Equal division of load between parallel conductors.
 - .10 Trip units tested and calibrated to the settings provided by the Co-ordination Study.
 - .11 Bus torque, supports, clearance, general mechanical conditions, and insulation resistance.

END OF SECTION

1. General

1.1 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.

2. Products

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 Provide a coordination/protective system study and short circuit study and arc flash hazard analysis of all equipment specified herein and submit for review.
- .3 Study shall be included the following items:
 - .1 Utility system characteristics, including available fault levels, feeder, current time curves.
 - .2 208V main circuit breaker overcurrent, overload, and ground fault devices.
 - .3 347/600 and 120/208V panel boards, connecting feeder cables.
 - .4 120/208V transformer damage curves, magnetizing currents for all transformers 150 kVA and larger.
 - .5 Locked rotor currents, acceleration times and damage curves for motors 75 kW and larger.
 - .6 Any additional data necessary for successful completion of the coordination and short circuit study.
- .4 Data shall clearly state the operating time in cycles of each breaker and indicate whether the time current curves for relays are inclusive of breaker tripping time of otherwise.
- .5 Prepare a summation chart showing all ratings and settings with easy reference to the appropriate curve.
- .6 Symmetrical and asymmetrical fault current calculations shall be submitted to verify the correct choice of the protective elements of the system.
- .7 Prepare a systems single line diagram on which the resultant short circuit values, device numbers and equipment ratings are shown.
- .8 This study shall be provided by the distribution equipment vendor or by a firm specializing in and with relevant experience in performing these studies.
- .9 This study shall be performed by and bear the stamp of a Professional Engineer registered in the Province of Ontario.
- .10 Submit the complete study for review prior to submitting shop drawings of equipment.
- .11 Relay styles, CT ratios and fuse sizes have been selected on a preliminary basis for design purposes. Final selection shall be based on the results of this study and shall be included at no extra cost.
- .12 Arc Flash Hazard Analysis
 - .1 The Analysis shall be performed for the complete building electrical distribution system (existing and new distribution).
 - .2 The Analysis shall be performed with the aid of computer software intended for this purpose to calculate Arc-Flash Incident Energy (AFIE) levels and flash protection boundary distances.

- .3 The Analysis shall be performed in conjunction with a short-circuit analysis and a time-current coordination analysis.
- .4 The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (existing and new) including switchboards, switchgear, motor-control centres, panel boards, busway, and splitters where work could be performed on energized parts.
- .5 The Arc-Flash Hazard Analysis shall include all MV, 575v locations and significant locations in 240 volt and 208-volt systems fed from transformers equal to or greater than 125 kVA.
- .6 Results of the Analysis shall be submitted in tabular form, and shall include device or bus name, bolted fault and arcing fault current levels, flash protection boundary distances, personal-protective equipment classes and AFIE levels.
- .7 The Arc Flash Hazard analysis shall include calculations for maximum and minimum contributions of fault current magnitude. The minimum calculation shall assume that the utility contribution is at a minimum and shall assume a minimum motor load. Conversely, the maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.
- .8 The Arc-Flash Hazard Analysis shall be performed in compliance with IEEE Standard 1584-2018, the IEEE Guide for Performing Arc-Flash Calculations and NFPA 70E.
- .9 The Arc-Flash Hazard Analysis shall include recommendations for reducing AFIE levels and enhancing worker safety. One or more additional reiterations of the analysis shall be performed in attempt to lower incident energy levels.
- .10 Arc-flash labels shall be provided in compliance with ANSI Z535.4 to identify AFIE and appropriate Personal Protective Equipment classes and must also include the following information:
 - .1 Location designation
 - .2 Nominal voltage
 - .3 Arc flash boundary
 - .4 Incident energy
 - .5 Working distance
 - .6 Shock Boundaries
 - .7 Engineering report number, revision number and issue date

3. Execution

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical.
- .2 Provide the distribution equipment vendor with all relevant data for equipment not provided by that supplier.

END OF SECTION

1. General

1.1 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.

2. Products

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 Calibrate and verify the following equipment items supplied under this Contract for their respective voltage systems and components:
 - .1 208v switchboard.
 - .2 120/208v distribution.
- .3 The calibration and verification shall be carried out in the field after installation and connection of equipment but prior to energization, in the presence of the Owner and Consultant.
- .4 Submit details of all test procedures and instruments, together with technicians' names, to the Consultant prior to proceeding.
- .5 Submit written verification report after installation is completed to reflect as-built conditions.
- .6 Work shall be performed by the distribution equipment supplier.

3. Execution

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical.
- .2 Advise well in advance when each stage is ready for the calibration and verification, and complete the following:
 - .1 Ensure that all equipment is installed, connected, and cleaned inside and out.
 - .2 Ensure that the specified tests required to be done by the Contractor have been carried out.
 - .3 The electrical rooms are cleaned and are adequately illuminated and heated.
 - .4 Provide 120V convenience receptacles.
 - .5 Provide one qualified electrician to assist in the calibration and verification.
 - .6 Provide all other facilities, equipment, and personnel as reasonably required to assist in the calibration and verification.
- .3 For each circuit breaker, calibrate all protective relays and overcurrent device time and instantaneous trips in accordance with requirements of the protected equipment and the overall coordination scheme. Field set each relay according to the recommended settings.
- .4 Verify all transformer ratios, insulation values, fuse sizes, C.T. and P.T. ratios, etc. and certify that the installation is in accordance with the requirements of the manufacturer and the Coordination/Short Circuit Study. Submit a written report on this verification to the Consultant.
- .5 Carry out the tests required of calibration and verification as specified in the other related sections.

- .6 Ensure all bus and cable connections are tightened to manufacturers' specifications.
- .7 All relays are to be cleaned with dry, dust free compressed air.

END OF SECTION

1. General

1.1 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.

2. Products

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 Carry out an inspection of the equipment connections immediately after the plant is energized and operating under load and two months prior to expiration of the guarantee period, by means of thermography.
- .3 Inspect for loose connections at terminators, including mechanical and compression type connectors, bus joints, bolted connections, splices, and other fittings.
- .4 Check for poor connections caused by oxidation on contact surfaces.
- .5 Check for hot spots caused by overloading, phase unbalance, broken conductor strands or cable defects, and ground leakage.
- .6 Tighten, repair, or replace connections found to be marginal or unacceptable as a result of the Thermography Report.
- .7 The work shall be carried out by a firm specializing in and with relevant experience in thermography of 600V and 208V equipment or by the distribution equipment supplier.
- .8 AGA 782 Thermovision Infrared Portable Scanner or equivalent, capable of direct non-contact temperature measurement from minus 20°C to 1600°C with plus or minus .1°C resolution at 30°C and related photographic equipment, capable of producing the required thermograms.
- .9 Record all thermal anomalies or faults on polaroid pictures (thermograms) and corresponding real-image photographs of the areas concerned.

3. Execution

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical.
- .2 Thermography inspection shall be included the following:
 - .1 208v switchboard, distribution panels and panel boards, line, and load terminations.
 - .2 600v-120/208v transformers including line and load terminations, bushings.
 - .3 600v or 208v motor control centres, line and load connections and motor terminals of all motors 75 kW and larger.
 - .4 208v distribution panel boards.
- .3 Provide thermograms and real image photographs of all anomalies, including the temperature differential of the hot phase to a normal phase on pre-printed forms showing location of circuit, date and time of inspection, technician's name, component, phase, load, temperature rise and problem identification.

- .4 Report under the following classification:

Temperature Rise – Phase to Phase	Classification
1 degree – 10 degrees	Minor Problem
10 degrees – 35 degrees	Intermediate Problem
35 degrees Plus	Major Problem -Repair as soon as possible

- .5 All inspections to be carried out in the presence of a designated Owners/Consultant representative. Provide 1 weeks' notice of such inspections.

END OF SECTION

1. General

1.1 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA)
 - .1 CSA C22.2 No. 29, Panel boards and enclosed Panel boards.

1.3 SUBMITTALS

- .1 Submit shop drawings for all products specified in Part 2.
- .2 Drawings to include electrical detail of panel board, branch breaker type, quantity, ampacity, KAIC rating and enclosure dimensions etc.

2. Products

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 Panel boards shall be of the size, capacity and type as shown on the drawings. Series or integrated ratings shall not be an acceptable method of achieving specified interrupting levels for breakers, panels, or electrical equipment in general. Where an interrupting rating is specified, it shall be on a breaker, panel, or switchboard. Each breaker associated shall be fully rated to interrupt that magnitude of current. If there is a conflict between drawings and specifications, the higher rated value associated with that equipment shall be deemed to be correct.
- .3 Panel boards shall be of the sprinkler-proof, dead front type enclosed in code gauge steel equipped with door, gasket, lock, and directory and shall be suitable for surface or flush mounting as required.
- .4 Bussing in each panel shall be copper and shall extend the full length of the panel. Multi-section panels shall have full capacity rated horizontal bussing between each section.
- .5 Breakers shall be ambient compensated type, calibrated at 40 degrees C and be of the bolt-on type. Multi-pole breakers shall have common trip.
- .6 Panel boards for use on 240-volt or 208-volt system shall, unless otherwise noted be of the "NQ" panel or I-line panel as indicated on drawings.
- .7 Panel boards for use on 600-volt system shall, unless otherwise noted be of the "NF" panel as indicated on drawings.
- .8 Panels, including tubs, shall have two coats of primer paint and two coats of ASA 61 grey paint.
- .9 Panel boards shall be of the same manufacturer as the switchboard.
- .10 All circuit breakers shall be installed in panel boards before shipment.
- .11 Panel boards shall be provided with mains, number of circuits, KAIC rating and branch circuit breaker sizes as indicated in contract documents.

- .12 Lock-on devices shall be provided for fire alarm, emergency and exit lighting circuits and other circuits as indicated in contract documents.

3. Execution

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical.
- .2 Locate panel boards where indicated; and mount securely and plumb true and square to adjoining surfaces.
- .3 Panels are to be mounted so that the top of the panels are 1800mm above finished floor.
- .4 Provide 2 - 32mm empty conduits from each flush mounted panel to the ceiling spaces above and below for future installation.
- .5 Provide wire-ways above multi-section panels to avoid cross-wiring.
- .6 Numbering of breakers in multi-panel assemblies shall be consecutive. If necessary, provide narrow Dymo-mite strips with the required numberings.
- .7 Prior to energizing or commissioning the panels, they shall be fully inspected, tested, checked, and adjusted to include, but not limited to, the following:
 - .1 Grounding.
 - .2 Breaker settings.
 - .3 Breaker operation.
 - .4 Continuity of feeder cables.
 - .5 Phase resistance of feeder cables.
 - .6 Insulation resistance of feeder cables.
 - .7 Proper phasing of incoming and feeder cables.
 - .8 Equal division of load between parallel conductors.
 - .9 Bus torque, supports, clearance, general mechanical conditions, and insulation resistance.
- .8 30% of all breakers in panels shall be equipped with locking devices. These locking devices shall be installed as directed by the Consultant on completion of work and the unused units shall be handed over to the Owners.

END OF SECTION

1. General

1.1 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA)
 - .1 CSA C22.2 No. 29, Panel boards and enclosed Panel boards.

1.3 SUBMITTALS

- .1 Submit shop drawings for all products specified in Part 2.
- .2 Drawings to include electrical detail of power panel, branch breaker type, quantity, ampacity, KAIC rating and enclosure dimensions etc.

2. Products

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 Power panels shall be factory assembled, sprinkler proof, free standing, dead front type, complete with door and gasket suitable for use on the system as specified and shown on the drawings.
- .3 Power panels shall be of the size, capacity and type as shown on the drawings. Series or integrated ratings shall not be an acceptable method of achieving specified interrupting levels for breakers, panels, or electrical equipment in general. Where an interrupting rating is specified, it shall be on a breaker, panel, or switchboard. Each breaker associated shall be fully rated to interrupt that magnitude of current. If there is a conflict between drawings and specifications, the higher rated value associated with that equipment shall be deemed to be correct.
- .4 Fusible panels shall be of the "QM QB" type consisting of a fully convertible chassis to permit assembly of units in any desired arrangement. The fusible units shall have visible blades, integral handle mechanism, cover interlock, quick-make, quick-break mechanism, front operation, high pressure fuse holders and recessed live parts. The units shall be floor mounted and shall, unless otherwise noted, be 92" in height.
- .5 Breaker panels shall be switchboard QED distribution section type with the sizes and type of breakers as shown on the drawings. The branch devices/ breakers rated 400A and above shall be breaker(s) with electronic trip(s) (LSI).
- .6 Splitter troughs shall be complete with copper bus bars the length of the trough. The covers shall be bottom hinged with retained securing screws at the top.
- .7 Bussing in each panel shall be copper and shall extend the full length of the panel. Multi-section panels shall have full capacity rated horizontal bussing between each section.
- .8 Panels shall be provided with the non-ferrous plates for aluminium sheathed cables.

- .9 Panels, including tubs, shall have two coats of primer paint and two finish coats of ASA 61 grey paint.
- .10 Power panels shall be of the same manufacturer as the main switchboard.

3. Execution

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical.
- .2 Locate panel boards where indicated; and mount securely and plumb true and square to adjoining surfaces.
- .3 All panels less than 1520mm are to be wall mounted so that the top of the panel is 1980mm above finished floor.
- .4 Connect loads to the circuits as shown on the drawings.
- .5 Openings in panels shall be cut or punched. Burning of holes shall not be permitted.
- .6 Each panel and switches or breakers mounted in them, shall be identified.
- .7 Prior to energizing or commissioning the panels, they shall be fully inspected, tested, checked, and adjusted to include, but not limited to, the following:
 - .1 Grounding.
 - .2 Continuity of feeder cables.
 - .3 Breaker settings and fuses.
 - .4 Ground fault system operation.
 - .5 Breaker and switches operation.
 - .6 Phase resistance of feeder cables.
 - .7 Insulation resistance of feeder cables.
 - .8 Proper phasing of incoming and feeder cables.
 - .9 Equal division of load between parallel conductors.
 - .10 Trip units tested and calibrated to the settings provided by the Co-ordination Study.
 - .11 Bus torque, supports, clearance, general mechanical conditions, and insulation resistance.

END OF SECTION

1. General

1.1 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA)
 - .1 CSA C22.2 No. 29, Panel boards and enclosed Panel boards.

1.3 SUBMITTALS

- .1 Submit shop drawings for all products specified in Part 2.
- .2 Drawings to include electrical detail of distribution panel, branch breaker type, quantity, ampacity, KAIC rating and enclosure dimensions etc.

2. Products

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 The distribution panels shall be of the free standing and/or wall mounted type as described on the drawings, totally enclosed sprinkler proof design and shall consist of individual dead front type cells bolted together to form a complete panel assembly as shown on the drawings.
- .3 The equipment shall be constructed of formed dished steel panels on the front with flat steel covers on the sides, rear and top. A suitable channel base shall be supplied along the entire length of the panel assembly.
- .4 Distribution panels shall be of the size, capacity and type as shown on the drawings. Series or integrated ratings shall not be an acceptable method of achieving specified interrupting levels for breakers, panels, or electrical equipment in general. Where an interrupting rating is specified, be it on a breaker, panel or switchboard, each breaker associated will be fully rated to interrupt that magnitude of current. If there is a conflict between drawings and specifications, the higher rated value associated with that equipment shall be deemed to be correct.
- .5 Distribution section shall be switchboard QED distribution section. Branch devices/ breakers rated 400A and above shall be breaker(s) with electronic trip(s) (LSI).
- .6 All bussing shall be copper and shall extend the full length of the panel with provision for future extension. Multi-section panels shall have full capacity rated horizontal bussing between each section.
- .7 A full-length ground bus shall be provided.
- .8 The distribution panel shall be constructed so that, if necessary, it can be shipped in sections for reassembly on site by this Division.
- .9 Cable lugs for outgoing feeder cables shall be two-hole compression type.
- .10 Openings in the distribution panels are to be cut or punched. Burning holes will not be permitted.

- .11 Each distribution panel, switch unit, instrument, meter, etc. shall be identified with a black Lamicaid nameplate with engraved white letters.
- .12 The distribution panel shall be supplied complete with all necessary and required identification and warning signs.
- .13 The distribution panels shall be provided with the necessary plates for the outgoing aluminium sheathed and MICC cables.
- .14 The distribution panel shall have two coats of primer and two finish coats of ASA 61 grey paint.
- .15 The distribution panels shall be designed, manufactured, and tested in accordance with C.S.A. and C.E.M.A. Standards and shall meet the requirements of all Authorities having jurisdiction.
- .16 The distribution panels shall be as manufactured by Siemens, Eaton, or Square-D. The specification and layouts shown have been based upon Square-D equipment, however it shall be the responsibility of this Division to ensure prior to submission of the tender, that the equipment proposed can fit in the allocated space.

3. Execution

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical.
- .2 Install the distribution panels in accordance with the manufacturer's requirements and recommendations and the requirements of the Authorities having jurisdiction and local Hydro.
- .3 Cable lugs for outgoing feeder cables shall be two-hole compression type.
- .4 Openings in the distribution panels are to be cut or punched. Burning of holes will not be permitted.
- .5 Provide necessary plates for the outgoing aluminium sheathed and MICC cables.
- .6 Prior to energizing or commissioning the distribution panels, they shall be fully inspected, tested, checked, and adjusted to include, but not limited to, the following:
 - .1 Grounding.
 - .2 Continuity of feeder cables.
 - .3 Breaker settings and fuses.
 - .4 Ground fault system operation.
 - .5 Breaker and switches operation.
 - .6 Phase resistance of feeder cables.
 - .7 Insulation resistance of feeder cables.
 - .8 Proper phasing of incoming and feeder cables.
 - .9 Equal division of load between parallel conductors.
 - .10 Trip units tested and calibrated to the settings provided by the Co-ordination Study.
 - .11 Bus torque, supports, clearance, general mechanical conditions, and insulation resistance.

END OF SECTION

1. General

1.1 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA)
 - .1 CSA-C22.2 No.55, Special Use Switches.
 - .2 CSA-C22.2 No.111, General-Use Snap Switches.
 - .3 CSA-C22.2 No.42.1, Cover Plates for Flush-Mounted Wiring Devices.
 - .4 CSA-C22.2 No.42, General Use Receptacles, Attachment Plugs and Similar Devices.

1.3 SUBMITTALS

- .1 Submit shop drawings for all products specified in Part 2.
- .2 Provide manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish, and limitations.

2. Products

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 Classroom control panel modules will be supplied and installed by architecture division. Refer to architecture specification.
- .3 Receptacles shall be as specified in Section 26 27 26.
- .4 Computer outlets/ jacks shall be as specified Section 27 11 19.
- .5 PA system outlets/jacks shall be as specified Section 27 51 16.
- .6 Devices shall be flush mounted inside the classroom control panel module.

