CITY OF NIAGARA FALLS

VICTORIA AVENUE LIBRARY
4848 VICTORIA AVENUE
NIAGARA FALLS, ONTARIO

RFP66-2015
HVAC UPGRADES

TECHNICAL SPECIFICATIONS

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TITLE	REV
Technical Specifications	–

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SECTION 01 00 00 PROJECT PROCEDURES

PART 1 GENERAL

1.1 THE PROJECT

.1 Project Title: Victoria Avenue Library - HVAC Upgrades
.2 Project Location: 4848 Victoria Avenue, Niagara Falls

1.2 WORK SUMMARY

.1 The following is an overview of Work and is not complete. Contract Documents in their entirety fully describe Work, including items that may only be listed here. Work includes:
  .1 Modify and demolish existing services as required.
  .2 Demolish existing abandoned electric humidifiers and steam distribution.
  .3 Demolish existing abandoned rooftop antenna including supports.
  .4 Rooftop Air Handlers
    .1 Replace existing 5 multizone rooftops with 5 variable speed mixed air handlers complete with heating, cooling, heat recovery.
  .5 Structural and Roofing
    .1 Provide structural design.
    .2 Provide structural reinforcement as required including for rooftop air handlers, exhaust fans, outdoor units.
    .3 Provide railing to roof edge adjacent to RT1.
    .4 Provide roofing as required for all new equipment and services.
  .6 Air Distribution System
    .1 Replace existing 18 multi-zone dampers (within 5 multi-zone air handlers) with 26 variable air volume (VAV) air terminal boxes and 5 reheat coils.
    .2 Replace 4 exhaust fans.
    .3 Modify ductwork configuration and rezoning for air terminal installation.
    .4 Provide transfer grilles as indicated, as required.
  .7 Heating Plant
    .1 Replace existing natural gas boiler with natural gas condensing fire tube boiler.
    .2 Provide combustion air and combustion products venting.
    .3 Provide boiler pump.
    .4 Provide 2 building heating water pumps and variable frequency drives.
  .8 Perimeter Heating System
    .1 Modify piping and zoning of existing perimeter convectors.
    .2 Provide control valves to each perimeter convector and forced flow cabiner heater.
  .9 IT Room
    .1 Provide split heat pump unit to the IT room.
    .2 Coordinate operation of above with other building systems.
  .10 Archives Spaces
    .1 Provide split heat pump unit to the Archives space.
    .2 Provide dampers to ventilation systems serving this space to block off supply and return air.
    .3 Treat space as storage and not occupiable.
    .4 Coordinate operation of above with other building systems.
  .11 Greenhouse Heating
    .1 Provide control valve to greenhouse wall fin heaters.
    .2 Provide zone temperature sensor.
    .3 Provide electric unit heater.
    .4 Provide independent thermostat.
  .12 Building Automation System
    .1 Provide BAS including with new supervisory controllers, distributed controllers, sensors, control sequences.
  .13 Perform complete building air distribution system cleaning.

.14 Perform complete piping systems flushing.
.15 Perform complete building air and water testing and balancing.
.2 Provide fully functional systems that are complete and ready for intended use and effect.
.3 Work may require use of particular means, methods, sequences, techniques, or procedures of construction not explicitly described in Contract Documents, which may require use of particular or specialty trades.
.4 Considerations
.1 Phase-in work to avoid disruption to existing services and operations, including:
.1 Shutdown of natural gas supply to building is limited to 1 shutdown of 4-hours duration during non-heating season except for work required to be completed by local utilities.
.2 Shutdowns of electrical circuits are limited to 2 shutdowns of 30-minutes duration for each separate circuit when temporary utilities or services are not provided.
.3 Lighting systems cannot be shutdown during required operating hours.
.4 A limited quantity of parking spaces may be blocked off at 1 time and must be coordinated with Owner.
.2 Services may be required to be available for operation for longer than indicated heating and cooling seasons, and may only be disrupted in opposite seasons.
.3 Services may be required to be available for operation for longer than typical heating season, and may only be disrupted in opposite seasons. Phase-in work to ensure required operation is met at all times.
.4 Available space for new equipment and services is limited. Modify layouts, routing, mounting and existing services as required by Work.
.5 Available space for new equipment and services is limited. Modify new equipment mounting, new equipment frames, and existing services as required by Work.
.6 Provide to Owner demolished components that Owner wishes to keep on site.
.7 Some loops may require isolation and draining of affected sections in order to complete aspects of Work. Coordinate in advance with Owner.
.8 Portions of Work may require local freezing or other similar techniques for temporary isolation of water piping.
.9 Control system must remain operational at all times during construction. Do not remove or disable existing controls until performance of new controls can be satisfactorily demonstrated.
.10 Work includes installation of heating water control valves during heating season. Shutdowns affecting any one building zone are limited to 1 shutdown per zone of maximum 4-hour duration. Disruption or shutdown of heating water supply to entire building is not acceptable at any time for any duration.
.11 Disruption of any services for any duration requires advance notice and approval by Owner. Adhere to advance notice requirements stipulated by Owner.
.12 Services may be required to be available for operation for longer than typical heating season, and may only be disrupted in opposite seasons. Phase-in work to ensure required operation is met at all times.
.13 Owner may incur significant costs as a result of Contractor failing to meet contractual obligations, including:
.1 Milestone dates.
.2 Disruption of services beyond permitted durations.

1.3 DEFINITIONS AND ACRONYMS

.1 Inclusiveness
.1 Specific words or terms including the following have been removed or replaced for brevity, the absence of which in no way limits the scope of the description:
.1 “All”.
.2 “To” instead of “in accordance with”.

.2 The word “including” or the word “includes” shall be taken to mean “including but not limited to”.

.3 Lists of products, qualities, or responsibilities may be listed after inclusive statements for various purposes including for clarification, examples. The absence of list items shall not limit the inclusiveness of such statements.

.2 Abbreviations, Acronyms, Names and Terms: Where acronyms, abbreviations, names and terms are used in Drawings, Specifications or other portions of Contract Documents, they shall mean the recognized name of the trade association, document generating organization or body, document publishing organization or body, authority having jurisdiction or other entity applicable.

.1 AABC: Associated Air Balance Council
.2 ACR: The American College of Radiology
.3 AHRI: Air-Conditioning, Heating, and Refrigeration Institute (formerly Air-Conditioning and Refrigeration Institute)
.4 AMCA: Air Movement and Control Association International, Inc.
.5 ANSI: The American National Standards Institute, Inc.
.6 ASHRAE: American Society of Heating, Refrigerating and Air-Conditioning Engineers
.7 ASME: American Society of Mechanical Engineers
.8 ASTM: American Society for Testing and Materials International
.9 AWS: American Welding Society
.10 BTL: BACnet Testing Laboratories, established by BACnet International
.11 CAABC: Canadian Associated Air Balance Council
.12 CGSB: Canadian Government Standards Board
.13 CHC: The Canadian Hydronics Council
.14 CRCA: Canadian Roofing Contractors' Association
.15 CRCA: Chicago Roofing Contractors Association
.16 CSA: Canadian Standards Association
.17 CSC: Construction Specifications Canada
.18 CWB: The Canadian Welding Bureau
.19 DOE: Department of Energy (United States)
.20 ESA: Electrical Safety Authority (Ontario)
.21 FCIA: Firestop Contractors International Association
.22 GSI: Green Seal, Inc.
.23 HI: The Hydronics Institute, Inc. (currently a division of Air-Conditioning, Heating, and Refrigeration Institute, formerly a division of Gas Appliance Manufacturers Association Inc.)
.24 IEC: International Electrotechnical Commission
.25 IEEE: Institute of Electrical and Electronics Engineers, Inc.
.26 IES: Illuminating Engineering Society (formerly Illuminating Engineering Society of North America)
.27 ISO: The International Organization for Standardization
.28 MICA: Midwest Insulation Contractors Association
.29 MPI: Master Painters Institute Inc.
.30 NADCA: The HVAC Inspection, Maintenance and Restoration Association (also known as the National Air Duct Cleaners Association)
.31 NEBB: National Environmental Balancing Bureau
.32 NECA: National Electrical Contractors Association
.33 NEMA: National Electrical Manufacturers Association
.34 NFPA: National Fire Protection Association
.35 NIST: The National Institute of Standards and Technology
.36 OIRCA: Ontario Industrial Roofing Contractors Association
.37 OSMCA: Ontario Sheet Metal Contractors Association
.38 PEO: Professional Engineers Ontario

.39 SCAQMD: South Coast Air Quality Management District
.40 SMACNA: Sheet Metal and Air Conditioning Contractors' National Association, Inc.
.41 SSPC: The Society for Protective Coatings
.42 TIA: The Telecommunications Industry Association (formerly a part of the Electronic Industries Alliance)
.43 TIAC: Thermal Insulation Association of Canada
.44 UL: Underwriters Laboratories Inc.
.45 ULC: Underwriters Laboratories of Canada

.3 Words and terms used on Drawings and in Specifications are defined as follows:
.1 "Applicable": As appropriate for the particular condition, circumstance or situation.
.2 "Approve(d)": Approval action shall be limited to the duties and responsibilities of the party giving approval, as stated in Contract Documents. Approvals shall be valid only if obtained in writing and shall not apply to matters regarding the means, methods, techniques, sequences and procedures of construction. Approval shall not relieve Contractor from responsibility to fulfill requirements of Contract Documents. Where party giving approval is not indicated, approving party shall be Owner or Engineer.
.3 "Capability": Provide products as required including equipment and components ready for future configuration to make Work perform and/or operate as specified.
.4 "Code": Refer to "Regulation".
.5 "Concealed": Equipment, services and components that are not exposed to view and non accessible via doors and hatches.
.6 "Configure": Complete activities required to meet performance or functionality requirements including initialization, jumper and dip switch setting, software parameter selection, programming, testing, commissioning, tuning and adjusting.
.7 "Crown": The Crown in right of Canada and in right of all Canadian provinces.
.8 "Directed": Limited to duties and responsibilities of Owner or Engineer as stated in Contract Documents, meaning as instructed by Owner or Engineer, in writing, regarding matters other than the means, methods, techniques, sequences and procedures of construction. Terms such as "directed," "requested," "authorized," "selected," "approved," "required," and "permitted" mean "directed by Owner," "directed by Engineer," "requested by Owner," and similar phrases. No implied meaning shall be interpreted to extend the responsibility of Owner, Engineer or other professional designers as indicated into Contractor's supervision of construction.
.9 "Equal" or "Equivalent": As determined by Engineer or other indicated responsible professional designer as being equivalent, considering such attributes as durability, finish, function, suitability, quality, utility, performance and aesthetic features.
.10 "Exposed": Means not "concealed".
.11 "Functionality": Provide Work as required to be complete in every respect and fully functional, including installation, field finishing, configuration, and commissioning.
.12 "Furnish": Supply and deliver to Site, ready for unloading, unpacking, assembly, installation, and similar operations.
.13 "Indicated": Refers to graphic representations, notes, or schedules on Drawings, or other Paragraphs or Schedules in Specifications, and similar requirements in Contract Documents. Terms such as "shown," "noted," "scheduled," and "specified" are used to help the reader locate the reference. There is no limitation on location of reference within Contract Documents.
.14 "Install": Describes operations at Site including the actual unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, configuring and similar operations.
.15 "Installer": Refers to Contractor or an entity engaged by Contractor, including an employee, subcontractor or sub-subcontractor, for performance of a particular construction activity, including installation, erection, application and similar

operations. Installers are required to be experienced in the operations they are engaged to perform.

.16 "Intent": Refer to "Functionality".

.17 "NIC": Not In Contract. Indicates work completed or to be completed under separate contract.

.18 "OFCI": Owner Furnished Contractor Installed. Indicates materials, products or equipment to be provided under separate contract, and may include field finishing, configuration, and commissioning.

.19 "Products": Materials including equipment and components forming the Work.

.20 "Project": Construction and related services of which Work may be the whole or a part.

.21 "Proper": As determined by Engineer or other indicated responsible professional designer as being proper for Work, excluding matters regarding the means, methods, techniques, sequences and procedures of construction, which are solely Contractor's responsibility to determine.

.22 "Provide": Furnish and install, complete and ready for the intended use and effect.

.23 "Regulation": Includes laws, statutes, regulations, orders, ordinances, codes, and standards issued or used by authorities having jurisdiction over Work. Includes federal, provincial and municipal governmental agencies, governing and local authorities, utilities, utility districts and other agencies serving the site. Includes rules, practices, conventions and agreements of authorities having jurisdiction and within the construction industry that control requirements and performance of Work.

.24 "Regulatory": As required by regulation.

.25 "Required": Necessary for performance of Work in conformance with requirements of Contract Documents including:

.1 Regulatory requirements.

.2 Requirements of referenced documents.

.3 Duties and responsibilities stated in the Bid Documents and Contract Documents.

.4 Requirements specified or referenced in the Specifications.

.5 Notes, schedules and graphic representations on the Drawings.

.6 Requirements generally recognized as accepted trade or industry practice.

.26 "Selected": As selected by Owner, Engineer or other indicated responsible professional designer from the full selection of the manufacturer's products, unless specifically limited in Contract Documents to a particular aspect, including quality, color, texture or price range.

.27 "Site": Same as "Site of Work" or "Project Site" or "Job Site"; the area or areas or spaces occupied by Project and including adjacent areas and other related areas occupied or used by Contractor for construction activities, either exclusively or with others performing other construction on Project.

.28 "Standby Power": Electrical power generated on site and used during periods of utility power failure, whether or not the site generated power is used only during periods of utility power failure, and whether or not the site generated power is used for loads required to be supplied by emergency power.

.29 "Statute": Refer to "Regulation".

.30 "Statutory": Refer to "Regulatory".

.31 "Supply": Refer to "Furnish".

.32 "Work": Construction and related services required to meet Contract Documents.

.4 Names for manufacturers and products are defined in the following order:

.1 As determined by Engineer.

.2 As generally recognized by construction industry practice.

.5 Words, terms, abbreviations, measurement units not otherwise specifically defined in this Section or in Contract Documents are defined in the following order:

.1 As determined by Engineer when a conflict exists between any of the following.

.2 As described by regulation.

.3 As described by referenced documents.
.4 As described in specialty dictionaries in the following order:
.1 Dictionary of Architecture and Construction, Latest Edition (Cyril M. Harris, McGraw-Hill Professional).
.2 Encyclopedia of Associations, online directory by Thomson Gale, accessible through many public libraries.
.5 As determined by Engineer. Input may be provided by Contractor on definitions based on the following in the following order:
.1 As generally recognized by construction industry practice.
.2 As generally recognized by trade practice.

1.4 MULTIPLE CONTRACT SUMMARY

.1 All products indicated shall be considered to be fully part of Work unless otherwise denoted by NIC (Not in Contract) or OFCI (Owner Furnished Contractor Installed).
.2 Owner has other ongoing or concurrent separate contracts including:
.1 Envelope and glazing replacements.
.2 Hazardous material abatement, including asbestos and lead paint.
.3 Maintenance, repairs and service.
.3 Owner has other recently completed contracts with results still within warranty period including:
.1 Glazing replacements.
.4 Regularly meet with other contractors, and coordinate activities with other contractors as required.
.5 Include provisions necessary to make concurrent NIC and OFCI work under separate contracts with Owner complete and fully functional in every respect, including field finishing, configuration, and commissioning.
.6 Coordinate and cooperate with other contractors responsible for project health and safety in compliance with the Occupational Health and Safety Act.

1.5 ADDITIONAL TECHNICAL INFORMATION

.1 Contractor acknowledges that it has reviewed or has had the opportunity to review, Additional Technical Information not included in Contract Documents including the following:
.1 Building drawings.
.2 Supplemental project and renovation drawings.
.3 Hazardous materials reports.
.4 Other reports and plans.
.2 The following information will be available for review at Engineer's business address upon notice of request:
.1 Referenced documents.

1.6 CONTRACTOR RESPONSIBILITY

.1 Contractor acknowledges that it has visited or has had the opportunity to visit Site to visually inspect the general and local site conditions that could affect Work.
.2 Contractor acknowledges that intent of Drawings and Specifications are to describe design intent including scope and quality of Work in a finished state. Contractor is solely responsible for all means, methods, sequences, techniques, and procedures of construction to complete Work as so described.
.3 Contactor acknowledges that should Drawings and Specifications indicate specific means, methods, sequences, techniques, and procedures of construction, that such specifics are for the purposes of minimum quality in completing the Work to a finished state.
.4 Contractor failure to adhere to procedures, including submittals and changes, in no way relieves Contractor of their responsibility for Work.

1.7 UNKNOWN SITE CONDITIONS

.1 If all of the following conditions exist, Contractor shall stop Work and give written notice of the conditions before they are disturbed, and in no event later than 5 working days after first observance of the conditions.
  .1 Nature of condition is hidden or concealed from visual inspection or other inspection responsibilities identified in the Bid Documents.
  .2 Condition is materially different from those indicated in Contract Documents.
  .3 Condition is materially different from those indicated in Additional Technical Information.
  .4 Condition is materially different from those normally encountered.
.2 Contractor shall not be entitled to any adjustment in Contract Price or Contract Time if any of the above conditions do not exist.

1.8 HAZARDOUS MATERIALS

.1 Asbestos abatement NIC.
.2 Should Contractor encounter or suspect known or unknown NIC hazardous materials requiring abatement, Work shall continue in other areas without disturbing hazardous materials.
.3 Contract Time will be extended to the amount of time when all of the following conditions no longer exist:
  .1 Work is complete in other areas without unknown hazardous materials requiring abatement.
  .2 Contractor is not able to complete Work in areas with unknown hazardous materials encountered or suspected.
  .3 Owner has not completed addressing any issues surrounding hazardous materials in areas with hazardous materials encountered or suspected.
.4 Contractor agrees to hold harmless and indemnify Owner and Engineer from and against any claim or liability arising out of Contractor's performance of the removal of hazardous materials including any time spent or expenses incurred by Owner and Engineer in defence of any such claim.

1.9 USE OF SITE AND PREMISES

.1 Schedule Restrictions
  .1 Schedule daily and weekly construction activities as required by Owner.
  .2 Schedule Work around:
    .1 Work being performed by others under separate contracts with Owner.
  .3 Schedule Work outside of occupied hours for:
    .1 Work in occupiable areas.
    .2 Work requiring disruption of services to occupiable areas.
    .3 Work that may disrupt or disturb occupants.
.2 Request clarification of all matters regarding the use of site and premises that may impact construction activities.
.3 Meet Owner requirements during construction including:
  .1 Allowable construction hours.
  .2 Notices and scheduling of Work.
  .3 Notices and scheduling of disruption of services.
  .4 Facilities and utilities use.
  .5 Parking.
  .6 Security requirements.
  .7 Identification requirements.
  .8 Access requirements including availability and requirements of use for elevators, loading areas and pathways.
  .9 Disruption mitigation requirements including noise, vibration, dust, combustion gases, and smoke.
  .10 Submission of written plans for various aspects of Work, including phase-in planning, disruption mitigation, emergency procedures, Methods of Procedures (MOP).

.11 Hazardous materials.
.12 Storage requirements.
.13 Disposal requirements including for garbage and debris.
.14 Cleanliness and organization of work areas including for tools, materials, equipment.
.15 Cleanliness and visual appearance of areas affected by Work.
.16 Protection of surfaces and other items affected by Work.
.17 Specific Limitations
    .1 Construction Hours
        .1 Work in various areas is required to be completed outside of normal facility operating hours.
        .2 Work in occupiable spaces is required to be completed outside of normal occupied hours.
        .3 Work is some areas is required to be compelted during scheduled shutdown periods.
        .4 Prior to the beginning of scheduled operations each day, remove visual evidence of Work from occupied areas such that occupants should be unable to visually determine that areas were impacted by Work.
    .2 Identification Requirements: Contractor company and name tags for every individual must be worn readily visible and at all times while on site.
    .3 Access Requirements: Minimize use of public access entrances and exits where possible, otherwise coordinate and schedule use.
    .4 Disruption Scheduling: Specific other services may not be disrupted during normal facility operating hours, including fire detection system.
    .5 Materials Storage: Storage space on site is limited to service rooms in working areas with the provision that stored materials cannot interfere with normal facility operations.
    .6 Security Arrangements: Security is required after normal hours in all locations. Security by base building security provider.
    .7 Security by base building security provider.
    .8 Fire watch by base building fire watch provider.
    .9 Cleaning of occupied areas by base building cleaning provider.
.4 Emergency Egress: Maintain means of egress during construction including pathways, exit ways, exit doors, drives, gates, as required by Owner and authorities having jurisdiction.

1.10 CONVENIENCE WARNINGS

.1 Drawings or Specifications may contain cautionary notes or warnings, including drawing Contractor's attention to matters regarding means, methods, sequences, techniques, and procedures of construction. Contractor acknowledges that such warnings may not be accurate, complete, or comprehensive, and that such warnings in no way reduce Contractor's sole responsibility for means, methods, sequences, techniques, and procedures of construction.

1.11 DRAWINGS AND SPECIFICATIONS INCONSISTENCIES

.1 Contractor shall report to Engineer immediately when elements essential to proper execution of Work are discovered to be missing, or mistakes are found in Drawings and Specifications, or if design intent is unclear.
    .1 Should an essential element be discovered as missing or mistakes are found prior to receipt of Bids, an Addendum will be issued so that costs may be accounted for in Contract Price.
    .2 Should an obvious omission or obvious mistake describing a necessary element be discovered and reported after execution of the Agreement, Contractor shall provide the element as though fully and correctly described, and a no-cost Instruction or Change Order shall be executed.
    .3 Refer to related general requirements regarding construction interfacing and coordination.

.2 In case of inconsistency(s) between or within Drawings and Specifications, provide the following unless interpreted otherwise by Engineer:
  .1 For differences in indicated quality, adhere to better quality of Work.
  .2 For differences in indicated quantity, adhere to greater quantity of Work.
  .3 For other differences, adhere to the more stringent requirement as determined by Engineer.

1.12 REFERENCES

.1 Referenced Documents: Drawings and Specifications contain various references, including to various codes, standards, practices and requirements. Such references are used for various purposes, including for products, execution, tests and inspections.

.2 Relationship to Drawings and Specifications: Referenced documents in Drawings and Specifications are made a part of Drawings and Specifications to the extent applicable, and shall have the full force and effect as though printed in their entirety in Specifications, including design and installation requirements. Where referenced documents are indicated, whether use of referenced documents are specifically or not specifically identified, adhere to requirements of referenced documents in their entirety, including installation and design requirements. Design requirements indicated in reference documents are to be treated as delegated design.

.3 Completeness: Referenced documents include, whether specifically referred to or not, addenda, errata, interpretations, supplements, handbooks and guidelines as issued or used by:
  .1 Referenced document issuing body(s).
  .2 Authority(s) having jurisdiction(s).

.4 References Within References: Referenced documents include additional references to other reference documents. Adhere to requirements of these other referenced documents in their entirety to the extent applicable, including installation and design requirements. Design requirements indicated in reference documents are to be treated as delegated design.

.5 Convenience: Specific references are for convenience only and do not limit completeness, including:
  .1 Related Referenced Documents: References may include additional references to related documents, including addenda, errata, interpretations, supplements, handbooks and guidelines.
  .2 Specification Sections Relationships: Specification Sections may contain lists of other relevant or related Sections.

.6 Copies: Referenced documents are not furnished with Drawings and Specifications as it is presumed that Contractor, subcontractors, manufacturers, suppliers, trades and crafts are familiar with these generally recognized standards of the construction industry.

.7 Names: In the event a referenced document is no longer available or recognized, reference shall be understood to be either:
  .1 Latest edition of replacement reference from same publishing organization or body.
  .2 Latest edition of replacement reference from replacement publishing organization or body.

.8 Edition Dates
  .1 Where an edition or effective date of a referenced document is given, it shall be understood to be the more stringent of:
    .1 As indicated.
    .2 Latest edition adopted by authorities having jurisdiction.
  .2 Where an edition or effective date of a referenced document is not given, it shall be understood to be the more stringent of:
    .1 Latest edition adopted by authorities having jurisdiction.
    .2 Latest edition published at time of issuance of permits, certificates, licenses, or approvals by authorities having jurisdiction.

.3 Latest edition published at time of execution of Contract Documents, whether or not reference has been adopted by authorities having jurisdiction.

.3 Previous Edition Related Referenced Documents: Related reference documents from previous editions of references are to be used in the absence of updates to related documents with indicated reference edition.

.9 Referenced Grades Classes and Types: Where an alternative or optional grade, class or type of product or execution is included in a reference but is not identified on Drawings or in Specifications, provide the highest, best and greatest of the alternatives or options for the intended use and prevailing conditions.

.10 Conflicting Requirements: Where compliance with 2 or more references are specified, or requirements from 2 or more references and/or related reference documents are present, and these references establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer uncertainties and requirements that are different, but apparently equal, to decision by Engineer before proceeding.

1.13 REGULATORY REQUIREMENTS

.1 Crown Prerogative: Should Crown prerogative be applicable to Work, including statutes that may not bind the Crown, adhere to all laws as if Crown prerogative was not applicable and as if the Crown were bound by all statutes.

.2 Edition Dates: The edition date of applicable laws, regulations, orders and ordinances shall be that of the date of performance of Work. The edition date of applicable codes, standards and practices shall be that adopted at the time of issuance of documents or approvals by authorities having jurisdiction, and shall include modifications, additions and interpretations adopted by that jurisdiction.

.3 Precedence

.1 Where specified requirements differ from the requirements of applicable regulation, the more stringent requirements shall take precedence.

.2 Where Drawings or Specifications require or describe products or execution of better quality, higher standard or greater size than required by applicable laws, regulations, orders, and ordinances, Drawings and Specifications shall take precedence so long as such increase is legal.

.3 Where no requirements are identified in Drawings or Specifications, comply with requirements of regulation.

1.14 PERMITS

.1 Obtain and pay for documents and approvals for Work and affected systems, including, permits, certificates, licenses, testing, and inspections, as follows in the following order:

.1 Include the following, which may include items to complete on behalf of Owner:

.1 Electrical permits.

.2 Electrical inspections and approvals.

.3 Boilers and Pressure Vessels certificate of inspection.

.2 Exclude the following:

.1 Building permits.

.3 As required.

1.15 SUBSTITUTION PROCEDURES

.1 Request for Substitution (RFS): A written request submitted by Contractor to deviate from specified requirements for products, materials, layouts, and methods to complete Work, or to provide Work other than as indicated or specified in Contract Documents.

.2 RFSs are only to be submitted after Contractor has completed thorough investigations and planning to incorporate substitution into Work to achieve full use and effect.

.3 RFSs will only be considered when submitted in sufficient time to permit review by Engineer.

.4 RFSs to include differences between specified requirements and substitution, including the following:
  .1 Clear title denoting the document as a "Request for Substitution".
  .2 Reason for requesting substitution.
  .3 A summarized comparison of physical properties and performance characteristics for specified requirements and substitution, and clearly highlighting significant variations.
  .4 Indication of reductions to contract costs and dates.
  .5 Verification that substitution will not result in additional costs or a reduction in performance to other portions of Work.
  .6 Additional information for products including:
    .1 Identification, including manufacturer's name, address, telephone and fax numbers, and web site address where available.
    .2 Manufacturer's data sheets, including material descriptions, compliance with regulation and referenced documents and applicable standards, performance and test data.
    .3 Indication of availability of maintenance services and sources of replacement materials and parts, including associated costs and time frames.

.5 Provide additional information requested by Engineer to demonstrate substitution will perform equally as well or better than specified requirements.

.6 Provide additional information requested by Engineer to demonstrate substitution will perform equally as well or better than specified requirements.

.7 Clauses such as "or equal", "or approved equal", or other similar clauses, will not be construed as an invitation to submit RFSs or to unilaterally substitute in place of specified requirements.

.8 Failure to complete Work or portions of Work in adequate time to meet approved construction schedule will not be a valid reason to submit RFSs. Delays remain responsibility of Contractor, and will not result in an extension to Contract Time or be subject to reimbursement by Owner.

.9 Owner is under no obligation to consider substitutions recommended by Contractor.

.10 In the event a substitution has been incorporated into Work obtaining written acceptance of the RFS:
  .1 Contractor shall remove the substitution and replace it with specified requirements with no change in Contract Price or Contract Time.
  .2 Alternatively, Contract Price shall be reduced by the sum of:
    .1 The amount that the installed price of specified requirements exceeds that of substitution, as determined by Engineer.
    .2 Engineer fees required to evaluate and administer the impact of substitution.
    .3 The net present value of lifecycle costs resulting from substitution, as determined by Engineer, including energy efficiency, maintenance costs, fees related to application and approval of permits, and modifications to related Work resulting from substitution.

.11 Substitutions shall not result in any delay in completion of Work, including other activities and projects under separate contracts by Owner.

.12 Substitutions shall not result in any increase in Contract Price and Contract Time.

.13 Should additional costs be incurred by Owner, directly or indirectly, as the result of substitution, such costs shall be paid by Contractor through deduction in payment owed to Contractor by Owner. Additional costs may include:
  .1 Other activities and projects under separate contracts by Owner
  .2 Engineer fees including re-design and reviews.

.14 Should changes be required due to substitutions, such changes shall be made by Contractor at no increase in Contract Price and Contract Time, whether or not such changes are known at the time substitution is accepted. Changes may result in additional costs incurred by Owner.

1.16 CLARIFICATION PROCEDURES

.1 Request for Clarification (RFC): A document submitted by Contractor requesting clarification of a portion of Contract Documents, hereinafter referred to as an RFC.

.2 Submit a written RFC when any of the following occur:

.1 Requirement Unclear: Exact material, process, or system to be installed is unclear.

.2 Interference: Elements of construction are required to occupy the same space.

.3 Requirements Conflict: Work is described differently in more than 1 place.

.3 RFCs shall not be used for the following purposes:

.1 To request review of submittals.

.2 To request approval or acceptance of substitutions.

.3 To request changes that only involve change in Contract Price and Contract Time.

.4 To request methods of performing Work different than as indicated.

.4 Requested Information: RFCs that request interpretation of requirements clearly indicated in Contract Documents will be returned without interpretation.

.1 In cases in which RFCs are issued to request clarification of issues related to means, methods, sequences, techniques, and procedures of construction, Contractor to furnish information required for Engineer to analyze and/or understand the circumstances causing the RFC and prepare a clarification or direction as to how Contractor shall proceed. Examples include services routing including piping and ductwork, specific locations of Work shown diagrammatically, clearances indicated or required, apparent interferences.

.2 If information included with this type of RFC by Contractor is insufficient, the RFC will not be answered.

.5 Disputed Requirements: In the event that Contractor believes that a clarification by Engineer results in changes to Contract Price or Contract Time, Contractor is to not proceed with Work indicated by the RFC until authorized to proceed by Owner and Engineer and claims, if any, are resolved in accordance with Contract provisions.

1.17 CONTRACT MODIFICATION PROCEDURES

.1 Instruction Supplement: Consultant will issue an Instruction Supplement (Supplemental Instruction) authorizing changes in Work not involving adjustment to Contract Price or Contract Time.

.2 Change Proposal: If conditions require modifications to Contract Documents, or upon written request from Engineer, Contractor may propose changes by submitting a Change Proposal. Include the following:

.1 Complete description of proposed change.

.2 Reason for change.

.3 Details explaining impact on Contract Price.

.4 Details explaining impact on construction schedule and Contract Time.

.5 Indicate Contractor and subcontractors costs separately for labour and equipment and materials.

.6 Indicate taxes, delivery charges, equipment rental, and amounts of trade discounts.

.3 Change Order: On Owner's approval of a Change Proposal, Engineer will issue a Change Order for signature by Owner and Contractor.

1.18 CASH ALLOWANCE WORK

.1 Extent of Work

.1 Work described under this Article.

.2 Work described under this Article is separate and additional to Work described elsewhere in Contract Documents except as specifically indicated in this Article.

.3 Cash Allowance amounts do not include Contractor costs related to Work performed under Cash Allowances, including Contractor overhead, profit, management, supervision, coordination, administration. Such costs are to be included in Bid Price outside of Cash Allowance amounts.

.2 Description of Work

.1 Hazardous Materials Abatement
  .1 Service Provider: Ontario Environmental and Safety Network Ltd.
    .1 Contact: Jeff Drummond, Email: jdrummond@oesn.net, Phone: (905)988-1554
  .2 Scope: Assessment of hazardous materials affecting work, abatement of hazardous materials as required.

1.19 CASH ALLOWANCE PROCEDURES

.1 Additional Contractor Activities
  .1 Complete site reviews and investigations with subcontractor(s) 14-days after contract award.
  .2 Obtain quotation from subcontractor(s) for completion of work as described in Contract Documents under cash allowance provisions, or as defined during construction.
    .1 Quotation shall include reference to project Contract Documents.
  .3 Forward quotation to Engineer for approval under cash allowance approval procedures.
  .4 Contractor shall not proceed with work under cash allowance without written approval. Shop drawing approvals are not considered approval to proceed under cash allowance provisions.

1.20 PAYMENT PROCEDURES

.1 Schedule of Values: Provide schedule of values at least 14 days prior to first application for payment. Provide detailed schedule of values including:
  .1 Investigation, submittal, and mobilization costs.
  .2 Separate equipment material cost, and quantities for each equipment type.
  .3 Separate installation cost for major equipment.
  .4 Separate installation cost for each system.
  .5 Separate costs for balancing, start-up and system testing.
  .6 Individual itemized cash allowance amounts.
  .7 Commissioning costs.
  .8 Close-out costs.

1.21 PROJECT ADMINISTRATION

.1 Submittals and Transmittals
  .1 Format: Provide submittals and transmittals in electronic format unless otherwise indicated.
    .1 Electronic Format
      .1 Transmit to recipients' email addresses, or alternate means for large electronic file submissions.
      .2 Transmit photographs in JPG format acceptable to Engineer, including resolution, focus and light levels.
      .3 Transmit other submittals in file formats as indicated. Where file formats are not indicated, use Adobe PDF format acceptable to Engineer, including clarity and alignment, with original PDF source files where available. Unacceptable: Scans of other formats where PDF file can be generated from original source files.
      .4 File Naming: Name electronic files appropriately and consistently. Electronic file naming convention subject to review and approval by Engineer.
      .5 Multiple Electronic File Submission: Maintain separate subject matter in separate electronic files.
    .2 Paper Format
      .1 Transmit to recipients at recipients' business addresses.
      .2 Transmit in paper format acceptable to Engineer, including size, colour, clarity and alignment.
  .2 Recipients: As required.

.3 Response: Allow 10 working days for responses from Engineer unless otherwise indicated.

.2 Project Meetings: Conduct project meetings at Owner's preferred location at 2-week intervals.

.1 Attendees: Inform individuals whose presence is required of date and time of each meeting, including Contractor staff, subcontractors and suppliers. Inform individuals whose presence may not specifically be required but are involved of the project of date and time of each meeting to be available by phone during the meeting, including Contractor staff, subcontractors and suppliers. Notify Owner and Engineer of arranged meeting dates and times. Provide 2-week notification.

.2 Agenda: Prepare meeting agenda. Distribute meeting agenda not less than 2 working days before the meeting to invited attendees.

.3 Minutes: Prepare meeting minutes. Distribute meeting minutes within 2 working days of meeting to invited attendees and appropriate stakeholders as determined by Owner. Include the following information:

.1 Attendance.

.2 Discussions.

.3 Agreements.

.4 Action items in a separate list, including responsible parties and individuals, and required completion dates.

.4 Modifications: Owner may modify project meeting requirements, including Engineer to take responsibility for project meeting minutes, at no change to Contract Price or Contract Time.

.3 Progress Meetings: Conduct progress meetings at 1-week intervals. Coordinate dates of meetings with preparation of payment requests.

.1 Attendees: Participants shall be familiar with Work and authorized to conclude matters relating to Work.

.2 Agenda

.1 Review and approve minutes of previous progress meeting, including modifications to minutes.

.2 Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Work.

.3 Review progress since last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule in relation to Contractor's construction schedule.

.4 Determine how construction schedule will be expedited.

.5 Secure commitments from parties involved to do so.

.6 Discuss whether construction schedule revisions are required to ensure that current and subsequent activities will be completed within Contract Time.

.3 Schedule

.1 Updates: Update construction schedule after each progress meeting where revisions to construction schedule have been made or recognized.

.2 Distribution

.1 Submit updated construction schedule in colour ledger sized paper format concurrently with each progress meeting report.

.2 Transmit updated construction schedule in electronic format to Engineer.

.3 Revisions: Review and evaluate construction schedule regularly during construction. Revise construction schedule as necessary as a result of review, and resubmit within 2 working days.

.4 Format: Software generated Gantt chart as acceptable to Engineer including for ease of use of data.

.1 File Type: Microsoft Project and Adobe PDF of file.

.4 Reporting: Provide brief narrative progress report to define problem areas, anticipated delays, and impact on the construction schedule. Report corrective actions taken or proposed, and its effect including the effects of changes on schedules of separate contracts. Identify modifications since previous submittal, including activities and changes.

.5 Distribution

.1 Distribute reports and construction schedules within 2 working days of the meeting.

.2 Distribute to Contractor's site file, to subcontractors, suppliers, Engineer, Owner, and other concerned parties.

.3 Instruct recipients to promptly report, in writing, problems anticipated by projections shown in schedules.

.4 Other Meetings: Adhere to project meeting procedures for other meetings.

1.22 SUBMITTAL PROCEDURES

.1 Provide submittals as indicated. Required submittals may only be described in submittals articles of each Section, and may not be further described in products or execution articles of each Section.

.2 Submittals For Action

.1 Submit as indicated to Engineer and Owner for review. Reviews shall be for the limited purpose of reviewing general conformance with the design concept expressed in Contract Documents. Contractor acknowledges that such comments or lack thereof in no way relieve Contractor's responsibility for meeting all requirements of Contract Documents.

.2 It is Contractor's sole responsibility to ensure that submittals are timely, complete and comprehensive.

.3 Engineer may not review information provided if such information is incomplete or not comprehensive.

.4 Engineer may comment on incomplete or missing submittals.

.5 Engineer may provide commentary, notes or warnings on review of submittal. Contractor shall carefully read submittal review, complete investigations as required to address submittal review contents, and re-submit submittal prior to ordering products or proceeding.

.6 In the event Work requiring submittal for action has been completed without Engineer's written review, modify Work as required, including as indicated by Engineer, with no changes to Contract Price or Contract Time.

.3 Submittals For Information

.1 Submit as indicated to Engineer and Owner on behalf of Commissioning Authority and/or Owner. No review action will be taken by Engineer.

.4 Submittals For Closeout

.1 Submit as indicated to Engineer and Owner on behalf of Commissioning Authority and/or Owner. No review action will be taken by Engineer.

.5 Other Submittals

.1 Submit other submittals as indicated to Engineer and Owner.

.6 Submission

.1 Transmit each submittal with a letter of transmittal as acceptable to Engineer.

.2 Schedule submittals to expedite Work and coordinate submission of related items.

.7 Content: Identify relevant and required information, including:

.1 Project name.

.2 Contractor, subcontractor and supplier, as applicable.

.3 Pertinent Drawing and detail number, and Specification Section and Title, as appropriate, on each copy.

.4 Bill of materials for products or system features included in submittal. Bill of materials to include tag, description, quantities, makes, and model numbers or part to be

ordered. Where model numbers do not indicate special instructions or custom aspects, provide notes to describe requirements, as well as notes on who is responsible and where to provide, i.e. at factory by manufacturer or in field by Contractor. Where model numbers do not indicate all features and options, indicate selected features and options on each submittal page or product sheet by using boxes or highlights.

.5 Variations from Contract Documents.

.6 Extent of impacts on requirements due to variations from Contract Documents, including performance requirements.

.7 Product or system limitations that may be detrimental to successful performance of completed Work.

.8 Custom fabrications or assemblies that may require professional engineering services.

.9 Changes made since previous submission.

.10 Apply Contractor's stamp, signed or initialled, certifying that review, approval, verification of products required, field dimensions, adjacent construction Work, and coordination of information are in accordance with requirements of Work and Contract Documents.

.8 Format: Transmit submittals in electronic format unless otherwise indicated.

.9 Quantity: Unless otherwise indicated, submit 4 copies of submittals in paper format when printed or paper format is indicated.

.10 Distribution: Engineer will transmit reviewed submittals with further action as required to Contractor and others at Engineer's discretion. Submittals with completed review actions shall be distributed by Contractor as appropriate.

.11 Modifications: Engineer may at Engineer's discretion choose to:

.1 Review an incomplete submittal.

.2 Designate a transmittal as a request for substitution or change proposal.

.3 Designate a transmittal as a request for clarification.

.4 Review submittals for information or submittals for closeout.

1.23 QUALITY CONTROL

.1 Quality Assurance: Ensure products, services, workmanship and site conditions comply with requirements by coordinating, supervising, testing and inspecting Work, and by utilizing only suitably qualified personnel.

.2 Minimum Quality: Where no quality basis is prescribed, quality shall be in accordance with the more stringent of:

.1 Best accepted practices of the construction industry for projects of this type, and in this location.

.2 Quality of the latest changes and renovations to the existing building installation, as it exists now.

.3 Quality of the existing base building installation, as it existed when newly installed.

.3 Quality of Installation: Produce Work plumb, level, square and true, or true to indicated angle, and with proper alignment and relationship between the various elements. Ensure Work is properly related to form close joints and appropriately aligned junctions, edges and surfaces and is free of warp, twist, wind, wave or other irregularities.