3. Execution

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical.
- .2 Coordinate all work with architecture classroom control panel details including clocks, PA system, fire alarm system etc. and wiring devices sections of the specifications.
- .3 Make, model and dimensions of switches, duplex and computer cable outlets, thermostats and temperature sensors, clocks, speakers, intercom devices, including switches, keypads and handsets shall be supplied and installed by mechanical and electrical divisions.
- .4 Coordinate all work with Classroom control panel modules supplier/ millwork contractor to include all drilled or cut holes and speaker mountings to allow installation of all devices supplied and installed by mechanical and electrical divisions.

- .5 All cabling and wiring will be supplied and installed by mechanical and electrical divisions as indicated on drawings and specified in contract documents.
- .6 Classroom control panel modules shall have all contacts for services as required for installation of mechanical and electrical services by mechanical and electrical divisions.
- .7 Symbols on drawings shows approximate locations on classroom control panel module. Care shall be taken to locate each device to ensure that it is in the appropriate location to suit the classroom control panel module detail as shown on drawing.
- .8 Mounting heights of equipment/devices are referred to finished floor or finished ceiling unless otherwise noted.

END OF SECTION

1. General

1.1 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA)
 - .1 CSA-C22.2 No.55, Special Use Switches.
 - .2 CSA-C22.2 No.111, General-Use Snap Switches.
 - .3 CSA-C22.2 No.42.1, Cover Plates for Flush-Mounted Wiring Devices.
 - .4 CSA-C22.2 No.42, General Use Receptacles, Attachment Plugs and Similar Devices.

1.3 SUBMITTALS

- .1 Submit shop drawings for all products specified in Part 2.
- .2 Provide manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish, and limitations.

2. Products

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 Light switches on 120-volt circuits under 1200 watts shall be 15 amp. and above 1800 watts shall be 20 amp.
- .3 Light switches shall be premium specification grade, A.C., Toggle type switches.
- .4 Receptacles shall be of the type shown on the drawings with the standard C.S.A. configurations and shall be specification grade. Hubbell #5262.
- .5 Light switches and receptacles on normal power shall be white unless noted otherwise.
- .6 Isolated ground receptacles shall be orange. Hubbell #1G-5262.
- .7 Wall plates for flush mounted devices shall be multiple gangs super stainless-steel type 302.
- .8 Wall plates for surface mounted devices in unfinished areas shall be metal covers for F.S. type boxes.
- .9 The weatherproof plates shall be cast aluminium with lift cover for F.S. type boxes.
- .10 For T.V. and computer outlets provide blank cover plates unless work is complete.
- .11 For telephone outlets provide blank cover plates unless work is complete.
- .12 Receptacle mounted on the exterior walls of the building shall be with ground fault protection mounted in an F.S. type box with a Hubbell #5206WO and MX3200 weatherproof in-use cover plate.

- .13 50A/208V 1 phase 3W receptacle, range receptacle Smith & Stone #1-8450 complete with plug and cord set.
- .14 30A, 120/208V receptacle Smith & Stone #1-8430 dryer receptacle complete with plug and cord set.
- .15 Wiring devices shall, unless otherwise noted, be of Pass & Seymour, Hubbell, Leviton, or Cooper manufacture.
- .16 All service receptacles on roof shall be 15/20A combination GFI type receptacles complete with weatherproof in-use cover (Similar to Hubbell Cat. #MX3200).
- .17 Receptacle controlled by occupancy sensor shall be Similar to Hubbell Cat. #BR15C2GRY.

3. Execution

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical.
- .2 Symbols on drawings show approximate locations. Care shall be taken to locate each device to ensure that it is in the appropriate location to suit the Architectural finishes.
- .3 Mounting heights are referred to finished floor or finished ceiling unless related to benchmark elevations.
- .4 Provide cover plates for flush mounted manual starters.
- .5 Receptacle, telephone, etc. outlets shall, unless otherwise noted, be mounted vertically 400mm above finished floor in the finished areas and 1200mm in all unfinished areas. Thermostats shall be mounted 1400mm, unless otherwise noted.
- .6 Telephone, P.A., etc. wall outlets shall be spaced 100mm from power outlet.
- .7 All wiring devices cover plates shall be labelled using clear adhesive strips with black type identifying, panel and circuit number(s) for each device.
- .8 Single throw switch(es) shall be installed with handle in "UP" position when switch closed.
- .9 Switches shall be installed in gang type outlet box(es) when more than one switch is required in one location.
- .10 Receptacles shall be installed in gang type outlet box(es) when more than one receptacle is required in one location.
- .11 Suitable common cover plates shall be installed where wiring devices are grouped.
- .12 Cover plates meant for flush mount outlet boxes shall not be use for surface mounted outlet boxes.

END OF SECTION

1. General

1.1 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA)
 - .1 CSA C22.2 No. 248.12, Low Voltage Fuses

1.3 SUBMITTALS

- .1 Submit shop drawings for all products specified in Part 2.
- .2 Drawings to include electrical detail of fuse type, quantity, ampacity, voltage rating and dimension etc.
- .3 Submit fuse performance data characteristics for each fuse type and size. Performance data to include average melting time-current characteristics.

2. Products

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 Fuses protecting motor circuits shall be Form I Class 'J' time delay.
- .3 Other fuses up to 600A shall be Form I Class 'J'.
- .4 Other fuses above 600A shall be Form I Class 'L'.
- .5 All fuses shall be of Ferraz, Shawmut or Bussman.

3. Execution

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical.
- .2 Provide fuses for the complete electrical installation.
- .3 Supply six (6) spare fuses of each size and type installed.
- .4 Provide in the main electrical room a wall mounted metal cabinet complete with doors and lock, and an adequate quantity of pigeonholes to accommodate the spare fuses.
- .5 To avoid confusion and possible loss the fuses shall not be stored in the cabinets until they are physically counted by the Owner's representative and a written receipt obtained for them. A copy of the receipt shall be included in the manuals.

END OF SECTION

May 2025

1. General

1.1 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.

1.2 SUBMITTALS

- .1 Submit shop drawings for all products specified in Part 2.
- .2 Drawings to include electrical detail of disconnect switch, type, quantity, voltage, ampacity, and dimension etc.

2. Products

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 Disconnect switch(es) shall have the operating handle interlocked with the switch cover so that it can only be opened when the switch is in the "Off" position, and the handle cannot be put in the "On" position unless the cover is closed.
- .3 Fused disconnect switch(es) shall have steel reinforced clips and fuses shall be easily removable when the switch is in the "Off" position.
- .4 Switches shall have ample gutter space for top or bottom wiring and shall have fully visible blades when in the "Off" position, quick-make, quick-break mechanism and be horsepower rated.
- .5 Disconnect switch(es) shall be provided with ON-OFF switch position indication on switch enclosure cover.
- .6 Switches used outdoors shall be in a weatherproof enclosure.
- .7 Switches shall have provision for padlocking in the "Off" position and interlock defeat.
- .8 All motors shall be provided with a disconnect switch by this Division unless otherwise noted.
- .9 The disconnect switches shall be as manufactured by Eaton, Siemens, or Square 'D'.

3. Execution

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical.
- .2 Disconnect switch(es) shall be installed complete with fuses as indicated on drawings and in contract documents.

END OF SECTION

1. General

1.1 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA)
 - .1 CSA C22.2 No.14, Industrial Control Equipment.

1.3 SUBMITTALS

- .1 Submit shop drawings for all products specified in Part 2.
- .2 Drawings to include electrical detail of contactor, quantity, ampacity, voltage, control schematic wiring diagram and enclosure dimension etc.

2. Products

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 Contactors controlling panel boards or branch circuits shall be tungsten rated, electrically operated, electrically held of the size and rating specified, complete with control transformer, control circuit fuses, pilot light warning label, NO/NC contacts and On/Off/Auto selector switch.
- .3 Contactors shall be in sprinkler proof enclosure unless otherwise noted.
- .4 The contactors ampere rating shown on the drawings is the minimum continuous enclosed de-rated rating of the contactors. Contactors shall be designed and manufactured in accordance with NEMA Standards.
- .5 Contactors controlling branch circuits shall be mounted above the panel board from which they are fed, unless otherwise noted.
- .6 Contactors shall be of Allen-Bradley, Eaton, Siemens or Square 'D' manufacture.

3. Execution

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical.
- .2 Field designed and assembled contactor assemblies will not be acceptable.

END OF SECTION

1. General

1.1 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.

1.2 REFERENCES

- .1 International Electrotechnical Commission (IEC).
 - .1 IEC 947-4-1, Part 4: Contactors and Motor-Starters.

2. Products

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 The motors shall be provided and adjusted by Division 23, Mechanical.
- .3 The starters shall be supplied by Division 23, Mechanical.

3. Execution

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical.
- .2 Provide and connect conduit and power wiring to the motors.
- .3 Conduit and wiring for low voltage thermostats shall, unless otherwise noted, be provided by another Division of the Specification.
- .4 Wiring and conduit for line voltage thermostats shall be by this Division. Coordinate with Division 23, Mechanical drawings.
- .5 Take delivery of and install the starters and provide and connect conduit and power wiring to the starters. Control wiring and conduit shall, unless otherwise noted, be provided by Division 23, Mechanical.
- .6 Fuses for the fused combination magnetic starters shall be supplied and installed by Division 23, Mechanical.
- .7 Prepare schedule of each motor connected which shall include the following:
 - .1 Phase
 - .2 Voltage
 - .3 Horsepower
 - .4 Full load current
 - .5 Motor Purpose
 - .6 Fuse size and type
 - .7 Overload heater size and type
- .8 Submit the motor schedule for review by the Consultant and include the schedule in the manuals.

END OF SECTION

1. General

1.1 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.
- .3 Refer to section 26 50 10, Lighting Fixtures Schedule

2. Products

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 Light fixtures finish and construction shall meet ULC listings and CSA certifications related to intended installation.
- .3 Light Emitting Diodes (LED) shall comply with the following:
 - .1 Light emitting diodes shall be manufactured by "Cree" or equal.
 - .2 Junction temperature at 25°C ambient shall not exceed 60°-70°C.
 - .3 LED light fixture(s) shall follow LM-79 and LM-80 Standards. Luminaire photometric shall be performed by an independent company.
 - .4 Lumens per watt output (LPW) shall be not less than 100 LPW.
 - .5 The lifetime rating of driver, LEDs and all electrical components of complete fixture shall be 60,000 hours (minimum) at full load.
 - .6 Colour temperature shall range from 3500K to 5100k as called for in the Lighting Fixtures Schedule.
 - .7 All electrical components shall have a 5-year replacement (parts and labour) warranty.
 - .8 LED light fixture(s) shall be DLC certified.
 - .9 LED light fixture(s) shall be complete with 0-10V dimming driver.
- .4 The louvres for light coves in washrooms and display cases and where shown shall be 1/2"x1/2"x1/2" (13x13x13mm) continuous aluminium and shall be of American Louvre manufacture.
- .5 Lenses shall be acrylic (minimum of 0.175mm) with a maximum flame spread rating of 250 and smoke development classification of 600 and shall be of KSH, American Louvre manufacture.

3. Execution

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical.
- .2 Remove from the site all empty cartons, crates, etc. in which the fixtures and associated components are delivered.
- .3 Install lighting fixtures at locations as indicated on drawings and in contract documents.
- .4 The chain supports required for mounting and installation of recessed lighting fixtures shall be supplied and installed by this Division. The supports shall be attached to the structure with minimum 2 supports per fixture. The ceiling system shall not be used as a supporting means. Prior to installation of lighting fixtures, Electrical Contractor shall coordinate with consultant and get approval.

- .5 Surface mounted fixtures shall be independently supported from the structure above.
- .6 Fixtures connected to the circuits exceeding 150 volts to ground shall be mounted at least 8 feet above floor level.
- .7 Fixtures mounted in continuous rows shall be equipped with aligning clips to form straight uninterrupted line.
- .8 Align light fixtures mounted individually parallel or perpendicular to building grid lines.
- .9 The location of lighting fixtures in Service Areas, Electrical and Mechanical Rooms, etc. shall be determined after the equipment is installed.
- .10 Refer to the Architectural reflected ceiling drawings for the exact location of the lighting fixtures.
- .11 Cooperate with the other Divisions to establish proper clearances from sprinkler heads, diffusers, ducts, etc.
- .12 Surface mounted fixtures shall have minimum clearance of 2'-0" (600mm) from adjacent sprinkler heads.
- .13 Provide additional supports, hangers etc. required to support fixtures mounted under ductwork and the fixture supports shall not be attached to either the ductwork or the ductwork supports.
- .14 Provide and connect all branch circuit conduit and wiring to the signs (if required).
- .15 Angles required for support of 1/2"x1/2"x1/2" (13x13x13mm) louvre shall be by Ceiling Division.

END OF SECTION

1. General

1.1 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.

1.2 SUBMITTALS

- .1 Submit shop drawings for all products specified in Part 2.
- .2 Submit the following to the Consultant for review:
 - .1 Manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish, and limitations.
 - .2 Samples of materials and any other items as specified in succeeding Sections of this Division of the Specification.

2. Products

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 The lighting fixtures with the letter shown, shall be of the types as described below:

Type 'A1' Existing 2'-0" x 4'-0" light fixture to be relocated as shown.

Type 'B1' Existing 1'-0" x 4'-0" light fixture to be relocated as shown.

Type 'AB' Shall be Cooper Lighting, Metalux Cruze ST, Cat. #24CZ2-40-UNV-L840-CD1-WLS-U, 2'-0" x 4'-0" recessed LED light fixture for T-bar ceiling mounting, complete with high reflective matte white enamel paint finish, ribbed frosted acrylic lens, integrated occupancy sensor and 120-volt integral driver. Integral occupancy sensor shall be with dimming control to provide a 50% dim level during vacancy and 100% in occupancy. Photocell shall be disabled.

Type 'BA' Shall be Cooper Lighting, Metalux Cruze ST, Cat. #14CZ2-39-UNV-L840-CD1-U, 1'-0" x 4'-0" recessed LED light fixture suitable for drywall ceiling installation complete with drywall ceiling installation kit, high reflective matte white enamel paint finish, ribbed frosted acrylic lens and 120-volt integral driver.

Type 'BB' Shall be same as Type 'BA' except fixture shall be suitable for T-bar ceiling mounting and complete with integrated occupancy sensor, Cat. #14CZ2-39-UNV-L840-CD1-WLS-U. Integral occupancy sensor shall be with dimming control to provide a 50% dim level during vacancy and 100% in occupancy. Photocell shall be disabled.

Type 'BC' Shall be same as Type 'BA' except fixture shall be complete with integrated occupancy sensor, Cat. #14CZ2-39-UNV-L840-CD1-WLS-U. Integral occupancy sensor shall be with dimming control to provide a 50% dim level during vacancy and 100% in occupancy. Photocell shall be disabled.

Type 'C' Shall be Cooper Lighting Cat. #4SNLED-LD5-41SL-LW-UNV-L840-CD1-U-WG/SNF-4FT, 4'-0" long channel strip LED light fixture complete with snap on/off diffuse lens, 120-volt integral driver and wire guard.

- Type 'D' Shall be Current Prescolite, Cat. #LFR-4RDS-M-15L-40K-8-WD-DM1-LFR-4RDS-T-SS-WT-LFR-4RD-H, 4" diameter shallow LED recessed wide beam downlight complete with self-flanged high purity spun aluminum specular finish reflector, 4" housing frame and 120-volt input voltage integral driver.
- Type 'R' Shall be Current Beacon-Viper Wall, Cat. #VPW1-24L-25-3K7-3-120-XX-BTSO-12F wall pack surface mounted LED full cut-off light fixture complete with integrated motion sensor, corrosion resistant, diecast aluminum housing with powder coat paint finish and 120-volt integral weather-tight LED driver compartment. Integral motion sensor shall be with dimming control to provide a 30% dim level during no motion/ activity and 100% in motion/ activity. Fixture finish colour to be confirmed by Architect at later date.
- Type 'RA' Shall be Current Prescolite, Cat. #LFR-6RD-M-10L-35K-8-XW-DM1-LFR-6RD-T-SS-LFR-6RD-H, 6" diameter shallow LED recessed extra wide beam downlight complete with self-flanged high purity spun aluminum specular finish reflector, 6" housing frame and 120-volt input voltage integral driver.
- .3 LED light fixtures, unless otherwise noted, Signify/Philips Canada, Cooper, Acuity, and Current Lighting shall be considered equal provided they meet the specifications, designed lighting calculations based on absolute IES files of the respective light fixtures.

END OF SECTION

1. General

1.1 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA)
 - .1 CSA C22.2 No. 141 (latest edition), Unit Equipment for Emergency Lighting.

1.3 SUBMITTALS

- .1 Submit shop drawings for all products specified in Part 2.
- .2 Drawings to include electrical detail of system components, mounting method, source of power and special attachment etc.

2. Products

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 Emergency Battery Unit:
 - .1 Emergency battery units, BU-1, BU-2, BU-3, BU-4 and BU-5 as indicated on drawings are existing and shall be reused.
 - .2 Existing battery units which are identified on drawings to be relocated; shall be disconnected and removed from their existing locations, salvaged and stored safely in secure area during construction to avoid any damages to the units.
 - .3 Reinstall existing battery units at locations as shown on drawings and connect to 120v AC circuits as indicated on drawings.
 - .4 Provide all necessary conduit/ wiring and components to suit reinstallation of battery units as shown.
- .3 Remote Emergency Light Fixture Head - Type 'L2':
 - .1 Remote emergency light fixture heads (Type 'L2') as indicated on drawings are existing and shall be reused.
 - .2 Existing remote emergency light fixture heads (Type 'L2') shall be disconnected and removed from their existing locations, salvaged and stored safely during construction in secure area to avoid any damages to the fixture, lamp and lens.
 - .3 Reinstall remote emergency light fixture heads (Type 'L2') at locations as shown on drawings and connect to respective battery unit 24v DC circuits as identified on drawings.
 - .4 Provide all necessary conduit/ wiring and components to suit for reinstallation of remote emergency light fixture heads.

3. Execution

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical.

- .2 Install units where; shown on the drawings and provide all necessary mounting platforms and mounting hardware.
- .3 Electrical Contractor shall provide report with on-site readings to show lighting levels in all areas with emergency lighting fixtures.

END OF SECTION

1. General

1.1 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA)
 - .1 CSA C22.2 No. 141-02 (latest addition), Unit Equipment for Emergency Lighting.
 - .2 CSA C860, Performance of Internally Lighted Exit Signs.

1.3 SUBMITTALS

- .1 Submit shop drawings for all products specified in Part 2.
- .2 Drawings to include manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish, and limitations, mounting method, source of power and special attachment etc.

2. Products

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 Exit Sign:
 - 1. Exit Signs (Type 'E') as indicated on drawings are existing and shall be reused.
 - 2. Existing exit signs (Type 'E') shall be disconnected and removed from their existing locations, salvaged and stored safely during construction in secure area to avoid any damages to the fixture, lamp and pictogram/ lens.
 - 3. Reinstall remote exit signs (Type 'E') at locations as shown on drawings and connect to 120v AC and respective battery unit 24v DC circuits as identified on drawings.
 - 4. Provide all necessary conduit/ wiring and components to suit for reinstallation of exit signs.

3. Execution

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical.
- .2 Install exit lights to manufacturer's recommendations, listing requirements and authority having jurisdiction regulatory requirements.
- .3 Install units where shown; on the drawings and provide all necessary mounting platforms and mounting hardware.

END OF SECTION

May 2025

1. General

1.1 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA)
 - .1 CSA-C22.2 No.214 (Latest Edition), Communication Cables
 - .2 CSA-C22.2 No.232, (Latest Edition), Optical Fiber Cables.
 - .3 CSA-C22.1, (Latest Edition), Canadian Electric Code Part 1
- .2 Telecommunications Industry Association (TIA)/ Electronic Industries Alliance (EIA)
 - .1 TIA/EIA-568-D.1 (latest edition), Commercial Building Telecommunications Cabling Standard, Part 1: General Requirements.
 - .2 TIA/EIA-568-D.2 (latest edition), Commercial Building Telecommunications Cabling Standard, Part 2: Balanced Twisted-Pair Cabling Components.
 - .3 TIA/EIA-568-D.3 (latest edition), Optical Fiber Cabling and Components Standard.
 - .4 ANSI/TIA EIA-568-E.0 (lasts edition), Generic Telecommunications Cabling for Customer Premises.
 - .5 ANSI/TIA/EIA-569/ CSA T530 (latest edition), Commercial Building Standard for Telecommunications Pathways and Spaces.
 - .6 TIA/EIA-606-A (latest edition), Administration Standard for the Commercial Telecommunications Infrastructure.
 - .7 ANSI/EIA-310 (latest edition), Cabinets, Racks, Panels and Associated Equipment.
 - .8 ANSI J-STD-607/ CSA T527 (latest edition), Commercial Building Grounding and Bonding Requirements for Telecommunications.
 - .9 EIA/TIA TSB-36 (latest edition), Technical systems Bulletin – Additional Cable Specifications for Unshielded Twisted Pair Cables.
 - .10 EIA/TIA TSB-67 (latest edition), UTP End-to-End System Performance Testing.
- .3 IEEE 802.3 (latest edition), Specification for 10 Gb/s operation over Category 6 or higher 4-Pair Balanced Twisted Pair Cabling.
- .4 Ontario Electrical Safety Code (OESC) – Latest Edition.
- .5 Ontario Building Code (OBC) – Latest Edition.

1.3 SUBMITTALS

- .1 Submit shop drawings for all products specified in Part 2.
- .2 Drawings to include equipment and material detail including dimensions.
- .3 Submit drawings for jacks, copper cables, faceplates, patch panels, patch cords, wall brackets, racks, cable managers, wireless access points etc.

2. Products

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 This section includes minimum requirements for product design, quality, and performance, including preparation and installation of Category 6 channel systems.
- .3 Structured cabling channel system shall include jacks, patch panels, cable, cross-connect jumpers, patch cords, faceplates, and all connections.
- .4 Supply and install a complete voice and data structured cabling system as outlined in the tender drawings and specifications.
- .5 All work performed must conform to the latest version of the applicable codes, standards and regulations of authorities having jurisdiction.
- .6 Computer/data cabling installation scope shall be as follows:
 - .1 Existing computer/ data rack located in main electrical room is existing to remain complete with existing patch panel(s), network server, network switch(es), telephone and fibre cable terminations, and all other associated existing computer/ network equipment currently installed on existing rack.
 - .2 Provide plastic protective cover protecting computer/ data rack and associated equipment/ devices installed on existing rack from dust and debris during entire period of construction. Coordinate exact requirements with school board representative.
 - .3 Disconnect and remove existing data cables complete with computer/ data jack and cover plates for computer/ data outlets and wireless network access points (WAP) for locations as indicated on drawings. Salvage WAP's and store securely at safe place during construction for reuse.
 - .4 Install Category 6 data cables for computer/ data outlets, new and relocated wireless network access points (WAP) and voice cabling for telephone outlets for locations as shown on drawings.
 - .5 All data cables shall run to the existing/new computer/data rack(s) located in existing main electrical room.
 - .6 All voice cables shall run directly to the existing main telephone board located in existing main electrical room.
 - .7 Horizontal data cables shall be terminated in Cat. 6 jacks at the workstation end and in Cat. 6 existing/ new patch panel(s) at the existing/ new computer/ data rack(s) end as indicated on drawings.
 - .8 Provide new floor mounted rack for additional new patch panel(s) and other associated equipment installation.
 - .9 New floor mounted rack shall be installed beside the existing rack as shown on drawings keeping access clearance for existing electrical panel/ equipment behind both racks.
 - .10 Reuse existing patch panel(s) and provide new patch panel(s) as required to suit number of computer/ data drop terminations as shown on drawings.
 - .11 New patch panel(s) shall be mounted in existing/ new floor mounted rack(s) located in main electrical room complete with 2 vertical cable managers and one (1) horizontal cable manager for every patch panel supplied.
 - .12 Provide new 2 vertical cable manager and one (1) horizontal cable manager for every existing patch panel reusing for new cable terminations.
 - .13 Horizontal voice cables shall be terminated in Cat. 3 jacks at the workstation end and in existing BIX1A4 punch down blocks located in main electrical room. Provide designation strips and labels as required to suit proper installation.
 - .14 A cable hanger system has been provided in the corridors and other areas for all voice and data cables.
 - .15 Outlet boxes and conduits have been provided at each outlet location.

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- .16 Provide conduits from the outlet box to the corridor and terminate adjacent to the cable hanger system.
- .17 Supply only one (1) patch cord for every data drop installed. Patch cords will be installed by the Board at the rack end.
- .18 The length of the patch cords shall be:
 - .1 50% 4ft. long
 - .2 50% 6ft. long
- .19 Supply only one (1) line cord for every data drop installed. Line cords will be installed by the Board at the workstation end.
- .20 Line cords shall be 10ft. long.
- .21 Reinstall and configure existing wire access point (WAP) devices at relocated position with new computer/ data wiring at locations as shown on drawings.
- .22 Supply, install and configure new wireless access point (WAP) devices at locations as shown on drawings.
- .23 Type of new wireless access point (WAP) devices shall be provided as per school board standards and requirements. Exact model number shall be confirmed with school board IT department before ordering.
- .7 Termination of conduit above gypsum board ceiling will not be acceptable.
- .8 The Board has standardized in Hubbell Products for the Structured Cabling System. No alternative will be accepted, except where noted. Bidders must identify alternate products with their bids, including Manufacturer part numbers. No alternates will be considered unless they are clearly identified in the tender submission and approved by school board.
- .9 The successful bidder will be responsible for complete storage, handling, delivery, and installation of all materials.
- .10 The computer/ data cabling contractor will be responsible for cleanup related to his/her scope of work. The contractor will be expected to remove all debris related to his work daily. Failure to comply will expose the contractor to back-charges from the General Contractor or the Board for clean-up on the contractor's behalf.
- .11 The contractor shall have tradesmen who are fully qualified and experienced in the installation of a certified communications cabling system and wireless network systems.
- .12 The successful contractor will be required to submit the following documents, prior to being awarded the contract:
 - .1 Current training and certification status by the specified manufacturer (Hubbell).
 - .2 Proof of RCDD on staff.
 - .3 Experience in construction projects for school boards.
 - .4 Experience in construction projects working for General Contractors.
 - .5 Experience in troubleshooting and problem solving in data communication networks
- .13 At least one member of the contractor's project team must hold a current RCDD accreditation.
- .14 The RCDD will be responsible for quality control and certification of the project.
- .15 A Project Manager and Foreman shall be assigned to the project within 3 working days of contract award. These personnel shall not be removed from the project without the prior consent of the Board's representative.
- .16 The contractor must comply with all job-site union requirements for the duration of the project.

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- .17 The contractor shall not subcontract any portion of the work, unless authorized in writing by the Board's representative.
- .18 The contractor must comply with all requirements of the Occupational Health and Safety Act, without exception.
- .19 Outlets where noted shall be single gang flush mounted in wall or surface raceways.
- .20 Outlets if unwired, shall be provided with blank cover plates to suit related sections of this specification.
- .21 No tie wraps shall be used anywhere. Only Velcro shall be used.
- .22 All work performed must confirm to the latest version of the applicable codes, standards and regulations of authorities having jurisdiction.
- .23 Hubbell products shall be used for the structured cabling system.
- .24 Connectors – Category 6 Modular Jacks
 - .1 Design Requirements:
 - .1 Jacks shall be standard 8-position, Keystone, RJ-45 style.
 - .2 Jacks shall be designed for 4-pair, 100 ohm balanced unshielded twisted pair (UTP) cable.
 - .3 Each jack shall be single unit construction, with snap – fit to industry standard keystone opening (.760" x .580").
 - .4 Jack termination method shall follow the industry standard 110 IDC punch-down.
 - .5 Jacks shall have the Category 6 designation, visible from the front when installed.
 - .6 Jacks shall not require special cords, specialty tools or special installation requirements.
 - .7 Category 6 jacks shall be backward compatible with existing Category 3, 5, and 5e cabling systems for fit, form, and function.
 - .8 Approved Manufacturers:
 - .1 Hubbell Premise Wiring NEXTSPEED Ascent **HJS6x** (x=colour code) with "COBRA-LOCK" termination is the specified Category 6 jack.
 - .2 Hubbell Premise Wiring Xcelerator Category 6 Jack **HXJ6x** (x=colour code)
- .25 Patch Panels – Category 6, Loaded or Unloaded
 - .1 Design Requirements:
 - .1 Loaded Category 6 patch panels shall be standard 8-position, RJ-45 style, un-keyed receptacle, in 24-, 48- and 96-port configurations.
 - .2 Panel frames shall be black powder coated 14-gage steel with rolled edges top and bottom for proper stiffness.
 - .3 Unloaded patch panels shall accommodate Keystone Category 6 jacks, in 24-, and 48- port options.
 - .4 Panels shall accommodate a minimum of 24 ports for each rack mount unit (1 RMU = 1.75 in.).
 - .5 Panels shall be designed for 4-pair, 100 ohm balanced unshielded twisted pair (UTP) cable.
 - .6 Panels shall have individual port identification numbers printed on the front and rear of the panel and have label holders for client specific port identification on the front.
 - .7 Loaded panel adapter modules shall be 110-style termination with tin lead solder plated IDC contacts.
 - .8 Loaded panels shall have the Category 6 designation, visible from the front when installed.

- .9 Approved Manufacturers:
 - .1 Hubbell Premise Wiring HPJxx (xx=port count, 24, 48, 72) is the specified “Unloaded” Jack Panel.
 - .2 Hubbell Premise Wiring HP6xx (xx=port count, 24, 48, 72) is the specified “loaded” Jack Panel.
 - .3 The Hubbell Premise Wiring HPRCMB Rear Cable Management Bars should be used to support and manage terminated cable at the rear of the unloaded jack panels.
- .26 Patch Cords – Category 6
 - .1 Design Requirements:
 - .1 Category 6 patch cords shall be constructed with a smoke-coloured polycarbonate 8-position plug, having vertically staggered, trifurcated contacts, each having 50 micro-inches of gold plating.
 - .2 Patch cords shall have a snag-less feature, integral to the strain relief boot on each end.
 - .3 Patch cords shall be constructed with category 6 patch cable, with 24 AWG 7/32 tinned copper stranded conductors, each insulated with polyethylene, and overall jacket with UL flame-retardant PVC.
 - .4 Patch cords shall be manufactured using a T568B wiring format and shall function suitably for either T568A or T568B wiring schemes.
 - .5 Refer to section below for required colours.
 - .6 Category 6 patch cords shall be backward compatible with existing Category 3, 5, and 5e cabling systems for fit, form, and function.
 - .7 Approved Manufacturers:
 - .1 The Hubbell Premise Wiring HC6xxyy (xx=color, yy=length) is the specified Equipment and Patch Cord
- .27 Category 6 100 OHM Balanced UTP Cable – Plenum FT6
 - .1 Design Requirements:
 - .1 Category 6 UTP cable construction shall be four twisted pairs of 23 AWG insulated solid copper conductors, with a ripcord, surrounded by a tight outer jacket. Cable construction also includes a pair divider along the cable centre to maintain separation of individual pairs.
 - .2 Plenum FT6 cable shall be premium grade, tested out to 550 MHz.
 - .3 Plenum FT6 cable conductor insulation diameter shall be 0.039” ± .0005” high performance fluoro-copolymer.
 - .4 Plenum FT6 cable conductor outer jacket diameter shall be 0.220” ± .008” with a nominal wall thickness of 0.015”.
 - .5 Plenum FT6 cable jacket material shall be low smoke PVC.
 - .6 Cable shall be marked: “HUBBELL PREMISE WIRING ((LINK6)) CATEGORY 6 – [PLENUM] -- 4 PR 23 AWG c(UL)US <CMP> – (UL) VERIFIED TO TIA/EIA-568-C.2 -- Z/YY (XXXX) – NNNN”.
 - .1 Frequency of marking shall be every 2.0 ft.
 - .2 (()) denotes Next-Speed Link6 series.
 - .3 [] denotes PLENUM or RISER.
 - .4 < > denotes CMP or CMR.
 - .5 ‘Z’ represents the month of manufacture.
 - .6 ‘YY’ indicates the year of manufacture.
 - .7 ‘NNNN’ indicates the sequential footage markers.
 - .8 ‘XXXX’ indicates the job number.

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- .9 'NNNN' indicates the sequential footage markers.
- .7 UL, ETL, or CSA agency certification or verification markings shall be marked on the cable jacket according to the certifying agency's requirements.
- .8 Colour coding of the pairs shall be as follows:
 - .1 Pair 1: White/Blue; Blue
 - .2 Pair 2: White/Orange; Orange
 - .3 Pair 3: White/Green; Green
 - .4 Pair 4: White/Brown; Brown
 - .5 Cable shall be supplied in 1000 ft Reelex boxes.
- .28 Performance Requirements - Category 6 Channel Systems
 - .1 All cable and component transmission performance parameters shall be independently verified by a UL or ETL third party testing organization.
 - .2 Category 6 channel cable and components shall individually exceed Category 6 transmission requirements of ANSI/TIA/EIA-568-C.2-1, Transmission Performance Specifications for 4-Pair 100-ohm Category 6 Cabling Components.
 - .3 Category 6 channel system shall exceed 10 Gb/s transmission requirements for connecting hardware, per the requirements of ANSI/TIA-TSB-155 (current draft).
 - .4 The manufacturer shall provide Category 6 component compliance certificates from third party testing organization upon request.
 - .5 Channel cable and components shall be UL LISTED 1863 and CSA certified.
 - .6 Installed channel system shall exceed IEEE 802.3 DTE Power specification to 4 times the rated current limits with no degradation of performance or materials.
 - .7 Channel system shall be third party verified, error free Gigabit Ethernet performance to IEEE 802.3 standard.
 - .8 Channel system shall exceed 4-Gb/s data transmission capacity within the bandwidth of 1–250 MHz when configured in a 4-connector channel.
- .29 Product Specified – Specific System Colour Requirements
 - .1 Data – Patch Cords, Structured Cabling and Jacks - **BLUE**
 - .2 Voice – Patch Cords, Structured Cabling and Jacks - **WHITE**
 - .3 WAN Connection Patch Cords - **ORANGE**
 - .4 Camera – Patch Cords, Structured Cabling and Jacks - **GREEN**
 - .5 Wireless Access Point (WAP) – Patch Cords, Structured Cabling and Jacks - **ORANGE**
- .30 Voice Termination – BIX
 - .1 All voice cables shall be terminated in existing main Telephone board in existing BIX1A4 connectors mounted in BIX10A mounts. Supply and install all necessary accessories, designation strips, labels, D-rings, etc., for a complete installation. Provide new BIX terminal blocks complete with associated components if required.
- .31 Wall Mounted Outlets
 - .1 Use 2-port flush mount faceplates. Faceplates shall be constructed of ABS moulding compound.
 - .2 Each outlet shall be served by Category 6 jack.
 - .3 Faceplates shall be White in colour and shall be mounted at locations as shown on drawings.
 - .4 Each faceplate shall be mounted to an in-wall single gang box by Division 26.
- .32 Surface Mounted Box
 - .1 Use a 4-port surface mount box. Surface mount shall be constructed of ABS moulding compound.
 - .2 Each outlet shall be served by Category 6 jack.

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- .3 Surface boxes shall be White in colour and shall be mounted at locations as shown on drawings.
- .4 Provide surface mount boxes for all surface mount application.

.33 Labels

- .1 Labels shall be mechanically printed. Handwritten labels are not acceptable.
- .2 Supply and install self-laminated labels at both end of each cable.
- .3 Supply and install labels at each outlet location. Labels shall be affixed to the faceplate on the space provided by the Manufacturer.
- .4 Label all ports at the patch panel and voice field (BIX).
- .5 All data and voice outlets shall be labelled as follows:
 - .1 V-001 shall indicate voice outlet #1.
 - .2 DA-001 shall indicate data outlet in Hub "A", port #1.
 - .3 DB-001 shall indicate data outlet in Hub "B", port #1.

.34 Racks

- .1 Racks shall be UL listed and of aluminium construction with a black polyurethane or mil finish. They shall have a 15" base depth. Rack base shall be pre-drilled for securing rack to the floor. Racks shall have 12/24 mounting screws included in the package.
- .2 Rack rails shall be spaced for 19" mounting rail-to-rail and shall be of a U-shaped construction with 12/24 pre-tapped holes in the EIA-310-D standard hole pattern on both the front and rear.
- .3 Approved Manufacturers:
 - .1 Hubbell Premise Wiring HPW84RR19 or RF-MOTE equivalent.