.4 Manufacturer's Instructions and Recommendations: Comply with manufacturer's instructions in preparing, fabricating, erecting, installing, applying, connecting and finishing Work, unless more stringent requirements are required, indicated or specified.

.5 Protection: Take measures necessary to preserve and protect existing and completed Work free from damage, deterioration, soiling and staining, until Acceptance by Owner.

.6 Defects and Blemishes: Correct defects, blemishes and other aesthetic issues identified by Engineer.

.7 Deviations: Document and explain deviations from requirements, including applicable standards, referenced documents, building code research report requirements, and manufacturer's product installation instructions and recommendations. Include

acknowledgment by manufacturer that such deviations are acceptable and appropriate for Work. Ensure Work does not infringe on applicable patents or intellectual property rights.

.8 Photo Documentation
  .1 Photo document construction progress with time stamped digital photographs.

.9 Logs: Maintain daily sign in and sign out logs for all personnel on site. Owner may dictate location of logs.

.10 Verification of Quality: Work shall be subject to verification of quality by Owner or Engineer in accordance with provisions of Contract Documents.

.11 Inspections and Tests
  .1 Inform Owner and Engineer of required inspections, tests, and reviews, including those required by:
    .1 Conditions of warranty.
    .2 Product, material or equipment manufacturers.
    .3 Certification of Work.
    .4 Commissioning.
    .5 Contract Documents.
    .6 Authorities having jurisdiction.
    .7 Regulation.
  .2 Contact manufacturers, suppliers, authorities having jurisdiction, and others as required sufficiently in advance to confirm which, if any, inspections, tests, and reviews are required, including when required as a condition of permits, certificates, and licences not obtained by Contractor.
  .3 Make arrangements for required inspections, tests and reviews. Coordinate dates and times that are acceptable to Owner and Engineer.
  .4 Participate in and be present during inspections, tests and reviews, as well as additional follow-up inspections, tests and reviews.
    .1 Arrange and pay for the presense and participation of manufacturers, suppliers, service representatives, subcontractors, authorities having jurisdiction, and others that may be required to be present during such activities.

.12 Monitoring: Owner may monitor construction site including video surveillance to document construction progress and to provide evidence for valuing Change Directives.

1.24 TEMPORARY FACILITIES AND CONTROLS

.1 Provide temporary facilities and controls as required.

.2 Temporary Utilities
  .1 Provide temporary utilities as required, including electrical, lighting, water, heating, cooling, and ventilation as required.
  .2 Co-ordinate utility disruption and provision of temporary utilities as required by Owner to prevent interruption of building occupant activities.
  .3 Coordinate with Owner for points of connection, protection and payment of service charges.
  .4 Exercise measures to conserve energy.
  .5 Provide temporary emergency backup power in the event of interruption of existing power including backup standby power.

.3 Temporary HVAC: Provide temporary HVAC services as required, including heating, ventilation, cooling, and de-humidification. Purposes of temporary HVAC services include:
  .1 Maintain occupant comfort.
  .2 Maintain building environment.
  .3 Maintain equipment and system redundancy requirements.
  .4 Prevent interference or disruption of occupant operations.
  .5 Prevent damage, including to areas, systems, services, equipment, components, finishes.
  .6 Provide adequate temperature and humidity levels for storage, curing or drying.
  .7 Prevent migration and accumulation of dust, debris, fumes, smoke, gases, or odours.

.4 HVAC Protection: Provide protective systems and barriers at HVAC systems, including at air inlets and grilles, to prevent maintenance and operational impacts including migration and accumulation of dust and debris, clogging of filters.
.5 Temporary Communications: Provide temporary communications as required for proper performance of the Work.
.6 Temporary Barriers: Provide temporary fencing, barriers and guardrails as necessary to provide for public safety, to prevent unauthorized entry to construction areas, and to protect existing facilities and adjacent properties from damage from construction operations.
.7 Temporary Closures: Provide temporary closures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations and similar activities. Provide temporary weather-tight enclosure for building exterior.
.8 Work Protection: Provide temporary protection for installed products and services. Control traffic in immediate area to minimize damage.
.9 Floor Protection
  .1 Protect existing floors from soiling and damage.
  .2 Cover floors with minimum 2 layers of 0.08-mm (3-mil) polyethylene sheets, extending sheets 460-mm (18-in) up the side walls.
  .3 Cover polyethylene sheets with minimum 25-mm (1-in) fire-retardant plywood.
  .4 Provide mats to clean dust and debris from shoes.
.10 Protective Coverings: Provide protective coverings at walls, projections, jambs, sills and soffits of openings as necessary to prevent damage from construction activities, such as coatings applications, and as necessary to prevent other than normal atmospheric soiling.
.11 Other Temporary Provisions
  .1 Maintain safety systems and occupant protection.
  .2 Provide temporary pumping facilities, drainage, and related piping to maintain excavations and site free from standing water.
  .3 Provide temporary fencing, trailers, sanitary facilities, and other structures as required. Obtain approval for type, aesthetics, and location.
.12 Supervision: Provide supervision of temporary facilities and controls, including utilities and HVAC, where disruption or failure of such services may impact occupants, cause interruption of critical services, cause safety concerns, increase risk to life and property, cause other damages.
.13 Removal of Temporary Facilities and Controls
  .1 Remove temporary facilities and controls, including utilities, equipment, materials, prior to Substantial Performance Review.
  .2 Remove underground installations to a minimum depth of 610-mm (2-ft). Grade site as required.
  .3 Clean and repair damage caused by installation or use of temporary facilities and controls.
  .4 Restore existing and permanent facilities used during construction to original condition. Restore permanent facilities used during construction to condition equal to or better than at commencement of construction.

1.25 DELEGATED DESIGN REQUIREMENTS

.1 Delegated Design: Engage services of a Professional Engineer to provide design documents where indicated and where required by regulation, with design documents sealed, signed, dated, and identifying company name and contact information of Certificate of Authorization holder for the engineering work. Professional Engineer and services to include:
  .1 Insurance
    .1 Errors and Omissions (Professional Liability) Insurance: Company to have minimum $1,000,000 per occurrence and minimum $2,000,000 aggregate. Submit proof upon request.

.2 Additional Insured: Certificates of insurance issued able to meet Owner requirements including additional insured text. Submit proof upon request.

.2 Licences: Company and personnel licensed to practice Professional Engineering in the province of Ontario. Submit proof upon request, including individual licence number(s) and Certificate of Authorization number.

.3 References: References of Professional Engineer, including previous recent project work. Submit upon request.

.4 Drawings: Drawings to be completed and provided to Engineer in editable electronic files for shop drawings and project record drawings in AutoCAD format, compliant to CAD standards of Owner or Engineer as determined by Engineer, including:

.1 Background template, title block and attributes.

.2 Layers naming and use.

.5 General Reviews: Where delegated design work is for more than only product selection, same Professional Engineer that completed design to also provide general reviews.

1.26 GENERAL REVIEWS

.1 Terms: The term "general review" as defined and required by regulation, including local building code, professional practice guidelines. General review may be referred to or replaced by the term "general assessment" for the whole of or any part of Work as determined by Engineer, including general review not specifically required by local building code.

.2 Purpose: General reviews are completed by Engineer, or Professional Engineer under delegated design requirements, as required for the sole purpose of reviewing whether Work is in general conformance with the design concept.

.1 No implied approval or acceptance of submittals, substitutions, or changes shall be inferred from general reviews.

.2 No implied approval or acceptance of changes in Contract Price and Contract Time shall be inferred from general reviews.

.3 General reviews are not to be relied upon for testing, commissioning, and required inspections by authorities having jurisdiction or other quality assurance purposes.

.4 General reviews do not relieve Contractor of responsibility for meeting all requirements of Contract Documents.

.3 Frequency: Frequency of general reviews determined by Engineer during Contract Time or after Contract Time.

.1 General reviews will continue to be made until the final general review.

.4 Reports: Engineer will submit a report for each general review.

.1 General review reports may include references to other documents that are considered as part of the general review report.

.2 Notify Engineer in writing within 3 working days of receiving general review report should Contractor disagree with items noted in report including references.

.5 Punch Lists: Prepare and maintain on site a comprehensive list of items to be completed and corrected to make Work ready for acceptance by Owner.

.1 Update punch list with items described in general review reports.

.2 Immediately correct deficiencies and incomplete items described in general review reports at no change in Contract Price or Contract Time.

.6 Additional General Reviews and Meetings: Engineer fees due to additional general reviews and meetings requested by Contractor, or required by Engineer for reasons including Contractor's failure to meet construction schedule, correct deficiencies, and complete incomplete items, shall be paid by Contractor.

.1 Such fees shall be deducted from payments owed to Contractor by Owner. Owner will then pay Engineer.

.7 Final General Review

.1 Submit written request for final general review indicating completion of Work. Include date and signature.

.2 Final general review request will imply, whether stated or not, the following:
.1 Statement that all outstanding general review items have been rectified.
.2 Declaration that Contractor has prepared and completed all final completion submittals as described below.
.3 Upon receipt of request, Engineer will proceed with final general review.
.4 In the absence of written request for final general review, final general review will be completed after Substantial Performance has been first requested.

.8 Additional Final General Reviews and Meetings: Engineer fees due to additional final general reviews as required shall be paid by Contractor.
.1 Such fees shall be deducted from payments owed to Contractor by Owner. Owner will then pay Engineer.

1.27 PRODUCT REQUIREMENTS

.1 Selection: Provide products that are new, unused, undamaged.
.2 Ratings: Provide products that are rated for the conditions to which they will be subjected, including typical operation and potential extremes.
.3 Required Products: Provide products of types and kinds that meet regulatory requirements including provisions of local building code. Various product requirements apply, including:
.1 Combustible Materials: Provide products as indicated and that meet provisions of local building code, including where building is or is required to be of noncombustible construction to local building code, including:
.1 Noncombustible materials.
.2 Minor combustible components as specifically described. Provide submittals to Engineer on materials that may be defined as "similar minor components".
.3 Combustible materials and components and their application where specifically described.
.2 Fire Resistance Ratings: Where materials are required to have fire resistance ratings to local building code, provide products as indicated and that meet provisions of local building code, including:
.1 Determination of ratings and minimum ratings.
.2 Exceptions and exposure conditions of ratings.
.4 Standard Products: Where specific products are not specified or required be regulation, provide standard products of types and kinds that are suitable for intended purposes, use and effect, and that are usually and customarily used on similar projects under similar conditions. Products shall be subject to review and acceptance by Engineer.
.5 Completeness: Provide products complete with details and configuration needed for a complete installation and for intended purposes, use and effect, including accessories, trim, finish, safety guards, structural supports, platforms, braces, tie-rods, and other devices. Provide products with services and components connections of type(s) and configuration required to match the requirements for mating services and components.
.6 Service Connections: Coordinate requirements and types of connections to services and components by matching requirements for such services and components as indicated throughout Drawings and Specifications, or as required where not indicated.
.7 Consistency: Provide products of the same kind from the same manufacturer and from a single source over duration of Work. Provide specified product options from same manufacturer as product and native to product to the fullest extent possible.
.8 Visual Matching: Where sample matching is required, the decision by Engineer on whether a proposed product matches shall be final. Where no product visually matches but the product complies with other requirements, comply with provisions for substitutions for selection of a matching product in another category.
.9 Options Selection: Where requirements include the phrase "as selected from manufacturer's standard colors, patterns and textures" or a similar phrase relating to options as well as features, selections of products will be made by indicated party or, if not indicated, by

Engineer. Engineer will select options from the product line of submitted manufacturer if all other specified provisions are met.

.10 Specification Methods

.1 By Name: Products specified by one or more manufacturers, brand names or model numbers are included to describe operational characteristics, performance attributes, quality, serviceability, and other relevant characteristics.

.1 Other products having similar characteristics as determined by Engineer may be accepted under substitution procedures.

.2 By Description: Where Specifications describe a product, listing characteristics required, with or without use of a brand name, provide a product that has the specified attributes and otherwise complies with specified requirements as determined by Engineer.

.3 By Performance Requirements or Intent: Where Specifications require compliance with performance requirements, intent, or functionality, provide product(s) and/or assemblies that comply and are recommended by the manufacturer for the intended application. Verification of manufacturer's recommendations may be by product literature or by certification of performance from manufacturer.

.4 By Referenced Documents: Where Specifications require compliance with a referenced document including standards, provided product shall fully comply with the referenced document.

.5 By Combination of Methods: Where products are specified by a combination of attributes, including manufacturer's name, product brand name, product catalogue or identification number, industry standards, referenced documents, or description of product characteristics, provide products conforming to specified attributes.

.11 Products, Assemblies and/or Systems Assemblies Specified by Performance and/or Future Requirements: Where Specifications require compliance with performance or future requirements, including intent, functionality, or capability, select products and design assemblies and/or systems to meet specified requirements, provide and revise submittals to satisfaction of Engineer, and demonstate requirements met upon request to satisfaction of Engineer.

1.28 EXECUTION REQUIREMENTS

.1 Acceptance of Conditions

.1 Examine existing conditions, surfaces and substrata upon which Work depends.

.2 Drawings are diagrammatic and intended to convey scope of Work and indicate general and approximate location, arrangement and sizes of equipment and services including piping, ductwork, venting, and wiring.

.3 Obtain more accurate information about locations, arrangement and sizes from:

.1 Site inspection and measurement.

.2 Study and coordination of existing building drawings including base building drawings and supplemental project and renovation drawings, existing equipment and systems shop drawings, and manufacturers' literature.

.2 Means, Methods, Sequences, Techniques, and Procedures of Construction

.1 Engage a Professional Engineer under delegated design requirements to design and provide design documents on Work related to means, methods, sequences, techniques, and procedures of construction, including:

.1 Temporary structures including shoring, bracing, hoarding, underpinning, and scaffolding.

.2 Hoisting and rigging activities.

.3 Modifications or alterations to surfaces or structures, including doorways, walls, floors, ceilings, roofs.

.4 As required by regulation and Owner policies, including matters related to health and safety.

.3 Preparation

.1 Determine exact location and routes for Work including equipment and services.
.2 Relocation
  .1 Modify routing and/or relocate equipment and services as required.
  .2 Relocate existing equipment and services as required, including piping, ductwork, venting, electrical, controls, fire protection including sprinklers and detection.
.3 Demolition and Removal
  .1 Remove existing equipment and services as indicated.
  .2 Remove existing and obsolete equipment and services to satisfaction of Owner within affected areas including:
    .1 Equipment and services affected by Work, including interference and components modified by Work.
    .2 Equipment and services not affected by Work.
    .3 As indicated including markings on site.
  .3 Relocate existing equipment and services that interfere with Work.
  .4 Refrain from cutting by dismantling whenever possible. If cutting is required, submit Demolition Plan for review before cutting.
  .5 Create or enlarge openings in surfaces or structures, including doorways, walls, floors, ceilings, roofs, as required to permit installation of equipment and services, and reinstate as required.

.4 Hazardous Material Abatement: Remove hazardous materials as indicated.
.5 Transportation, Delivery and Handling
  .1 Comply with manufacturer's instructions and recommendations.
  .2 Provide all equipment and personnel as required.
  .3 Coordinate with Owner for delivery and acceptance.
  .4 Schedule delivery to minimize long-term storage and prevent overcrowding construction spaces. Coordinate with installation to ensure minimum holding time for items that are flammable, hazardous, easily damaged or sensitive to deterioration, theft and other losses.
.6 Storage
  .1 Provide temporary off site storage for products until ready for installation. Temporary on site storage is prohibited unless approved by Owner.
  .2 Store and protect products in accordance with manufacturers' instructions, with seals and labels intact and legible.
  .3 Store sensitive products in weather-tight enclosures or covered with an impervious sheet covering. Provide adequate ventilation, temperature and humidity control to avoid condensation, corrosion and damage due to temperature and humidity limits.
  .4 Periodically inspect storage areas to ensure that products are undamaged and are maintained under required conditions.
  .5 Products damaged by improper storage or protection shall be removed and replaced with new products at no change in Contract Price or Contract Time.
.7 Products, Assemblies and/or Systems Assemblies Specified by Performance and/or Future Requirements: Where Specifications require compliance with performance or future requirements, including intent, functionality, or capability, select products and design assemblies and/or systems to meet specified requirements, provide and revise submittals to satisfaction of Engineer, and demonstate requirements met upon request to satisfaction of Engineer.
.8 Installation of Products
  .1 Comply with manufacturer's instructions and recommendations for installation of products, except where more stringent requirements are specified, are necessary due to Work, or are required by authorities having jurisdiction.
  .2 Anchor each product securely in place, accurately located and aligned with other Work.
  .3 Clean exposed surfaces and provide protection to ensure freedom from damage and deterioration.

.4 Provide sufficient clearance for servicing and maintenance access.
.5 Protect installed products from damage during construction, including surface marring, vibration and dust. Provide protective wrappings as required.

.9 Cleaning
.1 Conduct cleaning operations as required, including Owner requirements, applicable laws, regulations, orders and ordinances, codes, standards, and practices, including waste management and environmental protection laws.
.2 Clean areas, equipment, fixtures, surfaces, and products affected by construction including:
.1 Parking areas, sidewalks, driveways and streets.
.2 Metal surfaces.
.3 Floor surfaces.
.4 Horizontal and vertical surfaces.
.5 Lighting fixtures.
.6 Glass and mirrors.
.7 Exterior grounds and gardens.
.8 Metalwork: Clean and buff metalwork to be free of soiling and fingerprints. Mirror finished metal work shall be buffed to high lustre.
.3 Building Exterior Cleaning: Clean surfaces in existing and adjacent buildings where construction activities have caused soiling and migration and accumulation of dust and debris.
.1 Wash down exterior surfaces to remove dust.
.2 Clean exterior surfaces of mud and other soiling.
.3 Clean exterior side of windows, including window framing.
.4 Ventilation System Cleaning: Replace filters and clean heating and ventilating equipment used for temporary heating, cooling and ventilation.
.5 Cleaning Frequency
.1 Minimum daily and more frequently as required for the following:
.1 Occupiable and visible areas.
.2 Minimum weekly and more frequently as required for remaining areas.
.6 Cleaning Agents and Materials
.1 Non hazardous to health or property.
.2 Use cleaning materials only on surfaces recommended by cleaning agent manufacturer.
.3 Use only those cleaning agents, materials and methods recommended by manufacturer of the material to be cleaned.
.7 Failure to Clean: Should cleaning by Contractor not be sufficient or acceptable to Owner, especially regarding paths of travel, Owner may engage cleaning service to perform cleaning and deduct costs for such cleaning from sums owed to Contractor.
.8 Contract Completion Review Cleaning: Execute a thorough cleaning prior to Contract Completion review. Complete final cleaning before submitting final Application for Payment.

.10 Reinstatement
.1 Reinstate systems and components that may have been modified or relocated due to Work to satisfaction of Owner and Engineer.
.2 In addition, reinstate the following areas and with indicated frequency:
.1 Minimum daily and more frequently as required for the following:
.1 Occupied and visible areas.
.2 As required for remaining areas to not interfere with building operations.

.11 Waste Removal
.1 Conduct disposal operations as required, including Owner requirements, applicable laws, regulations, orders and ordinances, codes, standards, practices, waste management laws, and environmental protection laws.

.2 Provide waste removal facilities and services as required to maintain the site and existing facilities in clean and orderly condition.
.3 Provide containers with lids. Dispose of waste off-site periodically.
.4 Open free-fall chutes are not permitted. Terminate closed chutes into appropriate containers with lids.

.12 Waste Management
.1 Separate and dispose of construction waste as required and in compliance with Owner requirements, applicable laws, regulations, orders and ordinances, codes, standards, and practices, including waste management and environmental protection laws.

.13 Inspections and Tests
.1 Inform Owner of required inspections, tests and reviews by authorities having jurisdiction and serving utilities, regardless if Owner solely has responsibility to communicate with authorities having jurisdiction and serving utilities over specific matters.
.1 Owner and Engineer may inform Contractor of same.
.2 Upon approval from Owner, arrange for inspections, tests and reviews, and coordinate dates and times acceptable to Owner and Engineer.
.3 Participate in and be present during inspections, tests and reviews, as well as additional follow-up inspections, tests and reviews.

1.29 FINAL COMPLETION SUBMITTALS

.1 Provide Project Record Drawings.
.1 Mark prints of drawings to show the actual installation where installation varies from that shown originally.
.2 Provide complete details on concealed elements that cannot be readily identified and recorded later, including layouts, schematics, products, components, installation methods.
.3 Mark record sets with erasable, red-coloured pencil. Use other colors to distinguish between changes for different categories of Work at the same location.
.4 Identify and date each Record Drawing, including the designation "PROJECT RECORD DRAWING" in a prominent location. Organize into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.

.2 Project Binders: Provide binders formats and types as follows.
.1 Binder Format: Provide bound and indexed binder volume sets and formats as follows:
.1 Each binder type and copy of each binder within a single binder, unless otherwise accepted by Engineer or Owner.
.2 Thickness as necessary to accommodate contents and ensure ease of use.
.3 Matching heavy duty, 3-ring loose-leaf binders, having clear vinyl pouch on front and spine for title page and spine index insertion.
.4 Front cover and spine indexed, formatted and containing content including binder volume number, client project number, project name, date of substantial completion, site name, site address, and client site ID number.
.5 Plastic sheet lifter to facilitate page turning.
.6 Table of contents located on front page, laminated with reinforced holes, and including contents of multiple binder volume set.
.7 Section dividers.
.8 Paper format of contents.
.9 Electronic format of contents, contained in a sleeved inside each binder type, in both DVD(s) and USB flash drive(s).
.2 Binder Type - Project Record Manual
.1 Contract: Contract documents, including signed contracts, bonding and insurance documentation.
.2 Drawings: Including various issued drawings sets for tender, permits, changes, scans of marked-up sets for as-builts, as-builts.

.3 Specifications
.4 Meetings: Meeting agendas, minutes, memos, and communications.
.5 Submittals: Contract submittal information including submittals and reviews.
.6 Instructions and Clarifications: Contract instruction supplements including clarification information.
.7 Changes: Contract change documentation including notices, proposals, reviews, orders, directives.
.8 Notices: Contract notices in writing, written statements.
.9 Site Reviews: Site reviews, reports, deficiency lists, observation lists.
.10 Payments: Contract payment documentation including certification, reviews.
.11 Permits: Application documents and approvals for permits, certificates, licenses, testing and inspections required including regulatory.
.12 Certificates: Other documents including certificates demonstrating compliance with requirements including regulatory.
.13 Guaranties and Warranties: Contract and overall project.
.14 Lien Documentation

.3 Binder Type - Operating and Maintenance Manual
.1 Products
.1 Submittals: Products selected and options, shop drawings.
.2 Product Data: Manufacturer's information on products, submittals, installation manuals, operation manuals, warranties.
.3 Maintenance Data: Manufacturer's information, list of spare parts, maintenance procedures, maintenance and service schedules for preventive and routine maintenance
.4 Operating Data: Emergency instructions and procedures, system and equipment descriptions, operating procedures, health and safety information, troubleshooting procedures, and sequence of operations.
.5 Maintenance contracts.
.2 Systems
.1 Submittals: System related submittals and documents, including shop drawings, schematics, layouts, diagrams.
.2 Tests: Balancing, measurements and testing data and reports.
.3 Commissioning: Data and reports.
.4 Other submittals as required.
.5 Maintenance contracts.

.4 Binder Type - Training Manual
.1 Software user manuals.
.2 Software training manuals.
.3 Training documentation, presentation slides, and other training related documentation.
.4 Sleeve containing DVD(s) of training videos, tutorial software, and other media related to training.

.3 Provide other closeout items including:
.1 Spare parts and materials.
.2 Software and license codes.
.3 Tools.
.4 Keys.

.4 Acceptance Procedures and Final Copies
.1 Prior to Substantial Performance application, complete and submit 1 copy each to Engineer, Owner, and Commissioning Authority for review and acceptance.
.2 Acceptance Criteria
.1 To the more stringent of the following, including quality, content, and format:

.1 ASHRAE-G-4: ASHRAE-G-4-2008 (RA 2013) Preparation of Operating and Maintenance Documentation for Building Systems.
.2 Additional requirements indicated in commissioning requirements.
.3 Create, add or modify and resubmit as required, including quality, content, and format.
.4 Upon written acceptance, provide 3 final copies in addition to electronic formats.

1.30 TRAINING REQUIREMENTS

.1 Provide sufficient training to deliver a thorough understanding of operation and maintenance of all systems, equipment, and components and their interrelationship with other systems.
.2 Provide training on the following systems and equipment:
.1 Systems, equipment, components and services.
.2 Control systems.
.3 Equipment and components requiring control.
.4 Systems, equipment and components requiring manufacturer's start-up activites.
.5 Fluid treatment and filling.
.3 General Training
.1 Provide the following training sessions on indicated training topics.
.2 General Structure
.1 Classroom based training at Owner's preferred location on site, unless otherwise indicated.
.2 Walk through of facility areas and rooms to identify locations of equipment and components, familiarization of systems and equipment.
.3 Training documentation, including presentation slides, tutorial software, and other media related to training.
.4 Hands-on demonstrations with attendee involvement.
.5 Questions and answers period.
.6 Additional requirements as indicated in commissioning requirements.
.3 Quantities
.1 Provide training sessions as indicated below each for up to 8 attendees excluding instructors.
.2 Provide 4 half day training session(s) after major construction has been completed and before Substantial Performance.
.3 Provide 1 additional half day training session(s) 6 months following Substantial Performance.
.4 Provide 1 additional half day training session(s) after above but before end of warranty period and scheduled to capture seasonal operational variance due to weather and/or operations.
.4 Topics: Include the following training topics on indicated systems and equipment:
.1 Overview and Description
.1 Design intent.
.2 System capabilities, modes of operation, and limitations.
.3 System sequences of operation for all modes of operation.
.4 Acceptable tolerances for system adjustments in all operating modes.
.2 Operations and Documentation
.1 Overview and use of documentation including product literature and operating manuals.
.2 Overview of independent controllers including programming, sequences, settings, troubleshooting, alarms, manual overrides, interfaces.
.3 Overview of digital controllers including programming, sequences, settings, troubleshooting, alarms, manual overrides, interfaces.
.4 Overview of controllers interfacing with other controllers, including digital, independent, equipment.

.5 Procedures for abnormal and emergency operating situations, including during power outage and fire.
.6 Procedures for conservation operating modes and strategies including utilities, energy, demand.
.7 Health and safety issues, concerns, personal protective gear, and special safety features.
.8 Recommended site informative documentation, including labels, posted instructions, posted documents, safety signage.

.3 Maintenance and Materials
.1 Overview and use of maintenance manuals.
.2 Troubleshooting procedures.
.3 Service, maintenance, and preventive maintenance requirements including scheduling, frequency and administrative procedures.
.4 Review of spare parts inventory, special tool use, and service contacts.
.5 Health and safety issues, concerns, personal protective gear, and special safety features.

.4 Training Providers
.1 Personnel Qualifications
.1 Experienced and skilled in training to target audience including:
.1 Owner representatives.
.2 Facility managers.
.3 Project managers.
.4 Operations staff.
.5 Tenant/occupant representatives.
.6 Service and maintenance staff.
.2 Experienced and skilled in training with a wide variety of topics including:
.1 Installation.
.2 Start-up.
.3 Troubleshooting.
.4 Service and maintenance.
.5 Emergency operations.
.3 Full time employees on the staff of the listed training provider types.
.2 Training Provider Types
.1 Manufacturer: The product manufacturer.
.2 Manufacturer's Representative: The product manufacturer's local authorized product representative for product sales and service.
.3 Manufacturer's Start-up: The product manufacturer's local authorized start-up and troubleshooting for product.
.4 Installer: The installer of products and systems on this project.
.5 Service Company: The company providing service for the installed products and systems.
.3 Specific Training Providers: Use the following approved service providers for applicable training activities:
.1 Ventilation Equipment: Manufacturer and manufacturer's start-up.
.2 Building Automation Systems: Manufacturer and manufacturer's start-up and service company.
.3 Fire Protection System: Owner's fire protection service company(s).
.4 Fluid Treatment: Owner's fluid treatment service company(s).
.5 Other: Manufacturer's representatives and manufacturer's start-up for systems, equipment and components requiring manufacturer's start-up services.
.4 Personnel Coordination

.1 Controls Interfacing: All training providers and personnel to be present when training is occurring for controllers that are interfacing with other controllers, including digital, independent, equipment.

.5 Alternate providers will not be accepted.

.5 Training Plan

.1 Prepare and submit training plan including the following:

.1 Schedule, location, duration, instructor names and qualifications, and detailed itinerary of training topics to be covered.

.2 Copies of training documentation to be provided.

.2 No later than 4 weeks prior to Substantial Performance, complete and submit details of training plan for review and acceptance.

.3 Create, add or modify training plan and resubmit as required.

.4 Upon acceptance, coordinate, arrange, and deliver training in accordance with accepted plan.

.6 Signage

.1 After training sessions, meet with site Occupational Health and Safety Committee to review and agree on additional signage requirements for site. Owner will provide additional signage.

1.31 CORRECTION PERIOD

.1 Correction Period: 12-month period starting at date of Total Performance of Work.

.2 Contractor agrees to pay for and promptly correct any defects, deficiencies or omissions that appear prior to and during the Correction Period, or such longer periods as may be specified for certain products or systems.

.3 Contractor warrants that Work, including all products and components thereof, shall conform to the Specifications and Drawings, set out in Contract Documents, in all respects and shall be new, or good quality material, of merchantable quality and fit for their intended purpose, as described and specified in Contract Documents and free of defects in materials and workmanship for Correction Period. Contractor shall extend the warranty on replaced parts and workmanship for a period of 12-months from date of acceptance of the replacement parts and/or workmanship.

.4 This warranty shall cover labour and material, including, without limitation, the costs of removal and replacement of covering materials. This warranty shall not limit extended warranties on any items of equipment or material called for elsewhere in the Specifications and Drawings or otherwise provided by any manufacturer of such equipment or material.

END OF SECTION 01 00 00

SECTION 01 99 00 COMMISSIONING

PART 1 GENERAL

1.1 REFERENCED DOCUMENTS

.1 ASHRAE-111: ASHRAE-111-2008 Practices for Measurement, Testing, Adjusting, and Balancing of Building Heating, Ventilating, Air-Conditioning, and Refrigeration Systems.
.2 NEBB-TABES: NEBB Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems, 2005.
.3 CXP: Commissioning Plan.

1.2 SUMMARY

.1 Contractor is responsible for performance and administration of commissioning activities.
.2 Commissioning is additional to activities indicated including start-up, quality control, quality assurance, testing and balancing.

1.3 COMMISSIONING AUTHORITY

.1 The following firm will be performing the duties of the Commissioning Authority:
  .1 Building Innovation Inc.
  .2 750 Oakdale Road, Unit 54
  .3 Toronto, Ontario M3N 2Z4
  .4 (416) 748-6222

1.4 INTENT

.1 CXP shall be revised throughout the project. As more detailed information becomes available, the CXP appendices will be populated with draft version documents for review by commissioning parties.
.2 Commissioning activities shall be revised as required throughout the project.
.3 Commissioning responsibilities include:
  .1 Attend commissioning meetings.
  .2 Coordinate participation of subcontractors, manufacturer's representatives, third party testing agencies, as required.
  .3 Provide feedback on commissioning plan including checklists, performance verification activities, and schedule.
  .4 Complete start-up and checklists and follow start-up notification, coordination, and related procedures.
  .5 Integrate commissioning notification periods and testing into construction schedule.
  .6 Review and comment on performance verification activities.
  .7 Provide test equipment, technical support, and reporting as required to perform performance verification activities.
  .8 Perform performance verification activities.
  .9 Perform post-construction performance verification activities as required.
  .10 Respond to commissioning issues, and correct items deemed to be deficiencies.
.4 Request clarification on unclear procedures or reporting requirements.
.5 Update and submit work schedule to include commissioning requirements. Revise schedule as required.

1.5 NOTICE

.1 Provide a minimum of 2-weeks notice of activities requiring third party involvement, unless otherwise indicated.
.2 Delays with required commissioning parties shall not be grounds for changes to Contract Time, including insufficient notification or coordination.

1.6 COMMISSIONING ACTIVITIES

.1 Provide sufficient time from qualified and knowledgeable personnel to assist with commissioning activities performed by others.

.1 Time described above is separate and in addition to time allocated for any other activities such as construction, start-up, verification, troubleshooting, deficiency correction.
.2 Quantities
.1 Provide 4 full day commissioning sessions on site after construction has been completed.
.2 If deficiencies are discovered that prevent successful completion of commissioning activities as planned, provide same quantity of commissioning sessions again at a later date that is acceptable to Owner and Commissioning Authority.
.3 Commissioning Providers
.1 The following commissioning providers to attend for the full duration of all indicated commissioning activities:
.1 Contractor.
.2 Representative of BAS contractor most familiar with the project.
.3 Representative of BAS contractor most qualified to provide technical assistance with BAS products and configuration, whether or not this is the same or a separate individual.

1.7 SUBMITTALS FOR ACTION

.1 Commissioning Implementation Plan
.1 Schedule for commissioning activities, including chronological sequence of activities.
.2 List of participants for each activity.
.3 Details of roles and responsibilities for each participant.
.4 List of materials, test equipment, configurations, required to perform commissioning activities, including who is responsible for providing those items.
.5 Details of load states, weather conditions, or other parameters required to perform commissioning activities, including how schedule will be adjusted if such conditions are not present.
.6 List of actions required by Owner, Contractor, or by others, in advance of commissioning in order to facilitate commissioning activities.
.7 Details of commissioning activities that may impact building systems or building operation. Provide plan for how commissioning activities can be completed in accordance with Contract Documents and Owner requirements.

1.8 ADMINISTRATIVE REQUIREMENTS

.1 Commissioning Implementation Review Meeting
.1 Schedule and conduct commissioning implementation review meeting as required. Adhere to project meeting procedures as described in Section 01 00 00 Project Procedures.
.2 Review Commissioning Implementation Plan.

PART 2 PRODUCTS

2.1 TEST EQUIPMENT

.1 Provide test equipment as required to complete performance verification activity requirements as indicated.
.2 To ASHRAE-111.
.3 Accuracy Tolerances: Provide test instruments with scale ranges, accuracies, and resolutions to NEBB-TABES minimum requirements unless otherwise specified.
.4 Calibration: Calibrate instruments within 6 months of tests.

PART 3 EXECUTION

3.1 GENERAL

.1 Perform commissioning activities as indicated.
.2 Respond to commissioning issues in a timely manner.
.3 Complete commissioning forms, including checklists and performance verification.

3.2 INSTALLATION AND START-UP

.1 Perform installation and start-up to CXP.
.2 In the event that installation and start-up activities were not be properly completed, Contractor is responsible for repeating such activities to the satisfaction of project stakeholders.

3.3 WITNESSED TESTS AND DEMONSTRATIONS

.1 Coordinate and schedule demonstrations and tests requiring witnessing to CXP.
.2 In the event that insufficient notice is given, or tests are completed without witnessing, Contractor is responsible for repeating such tests or samples of such tests to the satisfaction of project stakeholders.

3.4 PERFORMANCE VERIFICATION ACTIVITIES

.1 Review and comment on performance verification activities.
.2 Provide test equipment, subcontractors, manufacturers' representatives, and qualified staff as required to complete performance verification activities.
  .1 Planned duration of performance verification activities to be not less than 8 hours per day for the number of days indicated.
.3 In the event performance verification activities reveal deficiencies, Contractor will correct deficiencies, reschedule tests, and repeat tests to the satisfaction of project stakeholders.
.4 Perform post-construction seasonal performance verification activities as required.
.5 Performance verification activities include:
  .1 Minimum turndown tests.
  .2 Maximum load/capacity tests.
  .3 Noise tests.
  .4 Equipment performance measurement (flow, temperature, efficiency).
  .5 Equipment staging observation and tests.
  .6 General operation and performance observations and tests.
  .7 Equipment and component failure and limits mode tests.
  .8 Control systems performance reviews.
  .9 Data log reviews.
  .10 Failovers.
  .11 Communications systems.
.6 Schedule for performance verification activities to be completed over a duration of 3 consecutive working days in each season requiring performance verification activities.
.7 Seasonal performance verification activities shall be scheduled during peak loading conditions, and shall include:
  .1 Maximum load/capacity test.
  .2 Noise tests.
  .3 Equipment performance measurement (power measurements, flow measurements, temperature measurements).
  .4 Equipment staging observation and tests.
  .5 General operation and performance observations and tests.
  .6 Equipment and component failure and limits mode tests.

3.5 SERVICE PROVIDERS

.1 Use any the following approved service providers for all applicable commissioning activities:
  .1 For control systems: To installer requirements of Section 25 05 00 Building Automation System.
.2 Alternate installers will not be accepted.

3.6 TRAINING AND DOCUMENTATION

.1 Provide training and documentation:
  .1 As indicated in Section 01 00 00 Project Procedures.
  .2 To CXP.

END OF SECTION 01 99 00

SECTION 03 30 00 CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.1 SECTION INCLUDES

.1 Cast-in-place concrete including housekeeping pads.
.2 Relationship to other Sections:
  .1 Various Sections describe additional installation requirements for pads installed under this Section, including:
    .1 Section 15 00 00 Mechanical Equipment
    .2 Section 26 00 00 Electrical Equipment

1.2 REFERENCED DOCUMENTS

.1 CSA-A23.1/A23.2: CAN/CSA-A23.1-09/A23.2-09 Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.
.2 CSA-A3001: CSA-A3001-13 Cementitious Materials for Use in Concrete.
.3 CSA-G30.18: CSA-G30.18-09 Carbon Steel Bars for Concrete Reinforcement.

1.3 SUBMITTALS FOR ACTION

.1 Shop Drawings
  .1 Layout and Interference Plans: Isometric sketches indicating clearances, interferences, and relocation of interfering services, components, objects, and structures including:
    .1 Floor drain locations and services.
  .2 Mounting: Drawings for equipment mounting, including:
    .1 Pad dimensions and construction.
    .2 Surface preparation.
    .3 Maximum load at point loads.
    .4 Details of supplementary framing and reinforcement including bar reinforcements and dowels.

1.4 SUBMITTALS FOR CLOSEOUT

.1 Certificates
  .1 Letter from Contractor certifying the following meets requirements:
    .1 Concrete mix and curing.
    .2 Surface preparation.
    .3 Reinforcement.

PART 2 PRODUCTS

2.1 COMMON PRODUCT REQUIREMENTS

.1 Concrete to CSA-A23.1/A23.2.

2.2 CONCRETE

.1 Provide as required.
.2 Type
  .1 Cement: To CAN/CSA-A3001, general use type, pre-mixed.
  .2 Water: To CSA-A23.1/A23.2.
  .3 Colour: Match existing pads or as approved by Owner.
  .4 Finish: Steel trowel finish surface.
.3 Performance
  .1 Strength: Minimum 35-MPa compressive strength at 28-days.
  .2 Slump: 70-mm +/-20-mm (2.75-in +/- 0.75-in)
  .3 Air Content: 5-% to 8-%
.4 Unacceptable: Site mixed concrete.

2.3 REINFORCEMENT AND CONNECTORS

.1 Bar Reinforcements
  .1 Provide as required.
  .2 Type

.1 To CSA-G30.18.

.2 Dowels
- .1 Provide as required.
- .2 Manufacturers: Hilti Corp., HIT Anchor System
- .3 Type: Reinforcing dowel.
- .4 Materials: Epoxy
- .5 Size
  - .1 As indicated.
  - .2 10-mm (0.375-in) where not indicated.

PART 3 EXECUTION

3.1 EXAMINATION

.1 Complete final measurement of equipment and pad sizes. Ensure pads are sized and extended beyond equipment as indicated.

.2 Identify services that require relocation, including floor drains.

3.2 PREPARATION

.1 Demolition and Removal
- .1 Remove existing concrete including housekeeping pads as required, including from demolished equipment and components where pads are not indicated for reuse.
- .2 Repair surfaces to match existing after removal, including slope.

.2 Surfaces Preparation
- .1 Prepare surfaces as required.
- .2 Roughen surfaces by hammering with a bush hammer, bush chisel or light chipping gun as required.
- .3 Clean surfaces, including remove dirt, dust, debris.

.3 Bracing: Provide sufficient bracing and shoring during construction.

3.3 CONCRETE PADS

.1 Provide as indicated for new concrete pads and existing concrete pads extensions.

.2 Dimensions: Extend pads beyond equipment:
- .1 As indicated.
- .2 Where not indicated, minimum 75-mm (3-in) beyond equipment footprint.

.3 Reinforcement: Provide reinforcement including bar reinforcements as required.

.4 Pad Extensions
- .1 Reinforcement
  - .1 Provide reinforcement including dowels to join pad extensions to existing pads.
  - .2 Drill dowel holes into existing pad as required with minimum 100-mm (4-in) depth.
  - .3 Space dowels as required with minimum 500-mm (20-in) centres across width.

.5 Joining: Apply bonding agent to interface between new and existing concrete.

.6 Forming: Chamfer pad edges.

.7 Curing: Wet cure concrete with 2 layers of pre-soaked burlap using potable water only for soaking, and covered in polyethylene sheeting. Keep burlap wet for 3-days for curing.