.35 Vertical Cable Management Channels

- .1 The vertical cable management channel shall be comprised of three components: Vertical Channels, Steadfast gates, and covers.
- .2 The overall depth of the cable management shall be 10".
- .3 The vertical channel shall be comprised of two half-height sections of a fabricated "Z" profile (Z-Frame).
- .4 The Z-Frame shall be fabricated of 14ga cold rolled steel.
- .5 The surface finish shall be powder coat black or metallic silver as required to match equipment racks.
- .6 The Z-Frame shall have 4" diameter front to rear cable pass through holes.
- .7 The Z-Frame shall have a minimum of twelve sets of cable tie off points along its face for securing cable bundles running vertically.
- .8 The Z-Frame shall have formed hooks in its side allowing the channel to be easily fastened to the vertical upright of a rack of Hubbell manufacturer.
- .9 Gates shall be provided to retain cable within the envelope of the vertical channel.
- .10 The gates shall fasten to the Z-Frame without the use of fasteners.
- .11 The gates shall have rolled edges to maintain bend radius of cable.
- .12 The gates shall have reinforcing ribs along the forward surface.
- .13 The gates shall be fabricated from 4ga cold rolled steel.
- .14 Covers shall be fabricated from 20ga cold rolled steel.
- .15 Covers shall not be fabricated from a polycarbonate, acrylic, or other flammable material.
- .16 Decorative covers shall clip to gates without the use of fasteners.
- .17 Approved Manufacturers:
 - .1 Hubbell Premise Wiring Part Number VC76X, 6" Channel Width or RF-MOTE equivalent.

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.36 Horizontal Cable Management Channels

- .1 The Horizontal duct style cable management channel shall be steel in construction.
- .2 The duct cover shall be hinged at the bottom, allowing it to snap open or closed. There shall be no fasteners required for installation of the cover, and the cover shall be keyed for easy removal by rocking the cover to a horizontal position and sliding to the side. The duct cover shall be removable unless the cover is in the horizontal position.
- .3 The horizontal channel shall be comprised of two pieces, the cable management panel and hinged cover. The horizontal channel shall be 2U with 3 channel depths available for patch cords.
- .4 The horizontal channels shall be manufactured of ¼" steel rod for rigidity. Flat steel channel rings shall not be acceptable.
- .5 The horizontal channel base shall have 6 pass-through holes to allow patch cords to connect at the rear of hubs.
- .6 The pass-through holes shall be rolled edge design to prevent cable chafing. Rubber or plastic grommets shall not be used.
- .7 The horizontal channel shall provide for a rear cable organizer. The rear cable organizer shall clip to the rear of the panel without the use of tools or additional fasteners. The rear cable organizer shall provide for the attachment of a cable channel equal to the channel cover used on the front.
- .8 There shall also be provided vertical rings and transition spools to manage patch cords as they exit the horizontal channel.
- .9 Approved Manufacturers:
 - .1 Hubbell Premise Wiring Part Number HC219CE3N, 2U Horizontal duct style channel/ hinged cover 3.5" deep or RF-MOTE equivalent.

.37 Grounding and Bonding

- .1 The grounding and bonding requirements of this project shall meet CSA T527 and in intended to work in concert with the cabling topology and installed in accordance with CSA T530 (telecommunication pathways and spaces standard).
- .2 A copper ground busbar shall be provided at communication demarcation/ equipment location. Establish a communications ground that is continuous and permanent at communication demarcation /equipment location.
- .3 Ground wall bracket to the communication grounding system using green #6 AWG insulated stranded copper ground wire.

3. Execution

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical.
- .2 Preparation
 - .1 Cabling Contractor shall adhere to all Standards, regulations, and documents for data cabling installation.
 - .2 All products installed must meet or exceed all local, provincial, and federal building, fire, health, safety, and electrical codes.
 - .3 Horizontal and backbone cable pathway infrastructure (conduit, dual hanger/ cable tray, raceway, etc.) shall be fully deployed according to applicable codes and standards.
 - .4 Metallic horizontal cable pathways shall be bonded to an approved ground according to ANSI-J-STD-607-A.
 - .5 Racks, cabinets, and enclosures shall be installed in the proper locations, and bonded to an approved ground according to ANSI-J-STD-607-A.

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- .6 Prior to jack termination in the workstation outlet, horizontal cabling of the proper category shall be fully deployed from HUB room(s) to each outlet location according to applicable codes and standards.
- .7 Prior to panel termination in the Hub room(s), backbone and horizontal cabling shall be fully deployed
- .3 Computer/Data Network Cabling Installations
 - .1 The responsibility of the structure cabling contractor is to include but not to be limited to:
 - .1 Supply and installation of data /WAP and voice cabling to every outlet as noted on the drawings.
 - .2 Termination of data /WAP cabling at outlet and patch/ distribution panel.
 - .3 Supply and installation of device faceplates in surface and/or flush outlet boxes.
 - .4 Supply and installation of computer network wall bracket and patch/ distribution panels required for a complete and operational system.
 - .5 Testing in conformance with noted procedures.
 - .6 Labelling of outlet faceplates and associated port on distribution panel. An “As-Built” floor plan of “outlet addresses” must be provided at the completion of the project.
- .4 Pre-qualified computer network sub-contractors must be one of the following:
 - .1 Marcomm
Contact: Rick Boyd
Main: 905-695-1700
Fax: 905-695-1701
163 Buttermill Ave., Unit #3
Concord, Ontario
L4K 3X8
 - .2 Catech Systems Ltd.
Contact: Mark Corbeil
Main: 905-944-0000
Fax: 905-944-4855
201 Whitehall Drive, Unit #4
Markham, Ontario
L3R 9Y3
 - .3 Ozz Infrastructure Solutions Inc.
Main: 905-669-6223
Fax: 905-326-1733
20 Floral Parkway
Concord, Ontario
L4K 4R1
 - .4 Urban Electrical Contractors
Contact: Mario Herce
Main: 905-669-0280
Fax: 905-669-0836
790 Creditstone Road
Concord, Ontario
L4K 4P4
 - .5 Millside Total Communications
Tel: 905-876-1110
Email : sales@millsidetc.com
1-975 Fraser Drive
Burlington, ON
 - .6 Network Telecom
Contact: Dave Waddle
 - .7 Phone: 519-748-2226

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- .5 Installation – Category 6 Cable
 - .1 Using approved methods, pull cable into conduits, or place into raceway or dual hangers/ cable tray as specified. Do not exceed 25 Lb pull force per cable. Use appropriate lubricants as required to reduce pulling friction.
 - .2 All exposed wiring shall be installed in surface raceway.
 - .3 All wiring above ceilings or below access floors shall be installed in dual hangers/ cable tray or open-top cable hangers (J-hooks).
 - .4 Cable slack and service coils shall be stored properly above the ceiling or under the access floor.
 - .5 Cable ends for termination shall be clean and free from crush marks, cuts, or kinks left from pulling operations.
 - .6 Pathway fill ratio in conduit, tray, raceway, etc. shall not exceed 40% of pathway cross-sectional area.
 - .7 Follow industry recommendations for cable bend radius. Avoid kinking or twisting the cable during installation.
 - .8 No plastic cable ties allowed. Velcro straps shall be used.
 - .9 Maximum spacing of cable supports above the ceiling shall be 60".
 - .10 Maintain the following clearances from EMI sources:
 - .1 Power cable in parallel: 12" minimum.
 - .2 Power cable intersections: 6" minimum (at 90 degrees).
 - .3 Florescent lights: 12" minimum.
 - .4 Transformers and electrical service enclosures: 36" minimum.
 - .11 Communications cabling that must cross power cables or conduit shall cross at a 90-degree angle and shall not make physical contact.
 - .12 Length of each horizontal cable run from hub rooms/ closets to the wall outlet shall not exceed 90 meters.
 - .13 Leave sufficient slack for 90 degree sweeps at all vertical drops.
 - .14 Do not install cable in wet areas, or in proximity to hot water pipes or boilers.
 - .15 Installed cables shall have no abrasions with exposed conductor insulation or bare copper 'shiners". The installer is responsible to replace damaged cables.
 - .16 Firestop all cable penetrations through fire-rated barriers per local codes.
 - .17 All horizontal, UTP cables shall be continuous from end to end with no splices.
 - .18 The maximum length for horizontal cables shall not exceed 300' (90m). Tak-Tape wrap shall be used on wiring bundles. Nylon cable ties are not acceptable.
 - .19 Cables shall be properly labelled on front and back with the cable number and port connections for each port.
 - .20 Contractor shall assume the responsibility for any difficulties or damage to the cable during placement.
 - .21 Contractor shall provide school board with all installed cable measurements.
 - .22 Conduits shall be installed following building lines. Under no circumstances shall cables or conduits be fastened to suspended ceiling support systems. Conduits shall be supported to building structure independent of other support systems.
 - .23 All conduit systems shall be left with a nylon fish string to allow for future additional cables.
 - .24 Slack cable must be provided to allow for minor workstation relocations. A coil of slack cable of an approximate 6' (2m) length shall be provided at workstation locations.
- .6 Installation – Category 6 Jacks
 - .1 Terminate jacks according to manufacturer's instructions.
 - .2 To maximize transmission performance, maintain wiring pair twists as close as possible to the point of termination. The length of wiring pair un-twist in each termination shall be less than 0.5" (13 mm).
 - .3 Jacks shall be properly mounted in plates, frames, or housings with stuffer cap fully installed over IDC contacts.

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- .4 Horizontal cables extending from mounted jacks shall maintain a minimum bend radius of at least 4 times the cable diameter.
- .5 Cable terminations shall have no tensile or bending strain on IDC contacts after assembly of faceplate or housing to the wall outlet.
- .7 Installation – Category 6 Patch Panels
 - .1 Properly mount patch panels into the designated rack, cabinet, or bracket locations with the #12-24 screws provided.
 - .2 Terminate cables into the patch panel according to manufacturer's instructions.
 - .3 To maximize transmission performance, maintain wiring pair twists as close as possible to the point of termination. The length of wiring pair un-twist in each termination shall be less than 0.5" (13 mm).
 - .4 Horizontal or backbone cables extending from the panel terminations shall maintain a minimum bend radius of at least 4 times the cable diameter.
 - .5 Cable terminations shall have no tensile or bending strain on panel IDC contacts in each installed location.
 - .6 For horizontal cabling, jacks shall be terminated with faceplates assembled complete and properly mounted.
 - .7 Consolidation points equipment, where applicable, shall also be fully installed and terminated prior to testing.
 - .8 Panels shall be properly labelled on front and back with the cable number and port connections for each port.
- .8 Installation – Category 6 Patch Cords
 - .1 Remove patch cords from bags and apply channel or port identification labels per specification. Patch cord lengths should match the distance between connection points, with enough slack for cable management and bend radius control.
 - .2 For cross-connect panels in the hub rooms/ closets, place the patch cords properly into the installed front cable organizer. Plug each end into the respective panel and equipment ports. Push the plug into the receptacle until the latch clicks into position. Installed patch cords should be neat, with no kinks, tangles, or tight bends.
 - .3 To connect workstation equipment to the outlet, route the patch cord behind furniture and plug into the network port. Patch cords should not interfere with the operator space or electrical cords. Note: workstation cords are normally installed after placement of office furniture.
- .9 Field Quality Control – Testing
 - .1 Category 6 channel systems shall be tested as an installed horizontal and fibre as backbone cabling system. Jacks and faceplates are assembled complete and properly mounted. Panels are terminated and fully dressed in proper cable management. Patch cords are connected on each end of channels.
 - .2 Each channel in the horizontal or backbone channel system shall be identified and tested individually, using an industry standard level III tester with correct settings.
 - .3 Jacks shall be tested as part of the installed horizontal cabling system.
 - .4 Splicing of any cables will not be permitted for any reason.
 - .5 Testers shall be correctly set to test the type and manufacturer of the horizontal cable used in the link or channel being tested, including the correct NVP.
 - .6 Each horizontal and backbone channel is tested for the parameters listed below.

Wire Map / Continuity	Length	Insertion Loss
NEXT	PSNEXT	ELFEXT
PSELFEXT	Delay and Delay Skew	Return Loss

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- .7 A green "PASS" indication shall be obtained for each channel or link, using a level III tester.
- .8 Completed test reports shall be submitted per contract requirements.
- .9 Upon completion of the testing, the Consultant may ask the contractor to perform random tests of up to 30% of the cables. A penalty of \$500.00 will be deducted from the contract amount for each cable that fails the test.
- .10 Faceplates
 - .1 Jacks and/or connectors shall be terminated to the appropriate cable and inserted in the correct orientation into the faceplate prior to the mounting of the faceplate.
 - .2 Cable slack shall be stored behind the faceplate in such a way that allows the minimum bend radius of the cables to be maintained as per the following:
 - .1 Fibre Optic Cable, a minimum of 3 feet (1m) slack with a minimum bend radius of 1.18 inches (30mm).
 - .2 UTP cable, a minimum of 1 foot of slack with a minimum bend radius of 4 times the cable diameter. Care shall be taken when mounting the faceplate to avoid crimping or kinking the cables.
 - .3 Faceplates shall be securely mounted to a surface mounted housing, a recessed box, or box eliminator bracket.
 - .4 Faceplates shall be labelled with the appropriate port designations as per the EIA/TIA 606 standard.
- .11 Penetration Through Firewalls
 - .1 A conduit sleeve shall be provided where horizontal cables penetrate firewalls. The conduit sleeve shall be sized at 40% fill ratio with a plastic bushing at both ends.
 - .2 After the conduit sleeve is installed, the opening around the conduit shall be filled with ULC listed firestop and smoke seal materials.
- .12 As-Built Drawings
 - .1 Contractor shall always maintain an updated copy of as-built drawings on site.
 - .2 At the end of the project, contractor shall obtain AutoCAD files from the Consultant and update them with the work performed by the contractor. Contractor shall provide one (1) soft copy of updated as-built drawings and 3 sets of prints.
 - .3 As-built drawings shall be submitted to the Consultant no later than 10 working days following the completion of the installation.
- .13 Warranty
 - .1 Communications cabling contractor will be required to provide a 25-year manufacturer's Extended Component Warranty and an Application Assurance Warranty for the entire communications cabling system. Warranty shall be in effect from the date of substantial completion as certified by the Architect.
 - .2 Communications cabling contractor shall provide certification number within two weeks of award of the project.
 - .3 Communications cabling contractor shall provide a letter of Certification within two weeks of substantial completion. This document will include the following:
 - .1 Verification of the performance of the installed system.
 - .2 Manufacturer's certification number.
 - .3 Identification of the installation by location and project number.

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- .14 All cables must be properly handled and installed in accordance with the manufacturer's specifications. Undue pulling tension, abrasion or rough handling must be avoided to ensure that the cables will permit transmission up to the design speed of 1Gb/s. All cables must be installed without splices or cuts to ensure the elimination of reflections, discontinuities, impedance mismatches, etc. The maximum horizontal length from the workstation to the LAN/ Telecom room shall not exceed 300' (90m).
- .15 Wiring shall be mechanically protected by runs in cable tray or down drops in conduits.
- .16 Provide associated "J-hooks" as required for proper support.
- .17 Cabling Contractor is to adhere to all Standards, regulations, and documents for data cabling installation.
- .18 All products installed must meet or exceed all local, provincial, and federal building, fire, health, safety, and electrical codes.
- .19 The responsibility of the structure cabling contractor is to include but not to be limited to:
 - .1 Complete scope of work for structure cabling and devices as shown on drawings and indicated in specification.
 - .2 Supply and installation of device faceplates in surface and/or flush data outlet boxes and surface mounted raceways at locations as noted on drawings.
 - .3 Testing in conformance with noted procedures.
 - .4 Labelling of outlet faceplates and associated port on distribution panel. An "As-Built" floor plan of "outlet addresses" must be provided at the completion of the project.

END OF SECTION

1. General

1.1 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.

2. Products

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 The existing Carehawk-CH1000, P.A. system to remain and operational at all times.
- .3 Existing P.A. system music player, mic, administration console(s) and other associated components and devices currently located in existing office shall be relocated in new office area at locations as shown on drawings. All existing devices and components shall be temporarily disconnected, removed, salvage and securely stored during construction and shall be reinstalled when new office space will be ready. Provide new wiring for all existing P.A. devices and components relocated to new office location and provide all necessary components and adjust to suit.
- .4 Provide call button outlet boxes, speaker back boxes, P.A. system wiring, P.A. system devices, testing, conduits terminated in corridor and provide extension to the existing system as shown on drawings and indicated in specification and in accordance with manufacturer recommendation. Provide all associated components to suit.
- .5 All new P.A. system devices i.e., P.A. system speaker(s), call button etc. shall be compatible with existing P.A. system.
- .6 New Speaker shall be McBride #8229/25/7025 complete with back box McBride #MC20E.
- .7 New call button shall be McBride #MCSW-1 complete with back box and stainless-steel plate McBride #MCWP-13SW.
- .8 New P.A. system wiring shall be plenum rated FT-6 type Cat. 5, 24 AWG, four (4) twisted pair wiring. Install new wiring in new outlet/back boxes, conduits, and "free run" in corridor ceiling space. Provide associated "J-hooks" as required for proper support.
- .9 Install wiring in new conduits/outlet boxes.
- .10 Terminate new wiring in existing P.A. system panel.
- .11 Terminate all conduits in corridor ceiling.
- .12 The fish wire shall be installed in each conduit.
- .13 All distribution conduits shall be complete with slip sleeves to permit the installation of the distribution cables.
- .14 Installations of equipment and wiring shall be done in accordance with manufacturer's recommendations and school board requirements.
- .15 After completion of the system provides verification report by system manufacturer/installer.

- .16 Pre-qualified public address system sub-contractor:
 - .1 Hamilton Video & Sound Limited
Contact: Gord Faulkner
Tel: 905-522-1200 Ext-109
Cell: 905-746-4999
Email: gord@hvs.ca
1350 Osprey Drive Ancaster, ON L9G 4V5

3. Execution

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical.
- .2 Provide conduits, outlet boxes and other materials as required and/or shown on the drawings for installation of P.A. system devices and equipment.
- .3 Conduits for P.A. devices shall be terminated as shown on the drawings. Coordinate all work with the P.A. system supplier/installer.
- .4 The installation shall be in accordance with the Board's requirements.
- .5 All distribution conduits shall be complete with slip sleeves to permit the installation of the distribution cables.

END OF SECTION

1. General

1.1 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.

2. Products

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 The main existing telephone panel shall remain and shall be operational at all times.
- .3 Provide associated outlet boxes, back boxes, jacks, cover plates, telephone system wiring, connection, conduits terminated in corridor and provide extension to the existing system as shown on drawings, indicated in specification and in accordance with manufacturer's recommendation. Provide all associated components to suit.
- .4 Install wiring in new conduits/outlet boxes, and "free run" in corridor ceiling space. Provide associated "J-Hooks" (as required) for proper support.
- .5 Terminate new wiring in existing telephone system BIXS panel.
- .6 For each telephone outlet provide separate dedicated run of telephone system wiring and connect to existing telephone system BIXS panel/existing telephone system switch.
- .7 New telephone system wiring shall be four (4) pair, solid copper, 22 AWG cable, unshielded twisted pair (U.T.P.), category 3, ft-6 rated and shall match existing wiring.
- .8 Terminate all conduits in corridor ceiling. Provide J-Hook if required for proper support.
- .9 The fish wire shall be installed in each conduit.
- .10 All distribution conduits shall be complete with slip sleeves to permit the installation of the distribution cables.
- .11 Installation shall be in accordance with manufacturer's recommendations and school board requirements.
- .12 After completion of the system provide verification report by system manufacturer/installer.
- .13 Pre-qualified telephone system sub-contractor:
Network Telecom
Contact: Dave Waddle/ Bill Schultz
Phone: 519-748-2226

3. Execution

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical.
- .2 Provide all conduits, outlets and other materials as required and/or shown on the drawings for a complete system.
- .3 A fish wire shall be installed in each telephone conduit.