.8 Finishing: Seal and paint pads to Section 09 91 00 Painting no earlier than 10-days after curing has been completed. Match existing finishes or as approved by Owner.

END OF SECTION 03 30 00

SECTION 05 10 00 STRUCTURAL METAL

PART 1 GENERAL

1.1 SECTION INCLUDES

.1 Structural metal and related hardware for field fabricated and mounted systems and assemblies, including beams and frames, supports around openings, platforms, railings, lifting lugs and beams, and other supports and hangers for equipment, systems and components.

.2 Section does not include pre-engineered manufactured systems and assemblies.

1.2 REFERENCED DOCUMENTS

.1 ASTM-A123: ASTM-A123/A123M-08 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

.2 ASTM-A123: ASTM-A123/A123M-13 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

.3 ASTM-A153: ASTM-A153/A153M-09 Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

.4 ASTM-A325: ASTM-A325M-13 Standard Specification for Structural Bolts, Steel, Heat Treated 830 MPa Minimum Tensile Strength.

.5 CGSB-85.10: CAN/CGSB-85.10-99 Protective Coatings for Metals.

.6 CGSB-85.100: CAN/CGSB-85.100-93 Painting.

.7 CSA-G40.20/21: CSA-G40.20-13/G40.21-13 General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.

.8 CSA-S16: CAN/CSA-S16-09 Design of Steel Structures.

.9 CSA-W47.1: CSA-W47.1-09 Certification of Companies for Fusion Welding of Steel.

.10 CSA-W48: CSA-W48-14 Filler Metals and Allied Materials for Metal Arc Welding.

.11 CSA-W59: CSA-W59-13 Welded Steel Construction (Metal Arc Welding).

1.3 SUBMITTALS FOR ACTION

.1 Shop Drawings

- .1 Layout and Interference Plans: Scaled drawings indicating clearances, interferences, and relocation of interfering services, components, objects, and structures.
- .2 Mounting: Drawings for equipment mounting including:
  - .1 Dimensions and construction for beams, frames, supports, curbs.
  - .2 Maximum load at point loads.
  - .3 Details of supplementary structural steel framing members.
  - .4 Details of joining including welding and fasteners.
- .3 Support: Structural steel and related hardware for systems including platforms, supports around openings, lifting lugs and beams, and other supports and hangers for equipment, systems and components.

1.4 SUBMITTALS FOR INFORMATION

.1 Delegated Design Submittals

- .1 Design and design documents completed by a Professional Engineer for the following:
  - .1 Structure and modifications as installed does not exceed structural limits and requirements, including seismic provisions of local building code. Engineered drawings and record drawings of existing installation may not be available or may not exist including design drawings, shop drawings.
  - .2 Mounting of equipment, services and components as installed does not exceed structural limits of structure, including seismic provisions of local building code. Engineered drawings and record drawings of existing installation may not be available or may not exist including design drawings, shop drawings.
  - .3 Mounting systems and components are suitable for application and requirements, including seismic provisions of local building code.

.4 Mounting components and restraints are suitable for application and requirements, including seismic provisions of local building code.
.5 Railings and barriers. Engineered drawings and record drawings of existing installation may not be available or may not exist including design drawings, shop drawings.

.2 Qualification Statements
.1 Welding: Proof of certifications for company and personnel.
.2 Professional Engineering: Proof of licences for company and personnel.

1.5 SUBMITTALS FOR CLOSEOUT

.1 Certificates
.1 Letter certifying the following meets requirements:
.1 Welded connections.
.2 Torque applied to bolt tightening.
.3 Grouting of drilled inserts.

1.6 QUALITY ASSURANCE

.1 Qualifications
.1 Welding: Company certified to CSA-W47.1 by CWB.
.2 Professional Engineering
.1 Company and personnel licensed to practice Professional Engineering by PEO.
.2 Subject to approval.

1.7 WARRANTY

.1 Extended Correction Period and Warranty Period
.1 2-years.

PART 2 PRODUCTS

2.1 COMMON PRODUCT REQUIREMENTS

.1 Materials
.1 To CSA-G40.20/21.
.2 As required.

2.2 BEAMS

.1 Provide as required.

2.3 SUPPORT CHANNELS

.1 Provide as required.

2.4 LINTELS

.1 Provide as required.

2.5 BOLTS AND NUTS

.1 Provide as required.
.2 Materials: Stainless steel.
.3 Bolts
.1 To ASTM-A325 and CSA-S16.
.2 Identifiable with head markings.

2.6 ANCHORS

.1 Provide as required.
.2 Manufacturers: Hilti Corp., HY 150
.3 Type: For use with epoxy grout.

2.7 GROUT

.1 Provide as required.
.2 Manufacturers: Sika Canada Inc., Sikagrout 22
.3 Materials: Epoxy

2.8 PAINT

.1 Provide as required.
.2 Type
.1 Zinc Rich Paint
.1 To CGSB-85.10 and CGSB-85.100.
.2 Manufacturers: Fosroc International Limited, Galvafroid
.2 As required where not indicated.

PART 3 EXECUTION

3.1 PREPARATION

.1 Protection: As required.
.2 Bracing: Provide sufficient bracing during demolition, removal, and construction.

3.2 NOTIFICATION

.1 Notify Engineer of schedule and duration of the following work by minimum 2-days in advance before starting Work:
.1 Welded connections.
.2 Torque applied to bolt tightening.
.3 Grouting of drilled inserts.

3.3 COMMON EXECUTION REQUIREMENTS

.1 Welding
.1 To CSA-W59.
.2 Filler metals and allied materials to CSA-W48.
.3 Prepare galvanized components before welding by scraping off galvanizing prior to welding.
.2 Coating: Hot-dip galvanize iron and steel components to ASTM-A123 and ASTM-A153.
.3 Roof Mounted Equipment: Structurally tie supports into building structure.

3.4 BEAMS

.1 Install as required.
.1 Unacceptable: Field drilling of bolt holes.

3.5 DRILLED INSERTS

.1 Provide as required.
.2 Blow out holes to remove dust and debris from drill hole prior to grouting.
.3 Grout to fill in voids as required.
.4 Tighten structural bolts with torque wrench.

3.6 BOLTS AND NUTS

.1 Install as required.

3.7 ANCHORS

.1 Install as required.

3.8 GROUT

.1 Install as required.

3.9 FINISHING

.1 Paint components to Section 09 91 00 Painting.
.1 Prepare and finish paint components before installation.
.2 Prepare surfaces.
.3 Prime paint field welds with zinc rich paint.
.4 Prime paint structural members, excluding stainless steel materials and galvanized components.
.5 Touch-up damaged or marked areas with zinc rich paint before finish painting.
.6 Finish paint structural members.

END OF SECTION 05 10 00

SECTION 07 52 00 ROOFING

PART 1 GENERAL

1.1 SECTION INCLUDES

.1 Roofing and waterproofing through and at roofing, including penetrations, structural supports.

1.2 SUBMITTALS FOR ACTION

.1 Product Data
  .1 Manufacturers' product literature, specifications, and datasheets. Include product characteristics, performance criteria, options, and limitations.

.2 Shop Drawings
  .1 Layout and Interference Plans: Scaled drawings indicating clearances, interferences, and relocation of interfering services, components, objects, and structures.

1.3 SUBMITTALS FOR INFORMATION

.1 Delegated Design Submittals
  .1 Design and design documents completed by a Professional Engineer for the following:
    .1 Design of roofing and waterproofing modifications including roofing, decking, insulation, flashing, sealing.

.2 Qualification Statements
  .1 Professional Engineering: Proof of licences for company and personnel.

1.4 QUALITY ASSURANCE

.1 Qualifications
  .1 Roofing: Company member of CRCA and OIRCA.
  .2 Professional Engineering
    .1 Company and personnel licensed to practice Professional Engineering by PEO.
    .2 Subject to approval.

PART 2 PRODUCTS

2.1 COMMON PRODUCT REQUIREMENTS

.1 Materials
  .1 As required.
  .2 Match existing.

2.2 VAPOUR RETARDER

.1 Provide as required.

2.3 INSULATION

.1 Provide as required.

2.4 INSULATION ADHESIVE

.1 Provide as required.

2.5 MEMBRANE FLASHINGS

.1 Provide as required.

2.6 PITCH POCKETS

.1 Provide as required.

2.7 PITCH POCKET SEALANTS

.1 Provide as required.

2.8 CONES

.1 Provide as required.

2.9 SLEEVES

.1 Provide as required.

2.10 SEALANTS AROUND SERVICES

.1 Provide as required.

PART 3 EXECUTION

3.1 COMMON EXECUTION REQUIREMENTS

.1 Install as required.

3.2 VAPOUR RETARDER

.1 Install as required.

3.3 INSULATION

.1 Install as required.

3.4 INSULATION ADHESIVE

.1 Install as required.

3.5 MEMBRANE FLASHINGS

.1 Install as required.

.2 Performance

.1 Membrane fully adhered, with no deviations including air pockets, wrinkles, fish-mouths or tears.

3.6 PITCH POCKETS

.1 Install as required.

3.7 PITCH POCKET SEALANTS

.1 Fill pitch pockets completely with pourable sealant.

3.8 CONES

.1 Install as required.

3.9 SLEEVES

.1 Install as required.

3.10 SEALANTS AROUND SERVICES

.1 Completely seal around services.

3.11 SUPPORTS

.1 Install as required.

END OF SECTION 07 52 00

SECTION 07 92 00 JOINT SEALANTS

PART 1 GENERAL

1.1 SECTION INCLUDES

.1 Sealants, related products and accessories.

1.2 REFERENCED DOCUMENTS

.1 ASTM-C1193: ASTM-C1193-13 Standard Guide for Use of Joint Sealants.
.2 ASTM-C1472: ASTM-C1472-10 Standard Guide for Calculating Movement and Other Effects When Establishing Sealant Joint Width.
.3 ASTM-C1520: ASTM-C1520-02 (R2010) Standard Guide for Paintability of Latex Sealants.
.4 ASTM-D2240: ASTM-D2240-05 (R2010) Standard Test Method for Rubber Property - Durometer Hardness.
.5 CGSB-19.1: CAN/CGSB-19.1-M87 Putty, Linseed Oil Type.

1.3 DEFINITIONS

1.4 SUBMITTALS FOR ACTION

.1 Product Data
  .1 Manufacturer's printed product literature, specifications, and datasheets, including product characteristics, materials, finish, dimensions, clearances, performance criteria, certifications, options, and limitations.
  .2 Include the following additional information:
    .1 Colour matching methods and techniques.
    .2 Compatibility between products, including different sealants in contact with each other, primers, cleaners.
.2 Shop Drawings
  .1 Layout Plan: Lists indicating affected services, components, objects, and structures
.3 Samples
  .1 Sample sealants product for each type and colour.
  .2 Sample cured sealants for each type and colour where colour matching to existing or adjacent material is required.
  .3 Maintain approved samples on site to serve as standard of quality for appropriate on-site assembly.

1.5 SUBMITTALS FOR CLOSEOUT

.1 Spare Parts
  .1 1 spare sealant container of each type and colour.

1.6 QUALITY ASSURANCE

.1 Representative Area
  .1 Install sealants complete with backer materials and primers on representative areas to capture each type or colour for approval by Owner before commencing with full installation.

1.7 DELIVERY, STORAGE AND HANDLING

.1 Delivery and Acceptance Requirements
  .1 Deliver and store materials in original new containers, sealed, with labels intact.
  .2 Remove damaged, opened, and rejected materials from site.
.2 Storage and Handling Requirements
  .1 Provide and maintain dry, temperature controlled, ventilated, secure storage.
.3 Waste Management and Disposal
  .1 Place materials defined as hazardous or toxic waste, including used sealant and adhesive tubes and containers, in containers or areas designated for hazardous waste.

PART 2 PRODUCTS

2.1 COMMON PRODUCT REQUIREMENTS

.1 Application
  .1 To ASTM-C1193.
  .2 To ASTM-C1472.
  .3 To ASTM-C1520.
.2 Materials
  .1 Avoid using sealants that emit strong odours, contains toxic chemicals or is not certified as mould resistant in air handling units.
  .2 When low toxicity products are not possible, confine usage to areas that:
    .1 Offgas to exterior.
    .2 Are contained behind air barriers.
    .3 Are applied several months before occupancy to maximize offgas time.
  .3 Where sealants are qualified with primers, use only these primers.
.3 Colours
  .1 Match existing where not indicated, otherwise as indicated, otherwise as required by Owner.

2.2 BACKER MATERIALS

.1 Provide as required.
.2 Compressible Backer Rod
  .1 Materials
    .1 Extruded closed cell foam.
    .2 Polyethylene, urethane, neoprene or vinyl.
  .2 Shape: Preformed.
  .3 Size: Oversize 30-% compared to opening.
.3 Non-Compressible Backer Rod
  .1 Materials: Neoprene or butyl rubber.
  .2 Shape: Round solid rod.
  .3 Hardness: Shore hardness measurement of 70 durometer to ASTM-D2240 Type A scale.
.4 Compressible Foam Backer
  .1 Materials
    .1 High density foam.
    .2 Extruded closed cell polyvinyl chloride (PVC) or extruded closed cell polyethylene.
      .1 Hardness: Shore hardness measurement of 20 durometer to ASTM-D2240 Type A scale.
      .2 Tensile Strength: 140-kPa to 200-kPa (20-psi to 29-psi).
    .3 Extruded polyolefin.
      .1 Density: 32-kg/m3 (2-lb/ft3).
    .4 Neoprene.
  .2 Shape: Preformed.
  .3 Size: As recommended by manufacturer.
.5 Bond Breaker Tape
  .1 Materials
    .1 Polyethylene.
    .2 Will not bond to sealant.

2.3 JOINT CLEANERS

.1 Provide as required.
.2 Cleaners: Non-corrosive and non-staining type, compatible with joint forming materials and sealant as recommended by sealant manufacturer.
.3 Primer: As recommended by sealant manufacturer.

2.4 SEALANTS

.1 Provide as required.

2.5 OTHER ACCESSORY PRODUCTS

.1 Provide as required.

PART 3 EXECUTION

3.1 EXAMINATION

.1 Examine joint sizes and conditions to establish correct depth to width relationship for installation of backup materials and sealants.

3.2 PREPARATION

.1 Prepare surfaces for adhesion to sealants, including cleaning bonding joint surfaces of matter and substances to ensure quality of Work, including dust, rust, oil grease.
.2 Do not apply sealants to joint surfaces treated with coatings, including sealer, curing compound, water repellent, unless tests have been performed to ensure compatibility of materials. Remove coatings as required.
.3 Ensure joint surfaces are dry and frost free.
.4 Mask adjacent surfaces prior to priming and sealing as required including to prevent staining.
.5 Mask edges of joint where irregular surface or sensitive joint border exists to provide neat joint.

3.3 COMMON EXECUTION REQUIREMENTS

.1 Mixing: Mix materials to manufacturer's instructions.

3.4 BACKER MATERIALS

.1 Install as required.
.2 Install joint filler to achieve correct joint depth and shape within required compression.
.3 Bond Breaker Tape: Apply where required to manufacturer's instructions.

3.5 JOINT CLEANERS

.1 Priming: Prime sides of joints to sealant manufacturer's instructions immediately prior to sealing.

3.6 SEALANTS

.1 Installed as required.
.2 Application
  .1 Apply sealant in continuous beads.
  .2 Apply sealant using gun with proper size nozzle.
  .3 Use sufficient pressure to fill voids and joints solid.
  .4 Form surface of sealant with full bead, with consistent and smooth application and finish, including free from ridges, wrinkles, sags, air pockets, embedded impurities.
.3 Finishing
  .1 Tool exposed surfaces before skinning begins to give slightly concave shape.
  .2 Remove excess compound promptly as work progresses and upon completion.
.4 Curing
  .1 Cure sealants to sealant manufacturer's instructions.
  .2 Do not cover up sealants until proper curing has taken place.

3.7 OTHER ACCESSORY PRODUCTS

.1 Install as required.

3.8 CLEANING

.1 Clean as required.
.2 Clean adjacent surfaces immediately and leave Work neat and clean.
.3 Remove excess and droppings, using recommended cleaners as work progresses.
.4 Remove masking tape after initial set of sealant.

END OF SECTION 07 92 00

SECTION 09 91 00 PAINTING

PART 1 GENERAL

1.1 SECTION INCLUDES

.1 Interior and exterior painting.
.2 Relationship to other Sections:
  .1 Various Sections describe additional installation requirements for painting described under this Section, including:
    .1 Section 15 00 00 Mechanical Equipment
    .2 Section 15 05 00 Piping
    .3 Section 23 30 00 Ductwork
    .4 Section 25 05 00 Building Automation System
    .5 Section 26 05 00 Wiring and Cables

1.2 REFERENCED DOCUMENTS

.1 GSI-11: Green Seal 11 - Paint and Coatings, 3rd Edition.
.2 MPI-APL: MPI Approved Products List.
.3 MPI-RM: MPI Maintenance Repainting Manual, 2010.
.4 MPI-SM: MPI Architectural Painting Specifications Manual, 2010.
.5 SCAQMD-1113: SCAQMD Rule 1113 Architectural Coatings, 2011.
.6 SSPC-PM1-PP: SSPC Painting Manual, Volume 1, 4th Edition, Good Painting Practice.
.7 SSPC-PM2-SS: SSPC Painting Manual, Volume 2, 2011 Edition, Systems and Specifications.

1.3 SUBMITTALS FOR ACTION

.1 Product Data
  .1 Submit manufacturer's product literature, specifications, and datasheets, including product characteristics, performance criteria, options, limitations.
  .2 Include the following information:
    .1 Product name, type, and use.
    .2 Manufacturer's product number.
    .3 Colour number(s).
    .4 MPI Environmentally Friendly classification system rating.
    .5 Volatile Organic Compounds (VOC) content in units of g/L (oz/USgal).
.2 Shop Drawings
  .1 Layout Plan: Lists indicating affected services, components, objects, and structures
.3 Samples
  .1 Submit 200-mm by 300-mm (8-in by 12-in) sample panels of each paint, stain, coating or other finish with specified paint or coating in colors, gloss/sheen, and textures required to MPI-SM. Submit on substrate materials matching that of specified application surfaces.
  .2 Maintain approved samples on site to serve as standard of quality for appropriate on-site surface.

1.4 SUBMITTALS FOR INFORMATION

.1 Operation and Maintenance Data: Submit manufacturer's application, cleaning, and maintenance instructions.
.2 Installer Qualification Statements: Upon request, provide a list of 3 comparable jobs including, date, job name and location, installer contact information, client contact information.

1.5 SUBMITTALS FOR CLOSEOUT

.1 Spare Paint: Provide spare paint on site for touch up purposes as required by Owner.

1.6 QUALITY ASSURANCE

.1 Standard of Acceptance

.1 Vertical Surfaces: No defects visible from a distance of 1-m (40-in) at 90-degrees to surface.
.2 Horizontal Surfaces: No defects visible from floor at 45-degrees to surface.
.3 Final coat to exhibit uniformity of colour and uniformity of sheen across full surface area.

.2 Proof of Conformance: Retain documentation to prove conformance with noted MPI requirements upon request, including purchase orders, invoices.

.3 Sample Areas: When requested, prepare and paint designated surface, area, room, or item as specified for review and approval. When approved by Owner, the sample area shall become acceptable standard of finish quality and workmanship.

1.7 DELIVERY, STORAGE AND HANDLING

.1 Delivery and Acceptance Requirements
.1 Deliver and store materials in original new containers, sealed, with labels intact.
.2 Remove damaged, opened, and rejected materials from site.

.2 Storage and Handling Requirements
.1 Provide and maintain dry, temperature controlled, ventilated, secure storage.

.3 Waste Management and Disposal
.1 Paint, stain and wood preservative finishes and related materials (thinners, solvents, etc.) are regarded as hazardous products and are subject to regulations for disposal.
.2 Material which cannot be reused must be treated as hazardous waste and disposed of in an appropriate manner.
.3 Place materials defined as hazardous or toxic waste, including used sealant and adhesive tubes and containers, in containers or areas designated for hazardous waste.
.4 To reduce the amount of contaminants entering waterways, sanitary/storm drain systems or into ground, the following procedures shall be strictly adhered to:
.1 Retain cleaning water for water-based materials to allow sediments to be filtered out.
.2 Retain cleaners, thinners, solvents and excess paint to be placed in designated containers and ensure proper disposal.
.3 Return solvent and oil soaked rags used during painting operations for contaminant recovery, proper disposal, or appropriate cleaning and laundering.
.4 Dispose of contaminants as required including hazardous waste requirements.
.5 Ensure empty or remaining paint containers are dry prior to disposal or recycling.

PART 2 PRODUCTS

2.1 COMMON PRODUCT REQUIREMENTS

.1 Listed in MPI-APL, having an "L" rating designation.
.2 Certified to GSI-11.
.3 Comply with SCAQMD-1113.
.4 Approved compatible with substrate to MPI-RM, MPI-SM, SSPC-PM1-PP and SSPC-PM2-SS.
.5 Pre-mixed and pre-tinted unless otherwise indicated.
.6 Materials as part of a paint system to be from a single manufacturer.

PART 3 EXECUTION

3.1 EXAMINATION

.1 Verify conditions to MPI-RM, MPI-SM, SSPC-PM1-PP and SSPC-PM2-SS.

3.2 PREPARATION

.1 Clean and prepare surfaces:
.1 To MPI-RM, MPI-SM, SSPC-PM1-PP and SSPC-PM2-SS.
.2 To paint manufacturers recommendations.
.3 As required, including removal of paint, sealants, dirt, dust, debris, scale, corrosion, oil, contaminants.

3.3 COMMON EXECUTION REQUIREMENTS

.1 Paint surfaces, including interior and exterior, to MPI-RM, MPI-SM, SSPC-PM1-PP and SSPC-PM2-SS.
.2 Repainting of existing finishes to MPI-RM.
.3 Ensure environmental conditions are acceptable before painting.
.4 Mask required legible components including nameplates before painting.
.5 Mask surrounding areas before painting.
.6 Unless otherwise indicated, colour and texture to match existing or adjacent surfaces if acceptable, otherwise as approved by Owner or as required.
.7 Unless otherwise indicated or required by finish type, paint with alkyd paint, exterior grade, 1 coat of primer paint, 2 coats of finish paint.

3.4 SURFACES

.1 Surfaces
  .1 Paint and/or finish new and existing surfaces unless otherwise indicated including the following:
    .1 Modifications to building surfaces including walls, floors, door assemblies.
.2 Equipment, Services and Components
  .1 Paint new and existing unfinished or unprotected equipment and services and components, including mechanical, electrical, piping, ductwork, conduits, components, within areas affected by Work unless otherwise indicated:
    .1 Where exposed to outdoor ambient conditions.
    .2 Where exposed to outdoor temperature conditions.
    .3 Where exposed to outdoor humidity conditions.
    .4 Where exposed-to-view in exterior and interior areas.
    .5 In interior areas with high humidity.
    .6 In interior areas with risks of condensation.
    .7 For systems at risk of condensation that have no other means of combined sealed thermal and vapour barriers.
    .8 In service rooms with fluid piping, including mechanical and electrical rooms.
    .9 To match existing systems, equipment, services and components.
  .2 Leave exposed conduits, piping, hangers, ductwork and other mechanical and electrical equipment in original finish and touch up scratches and marks in unfinished areas.
  .3 Colour: As required by Owner, otherwise match existing. Colour may vary for each service.
.3 Remaining Surfaces and Equipment and Services: Touch-up paint to match existing on surfaces and services affected by demolition, including removal of components that expose unfinished or non-matching surfaces and services.

3.5 FIELD QUALITY CONTROL

.1 Non-Conforming Work
  .1 Correct deficiencies in painted surfaces to satisfaction of Owner and Engineer.
  .2 Touch-up small affected areas.
  .3 Repaint large affected areas.
  .4 Scrape and/or sand defective paint surfaces before reapplication if required.

3.6 PROTECTION AND CLEAN-UP

.1 Protection: Protect newly painted exterior surfaces from elements condensation and contamination until paint coatings are completely dry. Erect barriers or screens and post signs to warn, limit and/or direct traffic.
.2 Clean-Up: Remove spilled, splashed, splattered and over-sprayed paint as work progresses. Remove waste materials and keep area free from accumulation of tools, equipment, surplus materials and debris.

END OF SECTION 09 91 00

SECTION 15 00 00 MECHANICAL EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

.1 Heating, Cooling, Heat Rejection, Pumps, Fans.

.2 Relationship to other Sections:

.1 Section 25 05 00 Building Automation System describes additional requirements for control of equipment and components provided under this Section.

.2 Section 25 90 00 Control Sequences describes additional requirements for control of equipment and components provided under this Section.

.3 Section 26 00 00 Electrical Equipment describes equipment and components supplied with equipment and components from this Section, including motors and variable frequency drives.

.4 Section 26 05 00 Wiring and Cables describes installation requirements of equipment installed under this Section.

.5 Section 26 90 00 Control Devices describes additional requirements of equipment provided under this Section.

1.2 REFERENCED DOCUMENTS

.1 AHRI-410: AHRI-410-2001 Forced-Circulation Air-Cooling and Air-Heating Coils.

.2 AHRI-550-590: ANSI/AHRI-550/590/551/591-2011 Performance Rating of Water-Chilling and Heat Pump Water-Heating Packages Using the Vapor Compression Cycle.

.3 AHRI-880: ANSI/AHRI-880/881-2011 Performance Rating of Air Terminals.

.4 AHRI-885: AHRI-885-2008 Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminals and Air Outlets.

.5 ASHRAE-15: ANSI/ASHRAE-15-2013 Safety Standard for Mechanical Refrigeration.

.6 ASHRAE-62.1: ANSI/ASHRAE-62.1-2013 Ventilation for Acceptable Indoor Air Quality, including User's Manual.

.7 ASHRAE-90.1: ANSI/ASHRAE/IES-90.1-2010 Energy Standard for Buildings Except Low-Rise Residential, including User's Manual.

.8 ASHRAE-90.1: ANSI/ASHRAE/IES-90.1-2013 Energy Standard for Buildings Except Low-Rise Residential, including User's Manual.

.9 ASME-BPVC: ASME-BPVC-2013 Boiler and Pressure Vessel Code.

.10 ASME-CSD-1: ASME-CSD-1-2012 Controls and Safety Devices for Automatically Fired Boilers.

.11 ASTM-B117: ASTM-B117-11 Standard Practice for Operating Salt Spray (Fog) Apparatus.

.12 ASTM-C534: ASTM-C534/C534M-13 Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.

.13 ASTM-C553: ASTM-C553-13 Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.

.14 ASTM-C612: ASTM-C612-04 Standard Specification for Mineral Fiber Block and Board Thermal Insulation.

.15 ASTM-C612: ASTM-C612-14 Standard Specification for Mineral Fiber Block and Board Thermal Insulation.

.16 ASTM-C921: ASTM-C921-10 Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.

.17 ASTM-D523: ASTM-D523-14 Standard Test Method for Specular Gloss.

.18 ASTM-D1654: ASTM-D1654-08 Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments.

.19 ASTM-G151: ASTM-G151-10 Standard Practice for Exposing Nonmetallic Materials in Accelerated Test Devices that Use Laboratory Light Sources.

.20 ASTM-G154: ASTM-G154-12 Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials.

.21 CSA-4.9: ANSI-Z21.13-2014/CSA-4.9-2014 Gas-fired Low Pressure Steam and Hot Water Boilers.
.22 CSA-B52: CSA-B52-05 (R2009) Mechanical Refrigeration Code, including Handbook, Supplement 1.
.23 CSA-B52: CSA-B52-13 Mechanical Refrigeration Code.
.24 CSA-C22.2-236: CSA-C22.2-236-11 Heating and Cooling Equipment.
.25 HI-BTS-2000: HI-BTS-2000, Rev 06.07, Testing Standard: Method to Determine Efficiency of Commercial Space Heating Boilers.
.26 MICA-NISM: MICA National Commerial and Industrial Insulation Standards Manual, 2014.
.27 NEMA-250: NEMA-250-2008 Enclosures for Electrical Equipment (1000 Volts Maximum).
.28 TIAC-BPG: TIAC Mechanical Insulation Best Practices Guide, 2013.
.29 UL-1995: UL-1995-11 Heating and Cooling Equipment.
.30 ULC-S102: CAN/ULC-S102-10 Surface Burning Characteristics of Building Materials and Assemblies.

1.3 DEFINITIONS

.1 "BACnet": A communications protocol adhering to ASHRAE-135.
.2 "HVAC": Heating, ventilating and air-conditioning, including outdoor air, air quality, pressurization, cooling, humidification, de-humidification.
.3 "TAB": TAB is used throughout this Section to describe the process, methods and requirements of testing, adjusting and balancing for HVAC.

1.4 SUBMITTALS FOR ACTION

.1 Product Data
  .1 Manufacturer's printed product literature, specifications, and datasheets, including product characteristics, materials, finish, dimensions, clearances, performance criteria, certifications, options, and limitations.
  .2 Include the following additional information:
    .1 Capacity and efficiency, including full and part loading.
    .2 Performance curves, including flow and resistance.
    .3 Electrical, including schematics, ladder logic, wiring diagrams, control sequences.
    .4 Required services, including utilities and distribution systems.
    .5 Sound and vibration ratings.
    .6 Certifications.
  .3 Combustion Equipment
    .1 Combustion venting requirements and manufacturer's instructions.
    .2 Efficiency and part load efficiency (10-% through to 100-% of design capacity in 10-% increments at various water temperatures).
  .4 Pressure Vessels Equipment
    .1 Ontario Pressure Vessels Regulation compliance.
  .5 Refrigerant Circuits Equipment
    .1 Labelling and Documentation: CSA-B52 and ASHRAE-15 labelling and documentation.
    .2 Ontario Operating Engineers Regulation compliance.
    .3 Refrigerant relief valve types, quantities, ratings.
  .6 Refrigeration Equipment
    .1 Efficiency and part load efficiency (10-% through to 100-% of design capacity in 10-% increments) based on loads and applicable temperatures at 2 decimal places accuracy.
    .2 Efficiency and part load efficiency (25-% through to 100-% of design capacity in 25-% increments) based on loads and applicable temperatures at 2 decimal places accuracy.
    .3 Turndown ratio.
    .4 AHRI ratings.

.5 Type of refrigerant used.
.6 Fluid flows for both gas (air or other gas as applicable) and liquid (water or other liquid as applicable) for design condition, minimum and maximum.

.2 Shop Drawings
.1 Schedule: List of products, including quantities, sizes, dimensions, locations.
.2 Layout and Interference Plans: Scaled sketches indicating clearances, interferences, and relocation of interfering services, components, objects, and structures.
.3 Mounting: Details of product mounting, including foundation details with loadings, anchor bolt arrangements, roof curb details, point loads, roof structure details.
.4 Suspension Systems: Details of suspended products, including:
.1 Location of suspension.
.2 Maximum load at each of the suspension points.
.3 Size of suspension rods or members.
.4 Details of supplementary structural steel framing members.
.5 Vibration and seismic control measures.
.6 Electrical Power: Details of electrical power connections.
.7 Interlocks: Details of electrical interlocks and life safety system interfaces, including schematics, ladder logic, wiring diagrams, control sequences.

.3 Demolition Plan: Details of demolition requirements, including manufacturer's certification, or lab reports describing the materials being cut into.

1.5 SUBMITTALS FOR INFORMATION

.1 Certificates
.1 Refurbished Parts: Certificate from equipment manufacturer that refurbished parts are acceptable for intended use.
.2 Equipment Start-up: Letter from manufacturer certifying:
.1 Start-up, installation, adjustments and testing has been executed in accordance with manufacturer's instructions and recommendations, and no warranty conditions have been violated.
.2 Equipment is performing in accordance with expectations.
.3 Vibration Hardware Installation: Letter from manufacturer certifying start-up and installation has been executed in accordance with manufacturer's recommendations and Contract Documents.
.4 Performance
.1 Letter certifying ASHRAE-90.1 compliance.
.2 Letter certifying ASHRAE-62.1 compliance.
.3 Documents on AHRI certification.
.5 Fuel Services Installation: Letter from installer certifying Work meets requirements.
.6 Combustion Venting Installation: Letter from installer certifying Work meets requirements.

.2 Manufacturer Information
.1 Operating and Maintenance Manual
.2 Installation Instructions
.3 Users Manuals
.4 Start-up Checklists

.3 Test and Evaluation Reports
.1 Start-up Reports: Completed manufacturer's start-up checklists and notes.
.2 Electrical: Measurements for equipment when off and powered up, for power as well as voltage and current measurements for each phase.
.3 Testing and Balancing Reports
.4 Combustion Tests and Analysis Reports

.4 Qualification Statements
.1 Noise and Vibration: Proof of certifications for company personnel.
.2 TAB: Proof of certifications for company and personnel.

1.6 SUBMITTALS FOR CLOSEOUT

.1 Maintenance Contracts
.2 Spare Parts
  .1 Spare parts for 1 year of operation.
  .2 Spare parts recommended by manufacturers.
.3 Tools
  .1 Special tools required for operation and maintenance.

1.7 QUALITY ASSURANCE

.1 Qualifications
  .1 Noise and Vibration Testing
    .1 Company NEBB certified.
    .2 Personnel to be NEBB Sound and Vibration Certified Professional.
  .2 TAB
    .1 Company and personnel CAABC or NEBB certified.
    .2 Subject to approval.

PART 2 PRODUCTS

2.1 COMMON PRODUCT REQUIREMENTS

.1 Efficiency Performance: Provide equipment to meet the more stringent requirements of as indicated or as follows:
  .1 To ASHRAE-90.1.
.2 Noise Performance: Provide equipment and services, including piping and ductwork, to meet the following requirements:
  .1 Occupied Areas: Less than 35-N.C. Level.
  .2 Service Areas: Less than 50-N.C. Level.
  .3 Vibration created by mechanical equipment must be below the level of perception in occupied areas of the building.
.3 Start-up Control Requirements
  .1 For equipment capable of being powered by stanby power, provide the following to limit total start-up current upon power failure:
    .1 Soft start: Less than 200-% of full load current upon start-up.
    .2 Random or pre-set start-up delay.
.4 Ventilation Equipment
  .1 To ASHRAE-62.1.

2.2 BOILERS - HEATING

.1 Provide as indicated.
.2 Manufacturers
  .1 Lochinvar, LLC, FTXL Series
.3 Limitations
  .1 Equipment configuration as indicated.
  .2 Ensure acceptable service clearances maintained, including for combustion venting, piping, floor drains.
  .3 Ensure required combustion venting configuration can be routed as indicated.
.4 Type
  .1 Floor mounted.
  .2 Minimum heat input capacity as indicated.
  .3 Minimum combustion efficiency of 97.5-% tested to HI-BTS-2000.
  .4 Minimum turndown ratio of 7:1.
  .5 Category IV venting.
  .6 Certified for room air combustion as well as direct vent sealed combustion to same pressure zone.
  .7 Direct vent sealed combustion to same pressure zone.

.8 Maximum emissions 20-ppm NOx corrected to 3-% O2 tested by independent laboratory.
.9 Stainless steel heat exchanger.
.10 Minimum pressure relief valve rating of 50-psig.
.11 Maximum working pressure rating of 160-psig.
.12 Condensate neutralization package.
.13 Direct spark ignition.
.14 Electronic Control Options
.1 Remote enable/disable control.
.2 Outdoor air temperature reset of heating water supply temperature.
.3 Control to building heating water return temperature setpoint.
.4 LCD display capable of displaying status, supply and return temperatures, firing rate, and alarm status.
.5 Modulating firing control.
.6 Integral multiple boiler sequencer control.
.7 BACnet interface.
.1 BACnet panel, BTL tested and listed on BTL website, as required to fully interface with building automation system using BACnet.
.8 Pump control from heating boiler.
.9 CON-X-US Remote Connectivity
.15 Flow switch to manufacturer's recommendations.
.16 Low water cutoff switch to manufacturer's recommendations.
.5 Certifications, Listings and Registrations
.1 To CSA-4.9.
.2 To ASME-BPVC, "H" Stamp.
.3 National Board.
.4 To ASME-CSD-1.
.5 Factory Mutual.
.6 Canadian Registration Number (CRN).
.7 AHRI certified.
.6 Substitution Limitations
.1 Substitutions not accepted.

2.3 SPLIT AIR SOURCE HEAT PUMP SYSTEM - SINGLE ZONE - OUTDOOR UNIT

.1 Provide as indicated.
.2 Manufacturers
.1 LG Electronics Canada Inc., LSU-HV3 Series
.3 Refrigerant: R410A.
.4 Options: Provide the following:
.1 Mounting: As indicated.
.2 Low ambient operation kit. Enables heating and cooling operation to as indicated.

2.4 SPLIT AIR SOURCE HEAT PUMP SYSTEM - MULTI ZONE VRF - OUTDOOR UNIT

.1 Provide as indicated.
.2 Manufacturers
.1 LG Electronics Canada Inc., LMU-CHV Series
.3 Refrigerant: R410A.
.4 Options: Provide the following:
.1 Mounting: As indicated.
.2 Low ambient operation kit. Enables heating and cooling operation to as indicated.

2.5 SPLIT AIR SOURCE HEAT PUMP SYSTEM - INDOOR UNIT - WALL MOUNTED

.1 Provide as indicated.
.2 Manufacturers
.1 LG Electronics Canada Inc., LSN-HV3 Series

.3 Refrigerant: R410A.
.4 Options: Provide the following:
.1 Mounting: As indicated.
.2 Wired remote controller.
.3 Dry contact for on/off control, run status, error status.
.4 Integral condensate pump.

2.6 SPLIT SYSTEM INDOOR UNIT REMOTE CONTROLLERS

.1 Provide as required.
.2 Manufacturers: Same as split system equipment manufacturer.
.3 Type
.1 Wired.
.2 Display: On/off LED indicator, backlit.
.3 Battery: Standard batteries for backup power sized for 3-hours backup duration.
.4 Grouped Control: Control up to 8 indoor units, with capability of setting individual settings for each indoor unit.
.4 Features: Configurable control functions:
.1 On/off.
.2 Temperature setting.
.3 Modes for cooling, heating, dry, fan, auto.
.4 Fan speed.
.5 Air flow direction.
.6 Clock.
.7 Schedules for 7 separate days, holidays.
.8 Schedules for 2 modes each day.

2.7 PUMPS

.1 Provide as indicated.
.2 Manufacturers
.1 Bell and Gossett
.3 Motors: To Section 26 00 00 Electrical Equipment.
.4 Pumps may be selected to operate into motor service factor on the run-out condition under the following conditions:
.1 For systems with variable frequency drives.
.2 For systems with adjustable electrical overloads.
.3 Maximum of 2/3 of motor service factor or 10-% higher than nameplate.
.4 With review by Engineer.
.5 With proof of manufacturer warranty provided for selection.
.5 Ancillary Components: Indicated ancillary components may be substituted with the following from pump manufacturerto Section 15 05 00 Piping:
.1 Combination Strainer/Flow Straightener: Combined strainer and flow straightener.
.2 Combination Balancing/Check Valve: Combined balancing valve and check valve.
.1 Not Acceptable: Use as a shutoff valve.

2.8 FANS - EXHAUST - ROOF - DOWNBLAST

.1 Provide as indicated.
.2 Manufacturers
.1 Greenheck Fan Corporation, GB Series
.3 Features
.1 Belt drive.
.2 Backward inclined centrifugal fan.
.3 Permament sealed bearings.
.4 Vibration isolation.
.5 Local disconnect switch rated for environment.
.6 Adjustable motor sheave.