END OF SECTION

1. General

1.1 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.

2. Products

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 Clocks shall be surface mounted, battery operated- 12" diameter, Simplex #6310-9422 or 12" diameter Infinity Instruments Standards, complete with batteries and hangers.
- .3 Clocks in general purpose room shall be 14" diameter and shall be complete with wire guard.

3. Execution

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical.
- .2 Provide hangers for all clocks.
- .3 Supply and install clock in each room containing a classroom control panel and as shown on drawings. Include in contract 4-additional clocks which will be installed in rooms as designated by the school board representative and on site.

END OF SECTION

1. General

1.1 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.

1.2 SUBMITTALS

- .1 Submit shop drawings for all products specified in Part 2.
- .2 Drawings to include equipment and material detail including dimensions.
- .3 Submit drawings for jacks, TV cable, faceplates, splitters, connectors etc.

2. Products

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 Provide cable T.V. wiring and equipment for Library, Staff Lounge, and General Office areas. Provide conduit, wiring and devices, and all required equipment as described and shown on drawing for these areas.
- .3 The plywood backboards shall be supplied by this Division.

3. Execution

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical.
- .2 Provide conduits, outlets, and other materials as required and/or shown on the drawings for installation of cables and equipment.
- .3 The installation shall be in accordance with the requirements of the Cable T.V. Company.
- .4 All distribution conduits shall be complete with slip sleeves to permit the installation of the distribution cables.
- .5 A fish wire shall be installed in each Cable T.V. conduit.

END OF SECTION

1. General

1.1 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.
- .3 Description
 - .1 The project involves the supply and installation of:
 - .1 Keyscan CA8500 (8) door control units, HID proximity card readers, request to exit motion sensors, door position switches, grade 1 electrified door strikes at the following doors:
 - .1 Main Entrance
 - .2 Other doors as shown on drawings.
 - .3 Remaining is spare.
 - .2 System includes HID iClass SE Legacy Reader Series proximity cards.
 - .3 Keyscan – Aurora integration solutions web-based access control management. System is programmed and monitored from Central Board office with limited local control. Local proximity cards are managed at the school level.
 - .4 Automatic Operator Doors – require a sequencer to integrate with reader and strike.
 - .2 The supply, installation, set-up and testing of all the new electronic access control and intercom security field devices and cabling.
 - .3 The Access Control System Contractor is to confirm the compatibility and supply and install, where required, new security communication and/or transmission cable as per the manufacturer's individual cabling requirements. The Access Control System Contractor shall provide functional access control interface in accordance with manufacturer's performance, functionality and suggested cable and power distances.
- .4 Related Work
 - .1 The Access Control System Contractor is to supply all power and required electrical circuit(s) to access control mounting board and all system(s) power supply locations.
 - .2 The Access Control System Contractor is to work in conjunction with HDSB Information Technology department to ensure that the HDSB communication, database and web server meet the minimum criteria of Keyscan Inc. for optimal performance. In addition, it is the responsibility of the Access Control System Contractor to assist in the configuration, set-up, programming and testing of each server, access control panel and configuration of outbound WAN/Switch port alongside HDSB Information Technology representatives.
 - .3 The Access Control System Contractor shall supply location specific line format power and device as- built drawings, user manuals and training for each piece of equipment and software as outlined in this section.
- .5 Quality Assurance
 - .1 All power over Ethernet (POE) AC and DC power wiring shall conform to POE IEE 802.3af Class 3, OESC, CSA Standard C22.1 and other applicable local and national codes.
 - .2 The Access control platform shall be listed in accordance with Underwriters Laboratories UL294 Standard for Access Control System Units.
 - .3 Access control equipment shall be listed in accordance with Underwriters Laboratories UL1076 for Proprietary Alarm Units.

- .4 The access control system shall support American Disabilities Act (ADA) compliance in door access control operation.
- .5 Plenum rated UTP, CMP cable, CAT5e data and/or power cabling must adhere to NFPA 262 flame rating in all ceiling spaces above tile, whether those areas are designated as plenum ceiling spaces or not.
- .6 All newly installed access control cables shall be formed, neatly laced or tie wrapped, and/or clamped in position within raceway, ceiling space and/or within conduit enclosures.
- .7 All new cables shall be installed with sufficient cable slack to:
 - .1 Prevent stress and strain on connectors and cables.
 - .2 Allow easy disconnection of equipment.
- .8 When new cables run through holes, frames, or conduit the cable shall be protected by suitable grommets.
- .9 All new cables shall be concealed in conduit or laid in existing cable raceway. Where free movement of equipment is required, flexible conduit shall be deployed. When new cable is installed in a raceway or conduit, all cable(s) shall be tested for continuity and insulation breakdown or skinning. No newly installed conduits shall exceed 300 feet, 100 metres, in length without a suitable junction pull box. Where cable is installed in an open and secure ceiling space, without conduit or raceway, all cables shall be identified every 100'. All exposed cables within a ceiling space must be neatly fastened and/or tied to existing ceiling or wall slab and/or held with j-hooks and/or strapped to existing conduit. All cables below ceiling space, or not within existing raceway, shall be installed in conduit and identified as an access control conduit.
- .10 All new cables shall be continuous between termination and connection points. Connectors and splices shall be located within a secure enclosure or junction box and are not permitted inside conduit.
- .11 All new cables shall be installed and located so that high voltage induction does not degrade system operation.
- .12 All new outdoor cabling shall have drip loops at the point of entry into enclosures and junction boxes, and all entries shall have a weather tight seal. Where cable connection is exposed to outdoor elements, it shall be protected with heat shrink material.
- .13 All new components installed, that may require removal for servicing, shall not be affixed by rivets, welds, metal tags or other similar means that would prevent removal.
- .14 Damage to the Owner's property including equipment, buildings, etc during this project's installation or testing shall be made good by the Access Control System Contractor. Any damage whatsoever during installation or testing of equipment supplied by the Access Control System Contractor shall result in that equipment being replaced by new and undamaged equipment.
- .15 At the end of each day, during the installation period, the portions of the site utilized by the Access Control System Contractor shall be cleaned, tied and any waste material generated by the Access Control System Contractor shall be disposed. At the conclusion of the installation, the site and equipment shall be cleaned thoroughly and all damage to site or equipment made good.
- .16 The Access Control System Contractor shall warranty the complete access control and intercom system for the period of twenty-four months from system commissioning and HDSB Owner's representative written acceptance.
- .17 The Access Control System Contractor is to co-ordinate equipment wall and floor rack mount locations with HDSB project authority and Commissioning agent.
- .6 Submittals
 - .1 Shop Drawings and Project Administrative Manual (PAM):
 - .1 Upon award, the Access Control System Contractor is to provide two sets of Shop Drawings for all equipment access control system devices, components, and software.

.2 Acceptance Test and Commissioning Plan:

- .1 The Access Control System Contractor is to submit their Acceptance Test and Commissioning Plan.

.3 Training:

- .1 The Access Control System Contractor is to submit their Training outline in accordance with Access Control System Specification.

.4 Operator/Maintenance Manuals:

- .1 Access Control System Contractor shall provide an Operator and Maintenance manual as described in Access Control System Specification.

.5 As-Built Drawings:

- .1 Access Control System Contractor shall provide as-built drawings after project installation as per Access Control System Specification.

1.2 SUBMITTALS

- .1 Submit shop drawings for all products specified in Part 2.
- .2 Submit manufacturer's instructions, printed product literature and data sheets for control panels, detection accessory devices, power supplies and wiring. Include product characteristics, performance criteria, physical size, finish, and limitations.

2. Products

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.

.2 Access Control Configuration

- .1 The Electronic Access Control system shall be used to control staff and visitor movements through a single interior and/or exterior door(s) at School. The administration software application shall be functional with Windows Explorer and capable of running on a non-proprietary CPU. No annual data base licensing shall be permitted. The access control system device readers, door position switches and request to exit devices shall communicate with the HDSB remote server via use of either the HDSB WAN 10/ 100 TCP/ IP network or a Dynamic Host Communication Protocol secure web client browser application. The supply of the outbound network operability is the sole responsibility of HDSB. The electronic access control system shall consist of the device elements in the quantities represented and/or specified in the project drawings. The Access Control System Contractor shall install all required and/or additional door hardware, controls, communicators, supervisory and field devices for a manufacturer, and local fire jurisdiction, approved functional access control system. Hardware, Controllers, Software, Devices and Modules include, but are not limited to:
 - .1 Keyscan CA8500 8 Reader Controller c/w 8 door output relays.
 - .2 HID iClass SE R10 Proximity Reader c/w 100 HID 2021 iClass series printable proximity cards per site - Contact HDSB to obtain and program the cards. Main office Tel: 905-335-3663 Ext. 3332.
 - .3 Keyscan NETCOM2P RS232 to TCP/IP converter.
 - .4 Kantech T-REX-XL White Request to Exit c/w with tamper, piezo and timer or equivalent.

- .5 Keyscan – Aurora integration solutions web-based access control management and Web Client License.
 - .6 CSA approved strike power supply/transformers c/w battery.
 - .7 Recessed mounted door contacts.
 - .8 Necessary, and/or required door closers, Grade 1 cycle ANSI/BHMA A156.31-2007 electric strike(s), power transfer hinge(s), electrified panic hardware and maglock(s) to suit the door-portal egress hardware requirements in compliance with local jurisdiction and all Ontario Building and Fire Code requirements.
 - .9 All necessary hardware permits are the responsibility of the Security Contractor.
 - .10 Manufacturer, Fire and Building Code approved cable.
 - .11 Install cable(s), conduit, and all system devices (equipment and hardware).
 - .12 Necessary wall back boards.
- .2 The access control system shall provide continuous unattended access control entry and denial with alarm point monitoring while meeting or exceeding the technical, operational and feature requirements of this specification. The access control system shall grant access, deny access, or signal an alarm event. Following a power failure, and the restoration of main or back-up power, the access control system shall revert automatically to normal service status without the need for operator intervention. The system shall restart in the same state as existed before the power interruption.
- .3 The access control system shall report alarm(s). The reporting text shall include date, time, and a pertinent description of the event and the condition. The software shall be capable of providing colour coded message text for a variety of different events. All events shall be documented and categorized by a visual representation.
- .4 The access control system shall have the ability to manually lock/unlock door portal from local and remote centralized location via TCP/IP, web-based browser, or hardwired key switch device.
- .5 The access control software application shall enable the creation and definition of a user access card/fob. The following user information shall be able to be saved on the user section:
- .1 Card number.
 - .2 First and last name.
 - .3 Card type.
 - .4 Start and expiry date.
 - .5 State of card enabled or disabled, active or not active.
 - .6 Comments.
- .6 The access control system shall be able to perform the following tasks:
- .1 Control access to various doors equipped with a card reader. Allow the ability to set card use count options to limit the number of times a card can be used.
 - .2 Monitor defined "door forced open" alarm points at all the doors controlled by card readers based on a programming schedule.
 - .3 Generate reports with the ability to view them on a monitor, print them and e-mail them.
 - .4 Supervise and detect, and remotely annunciate, "open", "high impedance", "low impedance" and "short conditions".
 - .5 Supervise access control panel housing cabinet door opening.

3. Execution

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical

- .2 Install the complete access control system as indicated/described in contract documents and in accordance with the manufacturer's instruction.
- .3 Confirm exact locations of all components prior to roughing-in.
- .4 Acceptance Test and Commissioning
 - .1 The Commissioning Phase of this project shall consist of three (3) major milestones, and are as follows:
 - .1 Acceptance Test Procedures (ATP).
 - .2 Formal Test Procedures.
 - .3 Final Systems Acceptance.
 - .2 The following tests shall be included for each access control device:
 - .1 Verify operation and event logging of each access control card reader location in all operating scenarios including valid/invalid-denied access card, expired and disabled card, disable reader, communication failure and standalone mode.
 - .2 Verify annunciation, acknowledge, cancel, bypass, mask, and event logging of each alarm point in the access control system.
 - .3 Verify successful operation of all access control and intercom system administrative menu features and standard operational functions.
 - .4 Verify proper operation and start-up of all systems(s) software after power brown out, power failure and power restoration.
 - .5 The ATP shall be approved when all issues, comments and/or concerns have been addressed satisfactorily.
- .5 Training and Programming
 - .1 The Training and Programming Phase is made up of two (2) milestones:
 - .1 The Access Control System Contractor shall perform all Operator and Administrative Training on site. The training and programming shall be performed as follows:
 - .1 Stage #1 - hands on training for both operator and administrative personnel.
 - .2 The Access Control System Contractor shall supply all training aids, discs, manuals, and equipment in sufficient quantities for the number of training session attendees.
 - .3 The final documentation phase of the project begins upon approval of the Shop Drawings. This phase contains three (3) major milestones, and they are as follows:
 - .1 Operator Manual Approval.
 - .2 Maintenance Manual Approval.
 - .3 As-Built Drawings Approval.
 - .4 The Access Control System Contractor shall prepare and submit one (1) copy of the Operator and Maintenance Manual for review by the Project Management Commissioning Agent within 30 days of shop drawing approval. Manuals shall be approved when all comments by the Security Consultant have been addressed satisfactorily.
 - .5 The Access Control System Contractor shall deliver one (1) copy of each manual.
 - .6 The Access Control System Contractor shall prepare and submit two (2) copies of as-built drawings.
- .6 Contractor Requirements
 - .1 Access Control System contractors to meet the following criteria:
 - .1 Compliant Keyscan Inc. Certified Equipment Re-seller.
 - .2 Compliant Keyscan Inc. Access Control Installer.

.2 Acceptable Access Control System Contractors:

- .1 Hamilton Video & Sound (905) 522-1200 or email gord@hvs.on.ca

END OF SECTION

1. General

1.1 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.
- .3 Scope of Work
 - .1 Contractor shall provide all labour, materials and equipment required to supply and install new video surveillance system as specified and as shown on drawings.
 - .2 Supply and install an IP based video surveillance system. The system shall create an independent network from the school network to support an IP based solution.
 - .3 This is a Performance Based Bid Specification. Materials or articles specified by brand names, catalogue number, manufacturer's/supplier's name shall be used to identify the style and quality of systems and equipment desired. Alternates to the equipment may be submitted but the base specifications requested as noted must be priced.
 - .4 The system, equipment, devices, materials, or articles shall be proposed by the Bidder under the following conditions:
 - .1 The Tender quoted sum shall be based on the quantity of cameras per drawings.
 - .1 Total quantities of IP video surveillance cameras.
 - .2 Combination of indoor & outdoor.
 - .3 One CAT5E drop to each IP video surveillance system network device on the dedicated network including a drop to the school's administrative network (per NVR) for local and remote connection to the NVR for live view and playback. Include IP system network drop to PC (decoder) controlling camera display on local monitor.
 - .2 One (1) Network Video Recorder minimum 64 channel with 3TB of storage with adequate software and licensing.
 - .1 As part of HDSB's safe school initiative, the school has a lock-down initiation/alert system. Include in the Tender quotation the function in the event of a Lock-Down condition the NVR has the functionality to engage in full record mode of all cameras until the Lock-Down condition is over. Division 26/ Video Surveillance contractor shall include IP relay, other necessary equipment, install and programming to ensure the capability of this function.
 - .3 One (1) 32" colour monitor.
 - .4 The system architecture shall be capable of being accessible from HDSB's LAN/ WAN network or Internet.
 - .1 The HDSB will provide the approved Bidder with the Static IP.
 - .2 Gateway and Subnet Mask for the interconnection of the NVR appliance to the school's administrative network. A red patch cord to be utilized for this connection. No IP cameras shall be directly connected to the school's network switches.
 - .5 All the necessary installation of power outlets to support the equipment and any other associated or necessary equipment e.g., POE Switch (managed multi-port).
 - .6 The Tender quote should include product names and detailed cut-sheets for each type of equipment and device included in the Tender quoted sum for school.

- .7 The Tender amount which will be considered is that provided for work at the considered school as one project.
- .8 Unspecified or rejected equipment, devices or materials if built into the work shall be replaced with the specified/accepted materials at no additional cost to HDSB.
- .9 A three-year parts and labour warranty shall be provided upon acceptance of the completed project. This warranty shall be in the form of a letter on the successful Bidder's letterhead. The vendor shall then maintain sufficient stock to maintain the system with the minimum downtime for the end user for the duration of the warranty period.
- .10 A Solution Silver Axis Channel Partner in good standing. Qualifying bidders are asked to include supporting documentation in the form of either.
 - .1 A copy of the prospective bidder's current and valid certificate, or
 - .2 A letter from Axis confirming the prospective bidder's conditional status.
- .11 The installation of the cameras, NVR, POE switches and monitors are to be carried out by the Video Surveillance subcontractor to the electrical contractor.
- .4 Pre-qualified access control system sub-contractor:
 - .1 Hamilton Video & Sound Limited
Contact: Gord Faulkner
Tel: 905-522-1200 Ext-109
Cell: 905-746-4999
Email: gord@hvs.ca
1350 Osprey Drive Ancaster, ON L9G 4V5
- .5 Alternates to the equipment may be submitted but the base specifications requested as noted must be priced. Alternates to equipment must be submitted to the School Board for approval.

1.2 SUBMITTALS

- .1 Submit shop drawings for all products specified in Part 2.
- .2 Submit manufacturer's instructions, printed product literature and data sheets for control panels, detection accessory devices, power supplies, cameras, NVR, and wiring. Include product characteristics, performance criteria, physical size, finish, and limitations.

2. Products

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 System Architecture
 - .1 The video system shall consist of the following components: IP Cameras, Network Switches, Video Management Software, Mounting Hardware and Dome Enclosures, Video Monitors, Video Appliance, Communications Network, wiring, separate patch panels, terminations, testing and commissioning.
 - .2 Each Camera and each Network Switch shall have an IP address on the Network.
 - .3 All control commands shall be transmitted over the network using standard IT protocols.
 - .4 Video shall be transmitted over the network from each Camera to a Network Switch, where it shall be relayed to Viewers.
 - .5 Video temporarily and/or permanently shall be stored on a Video Appliance rack mounted in main LAN rack located in existing main electrical room at location as indicated on the drawings.
 - .6 System administration functions shall be achieved from a web browser from either local or remote locations.