.7 Protective clear finish.
.8 BSN - Bird Screen
.1 Galvanized steel construction.
.9 RCB - Roof Curb
.1 Welded galvanized steel construction.
.2 1.5-in insulation.
.3 Straigt sided.
.4 Flashing flange.
.5 Wood nailer.
.6 Curb seal.
.7 Match finish to fan housing.
.10 BDR - Backdraft Damper
.1 Gravity.
.2 Balanced.
.3 Galvanized steel construction.
.4 Motors: To Section 26 00 00 Electrical Equipment.
.5 Materials
.1 Fan Wheel
.1 Aluminum.
.2 Housing
.1 Aluminum
.6 Selection: Fans may be selected to operate into motor service factor on the run-out condition under the following conditions:
.1 For systems with variable frequency drives.
.2 For systems with adjustable electrical overloads.
.3 With review by Engineer.
.4 With proof of manufacturer warranty provided for selection.
.7 Substitution Limitations
.1 Substitutions may be accepted under substitution provisions described in Contract Documents.
.2 Substitutions may be limited by various requirements and may require re-design, including:
.1 Physical characteristics, including weight, height, length, width.
.2 Minimum and maximum airflows, maximum pressure drops, noise.
.3 Re-design differences as a result of substitution to delegated design requirements described in Contract Documents.
.4 Acceptable Substitution Manufacturers
.1 JencoFan, DB Series
.2 PennBarry, DX_B Series

2.9 SEMI-CUSTOM VENTILATION UNITS - MIXED AIR HEATING AND COOLING

.1 Manufacturers
.1 Trane Inc., Horizon Series
.2 Limitations: Specific limitations may be exceeded based on indicated requirements of Substitution Limitations below.
.1 Refrigerant Compressor Quantity: Refrigerant compressor quantity of 2 or 3.
.2 Refrigerant Circuit Quantity: Refrigerant circuit quantity of 2.
.3 Refrigerant Charge: Refrigerant charge per circuit to not exceed 36-kg (80-lb).
.4 Refrigerant Compressor Power: Refrigerant compressor power to be less than 11-kW.
.5 Refrigerant Piping: Refrigerant circuit piping to not be field modified, including requirements for controls, safeties and independent safeties, including during installation.
.3 Energy Recovery Wheel
.1 Type

.1 Energy recovery unit between 2 air streams with motorized wheel.
.2 Features
.1 Wheel dessicant designed for absorption of water vapour. All surfaces coated with nonmigrating adsorbent layer of desiccant prior to being formed into the honeycomb media structure to insure that all surfaces are coated.
.2 Wheel media cleanable with low temperature steam, hot water or light detergent without degrading the latent recovery.
.3 Rotor media coated to prohibit corrosion.
.4 Bypass dampers around heat recovery.
.3 Materials
.1 Wheel Media: Aluminum.
.4 Performance
.1 Effecrtiveness: Minimum 80% at peak conditions in both heating and cooling modes.
.4 Refrigeration Compressor
.1 Type: Direct drive hermetically sealed digital scroll compressor per compressor.
.2 Quantity: 2 or 3.
.3 Turndown: Modulating with minimum 5:1 per compressor.
.4 Refrigerant Circuits: 2
.5 Refrigerant Type: High pressure refrigerant, R-410A.
.6 Compressor Cooling: Compressors are cooled by refrigerant on the suction side.
.7 Options: Provide the following:
.1 Condenser Fans: Direct drive condenser fans with vertical discharge and heavy gauge steel fan guards.
.1 Variable Frequency Drives: To Section 26 00 00 Electrical Equipment.
.2 Sound: Compressor sound blankets.
.3 Mounting: Springs.
.4 Crankcase heaters.
.5 Refrigerant Control
.1 Electronic expansion valve, adjustable, external equalizer.
.2 High and low refrigerant pressure switches.
.3 Variable speed heat pressure control.
.6 Refrigerant Piping Components
.1 Liquid line filter drier.
.2 Sight glass and moisture indicator.
.3 Service gauge ports.
.7 Electrical
.1 Circuit breaker per compressor.
.2 Externally mounted disconnect switch.
.3 Access panels gasketed, hinged with lockable handles.
.4 External emergency stop contacts.
.8 Electronic Controls
.1 Low refrigerant temperature or pressure alarms.
.2 High refrigerant temperature or pressure alarms.
.3 Electrical input fault alarms.
.4 Local emergency stop.
.8 Performance
.1 AHRI certified.
.2 Nominal Rating: As indicated.
.3 Nominal Efficiency: As indicated.
.4 Maximum Power: Power less than 11-kW clearly identified on nameplate for compressor(s) power.
.5 Standard Conditions Ratings: To standard conditions of AHRI-550-590.

.6 Design Conditions Ratings: As required by coils.

.5 Refrigerant Coils
- .1 Type
  - .1 Energy transfer between refrigerant and air stream.
  - .2 Coil with tubes and fins for heat exchanger surfaces.
  - .3 Rated for refrigerant type, temperatures, pressures, phase change.
- .2 Construction: Single unit constructed. Field assembly or disassembly is prohibited.
- .3 Mounting: Integral to air handler cabinet.
- .4 Materials
  - .1 Copper tube and aluminum fin coil.
  - .2 Galvanized steel frame and mounting structure.
- .5 Performance
  - .1 Air Velocity
    - .1 Maximum 2.0-m/s (400-fpm) in both supply and exhaust air streams.
    - .2 Minimum as required to prevent freezing.
- .6 Maximum Power: Power less than 11-kW clearly identified on nameplate for compressor(s) power.

.6 Gas Heating
- .1 Type
  - .1 Natural gas fired heating section.
  - .2 Indirect heating of supply air through heat exchanger.
  - .3 Direct spark ignition.
- .2 Construction: Single unit constructed.
- .3 Natural Gas Pressure: Suitable for available natural gas pressure at installation location.
- .4 Mounting: Integral to air handler cabinet.
- .5 Materials
  - .1 439 stainless steel heat exchanger.
- .6 Performance
  - .1 As indicated.
  - .2 Nominal Rating: As indicated.
  - .3 Turndown: Modulating burner with minimum 10:1 turndown.
  - .4 Efficiency: Minimum combustion efficiency 80-%.
- .7 Options
  - .1 Combustion vent extension kit, minimum height 1.2-m (4-ft) above cabinet.

.7 Dampers
- .1 To Section 23 30 00 Ductwork.
- .2 Motorized dampers for:
  - .1 Outdoor air.
  - .2 Mixed air.
  - .3 Relief air.

.8 Supply Fan
- .1 Type
  - .1 Centrifugal, forward inclined AMCA rated and certified.
- .2 Construction
  - .1 Dynamically balanced pulleys.
  - .2 Variable pitch motor sheaves for fan speed adjustment.
- .3 Mounting: Integral to air handler cabinet.
- .4 Materials
  - .1 Galvanized steel blower wheel.
  - .2 Solid steel shafts.
  - .3 Galvanized steel pulleys.
- .5 Motors
  - .1 To Section 26 00 00 Electrical Equipment.

.2 Speed: As required.
.3 Electrical Power: As indicated.
.6 Variable Frequency Drives
.1 To Section 26 00 00 Electrical Equipment.
.7 Performance
.1 Air flow and external static pressure as indicated.
.2 Internal static pressure as required to maintain air flow through internal components.
.3 Minimum 60-% fan static efficiency.
.9 Powered Exhaust Fan
.1 Type
.1 As required.
.2 Centrifugal, forward inclined AMCA rated and certified.
.2 Mounting: Integral to air handler cabinet.
.3 Materials
.1 Galvanized steel blower wheel.
.2 Solid steel shafts.
.3 Galvanized steel pulleys.
.4 Motors
.1 To Section 26 00 00 Electrical Equipment.
.2 Speed: As required.
.3 Electrical Power: As required.
.5 Variable Frequency Drives
.1 To Section 26 00 00 Electrical Equipment.
.6 Performance
.1 As required.
.10 Cabinet
.1 Construction
.1 Unitary 1-piece construction, mounted on base rails of galvanized steel.
.2 Frame construction consisting of integral galvanized steel vertical and horizontal structural members.
.3 Frame construction to allow complete removal of wall and top panels without affecting structural integrity of the unit.
.4 Equipped with reinforcing cross-members as required for lifting.
.5 Base rail channels to support all components and service requirements.
.6 Base pan to have no penetrations within the perimeter of the curb other than the raised downflow supply/return openings for water integrity protection.
.7 Insulated throughout, antimicrobial, minimum 50-mm (2-in) thick and R-13, with all insulation captured or sealed.
.2 Materials
.1 Exterior: Minimum 18-ga galvanized steel with weather-resistant baked enamel finish.
.2 Floor Panels: Minimum 18-ga galvanized steel with G90 finish.
.3 Interior Liner: Minimum 18-ga galvanized steel with G90 finish.
.3 Tests
.1 Gloss Surface Tests: To ASTM-D523 and to ASTM-G151 and ASTM-G154 Common Exposure Conditions of Cycle 6, 500-hours, gloss reduction maximum 30-%.
.2 Salt Spray Exposure Tests: To ASTM-D1654 and to ASTM-B117 Salt Spray Exposure as follows:
.1 Procedure A (Evaluation of Scribed Specimens), Method 2 (Scraping), 1,000-hours, creepage or delamination size rating 6 or better.
.11 Features

.1 Drain Pan
.1 150-mm (3-in) high drain pan from outdoor air intake to past heating section and sloped to opposite corners with 19-mm (3/4-in) drain ports.
.2 Materials: Stainless steel.
.2 Filters
.1 Intake Filter Set: 100-mm (4-in) MERV-8 thick fiberglass disposable filters.
.2 Evaporator Filter Set: 50-mm (2-in) MERV-13 thick fiberglass disposable filters.
.3 Rated for minimum 3.0-m/s (600-fpm) air velocity.
.4 Permanent mounting racks.
.3 Bird screen.
.1 Materials: Galvanized steel.
.4 Outdoor air intake hood(s).
.5 Economizer hood.
.6 Doors
.1 Provide access doors to filter sections, fan sections, other serviceable components.
.2 Continuously hinged.
.3 Capable of opening 180-degrees with hold open devices.
.4 Minimum 2 half turn latches per door.
.5 Completely gasketed with compressible reinforced single piece vinyl gasket.
.12 Electrical
.1 Externally mounted disconnect switch.
.2 Access panels gasketed, hinged with lockable handles.
.13 Controls
.1 Air handling unit independent controller, including the following:
.1 Local programmable zone temperature control with digital display to allow adjustment of scheduling, settings.
.2 Fixed dry bulb temperature airside economizer.
.14 Certifications, Listings and Registrations
.1 To CSA-C22.2-236 and UL-1995.
.15 Substitution Limitations
.1 Substitutions may be accepted under substitution provisions described in Contract Documents.
.2 Substitutions may require re-design of services including piping, ductwork, venting, structural, power, and controls.
.3 Substitutions may be limited by requirements of:
.1 Physical characteristics, including weight, height, length, width.
.2 Structural work required, including resupport of roof.
.4 Pay for all re-design and cost increases resulting from substitution in accordance with Contract Documents including conditions and procedures.
.5 Acceptable Substitution Manufacturers
.1 Johnson Controls Inc., Series JD
.2 McQuay International, Maverick 1

2.10 VARIABLE AIR VOLUME BOXES - SINGLE DUCT

.1 Provide as indicated.
.2 Manufacturers
.1 Johnson Controls Inc., TSS or TSL Series
.3 Features
.1 Damper shaft position indicator.
.2 Wiring enclosure. Minimum NEMA Type 1 rated to NEMA-250.
.3 Control devices as required to Section 26 90 00 Control Devices.
.4 Building automation system controller to Section 25 05 00 Building Automation System.
.4 Options

.1 LOW - Low Profile
.2 TDS - Toggle Disconnect Switch
.3 SAR - Sound Attenuator
.1 Single piece construction.
.4 HLC - Hot Liquid Coil: Including:
.1 Features
.1 Rows and circuiting as required.
.2 Handing as required.
.3 Coil access plate.
.2 Performance: Fouling Factors: Sizing based on:
.1 Service Liquid: 0.0009-m2·°C/W (0.005-h·ft2·°F/Btu)
.2 Air: 0.0017-m2·°C/W (0.01-h·ft2·°F/Btu)
.5 CPA - Coil Piping Assembly: To Section 15 05 00 Piping, including:
.1 Control valve.
.2 Shutoff ball valves on supply and return piping.
.3 Gauge ports for temperature and pressure.
.4 Drain valve complete with caps.
.5 Strainer.
.6 Unions.
.7 Piping supports.
.5 Performance
.1 Air Leakage: 1-% of maximum inlet rated airflow at 750-Pa (3-inWC).
.6 Materials
.1 Box
.1 Single wall construction of 22-guage galvanized steel to Section 23 30 00 Ductwork.
.2 Insulation
.1 13-mm (1/2-in) fibregass insulation.
.7 Certifications, Listings and Registrations
.1 To AHRI-410.
.2 To AHRI-880.
.3 To AHRI-885.
.8 Substitution Limitations
.1 Substitutions may be accepted under substitution provisions described in Contract Documents.
.2 Substitutions may be limited by various requirements and may require re-design, including:
.1 Physical characteristics, including weight, height, length, width.
.2 Minimum and maximum airflows, maximum pressure drops, noise.
.3 Re-design differences as a result of substitution to delegated design requirements described in Contract Documents.
.4 Acceptable Substitution Manufacturers
.1 Daikin Applied, MQTH Series
.2 Trane Inc., VariTrane VC Series

2.11 UNIT HEATERS - ELECTRIC

.1 Provide as indicated.
.2 Manufacturers
.1 Dimplex North America Limited, EU Series
.3 Features
.1 Built-in unit mounted thermostat.
.2 Horizontal louvres, convex shaped, adjustable 5-ways, securable in place.
.3 Fan guard.
.4 Mounting acceessories for wall or ceiling mounting.

.4 Motors: To Section 26 00 00 Electrical Equipment.
.5 Materials
.1 Casing
.1 18 gauge steel. Polyester/epoxy powder coat finish.
.2 Heating Elements
.1 Metal tubular sheath fused with spital steel fins.
.2 Nickel chromium wire encase in magnesium oxide insulation
.3 Fan
.1 Aluminum blades.
.4 Louvres
.1 20 gauge steel. Polyester/epoxy powder coat finish.

2.12 EXPANSION TANKS

.1 Provide as indicated.
.2 Manufacturers
.1 Non-Potable Water
.1 Amtrol Inc., Extrol Line
.3 Type
.1 As indicated.
.2 Orientation: As indicated.
.4 Features
.1 Bladder Tanks
.1 Service fluid contained within bladder. Service fluid does not come in contact with tank interior wall.
.2 Replaceable bladder.
.5 Size
.1 Tank Volume: As indicated.
.2 Acceptance Volume: As indicated.
.6 Ratings
.1 Maximum Working Pressure: As indicated.
.2 Maximum Operating Temperature: 240-°F (115-°C).
.7 Options
.1 Sight glass
.2 Seismic restraints
.3 Isolating valves
.4 Relief valve
.5 Combination drain valve and air charger.
.8 Materials
.1 Shell: ASME approved steel, finished with red oxide primer.
.2 Bladder/Diaphragm: Heavy Duty Butyl Rubber / EPDM
.1 Thickness: Minimum 0.087-in (2.1-mm).
.3 Air Valve: Schrader valve with EPDM seats.
.9 Mounting: Floor.
.10 Supports: Integral mounts for anchoring to floor for floor mounted tanks.
.11 Certifications: ASME-BVPC Section VIII, Division 1.

2.13 NOISE AND VIBRATION CONTROL

.1 Provide noise and vibration control hardware supplied by a single supplier.

2.14 EQUIPMENT MOUNTING

.1 Provide mounting including frames, supports, pads and curbs as required.

2.15 EQUIPMENT INSULATION

.1 Provide insulation on equipment as indicated.
.2 Provide adhesive, tape, sealants, cement, and mastic as recommended by, and compatible with, insulation and insulation jacket manufacturers.

.3 Common Performance Requirements
.1 Flame-Spread: Maximum 25 tested to ULC-S102.
.2 Smoke Developed: Maximum 50 tested to ULC-S102.
.4 Type MF - Preformed Mineral Fibre
.1 Manufacturers
.1 Owens Corning Canada Inc., Fiberglass 700 Series
.2 Manson Insulation Products, AK Board or AK Flex
.2 To ASTM-C553 or ASTM-C612 as required.
.5 Type EF - Flexible Elastomeric Foam
.1 Manufacturers
.1 Nomaco Inc., FlexTherm
.2 To ASTM-C534.

2.16 JACKETS

.1 Provide jackets around insulated equipment unless otherwise indicated.
.2 Common Performance Requirements
.1 Flame-Spread: Maximum 25 tested to ULC-S102.
.2 Smoke Developed: Maximum 50 tested to ULC-S102.
.3 Type CAN - Canvas Jacket
.1 Provide as required.
.2 ULC Listed.
.3 Fabric: ASTM-C921, 220-g/m2 (6-oz/yd2), plain weave cotton treated with dilute fire retardant lagging adhesive.

PART 3 EXECUTION

3.1 EXAMINATION

.1 Pre-Installation Pressure Test
.1 Prior to installation, pressure test existing system in its entirety to identify deficiencies in existing piping.
.1 Identify and report on all pressure relief devices and equipment maximum pressure ratings.
.2 Increase system pressure by 25-psi until target pressure is reached. Target pressure as determined by Engineer, including maximum operating pressure, design limit pressure.
.3 Maintain system pressure for minimum 4-hour duration.
.4 Inspect piping connections, seals, and equipment for leaks.
.5 If there are no leaks, repeat above steps until pressure reaches target pressure.
.6 If there are leaks, report on findings, allow minimum 10-days for Owner to repair, repeat above until pressure reaches target pressure.
.2 Verification of Conditions
.1 Confirm all dimensions indicated.
.2 Ensure clearances and maintenance access to equipment meet or exceed manufacturer's recommendations. Notify Engineer of problems.
.3 Investigate required relocation of objects to prevent interference. Submit interference drawings as required.
.4 Investigate wall construction for structural members, hazardous material, and building and utility services before opening.
.3 Evaluation and Assessment
.1 Evaluate condition of equipment before Work. Report deficiencies to Engineer.
.2 Review proposed retrofits with manufacturers.

3.2 COMMON EXECUTION REQUIREMENTS

.1 Provide equipment with identification as indicated. Nameplates to match quality and style of existing.
.2 Provide services, including electrical, to equipment as required.

.3 Insulate equipment as indicated and as required where not indicated
.4 Replace services around equipment to fit equipment and to suit equipment requirements, including piping, ductwork, venting, wiring.
.5 Install products in locations providing appropriate ambient conditions for its operation, and allowing for adequate ventilation.
.6 Provide clearances around systems, equipment and components for inspection, servicing and maintenance and as required. Minimum clearance of 300-mm (1-ft).
.7 Provide clearances around products to prevent interference with adjacent systems, equipment and components.
.8 Provide valves and either unions or flanges to connect piping to equipment for ease of maintenance and assembly.
.9 Support equipment such that no loads are transmitted to services including piping, ductwork, venting, wiring.
.10 Noise and Vibration Control
  .1 Install vibration control hardware in accordance with manufacturer's instructions (and supervision where required) and only by workmen experienced in the installation of such systems.
  .2 Replace isolation pads, and modify supports as required to mitigate vibration and noise to Owner's satisfaction.
.11 Provide equipment safeties and interlocks as required.
.12 Manufacturer Services
  .1 Supervision: Manufacturer to supervise field assembly of equipment to ensure warranty and performance provisions are met.
  .2 Start-up: Manufacturer to approve installation, to supervise start-up, and to instruct Owner, unless otherwise indicated.
  .3 Adjusting: Adjust for optimal performance, under manufacturer supervision.

3.3 EQUIPMENT MOUNTING

.1 Intent: Contractor responsibility as requirements depends in part on final selection and installation location.
.2 Design mounting including frames, supports and curbs as required where not indicated.
.3 Support equipment such that no loads are transmitted to services including piping, ductwork, venting, wiring.
.4 Provide concrete housekeeping pads for base-mounted equipment.
  .1 Size: Minimum 100-mm (4-in) high, larger in width and depth by 75-mm (3-in).
.5 Provide stands for equipment that can be wall mounted but are not located on walls unless otherwise indicated. Anchor bolt to surfaces.
.6 Performance: Design equipment mounting:
  .1 To make equipment level.
  .2 To protect equipment from water damage.
  .3 To withstand seismic events with seismic restraint as required.
  .4 To minimize noise and vibration transmitted to services and building structure.
  .5 To withstand concentrated loads of 2-kN (450-lbf) applied at any point in any direction.

3.4 BOILERS - HEATING

.1 Install as required.
.2 Interface available points to BAS using BACnet.
.3 Start-up: Manufacturer to complete start-up.
.4 Field Testing
  .1 Complete combustion tests to the following load conditions, record temperatures during testing, submit results.
    .1 Minimum load, 25-% load, 50-% load, 100-% load.

3.5 SPLIT AIR SOURCE HEAT PUMP SYSTEMS

.1 Install as required.

3.6 PUMPS

.1 Install as required.
.2 Ancillary Components: Provide straight piping lengths for inlet and outlet connections as recommended by manufacturer.
.3 Insulation: Provide Type EF insulation, fabricated to allow removal. Insulation thickness based on largest pipe size of connected piping service type.

3.7 FANS

.1 Install as required.

3.8 AIR HANDLERS

.1 Install as required.
.2 Start-up: Manufacturer to complete start-up.

3.9 VARIABLE AIR VOLUME BOXES (VAV)

.1 Install as required.

3.10 UNIT HEATERS - ELECTRIC

.1 Install as required.

3.11 EQUIPMENT INSULATION AND JACKETS

.1 Replace insulation and jackets on existing equipment as indicated.
.2 Replace damaged insulation and jackets on existing equipment affected by Work.
.3 Insulate equipment including jackets where not indicated as follows:
  .1 At risk of condensation, including vapour barrier.
  .2 With surface temperatures greater than 50-°C (120-°F).
  .3 With surface temperatures greater than 35-°C (63-°F) delta temperature compared to surrounding conditions.
  .4 As required to ASHRAE-90.1.
.4 Install insulation, and seal seams and joints to prevent corrosion of equipment surface by condensation or precipitation.
.5 Install to:
  .1 MICA-NISM.
  .2 TIAC-BPG.
.6 Maintain continuity and integrity of vapour retarder jacket and finishes to prevent corrosion of equipment surface by condensation or precipitation.
.7 Provide access to service components and devices, including nameplates, access hatches and doors, operable components. Provide labels on covered components and devices.
.8 Seams
  .1 Seal seams using seam sealant acceptable to manufacturer and Engineer.
  .2 Match seam sealant to jacket.
  .3 Minimize the number of seams by using full length insulation pieces.
  .4 Position overlaps to shed water.
  .5 Locate longitudinal seams at the side of equipment that is least visible.
.9 Supports and Hangers
  .1 Install supports and hangers outside vapour retarder jacket.
  .2 Install high compressive strength insulation under equipment supports to prevent compression of insulation.
.10 Additional Finishing
  .1 Type CAN - Canvas Jacket: Paint jackets to Section 09 91 00 Painting.

3.12 FIELD QUALITY CONTROL

.1 Field Tests
  .1 Complete TAB, and submit report.
.2 Field Inspections

.1 Submit report from vibration control hardware supplier certifying that the installation has been carried out in accordance with manufacturer's recommendations.

.3 Non-Conforming Work
- .1 Provide sound and vibration test report upon request for non-conforming area.
- .2 Re-fabricate and re-install any installation of equipment, piping, and ductwork judged by Engineer to be unsound or poor with regard to the sound and vibration requirements.

.4 Manufacturer Services
- .1 Complete required tests on equipment.
- .2 Complete combustion tests on equipment.

.5 Fluid Level, Low Fluid, Flow Sensors and Switches
- .1 Set and coordinate settings with requirements of system and other flow devices including pumps and control valves.
- .2 Allow for 4additional site visits after start-up and during Correction Period for adjustments to flow sensors and switches during system operation and shutdown to achieve desired operation under various conditions including peak and seasonal loads.

3.13 LABELLING AND DOCUMENTATION

.1 Nameplates: Affix manufacturer's nameplates to equipment in a readily visible location.

.2 Identification: Provide lamacoid nameplates for identification on each enclosure, panel, or field equipment, including existing.
- .1 Construction: Laminated plastic with a different coloured core and engraved lettering to clearly show lettering with style as follows, unless otherwise specified:
  - .1 Style: Capital letters, minimum 12-mm (1/2-in) high, equal character spacing, centered (not justified).
  - .2 Colours: Colours of letters and background may change for each type of equipment or component. Provide colours to Owner requirements, otherwise provide white letters and black background.

.3 Warning: Install warning labels as required, including:
- .1 Warning of automatic control.
- .2 Warning of safety related matters.
- .3 Warning of restricted access by authorized and/or qualified personnel.
- .4 Warning of implications related to breaking means of restricting access including seals.

.4 Refrigeration System Marking and Labelling
- .1 Provide marking and labelling to CSA-B52 and ASHRAE-15, including:
  - .1 Signs, nameplates and instructions as required by CSA-B52, Article 5.11.
  - .2 Multiple sets of instructions for equipment of any size to CSA-B52, Article 5.11.5 to be posted at:
    - .1 Locations identified in CSA-B52, Article 5.11.5.
    - .2 Refrigeration equipment room main entrance as determined by Owner.
    - .3 Owner's preferred maintenance office.

.5 Ceiling Labelling
- .1 Provide coloured labels on ceiling surfaces to indicate equipment and components including the following:
  - .1 Variable air volume boxes.
  - .2 Dampers.
  - .3 Other air terminal devices.
  - .4 Reheat coils.
  - .5 Other coils.
  - .6 Control valves.
- .2 Label colours and/or styles may change for each type of equipment or component.
- .3 Provide labels as acceptable to Owner, including label type, material, size and colour.
- .4 Mark each label as acceptable to Owner, including equipment label, type, power circuit.

3.14 START-UP

.1 Provide the services of a qualified factory-trained manufacturer's representative to assist with installation and start-up.

.1 Submit manufacturer's start-up report, and written certification that the equipment has been installed, adjusted and tested in accordance with the manufacturer's recommendations.

3.15 ADJUSTING

.1 Adjusting: Adjust settings as required before Total Performance and throughout Correction Period to address performance issues, including safeties, operating limits, noise, vibration, efficiency, equipment longevity.

END OF SECTION 15 00 00

SECTION 15 05 00 PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

.1 Fluid piping and systems, water piping, closed and open loop systems, heating, service water systems, drain piping.

.2 Piping and piping components including components fittings, connectors, supports, valves, vents, drains, gauges, regulators.

.3 Relationship to other Sections:

.1 Section 25 05 00 Building Automation System describes additional requirements of components provided under this Section, including control valves.

.2 Section 25 90 00 Control Sequences describes additional requirements for control of equipment and components provided under this Section.

.3 Section 26 90 00 Control Devices describes additional requirements of components provided under this Section, including control valves.

1.2 REFERENCED DOCUMENTS

.1 AABC-TSB: AABC National Standards for Total System Balance, 2002.

.2 ASME-A13.1: ASME-A13.1-2007 Scheme for the Identification of Piping Systems.

.3 ASME-B16.1: ASME-B16.1-2010 Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.

.4 ASME-B16.3: ASME-B16.3-2011 Malleable Iron Threaded Fittings: Classes 150 and 300.

.5 ASME-B16.5: ASME-B16.5-2013 Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.

.6 ASME-B16.9: ASME-B16.9-2012 Factory-Made Wrought Buttwelding Fittings.

.7 ASME-B16.15: ASME-B16.15-2013 Cast Copper Alloy Threaded Fittings: Classes 125 and 250.

.8 ASME-B16.18: ASME-B16.18-2012 Cast Copper Alloy Solder Joint Pressure Fittings.

.9 ASME-B16.22: ASME-B16.22-2013 Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.

.10 ASME-B16.24: ASME-B16.24-2007 Cast Copper Alloy Pipe Flanges and Flanged Fittings: Classes 150, 300, 600, 900, 1500, and 2500.

.11 ASME-B18.2.1: ASME-B18.2.1-2012 Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series).

.12 ASME-B31.9: ASME-B31.9-2011 Building Services Piping.

.13 ASME-B40.100: ANSI/ASME-B40.100-2005 Pressure Gauges and Gauge Attachments.

.14 ASTM-A47: ASTM-A47/A47M-99 (2014) Standard Specification for Ferritic Malleable Iron Castings.

.15 ASTM-A53: ASTM-A53/A53M-12 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.

.16 ASTM-B32: ASTM-B32-08 Standard Specification for Solder Metal.

.17 ASTM-B88: ASTM-B88-09 Standard Specification for Seamless Copper Water Tube.

.18 ASTM-B209: ASTM-B209-10 Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

.19 ASTM-B813: ASTM-B813-10 Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube.

.20 ASTM-B828: ASTM-B828-02 (R2010) Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings.

.21 ASTM-C534: ASTM-C534/C534M-13 Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.

.22 ASTM-C547: ASTM-C547-12 Specification for Mineral Fiber Preformed Pipe Insulation.

.23 ASTM-C921: ASTM-C921-10 Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.

.24 ASTM-E96: ASTM-E96/E96M-13 Standard Test Methods for Water Vapor Transmission of Materials.
.25 AWS-A5.8: ANSI/AWS-A5.8/A5.8M Specification for Filler Metals for Brazing and Brazed Welding.
.26 CGSB-24.3: CAN/CGSB-24.3-92 Identification of Piping Systems.
.27 CGSB-51.53: CAN/CGSB-51.53-95 Jacketing, Polyvinyl Chloride Sheet, for Insulating Pipes, Vessels, and Round Ducts.
.28 CSA-B51: CSA-B51-09 Boiler, Pressure Vessel, and Pressure Piping Code.
.29 CSA-B214: CAN/CSA-B214-12 Installation Code for Hydronic Heating Systems, including CHC Handbook on Hydronic Heating Systems.
.30 CSA-W47.1: CSA-W47.1-09 Certification of Companies for Fusion Welding of Steel.
.31 CSA-W48: CSA-W48-14 Filler Metals and Allied Materials for Metal Arc Welding.
.32 CSA-W59: CSA-W59-13 Welded Steel Construction (Metal Arc Welding).
.33 Option: CSA-Z317.1 versions may be in force through operating practices of health care facility if adopted into operating practices by health care facility, and if so, may be enforceable by ON_MOHLTC who like to see it in the operating practices. Spec can refer to these out of best practices.
.34 FED-STD-595: United States Federal Standard 595 Colors Used in Government Procurement, issued by the General Services Administration, Revision C.
.35 IEC-60529: ANSI/IEC-60529-2013 Degrees of Protection Provided by Enclosures (IP Code).
.36 ISO-14726: ISO-14726-2008 Ships and Marine Technology - Identification Colours for the Content of Piping Systems.
.37 MICA-NISM: MICA National Commerial and Industrial Insulation Standards Manual, 2014.
.38 NEBB-TABES: NEBB Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems, 2005.
.39 NEMA-Z535.1: ANSI/NEMA-Z535.1-2006 (R2011) Safety Colors.
.40 TIAC-BPG: TIAC Mechanical Insulation Best Practices Guide, 2013.
.41 ULC-S102: CAN/ULC-S102-10 Surface Burning Characteristics of Building Materials and Assemblies.
.42 ULC-S115: CAN/ULC-S115-11 Standard Method of Fire Tests of Firestop Systems.

1.3 DEFINITIONS

.1 “DN”: Diameter Nominal (Metric)
.2 “NPS”: Nominal Pipe Size (Imperial)
.3 “NPT”: National Pipe Thread
.4 “Piping Components”: Additional hardware required to complete a fully functional piping system, including piping, fittings, connectors, anchors, guides, supports, hangers, air vents, vacuum breakers, valves, vents, drains, gauges, flow and pressure control and limiting, pump ancillary components, expansion tanks, chemical treatment systems.
.5 “TAB”: Testing, Adjusting, and Balancing

1.4 SUBMITTALS FOR ACTION

.1 Product Data
  .1 Manufacturers’ product literature, specifications, and datasheets. Include product characteristics, performance criteria, options, and limitations.
  .2 Control Valve Schedule including a separate line for each valve provided and a column for each of the valve attributes: Code Number, Configuration, Fail Position, Pipe Size, Valve Size, Body Configuration, Close off Pressure, Capacity, Valve CV, Design Pressure, and Actuator Type and Details.
.2 Shop Drawings
  .1 Piping Routing

.1 Layout and Interference Plans: Isometric sketches indicating clearances, interferences, and relocation of interfering services, components, objects, and structures.
.2 Fire Separations: Location of penetrations through fire separations and other assemblies.
.3 Pipe Drainage: Indicate details of piping slope angles and drainage where applicable.
.4 Expansion Compensation: Location of piping expansion control measures.
.5 Vibration Isolation: Location of vibration isolation connectors.
.6 Ports and Thermowells: Location of ports and thermowells.

.2 Mounting: Details of bases, hangers, and supports.
.3 Fire Stopping and Smoke Seals
.1 Locations and types marked on plan drawing.
.2 ULC assembly number certification.
.3 Required temperature rise and flame rating.
.4 Hose stream rating where applicable.
.5 Materials of fire stopping and smoke seals, primers, reinforcements, damming materials, reinforcements, and anchorages/fastenings.
.6 Assembly and penetration type and required ratings, adjacent materials.
.7 Openings size, thickness, dimensions.
.8 Proposed installation methods.
.9 Summaries of similar types of penetrations, assembly type and construction, service penetrating assembly, adjacent materials, fire stopping and smoke seal type, ratings, other work required.
.10 Copies of ULC certifications for proposed systems and designs for specific devices and materials.
.11 Image of sample tag.
.4 Labels: Scaled drawings indicating label types, dimensions, layout, locations, wording, font, spacing, colours. Specifically identify letter sizes larger than indicated minimum heights.

1.5 SUBMITTALS FOR INFORMATION

.1 Certificates
.1 Letter certifying piping support as installed has been designed and installed in compliance with required seismic restraint provisions.
.2 Letter certifying that materials comply with specified performance characteristics and physical properties.
.3 Letter from piping support manufacturer certifying pipe support systems have been installed in compliance with Contract Documents.
.4 Letter from fire stopping and smoke seals installer certifying that fire stopping and smoke seals have been installed in accordance with regulatory requirements and Contract Documents.

.2 Manufacturer Information
.1 Fluid Treatment: Submit written operating instructions on treatment dosages, control charts and test procedures.

.3 Balancing Reports
.1 Balancing Reports compliant with NEBB-TABES or AABC-TSB recommendations.
.2 Pressure Test Reports compliant with NEBB-TABES or AABC-TSB recommendations.

.4 Qualification Statements
.1 Welding: Proof of certifications for company and personnel.
.2 TAB: Proof of certifications for company and personnel.
.3 Professional Engineering: Proof of licences for company and personnel.

.5 Documentation
.1 Shutoff valve charts.

.6 Other/Photographs
.1 Required photographs.

1.6 SUBMITTALS FOR CLOSEOUT

.1 Maintenance Contracts
.2 Operation and Maintenance Data
.3 Maintenance Materials
.1 Fluid Treatment Supplies: Provide 1-year's supply of fluid treatment chemicals.

1.7 QUALITY ASSURANCE

.1 Qualifications
.1 Welding
.1 Company certified to CSA-W47.1 by CWB.
.2 Personnel to have welding qualifications to CSA-B51.
.2 TAB
.1 Company and personnel certified to CAABC or NEBB.
.2 Subject to approval.
.3 Fire Stopping and Smoke Seals: Company member of FCIA.
.4 Professional Engineering
.1 Company and personnel licensed to practice Professional Engineering by PEO.
.2 Subject to approval.

1.8 WARRANTY

.1 Extended Correction Period and Warranty Period
.1 2-years on welding, soldering.

PART 2 PRODUCTS

2.1 COMMON PRODUCT REQUIREMENTS

.1 The precise type, quantity and location of products furnished under this Section depends, in part, on routing and installation choices made by Contractor. Provide products:
.1 Rated to handle the extremes of temperature, pressure, abrasion, and corrosion to which they will be subjected.
.2 With materials suitable for the fluid type and conditions to which they will be exposed.
.3 Appropriately sized as required.
.4 As indicated.
.5 To ASME-B31.9.
.6 To CSA-B214.
.2 Piping Components and Fittings
.1 Materials: Match pipe unless otherwise indicated or required for system performance.
.2 Size: Match pipe size unless otherwise indicated or required for system performance including control.
.3 Type: Match type consistent with Work where not indicated.
.4 Joints: Use flanges for larger than NPS-2 unless otherwise indicated.

2.2 PIPES

.1 Provide as required.
.2 CO-T - Copper Tube
.1 To ASTM-B88.
.2 Type
.1 CO-T-K - Type K (Metric Type A)
.2 CO-T-L - Type L (Metric Type B)
.3 Weight
.1 CO-T-xH - Hard: Use unless otherwise required.
.2 CO-T-xS - Soft
.3 CS-P - Carbon Steel Pipe
.1 To ASTM-A53.

.2 Type
.1 CS-P-E - Type E: Electric-Resistance Welded, Grade B
.2 CS-P-S - Type S: Seamless, Grade B
.3 Weight
.1 CS-P-x40 - Schedule 40
.2 CS-P-x80 - Schedule 80
.4 SI-H - Silicone Hose
.1 Manufacturers
.1 Nexgen Hose Inc., Silicone Tubing, Class 791 Nexsil FDA
.2 Type
.1 Minimum of:
.1 Manufacturers as listed above.
.2 As recommended by combustion equipment manufacturer.
.5 Drainage Waste Vent
.1 Plumbing
.1 PVC or DWV or as required.
.2 Other Services
.1 As indicated, otherwise as required for service, otherwise match piping requirements.

2.3 FITTINGS

.1 Provide as required, including unions, flanges, tees, and elbows including long and short radius.
.2 Steel: Screwed and welded including flanged:
.1 Screwed Fittings: Malleable iron, to ASME-B16.3.
.2 Flanges and Flanged Fittings
.1 Steel: To ASME-B16.5.
.3 Buttwelding Fittings: Steel, to ASME-B16.9.
.4 Unions: Malleable iron, to ASTM-A47 and ASME-B16.3.
.5 Bolts and Nuts: To ASME-B18.2.1.
.3 Copper: Screwed and soldered including flanged:
.1 Cast Copper: To ASME-B16.18.
.2 Wrought Copper: To ASME-B16.22.
.3 Bolts and Nuts: To ASME-A307.
.4 Bronze: Screwed and brazed including flanged:
.1 Screwed Fittings: Cast bronze, to ASME-B16.15.
.2 Flanges and Flanged Fittings: To ASME-B16.24.
.5 Elbows
.1 Select elbows with equal inlet and outlet port diameters unless otherwise indicated.
.2 Provide long radius type unless otherwise indicated.
.3 Provide short radius type when approved by Engineer.

2.4 ANCHORS, GUIDES, SUPPORTS, AND HANGERS

.1 Design of piping support depends, in part, on routing and installation choices made by Contractor. Design of piping support is Contractor responsibility.
.2 Provide as required.
.1 Design to ASME-B31.9.
.2 Design for easy removal.
.3 Performance
.1 Design pipe supports to withstand seismic events as required. Seismic restraint provisions shall meet or exceed requirements for post-disaster buildings in the respective seismic zone.
.2 Prevent pipe noise and vibration from being transferred to supporting structure.
.3 Angularity of rod hanger resulting from horizontal movement of piping from cold to hot position not to exceed 4-degrees from vertical.

.4 For piping at risk of condensation mount hangers over insulation and vapour barrier to prevent condensation of hanger rods, including chilled piping, domestic water, cooling condensate piping, humid or wet environments.

2.5 FIRE STOPPING AND SMOKE SEALS

.1 Asbestos-free materials and systems capable of maintaining effective barrier against flame, smoke and gases to ULC-S115.
.2 Manufacturers: 3M, Fire Protection Products
.3 Materials
  .1 Fire stopping and smoke seal components: Certified by test laboratory to ULC-S115.
  .2 In assemblies: Systems tested to ULC-S115.
  .3 In wet environments, waterproof assemblies, or exterior assemblies including foundations and below grade floors: Waterproof, non-hardening.
  .4 Penetrations requiring vibration control: Elastomeric seal.
  .5 Damming and backup materials, supports and anchoring devices: To manufacturer's recommendations, and in accordance with tested assembly being installed as acceptable to authorities having jurisdiction.
  .6 Other locations: As required.
.4 Performance: Rating: 2-hours, unless otherwise required.

2.6 BALL SHUTOFF VALVES

.1 Provide as required.
.2 Manufacturers
  .1 Crane Co., Crane
  .2 Crane Co., Jenkins
  .3 Kitz Corporation
.3 Type
  .1 Heavy duty design.
  .2 Full port balls.
  .3 Solid balls with materials as follows as required:
    .1 Chrome plated.
    .2 Stainless steel.
  .4 Double o-ring.
  .5 Full sized lever handle.
  .6 Body materials with materials as follows as required:
    .1 Brass.
    .2 Stainless steel.
  .7 Close-off pressure rated for dead-end service with piping on 1 side of shutoff valve disconnected.

2.7 GLOBE SHUTOFF VALVES - ANGLED

.1 Provide as required.
.2 Manufacturers
  .1 Dahl Brothers Canada Limited
.3 Type
  .1 Regular pattern radiator valves.

2.8 OTHER SHUTOFF VALVES

.1 Provide as required.
.2 Manufacturers
  .1 Crane Co., Crane
  .2 Crane Co., Jenkins
  .3 Kitz Corporation
.3 Type
  .1 Materials: As required.

.2 Close-off pressure rated for dead-end service with piping on 1 side of shutoff valve disconnected.

2.9 CONTROL VALVES

.1 Provide as indicated.
.2 Manufacturers
  .1 Belimo Automation AG
  .2 Bray International, Inc.
.3 Size: As indicated where all characteristics are indicated. Where all characteristics are not indicated, as required including for performance of entire system.
.4 Materials: As required.
.5 Actuators: To Section 26 90 00 Control Devices.
.6 3-Way Valves
  .1 Select valve port configuration as required.

2.10 MEASURING PORTS - TEMPERATURE AND PRESSURE

.1 Provide as indicated.
.2 Manufacturers
  .1 Pete's Plug II
  .2 Wika
  .3 Caleffi
  .4 NuTech
.3 Features
  .1 2 self sealing valve cores.
  .2 Threaded connections.
  .3 Brass cap with colour cap strap.
.4 Materials
  .1 Body: Brass.
  .2 Valve: Nordel rated to 275-°F (135-°C) for systems with maximum operating temperature greater than 160-°F (71-°C). Otherwise, Neoprene rated to 200-°F (93-°C).
.5 Options
  .1 Provide extended length for insulated piping.
  .2 Provide 1 test gauge kit per quantity of 50 products.
.6 Performance
.7 Ratings
  .1 Maximum Working Pressure: Minimum 1,000-psig (6,895-kPa) at 140-°F (60-°C).
.8 Certifications, Listings and Registrations

2.11 COMBINATION AUTOMATIC FLOW LIMITING VALVE/BALL SHUTOFF VALVE

.1 Provide as indicated.
.2 Manufacturers
.3 Features
  .1 Automatic flow limiting valve with flow limiting diaphragm cartridge.
  .2 Full port ball shut off valve.
  .3 2 temperature or pressure measuring ports.
  .4 Threaded connections.
  .5 Union.
.4 Materials
  .1 Body: Brass.
  .2 Stem: Stainless steel.
  .3 Ball: Chrome plated.
  .4 Ball Seal: PTFE.
  .5 Cartridge Body: Brass.Diaphragm: EPDM.
  .7 Spring: Stainless steel.

.5 Options
.1 Metering port extensions for insulated piping.
.6 Performance
.1 Flow Accuracy: +/- 5-%
.7 Ratings
.1 Control Range: Maximum differential pressure: 60-psig (414-kPa).
.2 Maximum Working Pressure: Minimum 400-psig (2,757-kPa).
.3 Operating Temperature Range: -4-°F (-20-°C) to 250-°F (121-°C)
.8 Certifications, Listings and Registrations

2.12 COMBINATION STRAINER/BALL SHUTOFF VALVE

.1 Provide as indicated.
.2 Manufacturers
.3 Features
.1 "Y" type strainer with hose end drain valve and cap.
.2 Full port ball shut off valve.
.3 Temperature or pressure measuring port.
.4 Threaded connections.
.5 Union.
.4 Materials
.1 Body: Brass.
.2 Stem: Stainless steel.
.3 Ball: Chrome plated.
.4 Ball Seal: PTFE.
.5 Strainer: Stainless steel.
.5 Options
.1 Provide metering port extensions for insulated piping.
.2 Bypass port.
.6 Performance
.1 Maximum Working Pressure: Minimum (2,757-kPa).
.2 Operating Temperature Range: -4-°F (-20-°C) to 250-°F (121-°C)
.7 Ratings
.8 Certifications, Listings and Registrations

2.13 GLOBE MANUAL BALANCING VALVES

.1 Provide as indicated.
.2 Manufacturers
.1 Armstrong Fluid Technology, CBV-V/CBV-F Series
.2 IMI Hydronic Engineering, STAD/STAF Series
.3 Oventrop Corporation, Hydrocontrol R/F Series
.3 Features
.1 Globe style valve body.
.2 2 x 6-mm (1/4-in) threaded brass metering ports with check valves and gasketed caps.
.3 Handwheel capable of minimum 5 full 360-degree turns, complete with micrometer type indicators.
.4 Hidden memory stop to set and lock valve position at balance point.
.5 Straight or angled configuration as required.
.6 If available in product line:
.1 Venturi style measuring port built into valve body if available.
.2 Flow smoothing fins downstream of valve seat.
.4 Materials
.1 Valve Body, Stem, Disk: Cast iron for flanged, brass otherwise.
.2 Seat: EPDM or Viton as required.
.3 Handhweel: Reinforced nylon.
.5 Options

.1 Provide metering port extensions for insulated piping.
.6 Performance
.7 Ratings
.8 Certifications, Listings and Registrations
.9 Not Acceptable: Use as a shutoff valve.

2.14 STRAINERS

.1 Provide as indicated.
.2 Manufacturers
.1 Armstrong International, Inc.
.2 ISLIP Flow Controls Inc.
.3 Spirax-Sarco Limited
.3 Type
.1 NPS-2 and under:
.1 "Y" type.
.2 Screwed cleanout plug.
.2 NPS-2-1/2 to NPS-8:
.1 "Y" type.
.2 Bolted cleanout plug.
.3 Above NPS-8:
.1 "T" type.
.2 Bolted cleanout plug.
.4 Screen: Stainless steel.
.5 Materials: As required.
.6 Blowout: 19-mm (3/4-in) blow off valve unless otherwise indicated.

2.15 CHECK VALVES

.1 Provide as indicated.
.2 Manufacturers
.1 Crane Co.
.2 ISLIP Flow Controls Inc.
.3 Spirax-Sarco Limited
.3 Type
.1 NPS-2 and under:
.1 Type: Swing.
.2 Body: Y pattern with integral seat at 45-degrees, screw in cap with hex head.
.3 Disc: Renewable rotating disc, 2 piece hinge disc construction.
.4 Seat: Regrindeable.
.2 NPS-2-1/2 and above:
.1 Type: As required.
.2 Body: Bolted cover, tapped and plugged opening on each side for hinge pin.
.3 Disc: Secured to stem, rotating for extended life.
.4 Seat: Regrindable, integral with body.
.3 Materials: As required.

2.16 COMBINATION BALANCING/CHECK VALVES

.1 Provide as required.
.2 Provide components from same manufacturer as pump.
.3 Provide as indicated.
.4 Manufacturers
.1 S.A. Armstrong Limited
.2 Bell and Gossett
.3 Taco Inc.
.5 Type
.1 Combination of balancing valve and check valve.

.2 Body
.1 Cast iron valve body.
.2 Capable of elbow or straight orientation, field adjustable.
.3 Flanged connections.
.3 Balancing Valve.
.1 Globe style.
.2 Stainless steel stem.
.3 Field changeable o-ring.
.4 Check Valve
.1 Spring closure silent non-slam check.
.2 Bronze plug and disc.
.5 Measuring and Drain Ports
.1 2 ports on each side of valve body.
.2 2 brass ports including check valves and gasketed caps.

2.17 COMBINATION STRAINER/FLOW STRAIGHTENERS

.1 Provide as required.
.2 Provide as indicated.
.3 Provide components from same manufacturer as pump.
.4 Manufacturers
.1 S.A. Armstrong Limited
.2 Bell and Gossett
.3 Taco Inc.
.5 Type
.1 Combination of basket strainer and flow straightener.
.2 Body
.1 Cast iron.
.2 Flanged connections.
.3 Blow down connection point.
.3 Strainer
.1 Removable stainless steel strainer.
.2 Fine mesh startup strainer.

2.18 RELIEF VALVES

.1 Provide as required, including the following:
.1 Temperature relief valves.
.2 Pressure relief valves.
.3 Combined temperature and pressure relief valves.
.4 Automatic reseating combined temperature and pressure.
.2 Type
.1 Automatic reseating combined temperature and pressure.
.1 Manufacturers
.1 Watts Industries (Canada) Inc., Series 40/140/240/340
.2 To CSA-4.4.

2.19 DRAIN VALVES

.1 Provide as required.
.2 Manufacturers
.1 Crane Co.
.2 Conbraco Industries, Inc., Apollo
.3 Toyo Valve Co., Ltd.
.3 Sediment Faucets
.1 Provide 13-mm (1/2-in) sediment faucets with hose thread outlets.
.2 Materials: Brass unless otherwise required.

2.20 AIR SCOOPS

.1 Provide as indicated.
.2 Features
  .1 Single piece construction.
  .2 Piping connections on top and bottom.
  .3 Baffle to separate gases from liquids into vent connection.
.3 Manufacturers
  .1 Amtrol Inc., Air Separator, In-Line Purger
  .2 Taco, Inc., Model AS
.4 Ratings
  .1 Maximum Working Temperature: 149-°C (300-°F)
  .2 Maximum Flow Velocity: Minimum 2.4-m/2 (8-ft/s)

2.21 AIR VENTS

.1 Provide as required.
.2 Manufacturers
  .1 Maid-O'-Mist, No. 7 Series
  .2 Taco, Inc., 409
  .3 Honeywell International Inc., EA122 Series
  .4 Spirax-Sarco Limited, 13WS

2.22 COMBINED AIR VENT AND VACUUM BREAKERS

.1 Provide as required.
.2 Manufacturers
  .1 Armstrong International Inc., TAVB Series
  .2 Watts Industries (Canada) Inc., FV-4M1

2.23 PRESSURE GAUGES

.1 Provide as required.
.2 Manufacturers
  .1 H.O. Trerice Co.
  .2 Winters Instruments
.3 Size
  .1 Piping not greater than NPS-2: 63-mm (2-1/2-in) diameter dial face.
  .2 Piping greater than NPS-2: 100-mm (4-in) or 113-mm (4-1/2-in) diameter dial face.
  .3 Increase dial size by 50-mm (2-in) diameter when located at more than 2.4-m (8-ft) away from viewing area including floor, operating platform.
.4 Scale
  .1 Pressure not greater than 6.9-kPa (1-psi): Dual scale, inches of water gauge and ounces/in2 gauge.
  .2 Pressure greater than 6.9-kPa (1-psi): Dual scale, psi gauge and kilopascal gauge.
.5 Range: Select scale ranges to suit the application, including operating pressure or vacuum, with readings at approximately mid-point on the dial.
.6 Materials
  .1 Case
    .1 Exterior: Stainless steel.
    .2 Interior: Painted steel or aluminum.
.7 Housing
  .1 Minimum IP65, certified to IEC-60529.
.8 Performance
  .1 Accuracy: +/-1-% Grade 1A to ASME-B40.100.

2.24 TEMPERATURE GAUGES

.1 Provide as required.
.2 Manufacturers
  .1 H.O. Trerice Co.
  .2 Winters Instruments

.3 Size
  .1 Piping not greater than NPS-2: 50-mm (2-in) dial face.
  .2 Piping greater than NPS-2: 100-mm (4-in) or 113-mm (4-1/2-in) diameter dial face.
  .3 Increase dial size by 50-mm (2-in) diameter when located at more than 2.4-m (8-ft) away from viewing area including floor, operating platform.
.4 Scale: Dual scale, both Fahrenheit and Celsius degrees, direct reading to 1-°C (2-°F).
.5 Range: Select scale ranges to suit the application, including operating temperatures.
.6 Materials
  .1 As required, including compatible with thermowells.
.7 Housing
  .1 Minimum IP65, certified to IEC-60529.
.8 Performance
  .1 Accuracy: 1-% to 1-1/2-%

2.25 THERMOWELLS

.1 Provide as required, including for thermometers and other devices including fluid temperature sensors and switches.
.2 Provide spare thermowells as indicated.
.3 Provide device and thermowell as a complete assembly, including wellhead and Greenfield fitting.
.4 Materials: 316 stainless steel
.5 Construction: Component machined as a single part.
.6 Unacceptable: Component welded together from separate parts.

2.26 SIDESTREAM FILTERS

.1 Provide as indicated.
.2 Manufacturers
  .1 General Filtration, GFC Series
.3 Ratings
  .1 Pressure: 1,034-kPa (150-psi)
  .2 Temperature: 121-°C (250-°F)
.4 Size
  .1 Suitable for flow rate as indicated.
  .2 Select number of cartridges based on maximum 5-USgpm per cartridge.
.5 Features
  .1 Centre post design.
  .2 Swing bolt style lid with lifting handle.
  .3 Port Size: Minimum 1-1/2-in.
  .4 Drain: 1/2-in drain port at bottom.
  .5 Welded construction with integral legs for fixing to floor.
  .6 Accepts standard 10-in length DOE cartridges 2.5-in to 2.75-in diameter.
.6 Materials
  .1 Epoxy coated steel.
  .2 Buna N seal at lid.

2.27 CHEMICAL POT FEEDERS

.1 Provide as indicated.
.2 Manufacturers
  .1 Pump Solutions Group (PSG), a Dover Company, Neptune Brand
  .2 General Filtration
.3 Ratings
  .1 Pressure: 2,068-kPa (300-psi)
  .2 Temperature: 93-°C (200-°F)
.4 Size: As indicated.
.5 Features

.1 Cap
.1 Can be opened by hand without use of tools
.2 Minimum 2.5 turns to open.
.2 Number of Ports: Minimum 4 side ports.
.3 Port Size: Minimum 3/4-in.
.6 Materials
.1 Epoxy coated steel.
.2 Buna N seal at cap.

2.28 PIPE INSULATION

.1 Provide insulation on piping and piping components unless otherwise indicated.
.2 Provide adhesive, tape, sealants, cement, and mastic as recommended by, and compatible with, insulation and insulation jacket manufacturers.
.3 Common Performance Requirements
.1 Flame-Spread: Maximum 25 tested to ULC-S102.
.2 Smoke Developed: Maximum 50 tested to ULC-S102.
.4 Type EF - Flexible Elastomeric Foam
.1 Manufacturers
.1 Armacell LLC, AP Armaflex Tube
.2 Nomaco Inc., FlexTherm
.2 To ASTM-C534.
.5 Type MF - Preformed Mineral Fibre
.1 Manufacturers
.1 Owens Corning Canada Inc., SSL II FIBERGLAS
.2 To ASTM-C547.

2.29 JACKETS

.1 Provide jackets around insulated piping and piping components unless otherwise indicated.
.2 Common Performance Requirements
.1 Flame-Spread: Maximum 25 tested to ULC-S102.
.2 Smoke Developed: Maximum 50 tested to ULC-S102.
.3 Type ALU - Aluminum Jacket
.1 Provide as required.
.2 To ASTM-B209.
.3 Thickness: 0.4-mm (0.016-in)
.4 Finish: Corrugated unless otherwise indicated.
.5 Joining: Longitudinal and circumferential slip joints with 50-mm (2-in) laps.
.6 Fittings: 0.5-mm (0.02-in) thick die shaped fitting covers with factory attached protective liner.
.7 Banding and Mechanical Seals: 12-mm (1/2-in) wide; 0.5-mm (0.02-in) thick stainless steel.
.4 Type CAN - Canvas Jacket
.1 Provide as required.
.2 ULC listed.
.3 Fabric: ASTM-C921, 220-g/m2 (6-oz/yd2), plain weave cotton treated with dilute fire retardant lagging adhesive.
.5 Type PVC - Polyvinyl Chloride Jacket
.1 Provide as required.
.2 Manufacturers
.1 Johns Manville, Ceel-Co
.2 Knauf Insulation, Proto
.3 Provide preformed, moulded type jacketing as required for a complete vapour barrier jacket.
.4 To CGSB-51.53.
.5 Colour: White unless otherwise indicated.

.6 Moisture Vapour Transmission: To ASTM-E96, 0.02-metric-perm (0.03-USperm).
.7 Thickness: 0.5-mm (0.02-in)
.8 Fastenings: Solvent weld adhesive, unless other fastening means are accepted by Engineer, including tacks, pressure sensitive colour matching vinyl tape.

.6 Type SS - Stainless Steel Jacket
.1 Provide as required.
.2 Materials: 304 stainless steel.
.3 Thickness: 0.4-mm (0.016-in)
.4 Finish: Corrugated unless otherwise indicated.
.5 Joining: Longitudinal and circumferential slip joints with 50-mm (2-in) laps.
.6 Fittings: 0.5-mm (0.02-in) thick die shaped or fabricated fitting covers.
.7 Banding and Mechanical Seals: 12-mm (1/2-in) wide, 0.5-mm (0.02-in) thick stainless steel.

2.30 FLUID TREATMENT CHEMICALS

.1 Provide chemicals as required for start-up and flushing activities.
.2 Provide chemicals as required for control of corrosion, scale, and biological growth including algae.

PART 3 EXECUTION

3.1 EXAMINATION

.1 Inspect distribution piping for the existence of piping dead legs and sections that cannot be drained down. Notify Engineer of discoveries.
.2 Determine exact location and routes for piping. Modify routing and/or relocate existing services as required.
.3 Complete x-ray scans, consultation, and other investigative work as required to verify structural member construction, verify suitable locations, and ensure drilling and coring through structural members will not affect integrity.
.4 Investigate fire separations and non-fire-resistance rated assemblies in affected areas for existing fire stopping or smoke sealing that is improperly sealed or defective, as well as for penetrations not fire stopped or smoke sealed.

3.2 PREPARATION

.1 Eliminate piping dead legs and sections that cannot be drained down.
.2 Flush and clean affected piping systems including new and existing piping and piping components before being put into service.

3.3 COMMON EXECUTION REQUIREMENTS

.1 Install products including piping joining method:
.1 As indicated.
.2 To ASME-B31.9.
.3 To CSA-B214.
.4 Welding
.1 To CSA-W59.
.2 Filler metals and allied materials to CSA-W48.
.3 Prepare galvanized components before welding by scraping off galvanizing prior to welding.
.5 Soldering
.1 Soldering to ASTM-B828.
.2 Solders to ASTM-B32.
.3 Fluxes for soldered joints to ASTM-B813.
.4 Solders and fluxes to have less than 0.2-% lead content.
.6 Brazing
.1 In addition to soldering requirements, brazing alloys to AWS-A5.8, BCuP range.
.2 Unless otherwise indicated, provide and install piping and components to meet equipment manufacturer's requirements.

.3 Install concealed piping to minimize furring space, maximize headroom, and conserve space.
.4 Install piping components in accessible locations.
.5 Install to permit separate thermal insulation of each pipe unless otherwise indicated.
.6 Install to eliminate piping dead legs and sections that cannot be drained down.
.7 Group piping wherever possible.
.8 Grade: Slope piping as required to ensure proper drainage.
.9 Di-electric Connections: Provide for cathodic protection wherever dissimilar piping materials are connected together.
.10 Ensure piping is not supported from other services, including other piping systems.
.11 Ensure other services are not supported from piping, including other piping systems and wiring.

3.4 PIPES

.1 Install as required.
.2 Completely remove burrs, sharp edges, and other discontinuities from inside and outside surfaces of pipes and fittings prior to joint connection.
.3 Promtly remove excess flux from inside and outside surfaces of pipes and fittings following soldering or brazing.
.4 Minimize time between application of flux and completion of soldering or brazing.

3.5 FITTINGS

.1 Install as required.

3.6 ANCHORS, SUPPORTS, GUIDES AND HANGERS

.1 Design and provide anchors, supports, guides and hangers as required.
.2 Fasteners: Wedge, sleeve or epoxy type anchor bolts. Refrain from using self-drilling or power-driven anchor bolts.
.3 Anchors: Locate concrete anchors for equipment away from edges, stress joints, or existing fractures. Follow manufacturer's instructions on minimum anchor spacing.
.4 Hangers: Use trapeze type hangers where pipes are grouped together, unless otherwise indicated. Suspend horizontal member by adjustable rods with locking feature for maintaining level and slope. Provide auxiliary steel required to support trapeze between building steel.
.5 Refrain from hanging pipe from another pipe unless otherwise indicated.
.6 Adjust support system including hangers to equalize load.

3.7 PENETRATIONS

.1 Provide sleeves at penetrations and where piping passes through assemblies including walls, floors and ceilings.
.2 Pack sleeves with resilient packing or fire rated packing and materials as required.
.3 Flash parts built into or passing through to wet environments, waterproof assemblies, or exterior assemblies including roofs, outside walls.
.4 Patch holes to match existing surfaces.
.5 Provide minimum clearances as required between sleeves and uninsulated or insulated piping with minimum of:
  .1 From Combustibles: As required.
  .2 Below Grade: 25-mm (1-in)
  .3 Other Locations: 13-mm (1/2-in)
.6 Sleeve Materials
  .1 Exterior Assemblies: Carbon steel schedule 40, primed and painted to Section 09 91 00 Painting.
  .2 Masonry and Concrete Assemblies: Carbon steel schedule 40, primed and painted to Section 09 91 00 Painting.
  .3 Interior Frame Construction Assemblies in Conditioned Spaces: Carbon steel schedule 40.

.4 Other Frame Construction Assemblies: Carbon steel schedule 40 primed and painted to Section 09 91 00 Painting.

.7 Extend floor sleeves 38-mm (1-1/2-in) above floor surface.

.8 Seal floor sleeves with an approved stiff setting caulking compound to serve as a water dam.

.9 Conceal sleeves at penetrations in finished areas with approved escutcheons.

3.8 FIRE STOPPING AND SMOKE SEALS

.1 Fire stop and smoke seal at fire-resistance rated assemblies including:
- .1 Penetrations through masonry, concrete, and frame construction including gypsum board partitions and walls.
- .2 Penetrations through floor slabs, ceilings and roofs.
- .3 Openings and sleeves installed for future use.
- .4 Services, including mechanical and electrical.
- .5 As indicated.

.2 Fire stop and smoke seal at non-fire-resistance rated assemblies including:
- .1 Assemblies not fire-resistance rated but constructed as such.
- .2 As indicated.

.3 Install fire stopping and smoke seal material and components in accordance with manufacturer's certified tested system listing.

.4 Install to allow for movement and thermal expansion of services including piping and ducting.

.5 Ensure integrity of fire stopping and smoke seals are such that passage of flame, smoke and gases is prevented to unexposed side of assembly. Repair as required.

.6 Ensure integrity of insulation and vapour barriers. Repair as required.

.7 Repair holes, gaps, openings and improperly fire stopped and smoke sealed penetrations in affected assemblies.

.8 Provide tags for each fire stopping and smoke seal. Include relevant information on tags including installer name, company, trade license, installation date, fire stopping and smoke seal assembly number. Mount at locations as approved by Owner or as required by authorities having jurisdiction.

3.9 SHUTOFF VALVES

.1 Install as required.

.2 Provide shutoff valves to facilitate isolation and maintenance of serviceable equipment and piping components in addition to indicated locations.

.3 Install with stems above horizontal position unless otherwise indicated.

.4 Install isolating shutoff valves at branch take-offs for isolating purposes, unless otherwise specified.

.5 Install remote operators including chains on shutoff valves NPS-2-1/2 or larger where installed more than 2.4-m (8-ft) above floor.

.6 Provide caps for shutoff valves that terminate at end of piping. Provide threaded caps complete with chain for shutoff valves NPS-2 and smaller. Provide joint type as indicated for piping on shutoff valves larger than NPS-2.

.7 Provide numbered brass tags for identification for existing and new shutoff valves in affected areas. Coordinate numbering with existing and new shutoff valve charts. Provide new shutoff valve chart for affected areas, listing new and existing shutoff valves. Provide appropriately sized frames with glass cover for each affected area. Match existing shutoff valve chart frames unless otherwise approved by Owner. Mount shutoff valve charts in frames on walls of affected areas in locations approved by Owner.

3.10 CONTROL VALVES

.1 Install as required.

.2 Provide numbered brass tags for identification for existing and new control valves in affected areas. Coordinate numbering with existing and new control valve charts. Provide new control valve chart for affected areas, listing new and existing control valves. Provide

appropriately sized frames with glass cover for each affected area. Match existing valve chart frames unless otherwise approved by Owner. Mount valve charts in frames on walls of affected areas in locations approved by Owner.

3.11 MEASURING PORTS - TEMPERATURE AND PRESSURE

.1 Install as required.

3.12 COMBINATION AUTOMATIC FLOW LIMITING VALVE/BALL SHUTOFF VALVE

.1 Install as required.
.2 Provide 1 temperature/pressure test gauge kit for every 100 installed valves.

3.13 COMBINATION STRAINER/BALL SHUTOFF VALVE

.1 Install as required.
.2 Provide 1 temperature/pressure test gauge kit for every 100 installed valves.

3.14 GLOBE MANUAL BALANCING VALVES

.1 Install as required.
.2 Install with stems above horizontal position unless otherwise indicated.
.3 Provide 1 temperature/pressure test gauge kit for every 100 installed valves.
.4 Provide numbered brass tags for identification for existing and new balancing valves in affected areas. Coordinate numbering with existing and new balancing valve charts. Provide new balancing valve chart for affected areas, listing new and existing balancing valves. Provide appropriately sized frames with glass cover for each affected area. Match existing balancing valve chart frames unless otherwise approved by Owner. Mount balancing valve charts in frames on walls of affected areas in locations approved by Owner.

3.15 STRAINERS

.1 Install as required.
.2 Coordinate strainer basket mesh size for multiple strainers within same piping loop to:
  .1 Protect equipment, components and services as required.
  .2 Provide downstream strainer with finer mesh size on strainer basket.
.3 Provide drain piping for blowdown valves.

3.16 CHECK VALVES

.1 Install as required.

3.17 COMBINATION BALANCING/CHECK VALVES

.1 Install as required.
.2 Install to more stringent requirements of:
  .1 Combination balancing/check valve manufacturer
  .2 Same manufacturer as above and their requirements for their pumps.
  .3 Actual installed pump manufacturer and their requirements for their combination balancing/check valve.
  .4 Actual installed pump manufacturer and their requirements for their pumps.

3.18 COMBINATION STRAINER/FLOW STRAIGHTENERS

.1 Install as required.
.2 Install to more stringent requirements of:
  .1 Combination strainer/flow straightener manufacturer.
  .2 Same manufacturer as above and their requirements for their pumps.
  .3 Actual installed pump manufacturer and their requirements for their pumps.
  .4 Actual installed pump manufacturer and their requirements for their combination strainer/flow straightener.

3.19 PRESSURE REDUCING VALVES

.1 Install as required.

3.20 RELIEF VALVES

.1 Install as required.

.2 Set and coordinate temperature and pressure settings with requirements of system and other temperature and pressure control devices including safeties.
.3 Provide discharge piping to floor drain and terminate in a manner that minimizes the risk of damage or personal injury, including discharging directly above floor drain, funnel or hub drain unless otherwise indicated.

3.21 DRAINS AND DRAIN PIPING

.1 Provide drain valves and drain connections at low points of piping systems, at equipment, and at section isolating valves, in addition to indicated locations.
.2 Provide drain valves, drain connections, hose bibs, automatic air vents and vacuum breakers as required to ensure proper operation and ease of servicing.
.3 Provide threaded drip caps complete with chain on drain valves, drain connections and hose bibs.
.4 Provide drain piping as indicated.
.5 Provide drain piping to floor drains and terminate where discharge is visible, including to nearest floor drain, funnel or hub drain unless otherwise indicated.
.6 Provide drain piping with drain piping routed to avoid tripping, except as follows:
  .1 Unless otherwise indicated.
  .2 Drain pipe is a tripping hazard as determined by Owner.
.7 Provide hoses to connect drain connections to floor drains in cases where drain piping for blowdown valves are not provided.

3.22 AIR SCOOPS

.1 Install as required.
.2 Select product to achieve peak system operation flows rates on the lower flow of the following:
  .1 Manufacturer recommend flow rate.
  .2 50-% of product maximum flow rate.

3.23 AIR VENTS AND VACUUM BREAKERS

.1 Provide combined air vents and vacuum breakers unless otherwise indicated.
.2 Provide automatic air vents, vacuum breakers, and combined air vents and vacuum breakers:
  .1 As indicated.
  .2 At high points of piping systems in addition to indicated locations.
.3 Provide isolating valves at each device.
.4 Provide drain piping.

3.24 PRESSURE GAUGES

.1 Install in locations that facilitate easy reading including aiming.
.2 Install in locations to prevent restriction of fluid flow in piping. Increase size of piping as required.
.3 Mount not higher from the viewing area including floor, operating platform, as follows unless otherwise required:
  .1 Differential Pressure Gauges: 1.5-m (5-ft)
  .2 Non-differential Pressure Gauges: 2.4-m (8-ft)
.4 Provide stem pipes and ancillary components as indicated. Where not indicated, provide stem pipes complete with full port ball type shutoff valve.

3.25 TEMPERATURE GAUGES

.1 Install in locations that facilitate easy reading including aiming.
.2 Mount not higher than 2.4-m (8-ft) from the viewing area including floor, operating platform.

3.26 THERMOWELLS

.1 Mount in a threadolet or 13-mm (1/2-in) NPT saddle to allow easy access to thermometers and other devices for repair or replacement.

.2 Install in locations to prevent restriction of fluid flow of piping. Increase size of piping as required.
.3 Fill thermowells with a high temperature mineral grease prior to insertion of thermometers and other devices.

3.27 SIDESTREAM FILTERS

.1 Install as required.
.2 Insulate filters and associated piping. Do not restrict access to serviceable components.
  .1 Insulation Type: EF
  .2 Insulation Thickness: Match requirements of connected system piping. Refer to piping schedule on drawings.

3.28 CHEMICAL POT FEEDERS

.1 Install as required.
.2 Insulate pot feeder and associated piping. Do not restrict access to serviceable components.
  .1 Insulation Type: EF
  .2 Insulation Thickness: Match requirements of connected system piping. Refer to piping schedule on drawings.

3.29 FINISHING

.1 Paint piping to Section 09 91 00 Painting as indicated, and as required where not indicated.

3.30 PIPE INSULATION AND JACKETS

.1 Replace insulation and jackets on existing piping as indicated.
.2 Replace damaged insulation and jackets on existing piping affected by Work.
.3 Provide vapour barrier on piping at risk of condensation.
.4 Install insulation, and seal seams and joints to prevent corrosion of pipe surface by condensation or precipitation.
.5 Install to:
  .1 MICA-NISM.
  .2 TIAC-BPG.
.6 Maintain continuity and integrity of vapour retarder jacket and finishes to prevent corrosion of pipe surface by condensation or precipitation.
.7 Provide access to service components and devices, including nameplates, access hatches and doors, operable components.
.8 Seams
  .1 Seal seams using seam sealant acceptable to manufacturer and Engineer.
  .2 Match seam sealant to jacket.
  .3 Minimize the number of seams by using full length insulation pieces.
  .4 Position overlaps to shed water.
  .5 Locate longitudinal seams at bottom of pipe.
.9 Supports and Hangers
  .1 Install supports and hangers outside vapour retarder jacket.
  .2 Install high compressive strength insulation under pipe supports to prevent compression of insulation.
.10 Additional Finishing
  .1 Type CAN - Canvas Jacket: Paint jackets to Section 09 91 00 Painting.

3.31 PIPE LABELLING

.1 Provide labels for piping denoting service type, piping service function, and flow direction.
  .1 Materials: Pressure sensitive vinyl with protective overcoating, waterproof adhesive undercoating, suitable for ambient conditions of continuous 100-%RH and continuous operating temperature of 150-°C (300-°F) with intermittent temperatures of 200-°C (390-°F).
  .2 Common Requirements
    .1 To ASME-A13.1.
    .2 To CGSB-24.3.

.3 Text Label: Provide labels with text on full description of service and indication of flow direction and function as applicable, including supply, return, bypass, discharge, relief.
.1 Text Description: As required by Owner, including as indicated or match existing, otherwise to indicated requirements and referenced documents.
.2 Text Font Type: As required by Owner, otherwise match existing, otherwise to indicated requirements and referenced documents.
.3 Text Font Size
.1 Minimum 25-mm (1-in) high for services 50-mm (2-in) diameter and smaller based on finished diameter including finsulation and jacket.
.2 Minimum 75-mm (3-in) high for services 300-mm (6-in) diameter and larger based on finished diameter including finsulation and jacket.
.3 Minimum 50-mm (2-in) high for other finished services.
.4 Increase letter size by 25-mm (1-in) high for services located at more than 2.4-m (8-ft) above floor.
.4 Text Colour: As indicated, otherwise as required by Owner, otherwise match existing, otherwise to indicated requirements and referenced documents.
.5 Text Label Size
.1 Borders: Minimum 25-mm (1-in) border widths around and in addition to text.
.2 Width: Minimum 300-mm (12-in) overall width.
.6 Background Colour
.1 As required by Owner, including as indicated or match existing, otherwise to ASME-A13.1 for label colour scheme and NEMA-Z535.1 for colours.
.2 Colour may vary for each service.

.4 Flow Direction Label: Provide labels with arrows to indicate flow direction.
.1 Arrow Direction
.1 Provide arrows for normal flow direction of operating service.
.2 Provide additional arrows for services intended to normally have flow in both directions including flow reversal.
.2 Size
.1 Width: Minimum 50-mm (2-in) width.
.2 Height: To accommodate full circumference of finished service.
.3 Colour: Arrow colour to match text colour. Background colour to be opposite of text colour, or clear if approved by Engineer.

.5 Band Label: Provide coloured bands to indicate specific service type group and function.
.1 Arrangement: As indicated, otherwise as required by Owner, otherwise to ISO-14726.
.2 Size
.1 Width: Minimum 90-mm (3-1/2-in) width, including for main colour and additional colour.
.2 Height: To accommodate full circumference of finished service.
.3 Colours
.1 As required by Owner, including as indicated or match existing, otherwise to ISO-14726 for label colour scheme and colours.
.2 Colour may vary for each service. Multiple colour labels may be required.

.6 Locations
.1 To facilitate easy reading.
.2 To indicated requirements and referenced documents.

.7 Intervals
.1 As follows, or at each change of flow direction, or as required if approved by Engineer.
.2 Every 3-m (10-ft) of length for services with 25-mm (1-in) high and shorter text.

.3 Every 6-m (20-ft) of length for services with 25-mm (3-in) high and taller text.
.4 Every 4.5-m (15-ft) of length for other services.

.2 Ceiling Labelling
.1 Provide coloured labels on ceiling surfaces to indicate equipment and components including the following:
.1 Control valves.
.2 Coils.
.3 Equipment.
.2 Label colours and/or styles may change for each type of equipment or component.
.3 Provide labels as acceptable to Owner, including label type, material, size and colour.
.4 Mark each label as acceptable to Owner, including equipment label, type, power circuit.

3.32 FIELD QUALITY CONTROL

.1 Concealment Documentation: Photograph piping work at each stage of concealment including:
.1 Painting.
.2 Insulating.
.3 Installation of jacket.
.4 Wall finishing.
.5 Other obstructions or concealment.

.2 Testing Documentation: Photograph piping system and service fluid conditions at each stage of testing including:
.1 Flushing.
.2 Cleaning.
.3 Leak testing.
.4 Pressure testing.
.5 Other quality control activities.

.3 Leak Testing
.1 Leak test each closed system while under test pressure with both a soap solution and an electronic leak detector.

.4 Pressure Testing: Hydrostatically pressure test each closed system for a minimum of 4-hours or as required. Pressure test to a holding pressure of the minimum of:
.1 As required.
.2 1.5-times the maximum potential operating pressure.
.3 1,034-kPa gauge (150-psi gauge).
.4 Maximum component pressure ratings.

3.33 START-UP

.1 Fill new or existing piping loops affected by Work with appropriate fluids.
.2 Complete testing and flushing activities.
.3 Replace filters and strainers on equipment and systems during construction as required and immediately before equipment start-up.
.4 Replace existing and new filters and strainers on equipment and systems immediately after substantial performance.
.5 Promptly following filling or addition of any fluid to affected piping loops, provide quantities of fluid treatment chemicals necessary to restore chemical concentrations to levels recommended by fluid treatment service provider.
.6 Execute equipment start-up procedures as required.

3.34 FLUSHING

.1 Flush and clean affected piping systems including new and existing piping and piping components before being put into service.
.2 Flush with appropriate chemicals and fluid temperature as required.

.3 Flush piping with water flowing at velocity of minimum 1.8-m/sec (6-ft/sec) or as required for period of 2-hours or longer as required to remove dirt, scale, and cuttings from entire length of piping.
.4 For components at risk of damage due to flushing activities, temporarily replace such components with appropriate fittings for duration of flushing. Return required components to their proper places at the conclusion of flushing activities.
.5 Disposal of cleaning solutions/chemicals to be approved by authorities having jurisdiction.
.6 Manufacturers Assistance: Flushing to be approved and completed under supervision of Owner's fluid treatment service company(s).

3.35 BALANCING

.1 Balance flows as indicated.
.2 Balance flows as required where not indicated.
.3 Tolerance: +/-2-%
.4 Tolerance: As required to assure flows can be adjusted by others using only balancing valves to achieve required flow rates.
.5 Allow for 2 additional site visits after receipt of Owner written approval for adjustments.

3.36 ADJUSTING

.1 Supports and Hangers
  .1 Vertical under normal operating conditions.
  .2 Equalize loads.
.2 Make-up Water and Expansion Tanks
  .1 Set and coordinate pressure settings with requirements of system and other pressure control devices including make-up water and expansion tanks.
  .2 Make adjustments under the following combinations of conditions:
    .1 Flow rate or withdrawal is at maximum, 25-% of maximum, no flow rate.
    .2 Pressure is at maximum and minimum.
  .3 Allow for 4 additional site visits after start-up and during Correction Period for adjustments to pressure settings during system operation and shutdown to improve system performance under various conditions including peak and seasonal loads.

3.37 MAINTENANCE

.1 Include bi-monthly visit by Owner's fluid treatment service company(s) for first 6-months operation, to check operation and to conduct tests of pertinent fluid treatment systems and submit written report on same.

END OF SECTION 15 05 00

SECTION 22 11 16 DOMESTIC PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

.1 Domestic piping systems, makeup water.
.2 Piping and piping components including fittings, connectors, supports, valves, vents, drains, gauges, regulators.
.3 Relationship to other Sections:
  .1 Section 15 05 00 Piping describes additional requirements of piping and piping components furnished under this Section.

1.2 REFERENCED DOCUMENTS

.1 CSA-4.4: ANSI-Z21.22-1999/CSA-4.4-M99 Relief Valves for Hot Water Supply Systems.
.2 CSA-B64: CSA-B64-11 Series: Backflow Preventers and Vacuum Breakers.
.3 CSA-B64.10: CSA-B64.10-11 Selection and Installation of Backflow Preventers.
.4 CSA-B64.10.1: CSA-B64.10.1-11 Maintenance and Field Testing of Backflow Preventers.
.5 CSA-B125.1: ASME-A112.18.1-2012/CSA-B125.1-12 Plumbing Supply Fittings.
.6 CSA-B125.3: CSA-B125.3-12 Plumbing Fittings.
.7 CSA-B356: CAN/CSA-B356-10 Water Pressure Reducing Valves for Domestic Water Supply.

1.3 DEFINITIONS

1.4 SUBMITTALS FOR ACTION

.1 Product Data: To Section 15 05 00 Piping.
.2 Shop Drawings
  .1 Domestic Piping Routing
    .1 Layout and Interference Plans: Isometric sketches indicating clearances, interferences, and relocation of interfering services, components, objects, and structures.
    .2 Fire Separations: Location of penetrations through fire separations and other assemblies.
    .3 Pipe Drainage: Indicate details of piping slope angles and drainage where applicable.
    .4 Expansion Compensation: Location of piping expansion control measures.
    .5 Vibration Isolation: Location of vibration isolation connectors.
    .6 Terminations: Indicate details and locations of terminations including vents.
  .2 Mounting: Details of bases, hangers, and supports.
  .3 Fire Stopping and Smoke Seals: To Section 15 05 00 Piping.
  .4 Labels: Details of piping and other labelling as indicated including to Section 15 05 00 Piping.

1.5 SUBMITTALS FOR INFORMATION

.1 To Section 15 05 00 Piping. In addition, provide the following.
.2 Qualification Statements
  .1 Plumbing: Proof of licenses for company and personnel.

1.6 SUBMITTALS FOR CLOSEOUT

.1 To Section 15 05 00 Piping.

1.7 QUALITY ASSURANCE

.1 To Section 15 05 00 Piping. In addition, provide the following.
.2 Qualifications
  .1 Plumbing: Company and personnel to be licensed plumbers.

1.8 WARRANTY

.1 To Section 15 05 00 Piping.

PART 2 PRODUCTS

2.1 COMMON PRODUCT REQUIREMENTS

.1 To Section 15 05 00 Piping. In addition, provide the following.
.2 Materials: Provide as required.
  .1 Specifically Prohibited: Metals subject to corrosion including non-stainless steel, iron, aluminum.
.3 To the following in the following order as applicable to specific products.
  .1 As indicated when specifically waiving the following requirements or as a substitution to the following requirements.
  .2 Plumbing Supply Fittings: To CSA-B125.1.
  .3 Plumbing Fittings: To CSA-B125.3.

2.2 PIPES

.1 Provide as required.
.2 To Section 15 05 00 Piping.

2.3 FITTINGS

.1 Provide as required.
.2 To Section 15 05 00 Piping. In addition, provide the following.
.3 Plumbing supply fittings to CSA-B125.1.
.4 Plumbing fittings to CSA-B125.3.

2.4 ANCHORS, GUIDES, SUPPORTS, AND HANGERS

.1 Provide as required.
.2 To Section 15 05 00 Piping.

2.5 SHUTOFF VALVES

.1 Provide as required.
.2 To Section 15 05 00 Piping.

2.6 STRAINERS

.1 Provide as required.
.2 To Section 15 05 00 Piping.

2.7 CHECK VALVES

.1 Provide as required.
.2 To Section 15 05 00 Piping.

2.8 BACK-SIPHONAGE PREVENTERS AND BACKFLOW PREVENTERS

.1 Provide as required.
.2 Type
  .1 Reduced pressure principal backflow preventer type unless otherwise indicated.
  .2 Selection to CSA-B64.10 where not indicated.
.3 Manufacturers
  .1 Conbraco Industries Inc.
  .2 Watts Industries (Canada) Inc.
.4 Certifications
  .1 Certified to CSA-B64 unless otherwise indicated.
  .2 Back-siphonage preventers (anti-siphon fill valves) for tank type water closets certified to CSA-B125.3.

2.9 MAKE-UP WATER VALVES

.1 Provide as indicated.
.2 Provide make-up water valves to deliver make-up water when system pressure falls below regulated supply pressure.
.3 Manufacturers
  .1 Taco, Inc., 329 Series
  .2 Armstrong International Inc., GD Series

.3 Watts Industries (Canada) Inc., U5 Series

2.10 PRESSURE REDUCING VALVES

.1 Provide as required.
.2 Type
.1 Pressure relief valve on low pressure side and gate valves on inlet and outlet.
.2 To CSA-B356.

2.11 RELIEF VALVES

.1 Provide as required, including the following:
.1 Temperature relief valves.
.2 Pressure relief valves.
.3 Combined temperature and pressure relief valves.
.4 Automatic reseating combined temperature and pressure.
.2 Type
.1 Automatic reseating combined temperature and pressure.
.1 Manufacturers
.1 Watts Industries (Canada) Inc., Series 40/140/240/340
.2 To CSA-4.4.