.3 Surveillance Equipment Specifications

.1 Indoor/Outdoor, Network, Standard Definition Digital Camera(s):

- .1 The desired indoor camera for this project at minimum Hanwha Techwin Model #ANV-L7082R; A-Series 4MP WDR IR Dome IP camera, 3.3-10.3mm motorized varifocal lens. White in colour with multiple resolution selection, IP66 rated for weatherproof environment and IK10 rated for protection against impacts.
- .2 The desired outdoor camera for this project at minimum Hanwha Techwin Model #ANV-L7082R; A-Series 4MP WDR IR Dome IP camera, 3.3-10.3mm motorized varifocal lens. White in colour with multiple resolution selection, IP66 rated for weatherproof environment and IK10 rated for protection against impacts.

.2 Outdoor cameras must meet or exceed low light performance without the need of IR illumination 29.

.3 All cameras shall be c/w adaptors, mounting hardware, support rails, etc., as necessary to mount flush or surface, wall, or ceiling, indoor or outdoor, as required. Provide EMT conduit for surface outdoor wiring and wiremold raceway for interior wiring if necessary. Every attempt is to be made to conceal wiring within accessible ceiling spaces etc.

.4 The network camera shall support standard IT protocols.

.5 Network Video Recorder Specification:

- .1 The desired Network Video Recorder (NVR) for this project at minimum is Hanwha Techwin Model #XRN-1620B2 minimum of 10TB of storage, 16 camera licenses included.

.6 PoE Switch and Mounting Equipment:

- .1 The desired PoE Switch for this project at minimum is Trendnet, TPE-TG240g, 24 port PoE+ switch. PoE shall be installed in LAN rack(s) to suit school site.
- .2 It will be at the discretion of the bidder to determine the number of units required.
- .3 It is desired that the selected PoE Switches are mounted with Adjustable Depth Hinged Panel Mount Middle Atlantic; HPM-4-915-CAN.
- .4 It will be at the discretion of the bidder to determine the number of units required.

.7 Monitor and PC:

- .1 One (1) NEC E325 32" colour monitor with one (1) Peerless PA740 articulating wall mount bracket.
- .2 Supply and install Aimetis AIM-10D Thin Client c/w HDMI cable for local monitor.
- .3 Thin Client to display cameras on the NEC monitor.

.8 NVR Software:

- .1 The successful bidder shall supply the necessary and appropriate NVR software that is compatible with the equipment supplied and shall warrant the same. The successful bidder shall provide the appropriate workstation computer to manage the required NVR software.
- .2 Ability to access live remotely and securely or archived video through Web applications without having to install any applications on the local workstation.
- .3 Employ a motion detection algorithm to determine the presence of motion in a video file and can specify the level of motion required to trigger an event or archiving.

.9 Employ data encryption and user-access privileges:

- .1 Provide video bookmarking capabilities.
- .2 Provide full playback control, including playback speed, loop, and skip to next/previous video bookmark.
- .3 Employ digital zoom capability for clear identification.

- .4 Provide the ability to capture, name, and store and retrieve time-stamped snapshots for the purposes of copying, printing and/or e-mailing.
- .5 Support multiple compression formats such as H.264, MPEG-4 and MJPEG.
- .6 Manage multiple transmission methods within the same system.
- .7 Allow users in various locations to view a video feed simultaneously without putting strain on the network.
- .8 Ability to configure different video settings for different video usage, such as live viewing, remote live viewing, recording, etc., to maintain storage flexibility and bandwidth optimization.
- .9 Provide the ability to program "tours" for the series of cameras on the system; and be able to take time-stamped snapshots and/or record video at preset positions and/or transitions throughout the sequence.
- .10 Video Surveillance System Cables:
 - .1 New wire and cabling only for all Video Surveillance System devices and equipment to meet IP Version 6 requirements c/w FT-6 insulation rating suitable for installation in rated plenum ceilings and should not exceed 315 feet.
 - .2 All wiring and cabling for Video Surveillance System devices and equipment as specified by system manufacturer.
 - .3 All wiring and cabling for Video Surveillance System transmission is to be **green**.
 - .4 The cable shall be CAT5e or CAT6, FT6 rated Tevelec cable; **green** and shall be terminated to suitable Panduit Keystone jacks mounted in blank Panduit Keystone empty patch panels with 2ft green patch cords between the patch panels and switches.
- .11 UPS:
 - .1 Provide a Tripp-lite SmartPro 120V 500VA 300W line interactive UPS model SMART500RT500RT1U complete with mounting hardware and associated cabling.
- .12 Signage:
 - .1 Supply and install a sign at each front, rear and/or side entrances, affixed to the building at an unattainable height to read "PREMISES MONITORED BY VIDEO SURVEILLANCE" on an 8" x 10" lamicoid faceplate (engraved gravoply sign). Background colour to be Halton Blue (azure, blue) with white Helvetica lettering, 3/16" diameter bit.
- .13 Provide shop drawings in accordance with Section 26 00 10 and complete with full system riser diagram indicated every proposed device and wiring requirements.
- .14 Submit data for inclusion in Maintenance Manuals which shall be complete with parts list, maintenance, and manufacturer contact numbers.

3. Execution

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical.
- .2 Provide all necessary labour, material, components, wiring, conduits, commissioning, and training for complete operational video surveillance system.
- .3 The installation shall be done in accordance with the Board's and manufacturer's requirements.
- .4 A fish wire shall be installed in each conduit.

- .5 All distribution conduits shall be complete with slip sleeves to permit the installation of the distribution cables.
- .6 All cable for this project must be supplied by the video surveillance system sub-contractor and installed in a conduit network by the electrical contractor.
- .7 Electrical contractor is to co-ordinate all installations with the video surveillance sub-contractor at school.
- .8 Electrical contractor is to load/ install the surveillance software on one (1) administrative workstation as directed by the Board personnel.
- .9 The wiring to each camera is to include an allowance that the camera may be moved +/- 30 feet in the field (prior to rough-in) to allow optimum performance and positioning.
- .10 Cameras are to be installed and connected by video surveillance contractor. Mounting of cameras is to be secure and in ceiling mounted locations be mounted to structure (independent of ceiling).
- .11 Video surveillance contractor and the electrical contractor are to co-ordinate the installation of signage and monitor.
- .12 Video surveillance system contractor is to co-ordinate with the successful voice/ data sub-contractor for the installation of a network address for the digital recording device.
- .13 Video surveillance system contractor, in the presence of the consultant, is to co-ordinate camera set-up on site with school administration personnel.
- .14 Video surveillance contractor is to provide a minimum of eight (8) hours of onsite training to administrative personnel that will be operating the video surveillance system. Provide training and operational manuals. Contractor shall demonstrate set-up, parameters, system features and trouble shooting.
- .15 Manufacturer of equipment to carry a three-year factory warranty on their products.

END OF SECTION

1. General

1.1 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.

1.2 SUBMITTALS

- .1 Submit shop drawings for all products specified in Part 2.

2. Products

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 The existing security system shall remain and shall be operational at all times.
- .3 Provide associated outlet boxes, back boxes, security system wiring, security system devices, testing, conduits terminated in corridor and provide extension to the existing system as shown on drawings indicated in specification and in accordance with manufacturer recommendation. Provide all associated components to suit.
- .4 All new security system devices shall match existing and shall be compatible with existing security system.
- .5 Relocate existing security system devices as shown on drawings. Extend associated conduit, wiring and adjust all components to suit.
- .6 New security system wiring shall be plenum rated FT-6 type, 22 AWG, to match existing wiring. Install new wiring in new outlet/back boxes, conduits, in corridor ceiling space. Provide associated "J-hooks" as required for proper support.
- .7 Install wiring in new conduits/outlet boxes.
- .8 Terminate new wiring in existing security panel.
- .9 Terminate all conduits in corridor ceiling.
- .10 The fish wire shall be installed in each conduit.
- .11 All distribution conduits shall be complete with slip sleeves to permit the installation of the distribution cables.
- .12 Installations of equipment and wiring shall be done in accordance with manufacturer's recommendations and school board requirements.
- .13 After completion of the system provide verification report by system manufacturer/installer.

- .14 Pre-qualified access control system sub-contractor:
PASSWORD PROTECTION
120 Hughson Street South
Hamilton, Ontario L8N 2B2

Contact: Dean Lloyd
Email: dlloyd@password.com
Tel: 905-522-6680
Cell: 905-512-4413
OR

Contact: Nick Dion
Email: ndion@password.com Execution

- .15 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical.
- .16 Provide conduits, outlet boxes and other materials as required and/or shown on the drawings for installation of security system devices and equipment.
- .17 Conduits for security devices shall be terminated as shown on the drawings. Co-ordinate all work with the security system supplier/installer.
- .18 The installation shall be in accordance with the Board's requirements.
- .19 All distribution conduits shall be complete with slip sleeves to permit the installation of the distribution cables.

END OF SECTION

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1. General

1.1 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.

1.2 REFERENCES

- .1 Underwriter's Laboratories of Canada (ULC)
 - .1 CAN/ULC-S524 - Standard for the Installation of Fire Alarm Systems.
 - .2 CAN/ULC-S537 - Standard for Verification of Fire Alarm Systems.
 - .3 CAN/ULC-561-03 (latest edition) - Standard for Installation and Services for Fire Signal Receiving Centres and Systems.

1.3 SUBMITTALS

- .1 Fire alarm system ULC remote monitoring and certificate in accordance with CAN/ULC-561(Latest Edition) - Standard for Installation and Services for Fire Signal Receiving Centres and Systems.

2. Products

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical
- .2 Provide ULC remote monitoring for fire alarm system complete with all required components in accordance with CAN/ULC-S561-03 (Latest Edition) - Standard for Installation and Services for Fire Signal Receiving Centres and Systems.

3. Execution

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical.
- .2 Fire alarm system control panel interconnection shall include but not limited to the following:
 - .1 Wiring connection must be provided between the ULC monitoring system panel and the fire alarm system panel.
 - .2 Wiring connection must be in conduit and installed to CAN/ULC-S561-03 (latest edition) requirements.
 - .3 The connection must be an independent zone to all other security system devices.
 - .4 Two (2) zones of the remote monitoring control panel shall be assigned as follows:
 - .1 Fire Zone 1: 'Fire' – building fire system activated.
 - .2 Fire Zone 2: 'Fire Trouble' – building fire system is in trouble.
 - .3 Fire zones shall be designated twenty-four (24) hour zones and shall not be armed/disarmed by the digital keypad.
 - .4 Exact zone designations shall be confirmed and coordinated with fire alarm remote monitoring agency/contractor.

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- .5 Provide 21mm conduit from ULC remote monitoring control panel to main telephone equipment backboard for fire alarm system monitoring to a ULC Listed Central Monitoring Station and another 21mm conduit from ULC remote monitoring control panel to GSM-GS3060 cellular module.
- .6 Provide 21mm conduit from fire alarm panel to the new ULC monitoring control panel and another 21mm conduit from fire alarm panel to GSM-GS3060 Cellular module for connection of the fire alarm/trouble outputs.
- .3 ULC remote monitoring of fire alarm system shall be in accordance with CAN/ULC-561-03 (latest edition) and shall include but not limited to the following:
 - .1 Provide all required ULC remote monitoring equipment for complete system including but not limited to the following:
 - .1 DSC-PC1616 Control Panel.
 - .2 DSC-PK5500 LCD Icon Keypad.
 - .3 DSC-PC4050CR Red Fire ULC Cabinet.
 - .4 DSC-ATC-FTC3716 pre-mounted 16v Transformer.
 - .5 DSC-T1 Tamper Switch.
 - .6 DSC Cabinet Lock.
 - .7 2-12V Batteries.
 - .8 DSC-PC4701 Dual line dialler module
 - .9 GSM-GS3060 Cellular module.
 - .2 Keypad shall not be mounted in or on the remote monitoring control panel. It must be mounted below or beside the panel. No holes shall be drilled in the cabinet.
 - .3 Dedicated circuit shall be provided for power. Control panel shall not be tied into the fire alarm panel circuit breaker.
 - .4 A telephone line must be installed for the ULC remote monitoring control panel.
 - .5 Wiring between the fire alarm panel and the ULC remote monitoring panel must be in conduit.
 - .6 ULC certificate shall be installed near ULC remote monitoring control panel.
 - .7 Install all components for CAN/ULC-516-03 (latest edition) compliance for Fire Alarm remote monitoring through DSC monitoring panel controller and adjust all components to suit.
 - .8 All costs for testing, verification, connection to the designated ULC Central Monitoring Station, attendance of the designated alarm monitoring company technician and demonstration of the system shall be included in the tender price.
 - .9 Contactor shall also include for final connections to central monitoring station, in accordance with the latest requirements of CAN/ULC-S561-03 (latest edition).
 - .10 All work shall be performed by ULC listed suppliers/installers.
- .4 A phone connection will be required for fire alarm system remote monitoring. Electrical contractor shall coordinate all associated work with the owner.
- .5 Adequate power supplies shall be provided to power all equipment and devices for complete monitoring system.
- .6 2-12V batteries for minimum of 24-hour period operation shall be provided. All batteries shall be labelled with date of installation.
- .7 Plug-in transformers shall NOT be used. Primary side of transfer must be directly connected to electrical panel. Primary side electrical connection must be terminated junction box. Secondary side shall be wired straight into remote monitoring panel.
- .8 GSM-GS3060 cellular module shall be fed from the same circuit through separate power supply DSC-PC4204CX (ULC Labelled) and connected to the remote monitoring panel.

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- .9 GSM tamper shall be connected in series with cabinet tamper "CAB/GSM Tamper".
- .10 CA38A jacks shall be installed at main telephone backboard Bell demarcation point.
- .11 GSM-GS3060 cellular module Installation/Programming requirements shall include but not limited to the following:
 - .1 Line to Bell Demarcation.
 - .2 Relays for GSM shall be DSC RM1C ULC listed relays (ULC labelled).
 - .3 A programmable output from remote monitoring panel shall be connected through RM1C ULC relay to Input 1 on GSM for fire alarm system monitoring.
 - .4 Wiring from GSM to remote monitoring panel must be in conduit and mechanically protected.
- .12 Three (3) FT6 4/22 cables must be installed in 21mm conduit between the fire alarm system panel and remote monitoring panel. Fire alarm system panel shall be connected for 'Fire Alarm', 'Fire Supervisory' and 'Fire Trouble' monitoring. Remote monitoring company will verify and inspect. All fire alarm zone cables must be clearly labelled.
- .13 Provide 120-volt dedicated circuit compete with conduit/wiring at location of remote monitoring control panel /communication unit for connection to control cabinet and communication devices.
- .14 All wiring shall be FT6 plenum rated to conform to requirements of the Canadian Electrical Code and Provincial Codes. Only FT6 rated #22 AWG cable will be acceptable. All system wiring/cables shall be installed as per all applicable codes and regulations.
- .15 All work must be, clean, neat, and with high standard of workmanship. System wiring leading into the control panel must be neat and in raceway/conduit.
- .16 Wherever conduit/wires cross building expansion joints, install the conduit/wires in such a manner to permit free movement without imposing additional stress or load upon the support system, and to prevent excessive movement at joints and connections.
- .17 All work shall be completed in accordance with CAN/ULC-561-03 (latest edition) requirements and manufacturer's recommendations. Work that is unsatisfactory to the authorities having jurisdiction shall be replaced at no extra cost.

END OF SECTION

1. General

1.1 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.

1.2 REFERENCES

- .1 Underwriter's Laboratories of Canada (ULC)
 - .1 CAN/ULC-S524 - Standard for the Installation of Fire Alarm Systems.
 - .2 CAN/ULC-S525 - Audible Signal Device for Fire Alarm Systems.
 - .3 CAN/ULC-S526 - Visual Signal Devices for Fire Alarm Systems.
 - .4 CAN/ULC-S527 - Control Units.
 - .5 CAN/ULC-S528 - Manual Pull Stations for Fire Alarm Systems.
 - .6 CAN/ULC-S529 - Smoke Detectors for Fire Alarm Systems.
 - .7 CAN/ULC-S530 - Heat Actuated Fire Detectors for Fire Alarm Systems.
 - .8 CAN/ULC-S531 - Standard for Smoke Alarms.
 - .9 CAN/ULC-S536-S537 - Burglar and Fire Alarm Systems and Components.
 - .10 CAN/ULC-S548 - Water flow Indicators for Fire Protective Signalling Systems.
- .2 National Fire Protection Agency (NFPA)
 - .1 NFPA 72 - National Fire Alarm Code.
 - .2 NFPA 90A - Installation of Air Conditioning and Ventilating Systems.

1.3 SUBMITTALS

- .1 Submit shop drawings for all products specified in Part 2.
- .2 Submit manufacturer's printed product literature, specifications and data sheets as required and specified in specification.
- .3 Submit equipment and zoning layout complete with wiring diagram.

2. Products

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical
- .2 The fire alarm system shall be an Addressable Analog, Single Stage, Zoned, Non-coded, indicating, fully integrated system completes with F.A devices, modules, auxiliary contacts, conduits, wires etc. as specified below.
- .3 The Fire Alarm System shall be a Multi-Processor Based System designed specifically for Fire, Model EST3, and shall be ULC listed under CAN/ULC-S527 standard. Fire alarm system manufactured by Simplex/Grinnell-4100ES, Mircom-FX4000 shall be considered equal provided it meets the specifications. The Fire Alarm System shall include all required hardware and system programming to provide a complete and operational system, capable of providing the protected premises with the following functions and operations:
 - .1 Modular systems design, with a layered application design concept, including an Operational Layer and Human Interface Layer, to allow maximum flexibility of the system with a minimum physical size requirement.