2.12 DRAIN VALVES

.1 Provide as required.
.2 To Section 15 05 00 Piping.

2.13 AIR VENTS

.1 Provide as required.
.2 To Section 15 05 00 Piping.

2.14 VACUUM BREAKERS

.1 Provide as required.
.2 To CSA-B64.

2.15 PRESSURE GAUGES

.1 Provide as required.
.2 To Section 15 05 00 Piping.

2.16 TEMPERATURE GAUGES

.1 Provide as required.
.2 To Section 15 05 00 Piping.

2.17 THERMOWELLS

.1 Provide as required.
.2 To Section 15 05 00 Piping.

2.18 HEAT TRACING

.1 Provide as required.
.2 To Section 15 05 00 Piping.

2.19 PIPE INSULATION

.1 Provide as required.
.2 To Section 15 05 00 Piping.

2.20 JACKETS

.1 Provide as required.
.2 To Section 15 05 00 Piping.

PART 3 EXECUTION

3.1 EXAMINATION

.1 To Section 15 05 00 Piping. In addition, provide the following.
.2 Inspect distribution piping for the existence of piping dead legs and sections that will not normally have water flow. Notify Engineer of discoveries.

3.2 PREPARATION

.1 To Section 15 05 00 Piping.

3.3 COMMON EXECUTION REQUIREMENTS

.1 To Section 15 05 00 Piping. In addition, provide the following.
.2 Install to eliminate piping dead legs and sections that will not normally have water flow.

3.4 PIPES

.1 Install as required.
.2 To Section 15 05 00 Piping.

3.5 FITTINGS

.1 Install as required.
.2 To Section 15 05 00 Piping.

3.6 ANCHORS, SUPPORTS, GUIDES AND HANGERS

.1 Install as required.
.2 To Section 15 05 00 Piping.

3.7 PENETRATIONS

.1 Install as required.
.2 To Section 15 05 00 Piping.

3.8 FIRE STOPPING AND SMOKE SEALS

.1 Install as required.
.2 To Section 15 05 00 Piping.

3.9 SHUTOFF VALVES

.1 Install as required.
.2 To Section 15 05 00 Piping.

3.10 STRAINERS

.1 Install as required.
.2 To Section 15 05 00 Piping.

3.11 CHECK VALVES

.1 Install as required.
.2 To Section 15 05 00 Piping.

3.12 BACK-SIPHONAGE PREVENTERS AND BACKFLOW PREVENTERS

.1 Install:
  .1 As required.
  .2 To CSA-B64.10.
.2 Drains: Provide drain piping as required, including air gaps and to floor drains.
.3 Testing: Test as required.
  .1 Field testing to CSA-B64.10.1.
  .2 Simulate reverse flow and back pressure conditions to test operation.
  .3 Verify visibility of discharge from open ports.
.4 Tags: Provide tags, including for field installed and equipment mounted backflow preventers. Information to include installer name, company, trade license, installation date.

3.13 MAKE-UP WATER VALVES

.1 Install as required.
.2 Provide manual bypass.
.3 Set and coordinate pressure settings with requirements of system and other pressure control devices including expansion tanks.
.4 Adjust pressure settings as required.

3.14 PRESSURE REDUCING VALVES

.1 Install as required.

3.15 RELIEF VALVES

.1 Install as required.
.2 To Section 15 05 00 Piping.

3.16 DRAINS AND DRAIN PIPING

.1 Install as required.
.2 To Section 15 05 00 Piping.

3.17 AIR VENTS

.1 Install as required.
.2 To Section 15 05 00 Piping.

3.18 VACUUM BREAKERS

.1 Install as required.
.2 To Section 15 05 00 Piping. In addition, provide the following.
.3 Testing: Test as required.
.1 Field testing to CSA-B64.10.1.
.2 Simulate reverse flow and back pressure conditions to test operation.
.3 Verify visibility of discharge from open ports.

3.19 PRESSURE GAUGES

.1 Install as required.
.2 To Section 15 05 00 Piping.

3.20 TEMPERATURE GAUGES

.1 Install as required.
.2 To Section 15 05 00 Piping.

3.21 THERMOWELLS

.1 Install as required.
.2 To Section 15 05 00 Piping.

3.22 FINISHING

.1 To Section 15 05 00 Piping.

3.23 PIPE INSULATION AND JACKETS

.1 Install as required.
.2 To Section 15 05 00 Piping.

3.24 PIPE LABELLING

.1 Install as required.
.2 To Section 15 05 00 Piping.

3.25 FIELD QUALITY CONTROL

.1 To Section 15 05 00 Piping. In addition, provide the following.
.2 Testing of potable water systems as required.

3.26 STARTUP

.1 To Section 15 05 00 Piping.

3.27 FLUSHING

.1 To Section 15 05 00 Piping. In addition, provide the following.
.2 Disinfection
.1 Flush, disinfect and rinse system to requirements of Owner and local authorities having jurisdiction.
.2 Flush with water heated to sterilization temperatures.
.3 Complete flushing during unoccupied periods to prevent scalding dangers.

3.28 BALANCING

.1 To Section 15 05 00 Piping.

3.29 ADJUSTING

.1 To Section 15 05 00 Piping.

END OF SECTION 22 11 16

SECTION 23 11 23 NATURAL GAS PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

.1 Natural gas piping and gas piping components including fittings, valves, pressure regulators, relief vent piping.

.2 Relationship to other Sections:

.1 Section 15 05 00 Piping describes additional requirements of piping and piping components furnished under this Section.

1.2 REFERENCED DOCUMENTS

.1 CSA-B149.1: CAN/CSA-B149.1-05 Natural Gas and Propane Installation Code.

.2 CSA-B149.1: CAN/CSA-B149.1-10 Natural Gas and Propane Installation Code.

1.3 DEFINITIONS

.1 "Gas Piping": Same as natural gas piping.

1.4 SUBMITTALS FOR ACTION

.1 Product Data

.1 Manufacturers' product literature, specifications, and datasheets. Include product characteristics, performance criteria, options, and limitations.

.2 Shop Drawings

.1 Gas Piping Routing

.1 Layout and Interference Plans: Isometric sketches indicating clearances, interferences, and relocation of interfering services, components, objects, and structures.

.2 Fire Separations: Location of penetrations through fire separations and other assemblies.

.3 Pipe Drainage: Indicate details of piping slope angles and drainage where applicable.

.4 Expansion Compensation: Location of piping expansion control measures.

.5 Vibration Isolation: Location of vibration isolation connectors.

.6 Terminations: Indicate details and locations of terminations including vents.

.2 Mounting: Details of bases, hangers, and supports.

.3 Fire Stopping and Smoke Seals: To Section 15 05 00 Piping.

.4 Labels: Details of piping and other labelling as indicated including to Section 15 05 00 Piping.

1.5 SUBMITTALS FOR INFORMATION

.1 To Section 15 05 00 Piping. In addition, provide the following.

.2 Qualification Statements

.1 Gaseous Fuels: Proof of licenses for company and personnel.

1.6 SUBMITTALS FOR CLOSEOUT

.1 To Section 15 05 00 Piping. In addition, provide the following.

.2 Certificates

.1 Letter from installer certifying that natural gas piping and components meet requirements.

1.7 QUALITY ASSURANCE

.1 To Section 15 05 00 Piping. In addition, provide the following.

.2 Qualifications

.1 Gaseous Fuels: Company and personnel to have licences for gaseous fuels as required.

1.8 WARRANTY

.1 To Section 15 05 00 Piping.

PART 2 PRODUCTS

2.1 COMMON PRODUCT REQUIREMENTS

.1 To Section 15 05 00 Piping. In addition, provide the following.
.2 Provide products:
.1 As indicated.
.2 To CSA-B149.1.

2.2 PIPES

.1 Provide as required.
.2 To Section 15 05 00 Piping. In addition, provide the following.
.1 To CSA-B149.1.
.2 Size: One nominal size larger than required by CSA-B149.1 unless otherwise indicated.

2.3 FITTINGS

.1 Provide as required.
.2 To Section 15 05 00 Piping.

2.4 FLEXIBLE PIPE CONNECTORS

.1 Provide as required.
.2 To Section 15 05 00 Piping.

2.5 EXPANSION JOINTS

.1 Provide as required.
.2 To Section 15 05 00 Piping.

2.6 ANCHORS, GUIDES, SUPPORTS, AND HANGERS

.1 Provide as required.
.2 To Section 15 05 00 Piping.

2.7 FIRE STOPPING AND SMOKE SEALS

.1 Provide as required.
.2 To Section 15 05 00 Piping.

2.8 SHUTOFF VALVES

.1 Provide as required.
.2 Type
.1 NPS-2 and under: Full port ball valve.
.2 Above NPS-2: Plug valve.
.3 Outdoor Accessible Locations: Lockwing.

2.9 PRESSUE REGULATORS

.1 Provide as required.
.2 Manufacturer: Fisher Regulators, a brand of Emerson Process Management Regulator Technologies, a division of Emerson, Emerson Electric Co.
.3 Size: Oversize regulator 50-% larger capacity than required, unless oversizing can be proven to be detrimental to performance.
.4 Range: Unless otherwise indicated, select spring size to allow outlet pressure to be adjusted minimum +/-20-% of full range from nominal setpoint.
.5 Performance
.1 Noise: Less than 25-N.C. level in occupied areas.

2.10 PRESSURE REGULATOR VENTS

.1 Provide as required.
.2 Materials: To CSA-B149.1.
.3 Size: One nominal size larger than required by CSA-B149.1 unless otherwise indicated.
.4 Unacceptable: Non-rigid tubing, improper supports.

2.11 PRESSURE GAUGES

.1 Provide as required.
.2 To Section 15 05 00 Piping.

PART 3 EXECUTION

3.1 EXAMINATION

.1 Determine exact location and routes for piping. Modify routing and/or relocate existing services as required.
.2 Complete x-ray scans, consultation, and other investigative work as required to verify structural member construction, verify suitable locations, and ensure drilling and coring through structural members will not affect integrity.
.3 Investigate fire separations and non-fire-resistance rated assemblies in affected areas for existing fire stopping or smoke sealing that is improperly sealed or defective, as well as for penetrations not fire stopped or smoke sealed.

3.2 PREPARATION

.1 Flush and clean affected piping systems including new and existing piping and piping components before being put into service.
.2 Remove existing coatings including paint from gas piping components to be repainted, down to base material.

3.3 COMMON EXECUTION REQUIREMENTS

.1 To Section 15 05 00 Piping. In addition, provide the following.
.2 Replace existing gas piping as required, including gas piping to headers outside of affected Work area.
.3 Install products including piping joining method:
  .1 As indicated.
  .2 To CSA-B149.1.

3.4 PIPES

.1 Install as required.
.2 To Section 15 05 00 Piping. In addition, provide the following.
.3 Install drip pockets:
  .1 At low points in piping system.
  .2 At connections to equipment.

3.5 FITTINGS

.1 Install as required.
.2 To Section 15 05 00 Piping.

3.6 VIBRATION ISOLATION

.1 Install as required.
.2 To Section 15 05 00 Piping.

3.7 EXPANSION JOINTS

.1 Install as required.
.2 To Section 15 05 00 Piping.

3.8 ANCHORS, SUPPORTS, GUIDES AND HANGERS

.1 Install as required.
.2 To Section 15 05 00 Piping.

3.9 PENETRATIONS

.1 Install as required.
.2 To Section 15 05 00 Piping.

3.10 FIRE STOPPING AND SMOKE SEALS

.1 Install as required.
.2 To Section 15 05 00 Piping.

3.11 SHUTOFF VALVES

.1 Install shutoff valves with stems upright or horizontal unless otherwise approved.
.2 Install shutoff valves at branch take offs to isolate pieces of equipment, in addition to other indicated locations.
.3 Install shutoff valves at new and existing regulators.
.4 Exercise and service main shutoff valves.

3.12 PRESSURE REGULATORS

.1 Install as required.
.2 Adjust existing regulators as required to match load.
.3 Non-Performance
  .1 Location: Re-locate regulators should installed regulators result in operational issues with loads.
  .2 Noise: Replace regulators should installed regulators result in excessive noise for location.

3.13 PRESSURE REGULATOR VENTS

.1 Route regulator vents to terminate in appropriate location outdoors, including regulators on equipment and piping distribution. Obtain approval for regulator vent terminations.
.2 Provide regulator vent termination piping size of minimum NPS-3/4.
.3 Protect regulator vent terminations against blockage, damage, insects, and climate.

3.14 PRESSURE GAUGES

.1 Install as required.
.2 To Section 15 05 00 Piping.

3.15 FINISHING

.1 Paint gas piping system and components with yellow paint or other indicated colour(s) to Section 09 91 00 Painting.

3.16 PIPE LABELLING

.1 To Section 15 05 00 Piping. In addition, provide the following.
  .1 Pressure: Affix labels to piping denoting service type, gas pressures.
  .2 Intervals: Before and after each regulator.

3.17 FIELD QUALITY CONTROL

.1 To Section 15 05 00 Piping. In addition, provide the following.
.2 Test system to CSA-B149.1 and requirements of authorities having jurisdiction.

3.18 NON-CONFORMING WORK

.1 In case of disagreements regarding conformance of Work, retain and pay for a representative from applicable authorities having jurisdiction to inspect Work and provide a ruling.
.2 Correct non-conforming Work with no adjustment to Contract Price or Contract Time.

3.19 STARTUP

.1 To Section 15 05 00 Piping. In addition, provide the following.
.2 Purging: Purge after pressure test to CSA-B149.1.
.3 Pre Start-up Inspections
  .1 Check vents from regulators, control valves, and vent termination locations.
  .2 Check fuel trains.
  .3 Ensure entire installation is approved by authority having jurisdiction before start-up.
.4 Post Start-up Adjustments
  .1 As required for performance.

3.20 FLUSHING

.1 To Section 15 05 00 Piping.

3.21 ADJUSTING

.1 To Section 15 05 00 Piping. In addition, provide the following.
.2 Adjust regulators as required for system and combustion equipment performance.

END OF SECTION 23 11 23

SECTION 23 23 13 REFRIGERANT PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

.1 Refrigerant piping and piping components including fittings, shutoff valves, strainers, indicators.

.2 Relationship to other Sections:

.1 Section 15 05 00 Piping describes additional requirements of piping and piping components furnished under this Section.

1.2 REFERENCED DOCUMENTS

.1 ASHRAE-15: ANSI/ASHRAE-15-2013 Safety Standard for Mechanical Refrigeration.

.2 ASME-B16.22: ASME-B16.22-2012 Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.

.3 ASME-B16.26: ASME-B16.26-2011 Cast Copper Alloy Fittings for Flared Copper Tubes.

.4 ASME-B31.5: ASME-B31.5-2010 Refrigeration Piping and Heat Transfer Components.

.5 ASTM-B280: ASTM-B280-13 Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.

.6 CSA-B51: CSA-B51-09 Boiler, Pressure Vessel and Pressure Piping Code.

.7 CSA-B52: CSA-B52-05 (R2009) Mechanical Refrigeration Code, including Handbook, Supplement 1.

.8 CSA-B52: CSA-B52-13 Mechanical Refrigeration Code.

1.3 DEFINITIONS

.1 “ACR”: Air conditioning and refrigeration field services.

1.4 SUBMITTALS FOR ACTION

.1 Product Data

.1 Manufacturers’ product literature, specifications, and datasheets. Include product characteristics, performance criteria, options, and limitations.

.2 Shop Drawings

.1 Refrigerant Piping Routing

.1 Layout and Interference Plans: Isometric sketches indicating elevation changes, below grade routing, clearances, interferences, and relocation of interfering services, components, objects, and structures.

.2 Fire Separations: Location of penetrations through fire separations and other assemblies.

.3 Pipe Drainage: Indicate details of piping slope angles, traps, pockets and drainage where applicable.

.4 Expansion Compensation: Location of piping expansion control measures.

.5 Vibration Isolation: Location of vibration isolation connectors.

.6 Equipment Connections: Quantity and location of connections to equipment including refrigerant relief valves.

.2 Mounting: Details of bases, hangers, and supports.

.3 Fire Stopping and Smoke Seals: To Section 15 05 00 Piping.

.4 Labels: Details of piping and other labelling to requirements as indicated including Section 15 05 00 Piping.

.3 Labelling and Documentation

.1 Refrigerant Circuits: CSA-B52 and ASHRAE-15 labelling and documentation.

1.5 SUBMITTALS FOR INFORMATION

.1 To Section 15 05 00 Piping. In addition, provide the following.

.1 Equipment Start-up

.1 Letter from manufacturer certifying:

.1 Refrigerant piping to equipment has been sized and installed in accordance with equipment manufacturer's recommendations, and no equipment warranty conditions have been violated.

.2 Qualification Statements

.1 Refrigerant Piping and Refrigerant Systems: Proof of licenses for personnel.

1.6 SUBMITTALS FOR CLOSEOUT

.1 To Section 15 05 00 Piping. In addition, provide the following.

.2 Certificates

.1 Letter from installer certifying that refrigerant piping and components meet requirements.

1.7 QUALITY ASSURANCE

.1 To Section 15 05 00 Piping. In addition, provide the following.

.2 Qualifications

.1 Refrigerant Piping and Refrigerant Systems: Personnel to be licensed refrigeration and air conditioning mechanics.

1.8 WARRANTY

.1 To Section 15 05 00 Piping.

PART 2 PRODUCTS

2.1 COMMON PRODUCT REQUIREMENTS

.1 To Section 15 05 00 Piping. In addition, provide the following.

.2 Provide products:

.1 With materials suitable for the fluid type and conditions to which they will be exposed.

.1 Including refrigerant and lubricating oils.

.2 Appropriately sized as required.

.3 As indicated.

.4 To CSA-B51.

.5 To ASME-B31.5.

.6 To CSA-B52.

.7 To ASHRAE-15.

2.2 PIPES

.1 Provide as required.

.2 Steel: To Section 15 05 00 Piping.

.3 CO-T - Copper Tube

.1 Materials: Drawn copper, to ASTM-B280.

.2 Type

.1 CO-T-ACR - Type ACR

.1 To ASTM-B280.

.2 Processed for refrigeration installations, cleaned, deoxidized, dehydrated and sealed.

.3 Straight lengths, unless otherwise indicated. Coiled piping prohibited.

.3 Pressure Ratings

.1 7/8-in outside diameter and under: Rated working pressure of 3,500-kPa (500-psi) gauge, unless otherwise indicated.

.2 Over 7/8-in outside diameter: Rated working pressure of 2,400-kPa (350-psi) gauge, unless otherwise indicated.

2.3 FITTINGS

.1 Provide as required.

.2 Types

.1 Wrought Fittings

.1 Type: Wrought copper, to ASME-B16.22.

.2 Joints: Brazed. Filler metal BCuP series alloy 95-%Cu 5-%P with non-corrosive flux.

.2 Flared Fittings: Bronze or brass, to ASME-B16.26.

.3 Cast Fittings: Not permitted.

.4 Threaded Fittings: Not permitted unless otherwise indicated or except as required for refrigerant piping components.

.5 Flanged Fittings: Not permitted unless otherwise indicated or except as required for refrigerant piping components.

2.4 REFRIGERANT PIPING COMPONENTS

.1 Provide as required.

.2 Materials: Steel, stainless steel, brass, bronze.

.3 Joint Types

.1 Brazed: Filler metal BAg series alloy 50-%Ag 30-%Cu 15-%Zn with non-corrosive flux.

.2 Threaded: Teflon tape.

.3 Flanged: Gasket.

2.5 FLEXIBLE PIPE CONNECTORS

.1 Provide as required.

.2 To Section 15 05 00 Piping. In addition, provide the following.

.3 Type

.1 Processed for refrigeration installations, cleaned, deoxidized, dehydrated and sealed.

.2 Copper tubing with braided stainless steel outer covering.

.3 Joints: Brazed, threaded, flanged.

.4 Pressure Ratings

.1 7/8-in outside diameter and under: Rated working pressure of 3,500-kPa (500-psi) gauge, unless otherwise indicated.

.2 Over 7/8-in outside diameter to 2-1/8-in outside diameter: Rated working pressure of 2,400-kPa (350-psi) gauge, unless otherwise indicated.

2.6 ANCHORS, GUIDES, SUPPORTS, AND HANGERS

.1 Provide as required.

.2 To Section 15 05 00 Piping.

2.7 FIRE STOPPING AND SMOKE SEALS

.1 Provide as required.

.2 To Section 15 05 00 Piping.

2.8 SHUTOFF VALVES

.1 Provide as required.

.2 Size: Match full line size.

.3 Type

.1 7/8-in outside diameter and under: Class 500, rated working pressure 3,500-kpa (500-psi) gauge, globe or angle non directional type, diaphragm, packless type, with forged brass body and bonnet, moisture proof seal for below freezing applications, brazed connections.

.2 Over 7/8-in outside diameter outside diameter: Class 375, rated working pressure 2,400-kPa (350-psi) gauge, globe or angle type, diaphragm, packless type, back seating, cap seal, with cast bronze body and bonnet, moisture proof seal for below freezing applications, brazed connections.

.4 Performance: Minimize refrigerant pressure drop.

2.9 SERVICE VALVES

.1 Provide on high pressure and low pressure side of refrigerant piping circuits as required unless included with shutoff valves.

.2 Size: Minimum 1/4-in connection size.

.3 Type: Rated working pressure of 3,500-kpa (500-psi) gauge, forged brass body and bonnet, copper stub, brazed end connection, brass cap, removal valve core, quick connect coupling.

2.10 STRAINERS

.1 Provide as required by equipment manufacturer for protection of compressor inlet.
.2 Provide for protection of solenoid valves.
.3 Size: Match full line size.
.4 Type: Rated working pressure of 3,500-kPa (500-psi) gauge, straight or angle type, forged brass body or steel body, screwed cleanout plug, brazed end connections.
.5 Suction Line Strainers
  .1 40 mesh stainless steel or brass-reinforced Monel screen.
.6 Liquid Line Strainers
  .1 1-1/8-in outside diameter and under: 80 mesh stainless steel or brass-reinforced Monel screen.
  .2 Over 1-1/8-in outside diameter: 60 mesh stainless steel or brass-reinforced Monel screen.

2.11 INDICATORS

.1 Provide as indicated.
.2 Size: Match full line size.
.3 Type: Rated working pressure of 3,500-kPa (500-psi) gauge, forged brass body with replaceable, optical viewing window, colour changing moisture indicator, brazed end connections.

2.12 PRESSURE GAUGES

.1 Provide as required.
.2 To Section 15 05 00 Piping.

2.13 TEMPERATURE GAUGES

.1 Provide as required.
.2 To Section 15 05 00 Piping.

2.14 THERMOWELLS

.1 Provide as required.
.2 To Section 15 05 00 Piping.

2.15 REFRIGERANT

.1 Provide refrigerant as indicated by manufacturer.
.2 Provide lubricating oil compatible with equipment, and according to manufacturer's recommendations.

2.16 PIPE INSULATION

.1 Provide insulation on refrigerant piping and refrigerant piping components unless otherwise indicated.
.2 Provide adhesive, tape, sealants, cement, and mastic as recommended by, and compatible with, insulation and insulation jacket manufacturers.
.3 To Section 15 05 00 Piping.

2.17 JACKETS

.1 Provide jackets around insulated refrigerant piping and refrigerant piping components unless otherwise indicated.
.2 To Section 15 05 00 Piping.

PART 3 EXECUTION

3.1 EXAMINATION

.1 To Section 15 05 00 Piping. In addition, provide the following.
.2 Pre-installation refrigerant charge test.

3.2 PREPARATION

.1 To Section 15 05 00 Piping.

3.3 COMMON EXECUTION REQUIREMENTS

.1 To Section 15 05 00 Piping. In addition, provide the following.
.2 Install products including piping joining method:
  .1 As indicated.
  .2 To CSA-B51.
  .3 To ASME-B31.5.
  .4 To CSA-B52.
  .5 To ASHRAE-15.
.3 Routing
  .1 Determine final piping layout, final piping dimensions, final piping lengths, refrigerant charge, lubricating oil charge, piping fittings, traps, double risers, slopes of runs, accessories, required controls.
  .2 Provide lengths as short and direct as possible.
  .3 Avoid routing below grade.
.4 Refrigerant Piping Components
  .1 When piping and components are recommended but not supplied by the manufacturer, provide piping and components to meet the requirements of Specifications.
  .2 Provide the following components on systems of nominal 1-tons and larger.
    .1 Liquid Line Components: Replaceable core filter driers, shut off valves for the filter drier, solenoid valve, moisture indicating site glass.
    .2 Suction Line Components: Replaceable core filter driers, shut off valves for the filter drier.
    .3 Provide isolation valves at condensers to isolate refrigerant charge during maintenance. Coordinate with equipment manufacturer and authorities having jurisdiction for required additional refrigerant relief valves required when equipment has refrigerant circuit isolation valves.
.5 Grade
  .1 Refrigerant Circuits: Slope piping in direction of refrigerant flow.
  .2 Refrigerant Relief Vents: Slope piping in direction of drainage.

3.4 PIPES

.1 Install as required.
.2 To Section 15 05 00 Piping. In addition, provide the following.
.3 Preparation
  .1 Cut to proper length as measured on site.
  .2 Cut piping square.
  .3 Ream and deburr inside.
.4 Liquid Refrigerant Traps
  .1 Install as required at:
    .1 At bottom of vertical risers for compressor outlets if condenser is located above compressor.
    .2 At bottom of vertical risers for compressor inlets if evaporator is located above compressor.
    .3 At bottom of vertical risers for evaporator outlets if evaporator is located below compressor.
.5 Lubricating Oil Traps
  .1 Install as required for systems with multiple evaporators at:
    .1 At top of vertical risers for evaporator outlets if evaporator is located below compressor.
.6 Refrigerant Relief Vent Traps and Pockets
  .1 Install as required near refrigerant relief valves.
  .2 Sized to handle refrigerant and lubricating oil, as well as condensation and dirt.

3.5 FITTINGS

.1 Install as required.

.2 To Section 15 05 00 Piping. In addition, provide the following.
.3 Wrought Fittings, Brass or Bronze Fittings, Steel or Stainless Steel Fittings
  .1 Clean the inside of all fittings or components and the outside of all piping or tubing with abrasive cloth before brazing.
  .2 Flow sufficient rate of inert gas through piping or fittings during brazing to prevent oxidation of inside surfaces.
  .3 Remove all internal fittings or component parts that can be damaged by high temperatures before brazing. Reassemble all internal fittings or component parts after joints have cooled.
  .4 Wipe off any excess flux or brazing filler metal.
.4 Flared Fittings
  .1 Clean the inside of all fittings or components and the outside of all piping with abrasive cloth before flaring.
  .2 Flare angle to be 45-degrees unless otherwise indicated.
  .3 Joint compounds are not be applied between the mating surface of the fitting and flared pipe end.

3.6 FLEXIBLE PIPE CONNECTORS

.1 Install as required.
.2 To Section 15 05 00 Piping.

3.7 ANCHORS, SUPPORTS, GUIDES AND HANGERS

.1 Install as required.
.2 To Section 15 05 00 Piping.

3.8 PENETRATIONS

.1 Install as required.
.2 To Section 15 05 00 Piping.

3.9 FIRE STOPPING AND SMOKE SEALS

.1 Install as required.
.2 To Section 15 05 00 Piping.

3.10 SHUTOFF VALVES

.1 Install as required.
.2 To Section 15 05 00 Piping.
.3 7/8-in outside diameter and under: Secure shutoff valve to a rigid surface independent of any piping fasteners or supports.
.4 Systems containing 3-kg (6.6-lb) to 50-kg (110-lb) of refrigerant:
  .1 Install on compressor or compressor/condenser unit inlet and outlet piping.
.5 Systems containing more than 50-kg (110-lb) of refrigerant:
  .1 Install on compressor or compressor/condenser unit inlet and outlet piping.
  .2 Install on liquid receiver inlet and outlet piping.
  .3 Install on condenser inlet and outlet piping if there are multiple condensers connected in parallel.
  .4 Install on evaporator inlet and outlet piping if there are multiple evaporators connected in parallel.

3.11 SERVICE VALVES

.1 Install as required on high pressure and low pressure side of refrigerant piping circuits as required unless included with shutoff valves.
.2 To Section 15 05 00 Piping.

3.12 REFRIGERANT RELIEF VALVES

.1 Install as required.
.2 Tags: Provide and mount tags, including for field installed and equipment mounted refrigerant relief valves. Include relevant information on tags including installer name, company, trade license, installation date, test date.

3.13 STRAINERS

.1 Install as required.
.2 Mount horizontal.

3.14 INDICATORS

.1 Install as required.
.2 Locations
  .1 Systems without liquid receiver: Mount close to condenser outlet.
  .2 Systems with liquid receivers: Mount close to liquid receiver outlet.

3.15 PRESSURE GAUGES

.1 Install as required.
.2 To Section 15 05 00 Piping.

3.16 TEMPERATURE GAUGES

.1 Install as required.
.2 To Section 15 05 00 Piping.

3.17 THERMOWELLS

.1 Install as required.
.2 To Section 15 05 00 Piping.

3.18 REFRIGERANT

.1 Install as required.

3.19 FINISHING

.1 To Section 15 05 00 Piping.

3.20 PIPE INSULATION AND JACKETS

.1 Install as required.
.2 To Section 15 05 00 Piping. In addition, provide the following.
.3 Replace any damaged exterior pipe insulation.

3.21 PIPE LABELLING

.1 Install as required.
.2 To Section 15 05 00 Piping.

3.22 SYSTEM LABELLING AND DOCUMENTATION

.1 System Marking and Labelling
  .1 Provide marking and labelling to CSA-B52 and ASHRAE-15, including:
    .1 Signs, nameplates and instructions as required by CSA-B52, Article 5.11.
    .2 Multiple sets of instructions for equipment of any size to CSA-B52, Article 5.11.5 to be posted at:
      .1 Locations identified in CSA-B52, Article 5.11.5.
      .2 Refrigeration equipment room main entrance as determined by Owner.
      .3 Owner's preferred maintenance office.

3.23 FIELD QUALITY CONTROL

.1 To Section 15 05 00 Piping.

3.24 STARTUP

.1 To Section 15 05 00 Piping. In addition, provide the following.
.2 Pressure and Leak Test
  .1 Perform pressure and leak test before evacuating, charging, insulating and system operation. High and low pressure side of the refrigerant system must withstand the respective rated working pressures of the piping, fittings and components.
  .2 Use dry nitrogen as testing media.
  .3 To ASME-B31.5, CSA-B52 and ASHRAE-15.
  .4 Leak Detection Methods
    .1 Before In Service: Pressure testing to Section 15 05 00 Piping.
    .2 After Filling: Soap bubble or ultrasonic.

.5 Replace defective fittings with new including brazed joints. Repair only if replacement is not possible upon review by Engineer.

.3 Evacuating and Charging

.1 Use refrigerant charging manifold intended for the refrigerant as indicated.

.2 Purge refrigerant charging manifold of moisture and other non-condensable gases before use.

.3 Evacuate entire system until pressure of 100-Pa (0.015-psi) absolute is reached.

.4 Flush entire system with dry nitrogen.

.5 Re-evacuate entire system until pressure of 100-Pa (0.015-psi) absolute is reached for a minimum of 4-hours.

.6 Charge new or existing refrigerant piping affected by Work with lubricating oil first.

.7 Charge new or existing refrigerant piping affected by Work with refrigerant last.

.4 Replace filter driers and strainers before substantial performance.

.5 Execute equipment start-up procedures as required.

3.25 FLUSHING

.1 To Section 15 05 00 Piping.

3.26 BALANCING

.1 To Section 15 05 00 Piping.

3.27 ADJUSTING

.1 To Section 15 05 00 Piping.

3.28 MAINTENANCE

.1 To Section 15 05 00 Piping.

END OF SECTION 23 23 13

SECTION 23 30 00 DUCTWORK

PART 1 GENERAL

1.1 SECTION INCLUDES

.1 Ducts, dampers, silencers, connectors, liners, louvers, diffusers, grilles, registers.
.2 Relationship to other Sections:
  .1 Section 25 05 00 Building Automation System describes additional requirements of components provided under this Section, including control dampers.
  .2 Section 25 90 00 Control Sequences describes additional requirements for control of equipment and components provided under this Section.
  .3 Section 26 90 00 Control Devices describes additional requirements of components provided under this Section, including control dampers.

1.2 REFERENCED DOCUMENTS

.1 AABC-TSB: AABC National Standards for Total System Balance, 2002.
.2 AMCA-500-D: ANSI/AMCA-500-D-12 Laboratory Methods of Testing Dampers for Rating.
.3 AMCA-511: AMCA-511-13 Certified Ratings Program - Product Rating Manual for Air Control Devices.
.4 ASME-A13.1: ASME-A13.1-2007 Scheme for the Identification of Piping Systems.
.5 ASTM-A480: ASTM-A480/A480M-14 Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
.6 ASTM-A653: ASTM-A653/A653M-13 Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
.7 ASTM-B209: ASTM-B209-10 Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
.8 ASTM-C553: ASTM-C553-13 Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
.9 ASTM-C921: ASTM-C921-10 Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
.10 CGSB-1-GP-12: CGSB-1-GP-12-91 Standard Paint Colors.
.11 CGSB-24.3: CAN/CGSB-24.3-92 Identification of Piping Systems.
.12 ISO-14726: ISO-14726-2008 Ships and Marine Technology - Identification Colours for the Content of Piping Systems.
.13 MICA-NISM: MICA National Commerial and Industrial Insulation Standards Manual, 2014.
.14 NEBB-TABES: NEBB Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems, 2005.
.15 NEMA-Z535.1: ANSI/NEMA-Z535.1-2006 (R2011) Safety Colors.
.16 NFPA-90A: NFPA-90A-12 Standard for the Installation of Air-Conditioning and Ventilating Systems.
.17 NFPA-90B: NFPA-90B-12 Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
.18 NFPA-701: NFPA-701-13 Standard Methods of Fire Tests for Flame Propagation of Textiles and Films.
.19 SMACNA-006: ANSI/SMACNA-006-2005 HVAC Duct Construction Standards - Metal and Flexible.
.20 TIAC-BPG: TIAC Mechanical Insulation Best Practices Guide, 2013.
.21 ULC-S102: CAN/ULC-S102-10 Surface Burning Characteristics of Building Materials and Assemblies.
.22 ULC-S109: CAN/ULC-S109-03 Flame Tests of Flame Resistant Fabrics and Films.
.23 ULC-S115: CAN/ULC-S115-11 Standard Method of Fire Tests of Firestop Systems.

1.3 DEFINITIONS

.1 "Ductwork": This refers to the sheet metal, joints, turning vanes, transitions, flanges, hangers, insulation mounts, and other accessories making up a duct section or sections.
.2 "TAB": Testing, Adjusting, and Balancing.

1.4 SUBMITTALS FOR ACTION

.1 Product Data
  .1 Manufacturers' product literature, specifications, and datasheets. Include product characteristics, performance criteria, options, and limitations.
  .2 Control Damper Schedule including a separate line for each damper provided and a column for each of the damper attributes, including: ID, Fail Position, Damper Type, Damper Operator, Duct Size, Damper Size, Mounting, and Actuator Type and Details.
.2 Shop Drawings
  .1 Duct Routing
    .1 Layout and Interference Plans: Isometric sketches indicating clearances, interferences, and relocation of interfering services, components, objects, and structures.
    .2 Fire Separations: Location of penetrations through fire separations and other assemblies.
    .3 Duct Drainage: Indicate details of duct slope angles and drainage where applicable.
    .4 Expansion Compensation: Location of ductwork expansion control measures.
    .5 Vibration Isolation: Location of vibration isolation connectors.
    .6 Ports and Gauges: Location of ports and gauges.
  .2 Mounting: Details of bases, hangers, and supports.
  .3 Suspension Systems: Indicate the following for all suspended equipment:
    .1 Location of suspension.
    .2 Maximum load at each of the suspension points.
    .3 Size of suspension rods or members.
    .4 Details of supplementary structural steel framing members.
  .4 Penetrations
    .1 Location of penetrations.
    .2 Support details including lintels.
    .3 Sleeve details including dimensions, fasteners, and sealing.
  .5 Fire Stopping and Smoke Seals
    .1 Locations and types marked on plan drawing.
    .2 ULC assembly number certification.
    .3 Required temperature rise and flame rating.
    .4 Hose stream rating where applicable.
    .5 Materials of fire stopping and smoke seals, primers, reinforcements, damming materials, reinforcements, and anchorages/fastenings.
    .6 Assembly and penetration type and required ratings, adjacent materials.
    .7 Openings size, thickness, dimensions.
    .8 Proposed installation methods.
    .9 Summaries of similar types of penetrations, assembly type and construction, service penetrating assembly, adjacent materials, fire stopping and smoke seal type, ratings, other work required.
    .10 Copies of ULC certifications for proposed systems and designs for specific devices and materials.
    .11 Image of sample tag.
  .6 Labels: Scaled drawings indicating label types, dimensions, layout, locations, wording, font, spacing, colours. Specifically identify letter sizes larger than indicated minimum heights.
.3 Indoor Air Quality Management Plan: Submit Indoor Air Quality (IAQ) Management Plan in accordance with SMACNA-IAQ.

1.5 SUBMITTALS FOR INFORMATION

.1 Certificates
  .1 Letter certifying duct supports are in compliance with required seismic restraint provisions.
  .2 Letter certifying that materials comply with specified performance characteristics and physical properties.
  .3 Letter certifying duct supports are in compliance are in compliance with Contract Documents.
  .4 Letter from fire stopping and smoke seals installer certifying that fire stopping and smoke seals have been installed in accordance with regulatory requirements and Contract Documents.
  .5 Letter from licensed fire protection company certifying fire suppression and detection services are in compliance with regulatory requirements.
.2 Delegated Design Submittals
  .1 Design and design documents completed by a Professional Engineer for the following:
    .1 Mounting components and restraints are suitable for application and requirements, including seismic provisions of local building code.
.3 Manufacturer Information
  .1 Operating and Maintenance Manuals
  .2 Installation Instructions
.4 Balancing Reports
  .1 Balancing reports compliant with NEBB-TABES or AABC-TSB recommendations.
  .2 Pressure test reports compliant with NEBB-TABES or AABC-TSB recommendations.
  .3 Provide system schematic diagram with recorded measurements and requirements. Include time of measurements.
  .4 Indicate pressure drops across components, including intake and exhaust locations including louvers and grilles.
  .5 Indicate air conditions for outdoors as well as throughout system at different measurement times.
.5 Qualification Statements
  .1 Fire Protection: Proof of licenses for company and personnel.
  .2 TAB: Proof of certifications for company and personnel.
  .3 Professional Engineering: Proof of licences for company and personnel.

1.6 SUBMITTALS FOR CLOSEOUT

.1 Certificates
  .1 Letter from Contractor certifying all required fire dampers have been provided and installed correctly, and fire dampers product data has been provided including maintenance data for periodic testing.

1.7 QUALITY ASSURANCE

.1 Qualifications
  .1 Ductwork: Company member of SMACNA and OSMCA.
  .2 Fire Protection: Company and personnel to be licensed sprinkler and fire protection installers.
  .3 Fire Stopping and Smoke Seals: Company member of FCIA.
  .4 TAB
    .1 Company and personnel CAABC or NEBB certified.
    .2 Subject to approval.
  .5 Professional Engineering
    .1 Company and personnel licensed to practice Professional Engineering by PEO.
    .2 Subject to approval.

PART 2 PRODUCTS

2.1 COMMON PRODUCT REQUIREMENTS

.1 The precise quantity and location of ductwork depends on routing and installation choices made by Contractor. Provide ductwork:
  .1 Rated to handle the extremes of temperature, pressure, abrasion, and corrosion to which they will be subjected.
  .2 Constructed from materials suitable for the fluid type and conditions to which they will be exposed.
  .3 Constructed to pressure classification of the greater of unless otherwise indicated:
    .1 SMACNA 3-inWC
    .2 Existing ductwork.
  .4 As indicated.
.2 Duct dimensions indicate clear inside dimensions. Adjust duct sizes to accommodate liners and other obstructions.
.3 Certification: ULC labelled.
.4 Performance
  .1 Noise Tolerances: Provide ductwork free from vibration, rattling or drumming under operating conditions.

2.2 DUCTWORK MATERIALS

.1 Provide as indicated. Provide as follows where not indicated.
  .1 Buried Ductwork: Galvanized steel with PVC coating on inside and outside.
  .2 Buried Ductwork: Galvanized steel with PVC coating on inside and outside.
  .3 Uninsulated Unpainted Exterior Ductwork: Stainless steel type 304 to ASTM-A480.
  .4 Unpainted Ductwork: Galvanized steel with Z275 (G90) zinc coating to ASTM-A653, unless otherwise indicated.
  .5 Painted Ductwork: Galvanized steel with ZF75 (A25) zinc coating to ASTM-A653, unless otherwise indicated.

2.3 ELBOWS AND TRANSITIONS

.1 Provide elbows of standard radius design with inner radius equal to width of elbow unless otherwise indicated.
.2 Provide mitred elbows in areas with restricted free space.
.3 Type
  .1 90-degree Radius Elbows: Smooth centre line radius of 1.5-times duct diameter, or 5-piece construction, subject to approval.
  .2 45-degree Radius Elbows: 3-piece construction.
    .1 Provide branch connections to mains of eccentric conical configuration.
  .3 Mitered Elbows: Provide air turning vanes for mitered elbows, from 90-degree square elbows up to 45-degree elbows.
  .4 Air Turning Vanes: Provide small radius, single wall construction air turning vanes. Provide larger radius or double wall construction as required.
  .5 Exterior Air Intake: Provide 38-mm (1-1/2-in) drain flange in low point of ductwork.
.4 Size: Fabricate rectangular duct elbows, transition sections and take-off fittings of metal 1 gauge heavier than duct thickness of adjacent duct.