- .2 All System operational software is to be stored in FLASH memory. Control Panel disassembly, and replacement of electronic components of any kind shall not be required to upgrade the operations of the installed system to conform to future application code and operating system changes.
 - .3 Up to 128 Service Groups must be definable within the system program to allow the testing of the installed system based on the physical layout of the system, not on the wiring of the field circuits connected to the Fire Alarm Control Panel.
 - .4 Advanced Windows-based System Definition Utility with Program Version Reporting to document all changes made during system start-up or system commissioning. Time and Date Stamps of all modifications made to the program must be included to allow full retention of all previous program version data.
 - .5 System response to any alarm condition must occur within 3 seconds, regardless of the size and the complexity of the installed system.
 - .6 System Common Control Functions shall be automatically routed to any node of the system as a function of the time of day and date.
- .4 The Fire Alarm System shall include the following features and shall support the following operations in each installed cabinet or node of the system:
- .1 Up to 10 Signature Series Intelligent Device loops.
 - .2 Up to 125 Intelligent Smoke Detectors and 125 Intelligent Modules per Signature Data Circuit.
 - .3 Up to 144 Hardwired input/output Circuits.
 - .4 Up to 228 Manual Control (Input) Switches.
 - .5 Up to 456 LED Annunciation Points.
 - .6 Up to 63 Remote Display Units.
 - .7 Peer-To-Peer network connection of up to 64 system nodes wired as Class A.
 - .8 Ground fault detection by panel, by Signature Data Circuit and by device module.
 - .9 Ability to download all system applications programs and "firmware" from a computer through a single point in the system.
 - .10 True Distributed Intelligence, including microprocessor-based Detectors and Modules.
 - .11 A.C. Power Trouble Delay adjustable from 4 Hours to 10 Hours.
 - .12 Removable, Interlocked terminal blocks for the connection of the field wiring to the Fire Alarm Control Panel.
 - .13 Electronic Addressing of Field Devices.
 - .14 Advanced Power Management.
 - .15 Dead Front Construction.
- .5 Fire Alarm System Sequence of operation:
- .1 Activation of any alarm initiating device shall cause the following to occur:
 - .1 All audible signals to sound continuously for the mandatory period before they can be manually or automatically silenced.
 - .2 The type and location of the alarm to be indicated on the control panel and the remote annunciator.
 - .3 Transmit an alarm to the central station and Fire Department with indication on the annunciator.
 - .4 Operation of auxiliary contacts for control of auxiliary functions.
 - .5 Release fire doors held open by electric door hold open devices.
 - .6 De-energize electric maglock devices.
 - .7 Fan shut down.
 - .2 Activation of any supervisory device shall cause the following to occur:
 - .1 The common trouble alarm signal shall sound in the control panel and the annunciator.
 - .2 The type and location for the alarm to be indicated on the control panel and the annunciator.

- .3 Any malfunction on the system shall sound a trouble alarm signal and illuminate a trouble indicator on the control panel and the annunciator.
 - .1 The trouble alarm signal shall be suppressed during an alarm.
- .6 Fire Alarm System shall include an Emergency Operators' Interface Panel which shall include the following system annunciation and control functions:
 - .1 System Annunciation and Control Functions:
 - .1 Hands free Emergency Operation. The first and last highest priority event on the system shall be displayed automatically and simultaneously.
 - .2 Control Panel Internal Audible Signal shall have four programmable signal patterns to allow for the easy differentiation between Alarm, Supervisory, Trouble and Monitor conditions within the installed system.
 - .2 Five Discreet System Status LED's:
 - .1 Power Status LED:
 - .1 Green LED shall illuminate when AC power is present.
 - .2 Test Status LED:
 - .1 Yellow LED shall illuminate when any portion of the system is in the test mode. A programmable timer shall cause the system to automatically exit the test mode after a period of system inactivity. Alarm operation in the rest of the building shall not be affected by the test area. The Test LED shall function in a local or in a group mode.
 - .3 CPU Fail Status LED:
 - .1 Yellow LED shall illuminate when the panel controller has an internal failure.
 - .4 Ground Fault Status LED:
 - .1 Yellow LED shall illuminate when un-grounded wiring connected to the cabinets' power supply has continuity to ground. This feature shall function in either a local or group mode.
 - .5 Disable Status LED:
 - .1 Yellow LED shall illuminate whenever any point or zone in the installed system is manually disabled.
 - .3 Four Discreet Common Control Switches with associated Status LED's:
 - .1 Reset:
 - .1 Depression of the 'Reset' Switch starts the system reset operation. The associated Yellow LED shall have three flash rates during this operation to inform the user of the progress status of the reset cycle. The LED shall flash fast during the smoke detector power down sequence, then it shall flash slowly during the restart phase, and shall illuminate steadily for the restoral phase. The LED shall go out completely when the system is back to normal mode. Each phase, as well the overall reset cycle shall be programmable to perform other functions.

- .2 Alarm Silence:
 - .1 Depression of the 'Alarm Silence' Switch shall turn off all (audible and/or visible) Notification Appliance Circuits. The associated yellow LED illuminates when the Alarm Silence function is active, whether by the Alarm Silence Switch, or by an integral software timer. Subsequent activation of the Alarm Silence Switch shall resound the signals. Activation of the Alarm Silence switch shall be programmable to perform other functions.
- .3 Panel Silence:
 - .1 Depression of the 'Panel Silence' Switch shall turn off the systems' internal audible signal when configured as a 'local' system. The associated yellow LED illuminates when the panel silence feature is activated.
- .4 Drill Switch / LED:
 - .1 Depressing the 'Drill' switch activates the fire drill function. Yellow LED indicates that the fire drill function is active. The Drill Switch shall also be programmable to perform system functions other than the Drill Function.
- .4 Other Operator Control Switches:
 - .1 Previous Message Switch:
 - .1 Pressing the 'Previous Message Switch' shall scroll the display to show the preceding message in the selected queue. Holding the Previous Message Switch and pressing any queue select switch moves to the top of the respective queue event list. The operator may do scrolling through event messages at any time.
 - .2 Next Message Switch:
 - .1 Pressing the 'Next Message Switch' shall scroll the display to show the following message in the selected queue. Holding the Previous Message Switch and pressing any queue select switch moves to the bottom of the respective queue event list. The operator may do scrolling through event messages at any time.
 - .3 More Details Switch:
 - .1 Pressing the 'More Details Switch' shall show the address and 42-character location message of the active device on display. If a zone is active, pressing the switch displays the address and message of active devices within the zone. When multiple devices are active, the "Previous/Next" message switch may be used to scroll through the messages.
- .7 The Liquid Crystal display shall provide the means to inform the System Operator with detailed information about the off-normal status of the installed Fire Alarm System. The Main Display shall automatically respond to the status of the system and shall display that status on an 8 line by 21-character backlit alphanumeric Graphic Liquid Crystal Display. Provide displays in main panel and annunciator(s).
- .8 When the Fire alarm system is in the Normal Mode; the following status functions shall be annunciated by the Main LCD (Liquid Crystal Display):
 - .1 The current Date and Time.
 - .2 A Custom System Title (2 lines X 21 characters).
 - .3 A summary total of the Alarm History of the system.

- .9 When the Fire Alarm System is in the Alarm Mode; the LCD shall automatically reconfigure into four logical windows:
 - .1 System Status Window:
 - .1 The LCD shall show the system time, and the number of active points and disabled points in the system in this section of the LCD Display.
 - .2 Current Event Window:
 - .1 The LCD shall show the first active event of the highest priority in reverse text to highlight the condition to the Emergency Operator. The top line of the reversed text shall show the sequence number in which the displayed event was received, as well as its event type. The second and third lines of reversed text shall display an identification message related to the displayed event.
 - .3 Last Event Window:
 - .1 The LCD shall show the most recent, highest priority event received by the system.
 - .4 Type Status Window:
 - .1 The LCD shall show the total number of active events in the system, by event type. There shall be four different System Event Types, which shall be displayed:
 - .1 Alarm Events.
 - .2 Supervisory Events.
 - .3 Active Trouble Events.
 - .4 Active Monitor Events.
- .10 To simplify, and to clarify the System Status information, which is given to the Emergency Operator, the Main LCD shall include queues for each of the System Event Types. The Main LCD shall allow the Emergency operator access to the System Status information contained within those queues by pressing an associated queue select switch. Whenever there is an unacknowledged event in any of the System Event queues, the associated Status LED shall flash. Viewing each event listed in a queue shall acknowledge all events in that queue and shall cause the associated LED to illuminate steady.
- .11 All messages contained in any of the System Event queues shall be accessible for review by the Emergency Operator using the "Previous/Next" message switch. It shall be possible to route additional event information to a printer.
- .12 The Main LCD shall also allow the System Operator to access system maintenance functions through a four-level password system. The authorized System Operator shall be able to access the following functions:
 - .1 System Status:
 - .1 The system shall allow the operator to determine the status of individual system components, including active points, disabled points, and active points by panel.
 - .2 Enable:
 - .1 The system shall allow the operator to restore a disabled point (device) in the system, allowing that point (device) to operate as originally intended by the application program of the system. Additionally, the system shall allow the operator to restore any group function, guard patrol function, Panel, system module, "software - defined zone", operator control, or time control function.

.3 Disable:

- .1 The system shall allow the operator to disable any point (device) in the system, inhibiting that point (device) from operating as originally intended by the application program of the system. Additionally, the system shall allow the operator to disable any group function, guard patrol function, Panel, system module, "software - defined zone", operator control, or time control function within the system.

.4 Activate:

- .1 The system shall allow the operator to manually turn on any system output point, or system function. Alternate Smoke Detector sensitivity, message routing within the system, guard patrol timing, and check-in group timings shall be modifiable with this simple command from the control panel.

.5 Restore:

- .1 The system shall allow the operator to restore the primary (application program defined) operation to the Smoke Detector sensitivity and the message routing functions with this simple command from the control panel.

.6 Control Output:

- .1 The system shall allow the operator to manually command and control relays and LED's.

.1 Relays shall be able to be commanded to Latch, to energize as:

- .1 High Priority,
- .2 Low Priority, or
- .3 De-Energize.

.2 LEDs shall be able to be commanded to Latch, to energize as:

- .1 High Priority,
- .2 Low Priority,
- .3 Turn ON,
- .4 Turn OFF,
- .5 Slow Blink or
- .6 Fast Blink.

.7 Reports:

- .1 The system shall provide the operator with system reports, which give detailed description of the status of certain system parameters for corrective action, or for preventative maintenance programs. The system shall provide these reports via the Main LCD and shall be capable of being printed on any of the connected system printers.
 - .1 The system shall provide a report, which gives a sensitivity listing of all detectors, which have less than 75% environmental compensation remaining.
 - .2 The system shall provide a report, which provides a sensitivity listing of any detector.
 - .3 The system shall provide a report, which gives a listing of the sensitivity of all the detectors any given panel in the system, or any given SDC loop within any given panel.
 - .4 The system shall provide a report, which gives a chronological listing of up to the last 1740 system events.

- .5 The system shall provide a listing of all the firmware revision listings for all the installed network components in the system.
- .13 The system shall allow the authorized operator to perform all the following system functions:
 - .1 Set the System Time.
 - .2 Set the System Date.
 - .3 Set (Change) the System Passwords.
 - .4 Restart the System.
 - .5 Set the Dates for the System Holiday Schedule.
 - .6 Clear the Chronological System History File.
- .14 The system shall allow the authorized operator to perform test functions within the installed system. Test functions shall be defined by the authorized operator to be performed on a per cabinet, circuit, or service group basis.
- .15 Each panel in the installed system shall include local Control and Display Annunciators. These annunciators shall have integral membrane style, tactile push-button control switches, for the control of system functions, and LEDs with programmable (software-controlled) flash rates and slide-in labels for annunciation of system events. The Local Control Display Annunciators shall provide the system with individual zone and / or device annunciation.
- .16 Each remote annunciator panel in the installed system shall include remote Control and Display Annunciators. These annunciators shall have integral membrane style, tactile push-button control switches for the control of system functions, and LEDs with programmable (software-controlled) flash rates and slide-in labels for annunciation of system events. The Remote-Control Display Annunciators shall provide the system with individual zone and / or device annunciation.
- .17 Fire Alarm System Operations Interface:
 - .1 The Signature Device Card (SDC) shall be the interface between the Fire Alarm Control Panel and the Signature Series Detectors and Modules.
 - .2 The communications format between the SDC and the Signature Series Devices shall be 100% digital. Communications to devices must incorporate BROADCAST POLLING and DIRECT ADDRESS SEARCH to ensure the fastest reporting of off-normal conditions to the system human interface layer.
 - .3 It shall be possible to wire the SDC as Class A or Class B without twisted or shielded wire. It must be possible to wire branch circuits (T-Taps) from Class B Circuits.
- .18 Provide where indicated on the plans supervised hard wired Notification Appliance Circuits (NAC) for the control of 24Vdc EST Integrity Series Signalling Appliances. The NAC shall be Class B and shall control up to 3.5 amps of power to the circuit.
- .19 The Fire Alarm System shall allow Network Routing to be configured to any or all nodes (cabinets) in the network.
- .20 All the system Printer ports can be configured to display any or all the following functions:
 - .1 Alarm
 - .2 Supervisory
 - .3 Trouble
 - .4 Monitor
 - .5 Service Group
- .21 Each LCD Display on each node (cabinet) in the system shall be configurable to show the status of any or all the following functions anywhere in the system:
 - .1 Alarm
 - .2 Supervisory
 - .3 Trouble
 - .4 Monitor

.22 Fire Alarm Components:

.1 Intelligent Detectors - General Operation:

- .1 The System Intelligent Detectors shall be capable of full digital communications using both broadcast and polling protocol. Each detector shall be capable of performing independent fire detection algorithms. The fire detection algorithm shall measure sensor signal dimensions, time patterns, and combine different fire parameters to increase reliability and distinguish real fire conditions from unwanted deceptive nuisance alarms. Digital filters shall eliminate signal patterns that are not typical of fires. Devices not capable of combining different fire parameters or employing digital filters shall not be acceptable.
- .2 Each detector shall have an integral microprocessor capable of making alarm decisions based on fire parameter information stored in the detector head. Distributed intelligence shall improve response time by decreasing the data flow between detector and Analog loop controller. Detectors not capable of making independent alarm decisions shall not be acceptable. Maximum total Analog loop response time for detectors changing state shall be 0.5 seconds.
- .3 Each detector shall have a separate means of displaying communication and alarm status. A green LED shall flash to confirm communication with the Analog loop controller. A red LED shall flash to display alarm status. Both LEDs on steady shall indicate alarm-standalone mode status. Both LEDs shall be visible through a full 360 degree viewing angle.
- .4 The detector shall be capable of identifying up to 32 diagnostic codes. This information shall be available for system maintenance. The diagnostic code shall be stored at the detector.
- .5 Each smoke detector shall be capable of transmitting pre-alarm and alarm signals in addition to the normal, trouble and need cleaning information. It shall be possible to program control panel activity to each level. Each smoke detector may be individually programmed to operate at any one of five (5) sensitivity settings.
- .6 Each detector microprocessor shall contain an environmental compensation algorithm that identifies and sets ambient "Environmental Thresholds" approximately six times an hour. The microprocessor shall continually monitor the environmental impact of temperature, humidity, and other contaminants as well as detector aging. The process shall employ digital compensation to adapt the detector to both 24-hour long term and 4-hour short term environmental changes. The microprocessor shall monitor the environmental compensation value and alert the system operator when the detector approaches 80% and 100% of the allowable environmental compensation value. Differential sensing algorithms shall maintain a constant differential between selected detector sensitivity and the "learned" base line sensitivity. The base line sensitivity information shall be updated and permanently stored at the detector approximately once every hour.
- .7 The intelligent Analog device and the Analog loop controller shall provide increased reliability and inherent survivability through intelligent Analog standalone operation. The device shall automatically change to standalone conventional device operation in the event of a loop controller polling communications failure. In the Analog standalone detector mode, the Analog detector shall continue to operate using sensitivity and environmental compensation information stored in its microprocessor at the time of communications failure. The Analog loop controller shall monitor the loop and activate a loop alarm if any detector reaches its alarm sensitivity threshold.
- .8 Each Signature Series device shall be capable of automatic electronic addressing and/or custom addressing without the use of DIP or rotary switches. Devices using DIP or rotary switches for addressing, either in the base or on the detector shall not be acceptable.
- .9 The intelligent Analog detectors shall be suitable for mounting on any Signature Series detector mounting base.

.2 Fixed Temperature Heat Detector, SIGA-HFS:

- .1 Provide intelligent fixed temperature heat detectors, SIGA-HFS. The heat detector shall have a low mass thermistor heat sensor and operate at a fixed temperature. It shall continually monitor the temperature of the air in its surroundings to minimize thermal lag to the time required to process an alarm. The integral microprocessor shall determine if an alarm condition exists and initiate an alarm based on the analysis of the data. Systems using central intelligence for alarm decisions shall not be acceptable. The heat detector shall have a nominal alarm point rating of 135°F (57°C). The heat detector shall be rated for ceiling installation at a minimum of 70 ft (21.3m) centres and be suitable for wall mount applications.

.3 Fixed Temperature/Rate of Rise Heat Detector, SIGA-HRS:

- .1 Provide intelligent combination fixed temperature/rate-of-rise heat detectors SIGA-HRS. The heat detector shall have a low mass thermistor heat sensor and operate at a fixed temperature and at a temperature rate-of-rise. It shall continually monitor the temperature of the air in its surroundings to minimize thermal lag to the time required to process an alarm. The integral microprocessor shall determine if an alarm condition exists and initiate an alarm based on the analysis of the data. Systems using central intelligence for alarm decisions shall not be acceptable. The intelligent heat detector shall have a nominal fixed temperature alarm point rating of 135°F (57°C) and a rate-of-rise alarm point of 15°F (9°C) per minute. The heat detector shall be rated for ceiling installation at a minimum of 70 ft (21.3m) centres and be suitable for wall mount applications.

.4 Ionization Smoke Detector, SIGA-IS:

- .1 Provide intelligent ionization smoke detectors, SIGA-IS. The Analog ionization detector shall be complete with dual unipolar detector chamber to sense the presence of smoke particles provided by fast combustion as well as slow smouldering fires. The integral microprocessor shall dynamically examine values from the sensor and initiate an alarm based on the analysis of data. Systems using central intelligence for alarm decisions shall not be acceptable.
- .2 The detector shall continually monitor any changes in sensitivity due to the environmental effects of dirt, smoke, temperature, aging and humidity. The information shall be stored in the integral processor and transferred to the Analog loop controller for retrieval using a laptop PC or the SIGA-PRO Signature Program/Service Tool. The ionization detector shall be rated for ceiling installation at a minimum of 30 ft (9.1m) centres and be suitable for wall mount applications. The ionization smoke detector shall be suitable for direct insertion into air ducts up to 3 ft (0.91m) high and 3 ft (0.91m) wide with air velocities up to 5,000 ft/min. (0-25.39 m/sec) without requiring specific duct detector housings or supply tubes. The detector shall be protected by a ULC Listed protective guard in areas where subjected to mechanical damage or abuse. The guard shall be suitable for flush or surface mounted detector installation.
- .3 The percent smoke obscuration per foot alarm set point shall be field selectable to any of five sensitivity settings ranging from 1.0% to 3.5%. The ionization detector shall be suitable for operation in the following environment:
 - .1 Temperature: 32°F to 120°F (0°C to 49°C).
 - .2 Humidity: 0-93% RH, non-condensing.
 - .3 Elevation: No limit.