2.4 JOINTS

.1 To SMACNA standards.
.2 Type
  .1 Longitudinal Joints: Use Pittsburgh Lock joints tightly closed along full length of seam.
  .2 Transverse Joints: Use class to suit duct size and requirements.
    .1 Manufacturers
      .1 Ductmate Canada Ltd. flanged connections.
      .2 Dynair, Division of Carlisle Canada, Nexus 4 bolt flanged connection system.
  .3 Elbows: Use Pittsburgh Lock seams, with ends to match transverse joints of duct.

2.5 SEAMS

.1 Seal joints on ductwork to SMACNA standards.

.2 Common Performance Requirements
  .1 Flame Resistance: To fabric requirements of ULC-S109.
  .2 Flame-Spread: Maximum 25 tested to ULC-S102.
  .3 Smoke Developed: Maximum 50 tested to ULC-S102.
.3 Manufacturers
  .1 3M, EC800
  .2 Foster Products, No. 30-07
  .3 Carlisle Coatings & Waterproofing Inc., Hardcast, Iron Grip 601
  .4 Duro-Dyne Canada Inc., S-2 or Transcontinental Equipment "MP"
.4 Type
  .1 Exterior Air Intake: Continuously solder or seal joints to prevent dripping of moisture through joints.

2.6 VIBRATION ISOLATION DUCT CONNECTORS

.1 Provide fire retardant heavy fabric vibration isolation for duct connections to equipment.
.2 Common Performance Requirements
  .1 Flame-Spread: Maximum 25 tested to ULC-S102.
  .2 Smoke Developed: Maximum 50 tested to ULC-S102.
.3 Manufacturers
  .1 Ventfabrics, Inc., Fabrics for Flexible Connectors
  .2 Ventfabrics, Inc., Ventglas
.4 Size: Minimum 100-mm (4-in) wide total during normal operation of equipment and system.
.5 Certifications
  .1 To NFPA-701.

2.7 SUPPORTS AND HANGERS

.1 Design of ductwork support depends, in part, on routing and installation choices made by Contractor. Design of ductwork support is Contractor responsibility.
.2 Provide as required.
  .1 To SMACNA standards.
  .2 Design for easy removal.
.3 Performance
  .1 Design ductwork supports to withstand seismic events as required. Seismic restraint provisions shall meet or exceed requirements for post-disaster buildings in the respective seismic zone.
  .2 Prevent ductwork venting noise and vibration from being transferred to supporting structure.
  .3 Angularity of rod hanger resulting from horizontal movement of ductwork from cold to hot position not to exceed 4-degrees from vertical.
.4 Hangers
  .1 Provide mild steel rod hangers of 10-mm (3/8-in) dia. minimum size for ducts over 760-mm (30-in) in width. Provide 38-mm by 38-mm by 3-mm (1-1/2-in by 1-1/2-in by 1/8-in) steel angle across bottom of duct, attached to steel rods.
  .2 Provide strap hangers of 3-mm by 25-mm (1/8-in by 1-in) mild steel bar stock for ducts up through 760-mm (30-in) width unless otherwise indicated.

2.8 FIRE STOPPING AND SMOKE SEALS

.1 Asbestos-free materials and systems capable of maintaining effective barrier against flame, smoke and gases to ULC-S115.
.2 Manufacturers: 3M, Fire Protection Products
.3 Materials
  .1 Fire stopping and smoke seal components: Certified by test laboratory to ULC-S115.
  .2 In assemblies: Systems tested to ULC-S115.

.3 In wet environments, waterproof assemblies, or exterior assemblies including foundations and below grade floors: Waterproof, non-hardening.
.4 Penetrations requiring vibration control: Elastomeric seal.
.5 Damming and backup materials, supports and anchoring devices: To manufacturer's recommendations, and in accordance with tested assembly being installed as acceptable to authorities having jurisdiction.
.6 Other locations: As required.

.4 Performance: Rating: 2-hours, unless otherwise required.

2.9 FLEXIBLE DUCT - UNINSULATED

.1 Provide single ply aluminum construction with mechanical lock spiral joints.
.2 Provide flexible duct bearing as required.
.3 Provide sealed joints between flexible duct and rigid ductwork or equipment, made with non-flammable high velocity duct sealer, applied in accordance with duct manufacturer's recommendations, and gear type nylon strap connectors.
.4 Manufacturers
.1 Flexmaster Co. Ltd., Triple-Lock
.2 Thermaflex
.5 Size: Provide continuous lengths, not to exceed 2.4-m (8-ft).

2.10 FLEXIBLE DUCT - INSULATED

.1 Provide single ply aluminum construction with mechanical lock spiral joints.
.2 Provide flexible duct bearing as required.
.3 Provide sealed joints between flexible duct and rigid ductwork or equipment, made with non-flammable high velocity duct sealer, applied in accordance with duct manufacturer's recommendations, and gear type nylon strap connectors.
.4 Manufacturers
.1 Flexmaster Co. Ltd., Triple-Lock Thermal Duct
.2 Thermaflex
.5 Size: Provide continuous lengths, not to exceed 2.4-m (8-ft).

2.11 DUCT LINERS

.1 Provide rigid coated duct liners conforming to NFPA-90A and NFPA-90B, of 25-mm (1-in) thickness and 72-kg/m3 (4.5-lb/ft3) density.
.2 Manufacturers
.1 Owens Corning Canada Inc.
.2 Johns Manville
.3 Manson Insulation Products
.3 Fasten duct liners with plate type impaling pins and self-locking washers.
.1 Manufacturers
.1 Eckels Industries
.2 Continental Stud Welding Ltd.
.3 Tactoo Series T or weld pins and self locking washers.

2.12 CONTROL DAMPERS - GENERAL

.1 Provide as required.
.2 Manufacturers
.1 Tamco, Series 1000 or 9000
.3 Features
.1 Mount: As indicated, otherwise where not indicated select mount type to minimize airflow restriction including:
.1 In-Duct: For low velocity systems.
.2 Flanged: For high velocity systems or systems with low noise requirements.
.3 ERF: Extended rear flange. For non-ducted openings.
.4 RDT: Round duct transition kit. For square or rectangular dampers onto round duct.

.2 Action: As indicated, otherwise where not indicated:
.1 Opposed blade for modulating dampers.
.2 Parallel blade for on/off dampers.
.3 Leakage
.1 Minimum class as indicated. Maximum leakage as indicated.
.2 Tested to AMCA-500-D.
.4 Pressure: Maximum blade design total static pressure to match distribution system. Configure blades and sections as required.
.5 Design
.1 Blade and Frame Seals secured in integral slots and mechanically fastened to prevent shrinkage and movement over the life of the damper.
.2 Bearings: Designed to eliminate action between metal-to-metal or metal-to-plastic riding surfaces.

.4 Materials
.1 Frame: Extruded 6063-T5 aluminum, minimum 2.03-mm (0.080-in) thick.
.2 Blades: Extruded 6063-T5 aluminum.
.3 Blade Seals: Extruded EPDM.
.4 Frame Seals: Extruded silicone.
.5 Linkage: Aluminum and corrosion-resistant zinc-plated steel linkage hardware.

.5 Actuators: To Section 26 90 00 Control Devices.

.6 Options
.1 Thermally Insulated: Required for outdoor air intakes, unconditioned areas, not within air handlers, areas subject to freezing conditions including dampers near exhaust air outlets, dampers near outdoor air streams.

.7 Certifications
.1 To AMCA-511.

2.13 BALANCING DAMPERS

.1 Provide as required, including at supply terminations including diffusers and grilles.

.2 Constant Volume Systems
.1 Provide balancing dampers at each branch duct and where necessary for proper balancing of system.

.3 Variable Air Volume Systems
.1 Provide balancing dampers at each main branch duct and where necessary for proper balancing of system.

2.14 FIRE DAMPERS

.1 Provide as required, including provide fire dampers in ductwork passing through fire separations.

.2 To NFPA-90A, ULC labelled.

.3 Materials: Provide fire dampers and frames constructed of same materials as duct in which they are installed.

.4 Type
.1 Hinged, fusible link type with channel frames, blades and housing.
.2 Type A: For rectangular ducts 250-mm (10-in) or greater.
.3 Type B: For rectangular ducts less than 250-mm (10-in). Ensure damper blades are outside of air stream when in open position.
.4 Type C: For round ductwork.

2.15 ACCESS HATCHES

.1 Provide access hatches:
.1 At fire dampers, automatic dampers, duct balancing dampers, coils.
.2 At equipment and components requiring maintenance, inspections and for convenience purposes.
.3 In fixed surfaces including walls, ceilings.

.4 At other locations as required.
.2 Type: Quick opening hardware. Lockable.
.3 Fasteners
.1 General: Provide countersunk holes where fasteners are not concealed.
.2 Size: Square with minimum free opening 0.37-m2 (4-ft2). Other shapes to be approved by Owner.
.4 Finish: To match fixed surfaces.

2.16 DUCT INSULATION

.1 Provide insulation on all ductwork, unless otherwise indicated.
.2 Provide adhesive, tape, sealants, cement, and mastic as recommended by, and compatible with, insulation and insulation jacket manufacturers.
.3 Common Performance Requirements
.1 Flame-Spread: Maximum 25 tested to ULC-S102.
.2 Smoke Developed: Maximum 50 tested to ULC-S102.
.4 Type MF - Preformed Mineral Fibre
.1 To ASTM-C553.

2.17 JACKETS

.1 Provide jackets around insulated ductwork unless otherwise indicated.
.2 Common Performance Requirements
.1 Flame-Spread: Maximum 25 tested to ULC-S102.
.2 Smoke Developed: Maximum 50 tested to ULC-S102.
.3 Type ALU - Aluminum Jacket
.1 Provide as required.
.2 To ASTM-B209.
.3 Thickness: 0.4-mm (0.016-in)
.4 Finish: Smooth unless otherwise indicated.
.5 Joining: Longitudinal and circumferential slip joints with 50-mm (2-in) laps.
.6 Fittings: 0.5-mm (0.02-in) thick die shaped fitting covers with factory attached protective liner.
.7 Metal jacket banding and mechanical seals: 12-mm (1/2-in) wide; 0.5-mm (0.02-in) thick stainless steel.
.4 Type CAN - Canvas Jacket
.1 Provide as required.
.2 ULC Listed.
.3 Fabric: ASTM-C921, 220-g/m2 (6-oz/yd2), plain weave cotton treated with dilute fire retardant lagging adhesive.
.5 Type COM - Composite Membrane
.1 Provide as required.
.2 Multi-ply embossed UV-resistant aluminum foil and polymer laminate applied to rubberized asphalt layer complete with a metalized polyester film that is coated with low temperature acrylic adhesive.
.3 Manufacturers
.1 Polyguard Products, Inc., Alumaguard All Weather

2.18 DIFFUSERS - SUPPLY - SQUARE CONE - FIRE RATED

.1 Provide as indicated.
.2 Manufacturers
.1 Price Industries Limited.,SCD-FR Series
.3 Features
.1 4 cone.
.2 White powder coat finish.
.3 Curtain type fire damper.
.4 Materials: Steel.

.5 Certifications
.1 ULC
.2 NFPA-90A

2.19 GRILLES - RETURN/EXHAUST - EGGCRATE - FIRE RATED

.1 Provide as indicated.
.2 Manufacturers
.1 Price Industries Limited.,Series 80
.3 Features
.1 Ducted.
.2 White powder coat finish.
.3 Curtain type fire damper.
.4 Options
.1 T-bar lay in.
.5 Materials: Steel.
.6 Certifications
.1 ULC
.2 NFPA-90A

2.20 GRILLES - TRANSFER

.1 Provide as indicated.
.2 Manufacturers
.1 Price Industries Limited.,STG Series

PART 3 EXECUTION

3.1 INSTALLERS

.1 Use any the following approved installers for fire protection including suppression and detection:
.1 Owner's fire protection service company(s).
.2 Alternate installers will not be accepted.

3.2 EXAMINATION

.1 Photograph, document and submit descriptions of existing deficiencies in affected systems, equipment, services and surrounding areas prior to commencing Work.
.2 Complete x-ray scans, consultation, and other investigative work as required to verify structural member construction, verify suitable locations, and ensure drilling and coring through structural members will not affect integrity.
.3 Investigate fire separations and non-fire-resistance rated assemblies in affected systems for existing fire stopping or smoke sealing that is improperly sealed or defective, as well as for penetrations not fire stopped or smoke sealed.
.4 Investigate ductwork through fire separations and non-fire-resistance rated assemblies in affected systems for fire dampers that are improperly selected, installed, defective, or missing.
.5 Investigate and review affected systems for as-built conditions, equipment, components, services.
.6 Record and submit findings, updates and corrections on marked-up existing drawings or other reporting means as approved.

3.3 PREPARATION

.1 Demolition and Removal
.2 Clean new services before being put into service.

3.4 COMMON EXECUTION REQUIREMENTS

.1 To SMACNA-006.
.2 Provide screens of 13-mm (1/2-in) mesh x 2.7-mm (0.105-in) diameter removable galvanized wire for air intakes, exhausts and open ends of ductwork, unless otherwise indicated or unless insect screen is required.

.3 Cross-break flat surfaces as required to prevent vibration or buckling.
.4 Provide necessary reinforcements, bracing, framing and gaskets.
.5 Provide required offsets and transitions, whether specifically indicated or not, to facilitate duct arrangement and to avoid interference with building structure, piping, equipment and services.
.6 Install ductwork as close as possible to walls, partitions and overhead structures to attain maximum headroom and clearance.
.7 Group ductwork wherever possible.
.8 Install to permit separate thermal insulation of each duct unless otherwise indicated.
.9 Install air sealing gaskets between flanged joints at duct connections to equipment.
.10 Install ductwork size transitions such that angle between the transition and straight run does not exceed 15-degrees, unless otherwise indicated.
.11 In occupied areas, paint interior of ductwork for at least 600-mm (2-ft) behind supply and exhaust grilles with matte black paint so as to render ductwork invisible from occupied space.
.12 Slope exhaust ductwork up away from register and without seams in bottom of duct for at least 3-m (10-ft) of duct run behind register.
.13 Slope exterior air intake ducts down at 1:100 to permit moisture induced by air intake to be drained. Install 38-mm (1-1/2-in) drain flange in bottom of duct at low point and run drain line to nearest floor drain unless otherwise indicated.
.14 Relocate and extend fire protection systems as required, including fire detection and adding sprinkler heads as required.

3.5 VIBRATION ISOLATION DUCT CONNECTORS

.1 Install as required.

3.6 SUPPORTS AND HANGERS

.1 Design and provide supports and hangers as required.
  .1 Include as required steel framing, braces.
.2 Unless otherwise indicated, install supports and hangers at intervals not over 2.4-m (8-ft) centres for ducts up to 1.5-m (5-ft) in width and at 1.2-m (4-ft) centres for ducts 1.2-m (5-ft) in width and over.
.3 Install miscellaneous steel angles or channels as required between joists or building steel for structural support of duct where building framing spacing does not coincide with the required hanger spacing.
.4 Install 1 handle on either side of short dimension of duct to allow easy removal. Install backing washers or plate for added strength. Match materials to prevent galvanic corrosion.
.5 Bend strap hanger around bottom of duct with a minimum of 38-mm (1-1/2-in) overlap and attach to sides and bottom of duct.
.6 Adjust support system including hangers to equalize load.

3.7 PENETRATIONS

.1 Provide sleeves at penetrations and where ductwork passes through assemblies including walls, floors and ceilings.
.2 Pack sleeves with resilient packing or fire rated packing and materials as required.
.3 Install sheet metal closure plates on each side of wall to cover sleeve.
.4 Flash parts built into or passing through to wet environments, waterproof assemblies, or exterior assemblies including roofs, outside walls.
.5 Patch holes to match existing surfaces.
.6 Provide minimum clearances as required between sleeves and uninsulated or insulated ductwork with minimum of:
  .1 Below Grade: 25-mm (1-in)
  .2 Other Locations: 13-mm (1/2-in)
.7 Sleeve Materials

.1 Exterior Assemblies: 12-gauge galvanized steel, primed and painted to Section 09 91 00 Painting.
.2 Masonry and Concrete Assemblies: 12-gauge galvanized steel, primed and painted to Section 09 91 00 Painting.
.3 Interior Frame Construction Assemblies in Conditioned Spaces: 18-gauge galvanized steel..
.4 Other Frame Construction Assemblies: 18-gauge galvanized steel primed and painted to Section 09 91 00 Painting.

.8 Seal floor sleeves with an approved stiff setting caulking compound to serve as a water dam.

3.8 FIRE STOPPING AND SMOKE SEALS

.1 Fire stop and smoke seal at fire-resistance rated assemblies including:
.1 Penetrations through masonry, concrete, and frame construction including gypsum board partitions and walls.
.2 Edge of floor slabs at curtain wall and pre-cast concrete panels.
.3 Top of masonry and gypsum board partitions.
.4 Intersection of masonry and gypsum board partitions.
.5 Control and sway joints in masonry and gypsum board partitions and walls.
.6 Penetrations through floor slabs, ceilings and roofs.
.7 Openings and sleeves installed for future use.
.8 Services, including mechanical and electrical.
.9 As indicated.

.2 Fire stop and smoke seal at non-fire-resistance rated assemblies including:
.1 Assemblies not fire-resistance rated but constructed as such.
.2 As indicated.

.3 Install fire stopping and smoke seal material and components in accordance with manufacturer's certified tested system listing.

.4 Install to allow for movement and thermal expansion of services including piping and ducting.

.5 Ensure integrity of fire stopping and smoke seals such that passage of flame, smoke and gases is prevented including to unexposed side of assembly of single sided fire stopping and smoke seals. Repair as required.

.6 Ensure integrity of insulation and vapour barriers. Repair as required.

.7 Repair holes, gaps, openings and improperly fire stopped and smoke sealed penetrations in affected assemblies.

.8 Provide tags for each fire stopping and smoke seal. Include relevant information on tags including installer name, company, trade license, installation date, fire stopping and smoke seal ULC assembly number certification. Mount at locations as approved by Owner or as required by authorities having jurisdiction.

3.9 FLEXIBLE DUCT

.1 Install as required.

.2 Supports and Hangers
.1 In addition to other indicated requirements, install supports and hangers at intervals not over 1.2-m (4-ft) centres.

3.10 DUCT LINERS

.1 Install as required.

3.11 CONTROL DAMPERS

.1 Install as required.

3.12 BALANCING DAMPERS

.1 Install as required.

3.13 FIRE DAMPERS

.1 Install as required.

3.14 ACCESS HATCHES

.1 Install as required.

3.15 DUCT INSULATION AND JACKETS

.1 Provide as indicated.
.2 Replace insulation and jackets on existing ductwork as indicated.
.3 Replace damaged insulation and jackets on existing ductwork affected by Work.
.4 Install insulation, and seal seams and joints to prevent condensation or precipitation.
.5 Install to:
  .1 MICA-NISM.
  .2 TIAC-BPG.
.6 Provide 25-mm (1-in) thick acoustic insulation as indicated.
.7 Provide access to service components and devices, including nameplates, access hatches and doors, operable components.
.8 Seams
  .1 Seal seams using seam sealant acceptable to manufacturer and Engineer.
  .2 Match seam sealant to jacket.
  .3 Minimize the number of seams by using full length insulation pieces.
  .4 Position overlaps to shed water.
  .5 Locate longitudinal seams at the side of the ductwork that is least visible.
.9 Supports and Hangers
  .1 Install supports and hangers outside vapour retarder jacket.
  .2 Install high compressive strength insulation under duct supports to prevent compression of insulation.
.10 Additional Finishing
  .1 Type CAN - Canvas Jacket: Paint jackets to Section 09 91 00 Painting.

3.16 DUCT LABELLING

.1 Provide labels for ductwork denoting service type, ductwork service function, and flow direction.
  .1 Materials: Pressure sensitive vinyl with protective overcoating, waterproof adhesive undercoating, suitable for ambient conditions of continuous 100-%RH and continuous operating temperature of 150-°C (300-°F) with intermittent temperatures of 200-°C (390-°F).
  .2 Common Requirements
    .1 To ASME-A13.1.
    .2 To CGSB-24.3.
  .3 Text Label: Provide labels with text on full description of service and indication of flow direction and function as applicable, including supply, return, bypass, discharge, relief.
    .1 Text Description: As indicated, otherwise as required by Owner, otherwise to match requirements for piping from indicated requirements and referenced documents.
    .2 Text Font Size
      .1 Minimum 25-mm (1-in) high for services 50-mm (2-in) diameter and smaller based on finished diameter including finsulation and jacket.
      .2 Minimum 75-mm (3-in) high for services 300-mm (6-in) diameter and larger based on finished diameter including finsulation and jacket.
      .3 Minimum 50-mm (2-in) high for other finished services.
      .4 Increase letter size by 25-mm (1-in) high for services located at more than 2.4-m (8-ft) above floor.
    .3 Text Colour: As indicated, otherwise as required by Owner, otherwise match existing, otherwise to match requirements for piping from indicated requirements and referenced documents.
    .4 Text Label Size

.1 Borders: Minimum 25-mm (1-in) border widths around and in addition to text.
.2 Width: Minimum 300-mm (12-in) overall width.
.5 Background Colour
.1 As required by Owner, including as indicated or match existing, otherwise to match requirements for piping from ASME-A13.1 for label colour scheme and NEMA-Z535.1 for colours.
.2 Colour may vary for each service.
.4 Flow Direction Label: Provide labels with arrows to indicate flow direction.
.1 Arrow Direction
.1 Provide arrows for normal flow direction of operating service.
.2 Provide additional arrows for services intended to normally have flow in both directions including flow reversal.
.2 Size
.1 Width: Minimum 50-mm (2-in) width.
.2 Height: To accommodate full circumference of finished service.
.3 Colour: Arrow colour to match text colour. Background colour to be opposite of text colour, or clear if approved by Engineer.
.5 Band Label: Provide coloured bands to indicate specific service type group and function.
.1 Arrangement: As indicated, otherwise as required by Owner, otherwise to match requirements for piping from ISO-14726.
.2 Size
.1 Width: Minimum 90-mm (3-1/2-in) width, including for main colour and additional colour.
.2 Height: To accommodate full circumference of finished service.
.3 Colours
.1 As required by Owner, including as indicated or match existing, otherwise to match requirements for piping from ISO-14726 for label colour scheme and colours.
.2 Colour may vary for each service. Multiple colour labels may be required.
.6 Locations
.1 To facilitate easy reading.
.2 To match requirements for piping from indicated requirements and referenced documents.
.7 Intervals
.1 As follows, or at each change of flow direction, or as required if approved by Engineer.
.2 Every 3-m (10-ft) of length for services with 25-mm (1-in) high and shorter text.
.3 Every 6-m (20-ft) of length for services with 25-mm (3-in) high and taller text.
.4 Every 4.5-m (15-ft) of length for other services.
.2 Ceiling Labelling
.1 Provide coloured labels on ceiling surfaces to indicate equipment and components including the following:
.1 Fire dampers.
.2 Control dampers.
.3 Equipment.
.2 Label colours and/or styles may change for each type of equipment or component.
.3 Provide labels as acceptable to Owner, including label type, material, size and colour.
.4 Mark each label as acceptable to Owner, including equipment label, type, power circuit.

3.17 DIFFUSERS, GRILLES AND REGISTERS

.1 Install as required.

3.18 FIELD QUALITY CONTROL

.1 Photograph ductwork at each stage of concealment including:
  .1 Painting.
  .2 Insulating.
  .3 Installation of jacket.
  .4 Wall finishing.
  .5 Other obstructions or concealment.
.2 Test ductwork before ducts are insulated, painted or concealed.
.3 Immediately correct defects discovered during tests and retest systems as required.
.4 Inspect and test ductwork for air leakage at joints and connections to equipment, under normal operating conditions. Provide systems leakage tests to SMACNA requirements.

3.19 CLEANING

.1 Prior to start-up of fans, blow out complete systems of ductwork with high velocity air for not less than 2-hours using where possible using the installed air handling equipment to full capacity and by blanking off duct sections to achieve required velocity.
.2 Do not install air filters prior to blow out of ductwork systems. Use auxiliary portable blowers for cleaning where installed fan systems are not adequate to blow out complete system free from dust and dirt.
.3 Clean interior of plenums, coils, and register, grille or diffuser outlet collars with industrial type vacuum cleaner.
.4 On completion of cleaning process, replace filters before placing systems in final operation.

3.20 BALANCING

.1 To Section 23 90 00 Balancing.
.2 Balance flows as indicated.
.3 Balance flows as required where not indicated.
.4 Balance flows to maximum of the following, within allowable limits including by equipment manufacturer:
  .1 To maximize flow limited by available motor power.
  .2 To maximize flow limited by available motor power including motor service factor.
  .3 To maximum flow as identified by equipment manufacturer.
.5 Fan System Air Volume
  .1 Tolerance: +/-2-%.
.6 Air Terminal Balancing and Calibration
  .1 Measure air terminal box maximum and minimum air flows and compare to setpoints.
  .2 Calibrate air terminal maximum and minimum air volumes to a tolerance of +/-10-%.
.7 Allow for replacement of fan sheaves and belts to suit final balancing requirements.

3.21 ADJUSTING

.1 Supports and Hangers
  .1 Vertical under normal operating conditions.
  .2 Equalize loads.
  .3 Adjust and modify to provide ductwork free from vibration, rattling or drumming under operating conditions.
.2 Balancing
  .1 Allow for 2 additional site visits after receipt of Owner written approval for comfort adjustments.

END OF SECTION 23 30 00

SECTION 23 30 30 AIR DISTRIBUTION SYSTEM CLEANING

PART 1 GENERAL

1.1 SECTION INCLUDES

.1 Air distribution system cleaning, including cleaning for ducts, ductwork, air distribution system components.

1.2 REFERENCED DOCUMENTS

.1 NADCA-ACR: NADCA-ACR-2013 Standard for Assessment and Cleaning and Restoration of HVAC Systems.

.2 NADCA-GS: NADCA General Specifications for the Cleaning of Commercial Heating, Ventilating and Air Conditioning Systems, 2011.

1.3 DEFINITIONS

.1 "Air Distribution System": All components and equipment used for distributing air within building including ducts, ductwork, grilles, louvers, access hatches, inspection ports and openings, mixing boxes, terminal units, ventilation equipment, fans, doors, coils, drain pans, housing, supports, humidifiers, blades, dampers, blades.

.2 "ASCS": Air System Cleaning Specialist.

1.4 INTENT

.1 Remove visible surface contaminants and deposits from air distribution systems.

.2 Clean air distribution systems components without disrupting occupants or facility operations.

1.5 SUBMITTALS FOR ACTION

.1 Air Distribution System Cleaning Plan: Methodology, detailed schedule, and procedures for cleaning.

.2 Photographs: Before and after cleaning of air distribution system.

1.6 SUBMITTALS FOR INFORMATION

.1 Certificates

.1 Letter certifying duct cleaning has been completed in accordance with Contract Documents and commissioning requirements.

.2 Marked Up Drawings: Review existing marked-up copy of drawings for as-built changes to locations and positions, including diffusers, air terminals, dampers.

.3 Qualification Statements

.1 Air Distribution Systems Cleaning: Proof of certifications for peronnel.

1.7 QUALITY ASSURANCE

.1 Qualifications

.1 Air Distribution System Cleaning

.1 Personnel ASCS certified by NADCA.

.2 Subject to approval.

1.8 ADMINISTRATIVE REQUIREMENTS

.1 Coordination and Scheduling

.1 Coordinate cleaning activities with commissioning activities described in Section 01 99 00 Commissioning, and TAB activities described in Section 23 90 00 Balancing.

.2 Perform cleaning prior to TAB activities.

.2 Cleaning Plan Review Meeting

.1 Schedule and conduct cleaning plan review meeting to communicate cleaning methods, schedule, and air distribution system cleaning procedures.

.2 Revise and resubmit cleaning plan as required .

PART 2 PRODUCTS

2.1 CLEANING EQUIPMENT

.1 Provide cleaning equipment including filters, vacuums, personal protective equipment as required.

2.2 CLEANING PRODUCTS

.1 Low VOC.

PART 3 EXECUTION

3.1 PREPARATION

.1 Review
  .1 Review existing information on systems, including balancing reports, equipment data, and building drawings.
  .2 Review systems and equipment to be cleaned.
  .3 Mark locations of components on drawings, including access hatches, volume control devices.
  .4 Review and coordinate duct cleaning procedures with other trades, including controls.

.2 Cleaning Plan: Prepare cleaning plan to communicate schedule, coordination, methodology, and disruption mitigation safeguards.

.3 Documentation: Photograph sections of air distribution system before cleaning with minimum:
  .1 Duct Lengths: 25-%
  .2 Concealed Components: 25-%
  .3 Exposed Components: 25-%

3.2 COMMON EXECUTION REQUIREMENTS

.1 Perform cleaning to NADCA-ACR and NADCA-GS.

.2 Containment: Collect debris including dust removed during cleaning, and ensure that debris is not dispersed outside air distribution system during cleaning process.

.3 Contaminant Control
  .1 Odours: Eliminate during cleaning.
  .2 Mist Vapours: Control during cleaning, including not spraying or affecting surfaces.

.4 Particulate Collection
  .1 Inside Exhaust: Filter air exhausting inside the building with HEPA filtration having 99.97-% collection efficiency for particles greater than or equal to 0.3-micron.
  .2 Outside Exhaust: Ensure air exhausting outside the building is located away from building openings including doors, air intakes.

.5 Air Volume Control Devices: Mark positions of air volume control devices prior to cleaning and restore such devices to their original position after cleaning, including fixed position dampers, balancing dampers.

3.3 CLEANING EXTENT

.1 Clean the following:
  .1 Entire air distribution system.

3.4 ACCESS HATCHES

.1 Provide additional access hatches as required to complete cleaning to Section 23 30 00 Ductwork.

3.5 VERIFICATION

.1 Verify to NADCA-ACR, Section 5, Cleanliness Verification and Documentation, using Method 1 Visual Inspection.

.2 Photograph sections of air distribution system after cleaning, matching the same sample sections from photographs taken on air distribution system before cleaning.

.3 Provide personnel to assist Owner or Engineer to spot verify up to 50-% of photographed sections of air distribution system. Verification may consist of reviews, inspections and tests.

3.6 FIELD QUALITY CONTROL

.1 Non-Conforming Work

.1 Repeat cleaning on areas as required to satisfaction of Owner or Engineer.

END OF SECTION 23 30 30

SECTION 23 51 00 COMBUSTION VENTING

PART 1 GENERAL

1.1 SECTION INCLUDES

.1 Vent, vent connectors, combustion gas/products exhaust, combustion air intake, and related piping, accessories, mounting components, finishing.

1.2 REFERENCED DOCUMENTS

.1 ASTM-A480: ASTM-A480/A480M-14 Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
.2 CSA-B149.1: CAN/CSA-B149.1-05 Natural Gas and Propane Installation Code, including Handbook.
.3 CSA-B149.1: CAN/CSA-B149.1-10 Natural Gas and Propane Installation Code.
.4 MICA-NISM: MICA National Commerial and Industrial Insulation Standards Manual, 2014.
.5 TIAC-BPG: TIAC Mechanical Insulation Best Practices Guide, 2013.
.6 UL-1738: UL-1738-10 Standard for Venting Systems for Gas-Burning Appliances, Categories II, III, and IV.
.7 ULC-S115: CAN/ULC-S115-11 Standard Method of Fire Tests of Firestop Systems.
.8 ULC-S636: ULC-S636-08 Standard for Type BH Gas Venting Systems.

1.3 DEFINITIONS

.1 “Combustion Equipment”: Refers to equipment that uses fuel and fuel combustion to operate.
.2 “Combustion Venting”: Refers to the chimney, vent, vent connector, combustion gas venting, combustion air venting, and related piping, accessories, mounting components and finishing making up a combustion venting section or sections. Same as vent.
.3 “Exhaust”: Same as combustion products exhaust or combustion gas exhaust.
.4 “Intake”: Same as combustion air intake.

1.4 SUBMITTALS FOR ACTION

.1 Product Data
  .1 Manufacturers’ product literature, specifications, and datasheets. Include product characteristics, performance criteria, options, and limitations.
.2 Shop Drawings
  .1 Venting Certification with Combustion Equipment
    .1 Combustion equipment manufacturr’s instructions indicating specific requirements and limitations of use of combustion venting to allow installation to be completed under combustion equipment manufacturer’s instructions to CSA-B149.1.
  .2 Venting Routing: Drawings indicating:
    .1 Layout and Interference Plans: Isometric drawings indicating clearances, interferences, and relocation of interfering services, components, objects, and structures.
    .2 Fire Separations: Location of penetrations through fire separations and other assemblies.
    .3 Venting Drainage: Indicate details of venting slope angles and drainage where applicable.
    .4 Expansion Compensation: Location of expansion control measures.
    .5 Vibration Isolation: Location of vibration isolation connectors.
    .6 Ports and Gauges: Location of ports and gauges.
    .7 Venting Components: Provide bill of materials on venting system indicating components and quantities and part numbers.
  .3 Drain Routing: Drawings indicating:

.1 Layout and Interference Plans: Isometric sketches indicating clearances, interferences, and relocation of interfering services, components, objects, and structures.
.2 Fire Separations: Location of penetrations through fire separations and other assemblies.
.3 Drainage: Indicate details of slope angles and drainage where applicable.
.4 Terminations: Details of roof penetrations, caps, weather proofing, and venting termination.
.5 Mounting
.1 Details of bases, hangers and supports.
.2 Details on guy wire supports.
.6 Fire Stopping and Smoke Seals
.1 Locations and types marked on plan drawing.
.2 ULC assembly number certification.
.3 Required temperature rise and flame rating.
.4 Hose stream rating where applicable.
.5 Materials of fire stopping and smoke seals, primers, reinforcements, damming materials, reinforcements, and anchorages/fastenings.
.6 Assembly and penetration type and required ratings, adjacent materials.
.7 Openings size, thickness, dimensions.
.8 Proposed installation methods.
.9 Summaries of similar types of penetrations, assembly type and construction, service penetrating assembly, adjacent materials, fire stopping and smoke seal type, ratings, other work required.
.10 Copies of ULC certifications for proposed systems and designs for specific devices and materials.
.11 Image of sample tag.
.7 Labels: Scaled drawings indicating dimensions, layout, locations, lettering, font, spacing, colours. Specifically identify letter sizes larger than indicated minimum heights.

1.5 SUBMITTALS FOR INFORMATION

.1 Certificates
.1 Letter certifying duct supports are in compliance with required seismic restraint provisions.
.2 Letter certifying that materials comply with specified performance characteristics and physical properties.
.3 Letter certifying duct supports are in compliance are in compliance with Contract Documents.
.4 Letter from fire stopping and smoke seals installer certifying that fire stopping and smoke seals have been installed in accordance with regulatory requirements and Contract Documents.
.5 Letter from licensed fire protection company certifying fire suppression and detection services are in compliance with regulatory requirements.
.2 Qualification Statements
.1 Fire Protection: Proof of licenses for company and personnel.
.2 Gaseous Fuels: Proof of gaseous fuels licenses for company and personnel.
.3 Liquid Fuels: Proof of liquid fuels licenses for company and personnel.
.4 Professional Engineers: Proof of Professional Engineer licences for company and personnel.
.3 Training
.1 Preconstruction Product Training: Proof of factory training on product installation.

1.6 QUALITY ASSURANCE

.1 Qualifications

.1 Fire Protection: Company and personnel to be licensed sprinkler and fire protection installers.
.2 Fire Stopping and Smoke Seals: Company member of FCIA.
.3 Gaseous Fuels: Company and personnel to have licences for gaseous fuels as required.
.4 Liquid Fuels: Company and personnel to have licences for liquid fuels as required.

1.7 ADMINISTRATIVE REQUIREMENTS

.1 Preconstruction Product Review
.1 Arrange for the following additional on site meetings:
.1 Review of installation requirements with product manufacturer.

PART 2 PRODUCTS

2.1 COMMON PRODUCT REQUIREMENTS

.1 Provide combustion venting rated to handle the extremes of temperature, pressure, and corrosion to which they will be subjected.
.2 Provide combustion venting constructed from materials suitable for the fluid type and conditions to which they will be exposed.
.3 Combustion venting dimensions indicate clear inside dimensions. Adjust combustion venting sizes to accommodate liners and other obstructions.
.4 The precise quantity and location of combustion venting depends on routing and installation choices made by Contractor. Provide combustion venting:
.1 To CSA-B149.1.
.2 To combustion equipment manufacturer's instructions and vent manufacturer's instructions.
.3 As indicated.
.5 Performance
.1 Noise Tolerances: Provide combustion venting free from vibration, rattling or drumming under operating conditions.
.6 Fabrication
.1 Materials that contact combustion venting to be:
.1 From same manufacturer as combustion venting and do not void venting product certifications.
.2 Alternate materials may be acceptable if alternate materials do not void venting product certifications if approved by vent manufacturer and Engineer.

2.2 COMBUSTION PRODUCTS EXHAUSTS

.1 Provide as required.
.2 Type
.1 SS Vent
.1 Manufacturers
.1 Security Chimneys International, Models Flex/SS/SSD
.2 Features
.1 Cat IV vent.
.3 Materials
.1 Inner wall with AL29-4C stainless steel.
.4 Certifications, Listings and Registrations
.1 To ULC-S636.
.2 To UL-1738.
.3 Limitations
.1 Dimensions as approximately indicated.
.2 Ensure required clearances maintained, including for combustibles, temperatures.
.3 Ancillary components including for mounting and penetrations required to touch venting to be from same vent manufacturer and be allowed for installation under vent manufacturer instructions.
.4 Substitution Limitations

.1 Substitutions may be accepted under substitution provisions described in Contract Documents.
.2 Substitutions may be limited by various requirements and may require re-design, including:
.1 Suitability for combustion products.
.2 Physical characteristics, including weight, height, length, width, strength.
.3 Expansion and contraction.
.4 Clearance to combustibles and surface temperatures.
.5 Product joint types and methods.
.6 Product quality.
.3 Re-design differences as a result of substitution to delegated design requirements described in Contract Documents, including design and design documents completed by a Professional Engineer.
.4 Acceptable Substitution Manufacturers
.1 To instructions of combustion equipment manufacturer.

2.3 COMBUSTION AIR INTAKES

.1 Combustion air intake venting system to be from same vent manufacturer and product for combustion products exhausts.

2.4 JOINTS AND SEAMS

.1 To vent manufacturer instructions.

2.5 CHIMNEY OPENING CAPS

.1 Provide as required.
.2 Materials
.1 Stainless steel type 304 to ASTM-A480.

2.6 TALL CONE FLASHING

.1 Provide as required.
.2 Materials
.1 Stainless steel type 304 to ASTM-A480.

2.7 STORM COLLARS

.1 Provide as required.
.2 Manufacturers
.1 As acceptable to vent manufacturer and combustion equipment manufacturer.
.3 Materials
.1 As recommended by vent manufacturer or combustion equipment manufacturer.
.2 Aluminum unless otherwise required.

2.8 SUPPORTS, GUIDES AND HANGERS

.1 Design of combustion venting support depends, in part, on routing and installation choices made by Contractor. Design of combustion venting support is Contractor responsibility.
.2 Provide as required.
.1 To vent manufacturer instructions.
.2 To CSA-B149.1.
.3 Design for easy removal.
.3 Performance
.1 Design combustion venting supports to withstand seismic events as required. Seismic restraint provisions shall meet or exceed requirements for post-disaster buildings in the respective seismic zone.
.2 Prevent combustion venting noise and vibration from being transferred to supporting structure.
.3 Angularity of rod hanger resulting from horizontal movement of combustion venting from cold to hot position not to exceed 4-degrees from vertical.

2.9 FIRE STOPPING AND SMOKE SEALS

.1 Asbestos-free materials and systems capable of maintaining effective barrier against flame, smoke and gases to ULC-S115.
.2 Manufacturers: 3M, Fire Protection Products
.3 Materials
.1 Fire stopping and smoke seal components: Certified by test laboratory to ULC-S115.
.2 In assemblies: Systems tested to ULC-S115.
.3 In wet environments, waterproof assemblies, or exterior assemblies including foundations and below grade floors: Waterproof, non-hardening.
.4 Penetrations requiring vibration control: Elastomeric seal.
.5 Damming and backup materials, supports and anchoring devices: To manufacturer's recommendations, and in accordance with tested assembly being installed as acceptable to authorities having jurisdiction.
.6 Other locations: As required.
.4 Performance: Rating: 2-hours, unless otherwise required.

2.10 DRAINS

.1 Provide as required.
.2 Materials
.1 Vent Connections: Match vent materials.
.2 Condensate Drain: As indicated.
.3 Drain Hose: As indicated.

2.11 CONDENSATE NEUTRALIZATION

.1 Provide:
.1 As required unless otherwise indicated, including to maintain pH of maximum condensate flow within limits as required by sanitary drain system.
.2 As recommended by combustion equipment manufacturer.