.5 Standard Detector Mounting Bases, SIGA-SB:

- .1 Provide standard detector mounting bases SIGA-SB suitable for mounting on North American 1-gang, 3 1/2" or 4" octagon box and 4" square box. The base shall, contain no electronics, support all Signature Series detector types, and have the following minimum requirements:
 - .1 Removal of the respective detector shall not affect communications with other detectors.
 - .2 Terminal connections shall be made on the room side of the base. Bases, which must be removed to gain access to the terminals, shall not be acceptable.
 - .3 The base shall be capable of supporting one (1) Signature Series SIGA-LED Remote Alarm LED Indicator. Provide remote LED alarm indicators as required to suit detector installation location and code requirements.

.6 Relay Detector Mounting Bases, SIGA-RB:

- .1 Provide relay detector mounting bases SIGA-RB suitable for mounting on North American 1 gang, 3 1/2 " or 4" octagon box and 4" square box. The relay base shall support all Signature Series detector types and have the following minimum requirements:
 - .1 The relay shall be a bi-stable type and selectable for normally open or normally closed operation.
 - .2 The position of the contact shall be supervised.
 - .3 The detector processor upon power shall exercise the relay operation up.
 - .4 The relay shall automatically de-energize when a detector is removed.
 - .5 The operation of the relay base shall be controlled by its respective detector processor. Detectors operating standalone mode shall operate the relay upon changing to alarm state. Relay bases not controlled by the detector microprocessor shall not be acceptable.
 - .6 Form "C" Relay contacts shall have a minimum rating of 1 amp @ 30 Vdc and be listed for "pilot duty".
 - .7 Removal of the respective detector shall not affect communications with other detectors.
 - .8 Terminal connections shall be made on the room side of the base. Bases, which must be removed to gain access to the terminals, shall not be acceptable.

.7 Duct Detector Housing, SIGA-DH:

- .1 Provide smoke detector duct housing assemblies, SIGA-DH, to facilitate mounting an intelligent Analog photoelectric detector, SIGA-PS, or 3D multi-sensor detector, SIGA-PHS, or 4D multi-sensor detector, SIGA-IPHS along with a standard, relay or isolator detector mounting base. Provide for variations in duct air velocity between 300 and 4000 feet per minute (300 to 1000 feet per minute for ion- photo-heat detector). Protect the measuring chamber from damage and insects. Provide an air exhaust tube and an air sampling inlet tube that extends into the duct air stream up to ten feet. Provide drilling templates and gaskets to facilitate locating and mounting the housing. Provide five one gang knockouts for mounting optional Signature Series modules. Finish the housing in baked red enamel. Provide remote alarm LED's, SIGA-LED, and Remote Test Stations, SIGA-DTS as required to suit detector installation location and code requirements.

.8 Single Input Module, SIGA-CT1:

- .1 Provide intelligent single input modules, SIGA-CT1. The Single Input Module shall provide one (1) supervised Class B input circuit capable of a minimum of 4 personalities, each with a distinct operation. The module shall be suitable for mounting on North American 2 1/2" (64mm) deep 1-gang boxes and 1 1/2" (38mm) deep 4" square boxes with 1-gang covers. The single input module shall support the following circuit types:
 - .1 Normally Open Alarm Latching (Manual Stations, Heat Detectors, etc.).
 - .2 Normally Open Alarm Delayed Latching (Waterflow Switches).
 - .3 Normally Open Active Non-Latching (Monitor, Fans, Dampers, Doors, etc.).
 - .4 Normally Open Active Latching (Supervisory, Tamper Switches).

.9 Dual Input Module, SIGA-CT2:

- .1 Provide intelligent dual input modules, SIGA-CT2. The Dual Input Module shall provide two (2) supervised Class B (Style 4) input circuits, each capable of a minimum of 4 personalities, each with a distinct operation. The module shall be suitable for mounting on North American 2 1/2" (64mm) deep 1-gang boxes and 1 1/2" (38mm) deep 4" square boxes with 1-gang covers or may be panel mounted. The dual input module shall support the following circuit types:
 - .1 Normally Open Alarm Latching (Manual Stations, Heat Detectors, etc.).
 - .2 Normally Open Alarm Delayed Latching (Waterflow Switches).
 - .3 Normally Open Active Non-Latching (Monitor, Fans, Dampers, Doors, etc.).
 - .4 Normally Open Active Latching (Supervisory, Tamper Switches).

.10 Single Input Signal Module, SIGA-CC1:

- .1 Provide intelligent single input signal modules, SIGA-CC1. The Single Input (Single Riser Select) Signal Module shall provide one (1) supervised Class B output circuit capable of a minimum of 2 personalities, each with a distinct operation. When selected as a telephone power selector, the module shall be capable of generating its own "ring tone". The module shall be suitable for mounting on North American 2 1/2" (64mm) deep 2-gang boxes and 1 1/2" (38mm) deep 4" square boxes with 2-gang covers, 100mm European square boxes or may be panel mounted. The single input signal module shall support the following operations:
 - .1 Audible/Visible Signal Power Selector (Polarized 24 Vdc @ 2A, 25Vrms at 50W or 70Vrms @ 35 Watts of Audio).

.11 Control Relay Module, SIGA-CR:

- .1 Provide intelligent control relay modules, SIGA-CR or intelligent polarity reversing control relay modules, SIGA-CRR. The Control Relay Module shall provide one form "C" dry relay contact rated at 2 amps @ 24 Vdc to control external appliances or equipment shutdown. The control relay shall be rated for pilot duty and releasing systems. The position of the relay contact shall be confirmed by the system firmware. The Polarity Reversing Relay Module will be used to power an activate groups of detectors sounder bases installed on the system. The control relay and polarity reversing modules shall be suitable for mounting on North American 2 1/2" (64mm) deep 1-gang boxes and 1 1/2" (38mm) deep 4" square boxes with 1-gang covers or may be panel mounted.

.12 Isolator Module, SIGA-IM:

- .1 Provide intelligent class A Isolator modules, SIGA-IM. The Class A Isolator Module shall be suitable for mounting on North American 2 1/2" (64mm) deep 2-gang boxes and 1 1/2" (38mm) deep 4" square boxes with 2-gang covers, or European 100mm square boxes. Following a short circuit condition, each isolator module shall be capable of performing an internal self-test procedure to re-establish normal operation. Isolator modules not capable of performing independent self-tests shall not be acceptable. The isolator base shall have the following minimum requirements:
 - .1 The isolator shall operate within a minimum of 23 msec. of a short circuit condition on the communication line.
 - .2 When connected in Class A configuration the Signature Loop Controller shall identify an isolated circuit condition and provide communications to all non-isolated Analog devices.

.13 Intelligent Manual Pull Stations - General Operation:

- .1 It shall be possible to address each Signature Series fire alarm pull station without the use of DIP or rotary switches. Devices using DIP switches for addressing shall not be acceptable. The manual stations shall have a minimum of 2 diagnostic LEDs mounted on their integral, factory assembled single or two stage input modules. A green LED shall flash to confirm communication with the loop controller. A red LED shall flash to display alarm status. The station shall be capable of storing up to 24 diagnostic codes that can be retrieved for troubleshooting assistance. Input circuit wiring shall be supervised for open and ground faults. The fire alarm pull station shall be suitable for operation in the following environment:
 - .1 Temperature: 32°F to 120°F (0°C to 49°C).
 - .2 Humidity: 0-93% RH, non-condensing.

.14 Manual Pull Station, SIGA-270, SIGC-270F, SIGC-270B:

- .1 Provide intelligent single action, single stage fire alarm pull station. The fire alarm pull station shall be of metal construction with an internal push button switch. Provide a locked test feature. Finish the station in red with silver "PULL IN CASE OF FIRE" lettering. The manual station shall be suitable for mounting on North American 2 1/2" (64mm) deep 1-gang boxes and 1 1/2" (38mm) deep 4" square boxes with 1-gang covers. Manual pull stations shall be provided with auxiliary contacts mounted at door(s) having maglock devices (to de-energize in case of activation of fire alarm in building) as shown on drawings.

.15 Self-Synchronized Strobes (Type 'QC'):

- .1 Provide strobes manufactured by EST. In-Out screw terminals shall be provided for wiring. The strobes shall have a red plastic faceplate. They shall provide 15 cd synchronized flash outputs. Strobes shall mount in a North American 1-gang box. The strobe shall have lens markings oriented for wall or ceiling mounting, as shown on drawings. It shall be possible to replace the lens markings with LKW series or LKC series lens marking kits. Ceiling mounted strobes shall have lens markings with correctly oriented lettering. Removal of an installed strobe to change the lens markings shall not be acceptable.

.16 Cone Speakers:

- .1 Provide electronic F.A. cone speaker manufactured by EST-Genesis G4 Series. In-Out screw terminals shall be provided for wiring. The cone speaker shall have a red plastic housing. A steady tone sound output level of 93 dBA peak shall be provided. Cone speaker shall mount to a North American 4" electrical box with extension ring using the 2 screws provided with ring. It shall not be necessary to completely remove the screws to facilitate mounting.

.17 Cone Speaker/Strobes:

- .1 Provide electronic cone speaker/strobes manufactured by EST. In-Out screw terminals shall be provided for wiring. The cone speaker shall have a red plastic housing. A steady tone sound output level of 93 dBA peak shall be provided. The strobe shall provide 15 cd synchronized flash outputs. The strobe shall have lens markings oriented for wall or ceiling mounting, as per drawings. It shall be possible to replace the lens markings with LKW series or LKC series lens marking kits. Ceiling mounted strobes shall have lens markings with correctly oriented lettering. Removal of an installed cone speaker/strobe to change the lens markings shall not be acceptable. Cone speaker/strobes shall mount in a 4" electrical box with extension ring using the 2 screws provided with ring. It must not be necessary to completely remove the screws to facilitate mounting.
- .23 Provide amplifiers to suit quantities of F.A. cone speakers as shown on drawings plus 20% spares for future use.
 - .24 Supervisory switches shall be alarm devices, which shall have normally open contacts that close on alarm. These devices will be supplied by another Division of this Specification but shall be installed and connected by this Division.
 - .25 The loss of power devices shall be provided by this Division.
 - .26 End of line resistors shall be provided by this Division for the complete system.
 - .27 Provide framed multi-colour fire alarm passive graphic display board consisting of electronically stored building outline, with floor(s) and zone(s) outline, printed on dimensionally stabilized clear film under UV protective clear acrylic shield. Different colours as approved by the Owner shall depict floor outline, zone areas and egress corridors. Every zone of fire alarm system shall be shown including alarm zones, elevators zones, mechanical ventilation system duct detector zones, fire pump zones, sprinkler and standpipe system zones, emergency generator zones, gas shut off valve zones, smoke control fans zones, etc. Symbol of legend, project name, true north and "YOU ARE HERE" notation shall be included.
 - .28 Edwards, Simplex and Mircom, manufacturer shall be considered equal if they meet the specification.

3. Execution

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical.
- .2 The equipment shall be installed strictly in accordance with the manufacturer's requirements and recommendations and the requirements of the Authorities having jurisdiction.
 - .1 Canadian Electrical Code.
 - .2 Canadian, Provincial and Local Building codes.
 - .3 Local Authorities Having Jurisdiction.
 - .4 Underwriters Laboratories Canada Inc.

- .5 ULC, BSA.
- .3 Install wiring to conform with the requirements of the Canadian Electrical Code. Size wiring in accordance with Class 2 requirements, except for A.C. Signal Circuits where the wiring shall be sized in accordance with Class 1 requirements but be protected from mechanical injury or other injurious conditions such as moisture, excessive heat, or corrosive action in conduit. Connect wiring to the screw terminals in the devices.
- .4 Install fire alarm systems in accordance with the latest Standards as identified in Section 1.2.1 above.
- .5 Install end-of-line resistors in a separate outlet box with grille.
- .6 Provide a complete system of relays for the auxiliary functions.
- .7 Mechanical connectors are not acceptable. Solder and insulate all joints if wire cannot be continuous.
- .8 Wire with colour coded conductors.
- .9 Supervise all wiring.
- .10 All wiring shall have copper conductors.
- .11 Prior to energizing or commissioning the system, the F.A. system shall be fully inspected, tested, checked, and adjusted to include, but not limited to, the following:
 - .1 That the type of equipment installed is that designated by the specifications.
 - .2 That the wiring connections to all equipment components show that the installer has complied with ULC and CSA requirements.
 - .3 That the equipment has been installed in accordance with the manufacturer's recommendations and that all devices have been operated and tested to verify their operation and that the system operates in accordance with the requirements of the Specification.
 - .4 That the supervisory wiring of those items of equipment connected to a supervisory circuit is operated as specified.
 - .5 That Governmental regulations will be met to the satisfaction of inspection office.
- .12 The inspection and testing reports and certification of fire alarm system prepared by the fire alarm vendor shall be submitted for review by the Consultant. This work shall be complete 3 weeks prior to occupancy date.
- .13 The "dB" readings shall be provided by the fire alarm system vendor in each area/room where audible devices are installed (part of this Contract). The testing report shall be prepared and submitted for review by the Consultant. This work shall be complete 3 weeks prior to occupancy.
- .14 System installation and operations shall be verified by the manufacturer's representative, and a verification certificate presented upon completion. The manufacturer's representative shall be responsible for an on-site demonstration of the system operation and initial staff training as required by the Owner and/or Consulting Engineer.
- .15 System changes shall be verified by the manufacturer's representative, and a verification certificate presented upon completion.
- .16 When the fire alarm system has been commissioned and verified it shall be fully demonstrated by this Division to the authorities having jurisdiction.

- .17 The supplier shall have sufficient stock on hand and have a fully equipped service organization capable of guaranteeing response time within 8 hours of service calls, 24 hours a day, 7 days a week.
- .18 Warranties all materials, installation, and workmanship for one (1) year from date of acceptance, unless otherwise specified.

END OF SECTION

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1. General

1.1 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.

1.2 REFERENCES

- .1 Underwriter's Laboratories of Canada (ULC)
 - .1 CAN/ULC-S524 - Standard for the Installation of Fire Alarm Systems.
 - .2 CAN/ULC-S537 - Standard for Verification of Fire Alarm Systems.
 - .3 CAN/ULC-S1001-11 – Integrated Systems Testing of Fire Protection and Life Systems.
- .2 National Fire Protection Agency (NFPA)
 - .1 NFPA 72 - National Fire Alarm Code.

1.3 SUBMITTALS

- .1 Fire alarm verification report and verification certificate in accordance with CAN/ULC-S537 - Standard for Verification of Fire Alarm Systems.
- .2 Integrated systems testing of fire protection and life systems report and certificate in accordance with CAN/ULC-S1001-11 – Standard for Integrated Systems Testing of Fire Protection and Life Systems.

2. Products

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical
- .2 Verify Fire Alarm System complete with all fire alarm zones in accordance with CAN/ULC-S537 (Latest Edition) - Standard for Verification of Fire Alarm Systems.
- .3 Employ and pay for the services of an independent company, (i.e.: CFMS-West, Contact: Joseph Tanel; Ph: 647-400-9872; email: joseph.tanel@cfmswest.ca, Lonergan Engineering Inc., Contact: Michael Lonergan; Ph: 416-684-2305; email: m.lonergan@lonerganeng.com, Vintage Fire and Life Safety Ltd.; Steve Salese; Ph: 519-998-8944; steve@vintagefireandlifesafety.com or Approved Equal) to inspect, test and verify the operation of the fire alarm system in accordance with CAN/ULC-S1001-11 for Integrated Systems Testing of Fire Protection and Life Systems.
- .4 Complete the installation, inspection, testing and verification of the fire alarm system as specified in Section 28 46 00, and perform "Integrated systems testing of fire protection and life systems" in accordance with CAN/ULC-S1001-11 with independent company and advise the Consultant and authority having jurisdiction in writing accordingly by providing all supporting documentation as required for CAN/ULC-S1001-11 inspection, testing and verification process three weeks prior to substantial completion of the contract.
- .5 Provide all information, drawings, documents, shop drawings, and assistance to the independent company who will be performing inspection, testing and verification of integrated system testing of fire protection and life system in accordance with CAN/ULC-S1001-11.

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- .6 Coordinate with fire alarm system manufacturer, fire alarm system verification contractor and other trades and contractors for door hardware system, access control system, elevator system, mechanical systems, sprinkler and standpipe systems, building controls system, lighting control systems, security system etc. and facilitate to provide all required assistance necessary in order that the inspection, testing and verification in accordance with CAN/ULC-S1001-11 for Integrated systems testing of fire protection and life systems as specified herein can be successfully completed.
- .7 Integrated Systems Testing of Fire Protection and Life Systems shall verify that the systems, their components including but not limited to Fire alarm systems, Sprinkler systems, Standpipe systems, Elevators, Hold-open devices, Cooking suppression system, Emergency generators, Fire pumps, Emergency Lighting systems, Electromagnetic locks, Smoke control systems, Ventilation (Pressurization) systems, Audio/Visual and/or Lighting controls, Notification systems, Water supplies, Water control valves, Freeze protection systems, Fixed fire suppression systems etc. and their interconnections with other building systems are functioning in accordance with the intent of their design.
- .8 The independent company who will be performing inspection, testing and verification of integrated system testing of fire protection and life system in accordance with CAN/ULC-S1001-11 and acting as Integrated Testing Coordinator (ITC) shall include and perform all procedures as required by CAN/ULC-S1001-11 but not limited to:
 - .1 ITC shall develop and prepare an Integrated Testing Plan specific to the project, outlining the required tests and necessary functional results to conduct integrated fire protection and life systems testing.
 - .2 ITC shall attend construction meetings prior of integrated testing procedure; to review the integrated testing process with the architect, consultant, electrical contractor, mechanical contractor, general contractor, and owner's representative.
 - .3 ITC shall review all relevant shop drawings during construction.
 - .4 ITC shall attend site prior to day of testing to review testing process with project team/ electrical contractor and confirm all systems are ready for testing.
 - .5 ITC shall discuss with the project team/ electrical contractor, the testing process to ensure all trades are aware of their expectations on day of testing.
 - .6 ITC shall ensure that integrated testing (IT) Plan is reviewed by consultant team prior to testing.
 - .7 ITC shall ensure that all applicable system start-up reports are received prior to testing.
 - .8 ITC shall perform testing of integrated fire protection and life safety systems in accordance with CAN/ULC-S1001-11 and integrated testing plan.
 - .9 ITC shall submit an integrated testing report, specific to the project and documenting the implementation of the integrated testing plan. The report shall confirm and acceptable to the requirements of the authorities having jurisdiction.

3. Execution

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical.
- .2 Inspect and test the fire alarm system and auxiliary equipment in accordance with CAN/ULC-S537 and integrated testing in accordance with CAN/ULC-S1001-11 as specified in Section 28 46 00 and as described above and complete and sign all necessary forms.
- .3 Provide a letter addressed to the Consultant confirming that the fire alarm system verification and integrated testing have been satisfactorily completed.

END OF SECTION