PART 3 EXECUTION

3.1 EXAMINATION

.1 Verification of Conditions
.1 Inspect vent routing including chimneys, chases.
.1 Verify free of obstructions.
.2 Verify not used for additional combustion venting not indicated.
.3 Verify dimensions are not smaller than as indicated or as required for combustion venting.
.4 Verify other nearby services and components including combustion venting, air intakes, air openings, other building openings.
.2 Determine exact location and routes for venting and piping. Modify routing and/or relocate existing services as required.
.3 Complete x-ray scans, consultation, and other investigative work as required to verify structural member construction, verify suitable locations, and ensure drilling and coring through structural members will not affect integrity.
.4 Investigate fire separations and non-fire-resistance rated assemblies in affected systems for existing fire stopping or smoke sealing that is improperly sealed or defective, as well as for penetrations not fire stopped or smoke sealed.

3.2 PREPARATION

.1 Flush and clean affected venting and piping systems including new and existing services and components before being put into service.

3.3 COMMON EXECUTION REQUIREMENTS

.1 The precise quantity and location of combustion venting depends on routing and installation choices made by Contractor. Provide combustion venting:
.1 To CSA-B149.1.

.2 To combustion equipment manufacturer's instructions and vent manufacturer's instructions.
.3 As indicated.

.2 Provide fittings including offsets and transitions to facilitate combustion venting arrangement and to avoid interference with building structure, piping, equipment and services. Limit quantities and types of fittings:
.1 As indicated.
.2 To vent manufacturer and combustion equipment manufacturer where not indicated and as approved by Engineer.
.3 To requirements of authority having jurisdiction and as approved by Engineer.

.3 Install indoor combustion venting as close as possible to walls, partitions and overhead structures to attain maximum headroom and clearance.

.4 Slope combustion venting to facilitate condensate removal, as recommended by combustion equipment manufacturer, vent manufacturer, and as required.

.5 Relocate and extend fire protection systems as required, including fire detection and adding sprinkler heads as required.

3.4 JOINTS AND SEAMS

.1 Seal joints and seams on combustion venting as recommended by combustion equipment manufacturer, vent manufacturer, and as required.

3.5 CHIMNEY OPENING CAPS

.1 Provide as required.

.2 Slope and mount to facilitate precipitation removal and prevent ponding as required.

3.6 STORM COLLARS

.1 Provide at penetrations through surfaces to outdoors, including roofs and ceilings, and as indicated to prevent precipitation from entering opening to building while also allowing for thermal expansion of combustion venting.

3.7 TALL CONE FLASHING

.1 Provide at penetrations through surfaces to outdoors, including roofs and ceilings, and as indicated to prevent precipitation from entering opening to building while also allowing for thermal expansion of combustion venting.

3.8 SUPPORTS, GUIDES AND HANGERS

.1 Design and provide supports, guides and hangers as required.
.1 Include as required steel framing, braces.

.2 Guy Wires: Provide guy wire supports as required, including to vent manufacturer instructions.

.3 Refrain from hanging combustion vent from another combustion vent unless otherwise indicated.

.4 Adjust support system including hangers to equalize load.

3.9 PENETRATIONS

.1 Provide sleeves at penetrations and where venting passes through assemblies including walls, floors and ceilings.

.2 Pack sleeves with resilient packing or fire rated packing and materials as required.

.3 Flash parts built into or passing through to wet environments, waterproof assemblies, or exterior assemblies including roofs, outside walls.

.4 Patch holes to match existing surfaces.

.5 Provide minimum clearances as required between sleeves and uninsulated or insulated venting with minimum of:
.1 From Combustibles: As required.
.2 Below Grade: 25-mm (1-in)
.3 Other Locations: 13-mm (1/2-in)

.6 Sleeve Materials

.1 Thimbles: As required.
.2 Exterior Assemblies: Carbon steel schedule 40, primed and painted to Section 09 91 00 Painting.
.3 Masonry and Concrete Assemblies: Carbon steel schedule 40, primed and painted to Section 09 91 00 Painting.
.4 Interior Frame Construction Assemblies in Conditioned Spaces: Carbon steel schedule 40.
.5 Other Frame Construction Assemblies: Carbon steel schedule 40 primed and painted to Section 09 91 00 Painting.

.7 Extend floor sleeves 38-mm (1-1/2-in) above floor surface.
.8 Seal floor sleeves with an approved stiff setting caulking compound to serve as a water dam.

3.10 FIRE STOPPING AND SMOKE SEALS

.1 Fire stop and smoke seal at fire-resistance rated assemblies including:
.1 Penetrations through masonry, concrete, and frame construction including gypsum board partitions and walls.
.2 Penetrations through floor slabs, ceilings and roofs.
.3 Openings and sleeves installed for future use.
.4 Services, including mechanical and electrical.
.5 As indicated.

.2 Fire stop and smoke seal at non-fire-resistance rated assemblies including:
.1 Assemblies not fire-resistance rated but constructed as such.
.2 As indicated.

.3 Install fire stopping and smoke seal material and components in accordance with manufacturer's certified tested system listing.
.4 Install to allow for movement and thermal expansion of services including venting and piping.
.5 Ensure integrity of fire stopping and smoke seals such that passage of flame, smoke and gases is prevented including to unexposed side of assembly of single sided fire stopping and smoke seals. Repair as required.
.6 Ensure integrity of insulation and vapour barriers. Repair as required.
.7 Repair holes, gaps, openings and improperly fire stopped and smoke sealed penetrations in affected assemblies.
.8 Provide tags for each fire stopping and smoke seal. Include relevant information on tags including installer name, company, trade license, installation date, fire stopping and smoke seal ULC assembly number certification. Mount at locations as approved by Owner or as required by authorities having jurisdiction.

3.11 COMBUSTION VENTING INSULATION AND JACKETS

.1 Install as required.
.2 Replace insulation and jackets on existing combustion venting as indicated.
.3 Replace damaged insulation and jackets on existing combustion venting affected by Work.
.4 Provide insulation as indicated unless application of insulation voids combustion venting product certifications, in which case provide protective barrier.
.5 Provide access to service components and devices, including nameplates, access hatches and doors, operable components.
.6 Install insulation, and seal seams and joints to prevent condensation or precipitation.
.7 Install to:
.1 MICA-NISM.
.2 TIAC-BPG.

.8 Seams
.1 Seal seams using seam sealant acceptable to manufacturer and Engineer.
.2 Match seam sealant to jacket.
.3 Minimize the number of seams by using full length insulation pieces.
.4 Position overlaps to shed water.

.5 Locate longitudinal seams at the side of the combustion venting that is least visible.

.9 Supports, Guides and Hangers
.1 Install supports, guides and hangers outside vapour retarder jacket.
.2 Install high compressive strength insulation under venting supports to prevent compression of insulation.

.10 Additional Finishing
.1 Type CAN - Canvas Jacket: Paint jackets to Section 09 91 00 Painting.

3.12 DRAINS

.1 Provide drain pipe instead of drain hose unless otherwise indicated.

.2 Locations
.1 Low points in combustion venting system.
.2 Connection points to combustion equipment.
.3 As indicated.

.3 Access: Ensure drain connections are accessible for service.

.4 Traps: Provide traps on drains unless otherwise indicated or recommended by combustion equipment manufacturer.

.5 Grade: Slope drains as required to ensure proper drainage.

.6 Termination
.1 Direct drains to sanitary floor drains.
.2 Ensure sanitary floor drains are located below vent connections and traps.

.7 Drain Pipe
.1 Vent Connections: Rigid connection.
.2 Traps: P-trap.
.3 Joints
.1 Minimize joints.
.2 Provide unions to connect drain piping to vent connection or other equipment and components for ease of maintenance and assembly.
.4 Routing: Avoid routing drain pipes through separations.

.8 Drain Hose
.1 Vent Connections: Barbed fitting and clamps.
.2 Traps: Vertical loop and clamps.
.3 Joints: Provide continuous lengths.
.4 Routing: Do not route drain hoses through separations.

3.13 CONDENSATE NEUTRALIZATION

.1 Locate condensate neutralization kit away from traffic or service areas.

.2 Provide drain hose between condensate neutralization kit and sanitary floor drain as required.

3.14 FIELD QUALITY CONTROL

.1 Pre Start-up Inspections
.1 Ensure entire installation is approved by authorities having jurisdiction and combustion equipment manufacturers before start-up.
.2 Ensure entire special venting installation is approved by venting manufacturers before start-up.

.2 System Testing
.1 To CSA-B149.1.
.2 To requirements of authorities having jurisdiction.

3.15 NON-CONFORMING WORK

.1 In case of disagreements regarding conformance of Work, retain and pay for a representative from applicable authorities having jurisdiction to inspect Work and provide a ruling.

.2 Correct non-conforming Work with no adjustment to Contract Price or Contract Time.

3.16 BALANCING

.1 Balance system including manual dampers and barometric dampers as required. Balance at various conditions including:
  .1 Low load and high load of single combustion equipment operating.
  .2 Low load and high load of multiple combustion equipment operating.
  .3 As above for various seasons including summer season, shoulder season, winter season.
  .4 As above for each fuel type.
.2 Allow for 4 additional site visits after receipt of Owner written approval for adjustments.

3.17 ADJUSTING

.1 Supports, Guides and Hangers
  .1 Vertical under normal operating conditions.
  .2 Equalize loads.
  .3 Adjust and modify to provide combustion venting free from vibration, rattling or drumming under operating conditions.

END OF SECTION 23 51 00

SECTION 23 90 00 BALANCING

PART 1 GENERAL

1.1 SECTION INCLUDES

.1 Balancing including measurements, testing, adjusting, verification of existing.

1.2 REFERENCED DOCUMENTS

.1 AABC-TSB: AABC National Standards for Total System Balance, 2002.
.2 ASHRAE-111: ASHRAE-111-2008 Practices for Measurement, Testing, Adjusting, and Balancing of Building Heating, Ventilating, Air-Conditioning, and Refrigeration Systems
.3 NEBB-TABES: NEBB Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems, 2005.

1.3 DEFINITIONS

.1 "TAB": Used to describe the process, methods, and requirements of testing, adjusting, and balancing for applicable systems.

1.4 INTENT

.1 Perform TAB such that indicated systems, equipment and components perform as required.

1.5 SUBMITTALS FOR ACTION

.1 TAB Plan
  .1 Methodology and procedures for performing TAB.
  .2 Highlighted specific procedures different from referenced documents and other specification sections.
  .3 Test equipment list with test equipment specifications.

1.6 SUBMITTALS FOR INFORMATION

.1 Certificates
  .1 Letter certifying TAB has been completed in accordance with Contract Documents and commissioning requirements.
.2 Balancing Reports
  .1 Balancing reports compliant with NEBB-TABES or AABC-TSB recommendations.
  .2 Provide system schematic diagram with recorded measurements and requirements. Include time of measurements.
  .3 Indicate pressure drops across components, including intake and exhaust locations including louvers and grilles.
  .4 Indicate air conditions for outdoors as well as throughout system at different measurement times.
  .5 Provide calibration certificates for test equipment used.
.3 Marked Up Drawings
  .1 Marked up drawing indicating extent of differences between Drawings, building drawings and actual as-built conditions.
.4 Qualification Statements
  .1 TAB: Proof of certifications for company and personnel.

1.7 QUALITY ASSURANCE

.1 Qualifications
  .1 TAB
    .1 Company and personnel CAABC or NEBB certified.
    .2 Subject to approval.

1.8 ADMINISTRATIVE REQUIREMENTS

.1 Coordination: Coordinate TAB activities with commissioning requirements.
.2 Pre-TAB Review
.3 TAB Plan Review Meeting
  .1 Schedule and conduct TAB plan review meeting review meeting as required.
  .2 Review Contract Documents, and confirm in writing adequacy of provisions for TAB.

.3 Review specific procedures different from referenced documents and other specification sections.
.4 Provide written detailed justification for choice of TAB methodology and procedures when requested by Engineer or Commissioning Authority.
.5 Revise and resubmit TAB plan as required to satisfaction of Engineer and Commissioning Authority.

PART 2 PRODUCTS

2.1 TEST INSTRUMENTS

.1 Accuracy Tolerances: Provide test instruments with scale ranges, accuracies, and resolutions to NEBB-TABES minimum requirements unless otherwise specified.
.2 Calibrate instruments within 6 months of TAB.

PART 3 EXECUTION

3.1 EXAMINATION

.1 Evaluate affected systems, equipment, services and components before completing Work, including:
  .1 Confirm if balancing devices and components and other components affecting balancing and distribution systems isolation are present and adequate, including if improperly installed, defective, failed, or missing.
    .1 Air systems including:
      .1 Control dampers, manual dampers, draft dampers, fire dampers, balancing dampers.
    .2 Liquid systems including:
      .1 Control valves, shutoff valves, check valves, balancing valves.
  .2 Add access hatches as required to access components, including where access hatches are missing or inadequate.
  .3 Confirm if available documentation has correctly and accurately identified distribution system equipment and components.
  .4 Confirm if test ports and locations are present and adequate.
  .5 Confirm clearances and maintenance access to equipment and components are adequate.
  .6 Confirm physical access to concealed equipment and components are present and adequate.
  .7 Investigate and review possible system installation deficiencies, including openings, connections.
.2 Photograph, document and submit descriptions of existing equipment and components.
  .1 Air systems including:
    .1 Ventilation equipment, including air handlers, exhaust fans.
    .2 Ventilation equipment components, including energy sinks and sources, coils, filters, silencers, dampers.
    .3 Air terminals, including VAV boxes, FPBs, wiring configuration.
    .4 Air distribution control components, including control dampers.
    .5 Air distribution treatment components, including reheat coils.
    .6 Air distribution system components, including silencers, filters.
  .2 Liquid systems including:
    .1 Pressure equipment and components, including pumps, expansion tanks, makeup regulating valves.
    .2 Liquid terminals, including reheat coils, fan coils, forced flow units, zone heating.
    .3 Liquid distribution control components, including control valves.
    .4 Liquid distribution system components, including strainers, check valves.
.3 Photograph, document and submit descriptions of existing deficiencies and limitations to completing Work, including:
  .1 Sufficiency or missing balancing devices and components.

.2 Improperly installed, defective or failed balancing devices and components and other components affecting balancing and distribution systems isolation.
.3 Missing or improperly located test ports.
.4 Physical access restrictions.
.5 System installation deficiencies, including openings, connections.

.4 Mark up copy of existing building drawings to verify as-built conditions and to indicate differences between drawings and actual as-built conditions of air distribution systems and related aspects including the following:
.1 Air inlet and outlet component types, sizes and locations, including diffusers, registers, grilles, louvres.
.2 Air inlet and outlet component accessories, including screens, acoustic lining.
.3 Ductwork types including rigid, flexible.
.4 Ductwork sizes and locations including fittings.
.5 Ductwork access hatch sizes and locations.
.6 Air terminal equipment types and locations.
.7 Air terminal equipment accessory component locations including coils, control valves, dampers.
.8 Fire damper locations.
.9 Balancing device locations including balancing dampers.
.10 Transfer sizes and locations, including ductwork, openings.
.11 Access hatch sizes and locations.

3.2 PREPARATION

.1 Review existing balancing reports, equipment data, and building drawings.
.2 Review and coordinate TAB procedures with other trades, including controls.
.3 Prior to starting TAB, confirm:
.1 Equipment and systems have been properly started up.
.2 Equipment and systems have been verified for proper, normal and safe operation of mechanical and associated electrical and control systems.
.3 Required commissioning forms to Section 01 99 00 Commissioning have been fully completed.
.4 Review and document status of related and potentially related components and systems within or near the vicinity of affected systems and zones that may impact measurements and results of TAB, including open or closed doors, operational ventilation systems, neighbour zone conditions, outdoor ambient conditions.

3.3 COMMON EXECUTION REQUIREMENTS

.1 Perform TAB to:
.1 As indicated.
.2 ASHRAE-111.
.3 AABC-TSB or NEBB-TABES.
.4 Equipment and component manufacturers recommendations.
.2 Balance flows:
.1 As indicated.
.2 Where flows are not indicated:
.1 Balance affected work as required.
.1 For multiple components downstream from parts with indicated flows, balance components with even flows when all components are the same size, otherwise balance components with flows relative to the variation and sizes of components. Including components downstream of balancing devices with indicated flows such as air diffusers downstream of air terminals, with indicated flows multiple or multiple sectioned heating convectors and coils downstream of other balancing valve with indicated flows.
.2 Balance existing systems to the most recent document available from the following:
.1 Balanced flows from most recent Owner accepted balancing report.

.2 Design flows from supplemental project and renovation drawings.
.3 Design flows from building drawings.

.3 Balance to optimize system, including as follows.
.1 Open existing balancing components and devices to reduce required head before balancing.
.2 Rebalance balancing components and devices to reduce required head, including at energy sinks and sources and loads, throughout distribution systems.

.4 Coordinate work with other trades, including controls and building automation system.

.5 Air Systems
.1 Measure airflows with the following methods in the following order as can be applied to each measurement:
.1 Airflow hood.
.2 Multiple pitot tube traverse.
.3 Pitot tube traverse.

.6 Witnessing: Activities subject to witnessing by Owner and Engineer including measurements, verification of conditions that may affect measurements.

3.4 VENTILATION EQUIPMENT - GENERAL

.1 After air distribution supply system has been balanced, balance ventilation equipment to maximum air flow requirements.

.2 Adjust fan drives including belts and pulleys as required to balance air flows to values as indicated.

.3 Record duct static pressure setpoint and fan speeds at the following:
.1 Ventilation equipment inlet and outlet.
.2 Fans.
.3 At each major component within ventilation equipment.

3.5 VENTILATION EQUIPMENT - VARIABLE FLOW

.1 Variable flow systems include variable air volume and adjustable systems.

.2 Adjust fan pulleys to obtain 95-% variable drive speed at peak condition, including variable frequency drives and vanes.

.3 Confirm design diversity factor as indicated. Where not indicated, use design diversity factor of 80-%.

3.6 AIR TERMINAL BOXES - GENERAL

.1 Coordinate with other trades, including controls and building automation system, to calibrate box minimum and maximum flow settings.
.1 Verify a minimum of 100-% of each box by Pitot Tube Traverse to NEBB-TABES.
.2 Verify existing flow measuring device calibration by comparing Pitot Tube Traverse volume measurements and measured pressure drops across existing flow measuring device to manufacturer's performance curves.

3.7 PUMPS - GENERAL

.1 Record pressure at pump inlet and outlet, as well as at each component near pump.

3.8 CONTROLS COORDINATION

.1 Coordinate with controls contractors to confirm setpoints, and suitable operating ranges for:
.1 Differential and absolute pressure sensors and switches.
.2 Flow sensors and switches.
.3 Minimum and maximum flow settings on variable speed pumps.
.4 Minimum and maximum flow settings on variable speed fans.

3.9 ADJUSTING

.1 Re-balancing
.1 Re-balance system after additional repairs have been implemented.

3.10 REPORTING

.1 After settings and adjustments are completed, repeat completing all measurements throughout equipment and systems without making adjustments. Document status of related and potentially related components and systems within or near the vicinity of affected systems and zones that may impact measurements and results of TAB, including open or closed doors, operational ventilation systems, neighbour zone conditions, outdoor ambient conditions.

.2 Photograph, document and submit descriptions of completed equipment and components.

.1 Air systems including:

.1 Ventilation equipment, including air handlers, exhaust fans.

.2 Ventilation equipment components, including energy sinks and sources, coils, filters, silencers, dampers.

.3 Air terminals, including VAV boxes, FPBs, wiring configuration.

.4 Air distribution control components, including control dampers.

.5 Air distribution treatment components, including reheat coils.

.6 Air distribution system components, including silencers, filters.

.2 Liquid systems including:

.1 Pressure equipment and components, including pumps, expansion tanks, makeup regulating valves.

.2 Liquid terminals, including reheat coils, fan coils, forced flow units, zone heating.

.3 Liquid distribution control components, including control valves.

.4 Liquid distribution system components, including strainers, check valves.

3.11 VERIFICATION

.1 Reported results subject to verification.

.2 Repeat TAB as required to satisfaction of Engineer.

3.12 SETTINGS

.1 After TAB is completed, restore systems, equipment and components back to good working order, including remount drive guards, close access doors, lock devices in set positions, and ensure sensors and automatic controls are reverted back to normal operation.

.2 Permanently mark settings to allow restoration of original settings.

END OF SECTION 01 99 00

SECTION 25 05 00 BUILDING AUTOMATION SYSTEM

PART 1 GENERAL

1.1 SECTION INCLUDES

.1 Building automation hardware and software, controllers.
.2 Relationship to other Sections:
  .1 Section 25 90 00 Control Sequences describes additional requirements of components furnished under this Section, including configuration and programming of controllers.
  .2 Section 26 05 00 Wiring and Cables describes installation requirements of services required under this Section, including wiring.
  .3 Section 26 90 00 Control Devices describes control end device requirements for components furnished under this Section.

1.2 REFERENCED DOCUMENTS

.1 ASHRAE-135: ANSI/ASHRAE-135-2012 BACnet - A Data Communication Protocol for Building Automation and Control Networks.
.2 ASHRAE-G-11: ASHRAE-G-11-2009 Guideline on Field Testing of HVAC Controls Components.
.3 IEEE-802.3: IEEE-802.3-2008 Carrier Sense Multiple Access with Collision Detection (CMSA/CD) Access Method and Physical Layer Specifications.
.4 NEMA-250: NEMA-250-2008 Enclosures for Electrical Equipment (1000 Volts Maximum).

1.3 DEFINITIONS

.1 DVD
.2 RAM
.3 USB

1.4 INTENT

.1 This Section describes the scope, requirements, and intent of BAS. Provide design, construction, and commissioning services required to provide a system that meets the specified intent and requirements.
  .1 BAS Replacement
    .1 Demolish existing BAS including controllers, network wiring, end devices, signal conditioners, conduit, power wiring, end device wiring, pneumatic tubing, and control enclosures.
    .2 Provide new BAS.
    .3 Match sequences and performance of existing system unless otherwise indicated.
    .4 Where existing BAS performance or features conflict with specified performance or features, the more stringent requirements shall take precedence.
    .5 All existing programmable controllers must be replaced with controllers from a single manufacturer.
    .6 Existing end devices, wiring, and conduit compatible with new system may be reused unless otherwise indicated.
    .7 Contractor agrees to assume all responsibility for assessing extent, nature and capabilities of the existing system, and waives future claims against errors or omissions in documentation or graphics screens.
    .8 Contractor acknowledges that depictions of extent of existing system contained within Contract Documents are for the sole purpose of providing a general description of existing BAS extent, and not to provide an accurate or comprehensive points list or BAS description.

1.5 SUBMITTALS FOR ACTION

.1 Product Data
  .1 Manufacturers' product literature, specifications, and datasheets. Include the following information:
    .1 Product characteristics.

.2 Performance criteria.
.3 Options.
.4 Limitations.
.5 Photographs.
.6 Supplier information.

.2 Performance criteria for end devices includes accuracy, operating environment tolerances, and stability criteria.
.3 Detailed Bill of material list for each system or application, identifying quantities, part numbers, descriptions, and optional features.

.2 Shop Drawings
.1 BAS in its entirety, distinctly indicating existing parts and new Work.
.2 BAS network architecture diagrams including controllers, interconnections, repeaters and interfaces.
.3 Control panel and controller schedules.
.4 Floor plan drawings showing location of system components.
.5 System schematics and flow diagrams indicating point location, name, and hardware address.
.6 Diagrams indicating power wiring for all controllers and devices. Include panel numbers, panel locations, circuit breaker numbers, and wiring and conduit details.
.7 Points list describing hardware location, function, signal conditioning, and end devices for each point.
.8 Details of BAS programming including:
.1 Sequences of operation.
.2 Descriptions of variables and constants.
.3 Software architecture.
.4 For sequential-style programming languages, provide commented line by line listings of code.
.5 For graphical-based programming languages, provide commented logic drawings.
.9 Details of BAS data visualization and format including:
.1 Proposed trend log point grouping and scaling.
.2 Archive data format.
.10 Sample of archived data in specified format.
.1 Minimum 24-hour duration.
.2 All required points.
.11 Room Schedule including a separate line for terminal unit indicating location and associated BAS point, including airside and waterside terminal units, including air terminal boxes.
.12 Wiring and Ladder Logic
.1 Diagrams detailing BAS interfaces and hardware interlocks for all equipment affected by Work.
.2 Diagrams describing existing undocumented BAS interfaces and hardware interlocks.
.13 Interlocks: Schematic and wiring diagrams detailing electrical interlocks and life safety system interfaces.
.14 Labels: Scaled drawings indicating locations, as well as details of labelling including dimensions, layout, lettering, font, spacing, colours.

.3 Samples
.1 Zone End Devices: Submit samples of end devices, including zone temperature, humidity, and pressure sensors, to be located in occupied areas.

1.6 SUBMITTALS FOR INFORMATION

.1 Certificates
.1 Conformance: BACnet Protocol Implementation Conformance Statement to ASHRAE-135 for all BACnet devices and controllers.

.2 Letter from BAS manufacturer certifying proposed controllers are fully compatible with each other or any parts of existing system being reused where allowed.

.2 Manufacturer Information
- .1 Operating and Maintenance Manuals
- .2 Installation Instructions

.3 Testing Report: A report detailing the results of testing activities including the following:
- .1 Dates of testing activities.
- .2 Names and contact information of testing technician.
- .3 Point Calibration Results: Include points and devices tested, description of testing method, observations including point values, measured values, discrepancies, and a description of corrective action taken.
- .4 Output Testing Results: Include points and devices tested, description of testing method, observations including point values, measured values, discrepancies, and a description of corrective actions taken.
- .5 Failure Mode Test Results
- .6 Software State Test Results
- .7 Interlocks Test Results
- .8 Completed Testing Check List

.4 Test and Evaluation Reports
- .1 Report on air terminal box test, including:
  - .1 Hardware address of distributed controller.
  - .2 List of rooms served.
  - .3 Location of temperature sensors.
  - .4 Programmed maximum and minimum flow settings.
  - .5 Measured flow rates at maximum and minimum flows, per box.

.5 Periodic Inspection Reports
- .1 Provide written reports for each required post construction inspection including:
  - .1 Date of inspection.
  - .2 Climate conditions.
  - .3 Notes.
  - .4 Trend log printouts.
  - .5 Summary of adjustments or changes made.
  - .6 Updated documentation.
  - .7 Updated electronic copies of documentation.

.6 Marked Up Drawings
- .1 Marked up drawings indicating extent of differences between issued Drawings, building drawings and actual as-built conditions.

1.7 SUBMITTALS FOR CLOSEOUT

.1 Operating and Maintenance Data

.2 Electronic Data
- .1 Editable electronic files for drawings in both AutoCAD and Visio format.
- .2 A duplication of the contents of the manual in Adobe PDF format.
- .3 Archive copy of site-specific databases, software, configuration and sequences.
- .4 Electronic copy of controller database including point configuration, sequences, and other programmable parameters.

.3 Spare Parts
- .1 Keys: 4 sets of common keys to BAS enclosures.

.4 Tools and Software
- .1 Licenses to use and own proprietary software and documentation for an unlimited duration without additional fees. Licenses shall include required software updates to maintain functionality.
- .2 Copies hardware security devices, documentation.
- .3 Digital copies of software.

.4 Provide BAS software and tools needed for full functional use, including programming and configuration of new and existing controllers, programming changes, network management and expansion, and GUI use and development. Provide training required for use of software and tools.
.5 Provide system and programming manuals that describe system overview, programming and testing, in hard copy and electronic copy. Manuals to include detailed description of each software feature including:
.1 Editing and writing control programs
.2 Reading or modifying printout and logs
.3 Adding, deleting and modifying user password
.6 Provide highest level passwords and security access to hardware functions, configurations, and upgrades.

1.8 QUALITY ASSURANCE

.1 Installer Qualifications
.1 BAS Configuration
.1 Regularly engaged in the engineering, programming, installation and service of similar systems.
.2 Office within a 150-km radius of Site, that offers complete maintenance and support services on a 24-hour/day, 7-days/week, 365-days/year basis. This office shall have direct access to or inventory of spare parts and all necessary test and diagnostic equipment required for installation, commissioning and servicing.
.2 GUI Mock-up
.1 Prepare working mock-up of GUI screens.

1.9 ADMINISTRATIVE REQUIREMENTS

.1 Graphical User Interface Mock-up Procedures
.1 Install GUI mock-up on a computer (subject to approval), for review.
.2 Revise GUI mock-up as required, until approved, including for style, layout, aesthetics, units of measurement, buttons, links.
.3 Proceed with full programming and configuration of GUI.
.4 Completed GUI shall be subject to approval, based on requirements defined by approved GUI mock-up.
.2 Testing Plan Review
.1 Submit Testing Plan for approval 20-days prior to testing.
.2 Revise the Testing Plan as required to the satisfaction of the Engineer.
.3 Submit the Testing Report demonstrating results of testing activities.
.3 Field Documentation Review
.1 Arrange meeting no later than 1 week after shop drawings have been submitted to review field documentation plan with Owner.
.2 Provide a description of the following for approval:
.1 Colour coding scheme for communication, power, and control wiring.
.2 Labelling scheme for all wiring.
.3 Point naming conventions.
.4 Panel, equipment, and system naming conventions.
.5 Field labelling names, format, and information.
.4 Trend Log Data Review
.1 Trend log data is critical to commissioning and correction activities.
.2 Submit sample trend log data in the following electronic format:
.1 File Format: Microsoft Excel
.2 Minimum Interval: 1-min
.3 Points: Physical Analog and Digital Input and Output Points
.4 Format: Database quality table format, having columns containing point names and rows containing each sample, with no gaps, column shifts, or text between rows.

.5 Data shall be obtained through direct database query. Manual editing of text reports shall not be accepted.

.5 Phase In Coordination Meeting

.1 Coordinate and hold a phase in meeting with Owner to discuss and plan installation and migration plan from old control system to new control system.

1.10 WARRANTY

.1 Special Warranty

.1 Include modifications and adjustments during Correction Period, including logic, and sequences, settings, limits, tuning of PID controllers.

.2 Include labour and materials costs to remove, replace, and re-configure products provided under this contract should they become obsolete within 5-years.

.1 A product is deemed to be obsolete when the manufacturer ceases to manufacture, supply, or support replacement products that can directly replace the obsolete product.

.2 A product is deemed to be obsolete where replacement products are available, but require extraordinary configuration, costs, or additional hardware to replace the obsolete product.

.3 Provide the following throughout the Correction Period to inspect BAS operation and performance, including under varying climate conditions, loads, schedules, modes.

.1 4 site visit(s) per year, evenly scheduled throughout each calendar year unless modified by Owner, each site visit for 4-hours.

.2 12 remote access session(s) per year, evenly scheduled throughout each calendar year, each remote access session for 2-hours

.4 Update site documentation to reflect current system configuration, including paper and electronic versions as required.

.5 Create backup copies, complete with version designations, notations, modifications, changes.

PART 2 PRODUCTS

2.1 SYSTEM ARCHITECTURE

.1 Design BAS architecture in a logical manner, considering future expansion and changes.

.2 System shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, controllers and operator devices.

.3 System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.

.4 Provide separate sub-networks for controllers located on different floors, or wings such that sub-networks match logical physical building areas.

.5 GUI must appear as a single integrated system, accessible and controlled by a single application.

.6 System components, including controllers, devices, power supplies, signal conditioning hardware, wiring and other equipment, shall be rated to operate properly in the extremes of the environment that they are to be located in.

.7 Provide controllers from the same manufacturer.

.1 Prohibited: System architectures that require service contracts with multiple vendors.

.8 Integration

.1 Provide gateway devices or controllers having on board gateways to convert existing proprietary protocols to native BACnet to allow BACnet access to existing proprietary controllers.

.1 Provide BACnet Protocol Implementation Conformance Statement for gateways.

.2 Gateways shall be tested and listed on BACnet Testing Laboratories website for all functions available from proprietary network controllers.

.9 Performance
  .1 System Scan Rate: System capable of refreshing physical point values once every 5-sec.
  .2 GUI Refresh Delay: Maximum 5-sec from request for refresh.
  .3 Memory: Provide sufficient controllers, memory, and/or servers as required.
.10 System Management: Provide minimum supervisory and management functionality as defined by BACnet Advanced Workstation (B-AWS) to ASHRAE-135.
.11 Communications Networks
  .1 Identify requirements for communication networks, including wiring and additional components required to make communication networks fully functional including repeaters, gateways, boosters, interfaces and other equipment.
  .2 Provide required communication network wiring and cables.
  .3 Provide required additional components including repeaters, gateways, boosters, interfaces and other equipment.
  .4 Coordination: Coordinate IP addressing, remote access, security, and equipment specifications with Owner. Allow for 4-weeks notification.
  .5 Prohibited
    .1 Use of existing non-dedicated BAS networks or other tenant and occupant networks for BAS architecture unless otherwise indicated.
.12 Communications Networks - Ethernet
  .1 Provide ethernet network as required. Provide wiring for spare ethernet network for future use.
  .2 Intent: Additional controllers are intended to be added in future. Network shall be fully functional, with capability for future expansion.
  .3 Coordination: Coordinate IP addressing, security, and equipment specifications with Owner. Allow for 4-weeks notification.
  .4 Type: Ethernet to IEEE-802.3.
  .5 Wiring: Provide continuous wire lengths. Repeaters or other signal boosting devices are prohibited.
  .6 Performance: Minimum 100-Mbit/s.
.13 Communications Networks - Wireless
  .1 Provide wireless network between zone mounted controllers and associated temperature sensors.
  .2 Intent: Wireless networks must not conflict with existing wireless communications in the facility. Design wireless mesh and separate networks as required to produce balance of path redundancy, data transmission efficiency, and latency.
  .3 Coordination: Coordinate with Owner's information technology staff to ensure compatibility. Coordinate IP addressing, security, and equipment specifications with Owner. Allow for 4-weeks notification.
  .4 Type: BACnet over Zigbee to ASHRAE-135.
  .5 Frequency: 2.4-GHz
  .6 Performance
    .1 Wireless Range: Minimum 70-m (230-ft) inside and 400-m (1310-ft) outside..
    .2 Node RSSI (Signal Strength): 90-dbm or better.
  .7 Provide the following certifications and standards for wireless network components:
    .1 BACnet Protocol Implementation Conformance Statement.
    .2 Tested and listed on BACnet Testing Laboratories website.
.14 Time Clock Synchronization
  .1 All controllers relying on real time information (for scheduling, trending, etc.) shall be periodically, automatically synchronized with one other.
  .2 Controller real time clocks to be periodically, automatically synchronized with a third party Network Time Server, such as ntp.com.

2.2 POWER SOURCE

.1 Provide uninterruptable power supply for the following:

.1 Workstations
.2 Servers
.3 Communications Hardware
.4 Performance:
.1 Sized for minimums of 7-min full load runtime, 23-min 50-% load runtime, and a typical runtime of 60-min.
.2 Transfer time no greater than 4-msec.
.3 Capability of 90-% recharge in 4-hours.
.4 Protects against blackouts, brownouts, surges, and noise.
.5 Protects against surge and transients on power lines, and all applicable communications networks.

.2 Provide control power from a power source that originates from the panelboard, splitter, or switchboard that directly feeds equipment being controlled.
.3 Provide automatic protection for electronic equipment from power line transients and surges.

2.3 ALARMS AND EVENTS

.1 Configure alarms and events to trigger on abnormal operation of equipment and systems including:
.1 Failure of life safety devices.
.2 Alarm contact closure on equipment or other controllers.
.3 Alarm states of equipment connected over network.
.4 Equipment failure indicated by status signals not matching start/stop commands.
.5 Sensors showing values outside of expected range.
.6 Failed sensors, controllers, or communications network.
.7 Other alarms and events that are useful in operation and maintenance of building systems.

.2 Prioritize alarms as follows:
.1 Level 1: Events impacting life safety.
.2 Level 2: Events risking damage to building or equipment.
.3 Level 3: Events risking disruption to high priority zones or areas.
.4 Level 4: Events risking disruption to occupant comfort.
.5 Level 5: Other alarms.

.3 Alarms shall include information including:
.1 Date and time of alarm
.2 Point name, state, and value (if applicable)
.3 Priority

.4 Performance:
.1 Duration between alarm occurance and alarm annunciation at the local GUI shall not exceed 5-seconds.
.2 Duration between alarm occurance and alarm annunciation at a remote device shall not exceed 60-seconds.

.5 Alarm Management
.1 Provide full alarm management capabilities including:
.1 Security privileges restricting access to alarm management.
.2 Functionality to acknowledge, silence, or cancel alarms.
.3 Functionality to view and sort alarms by date/time, priority, point name, or other alarm attributes.
.4 Functionality to maintain an audit trail of user activities including user name, date and time of activity, details of alarm (acknowledge, delete, or cancel).

.6 Remote Notification
.1 Provide remote notification to notify remote staff of alarm conditions.
.1 Level 1 and 2 Alarms: Default notification to printer, pager, text message, and designated e-mail.

.2 Level 3-5 Alarms: Default notification to printer, and designated email.
.2 Alarm messages shall contain an informative response message describing the alarm event.
.7 Communications
.1 Configure messaging system(s) to describe alarm condition, including alphanumeric pages, short message service (SMS) text messages, emails.
.8 Automatic Report Generation
.1 Provide automatic report generation capability.
.1 Include up to 8 data points per report.
.2 Format: Printed, ASCII (comma delimited).
.3 Sampling Duration: As required.
.4 Reporting Frequency: As required.
.5 Report Triggering: Automatically scheduled without user intervention.

2.4 CONTROLLERS

.1 Provide as required.
.2 Manufacturers
.1 Johnson Controls, Inc., Metasys System Extended Architecture Platform
.2 Honeywell International, Inc., ComfortPoint Open with Enterprise Buildings Integrator
.3 Trane, Inc., Tracer SC
.3 Minimum Functionality
.1 BACnet Advanced Application Controller (B-AAC) to ASHRAE-135.
.2 DS-COV-B (Data Sharing, Change of Value Provider) to ASHRAE-135.
.3 Intrinsic alarm and event management to ASHRAE-135.
.4 Support for calendar objects for scheduling.
.4 Communication Protocols
.1 BACnet.
.2 Certifications and Standards
.1 BACnet Protocol Implementation Conformance Statement for all BACnet objects as required to meet indicated intent and performance requirements.
.2 Tested and listed on BTL website.

2.5 CONTROL PANEL ASSEMBLIES

.1 Provide enclosures NEMA-250 rated for the environment as required.
.2 Provide ventilation, heating, and humidity conditioning as required.
.3 Provide hinged, enamelled steel enclosures, and locking slotted flush latch for control panel assemblies.
.4 Ensure panels are neat including wiring.
.5 Provide convenience 120-VAC duplex receptacle in each enclosure, complete with fused on/off power switch, and GFCI protection.
.6 Provide colour coded and labelled wiring.
.7 Conceal panel wiring in new or reused panels using slotted PVC wiring ducts with covers.
.8 Mount controller LCD or LED display modules flush in panel faces unless otherwise indicated.

2.6 COMPUTER WORKSTATIONS

.1 Provide computer workstations in the following locations:
.1 Central maintenance office
.2 Computers
.1 Manufacturers
.1 Hewlett-Packard, Compaq
.2 Lenovo Group Limited
.3 Acer Inc.
.2 Features

.1 Form: Tower.
.2 CPU: Intel Corporation, Quad Core, 3.2-GHz
.3 Memory: 8-GB DDR3 RAM
.4 Hard Drive: 1-TB hard drive
.5 Operating System
.1 Microsoft Windows 7 Professional, 64-bit
.6 Software
.1 As required.
.2 Microsoft Corporation, Office Professional 2013, including standalone perpetual licence.
.7 Other Components: DVD reader/writer, speakers, network interface card(s), minimum 4 USB 3.0 ports regardless of location, minimum 2 unused USB ports on front of tower.
.8 Provide additional networking interfaces as required including:
.1 Bluetooth 3.0.
.2 Wireless.
.3 Additional network interface card(s).

.3 Keyboards
.1 Provide keyboard.
.1 Type: QWERTY USB.
.2 Manufacturers: Logitech

.4 Mouses
.1 Provide mouse.
.1 Type: Optical USB.
.2 Manufacturers: Logitech

.5 Monitors
.1 Provide monitor.
.2 Type: LCD with LED backlight.
.3 Manufacturers
.1 NEC Corporation
.2 Samsung
.3 Acer Inc.
.4 Features
.1 Size: 610-mm (24-in)
.2 Resolution: 1920x1080 or better as required.
.3 Refresh: 5-msec or better as required.
.4 Contrast Ratio: 1000:1 or better as required.
.5 Viewing Angle: 170-degrees

.6 Power Supply
.1 Provide power supply.
.1 Type: UPS with Battery Backup and Surge Protection.
.2 Manufacturers: APC by Schneider Electric
.3 Features
.1 Lithium ion battery.
.2 Boost and Trim Automatic Voltage Regulation.
.3 Battery can be charged from drained to 90-% in maximum of 4-hours.
.4 Customizable voltage sensitivity.
.5 Resettable circuit breaker.
.6 Battery failure notification.
.7 Minimum 6 outlets.
.8 USB connection.
.9 Surge Supression: 480-J, 36,000-A

.7 Printers

.1 Provide printer.
.2 Type: Colour Laser
.3 Manufacturers
.1 Hewlett-Packard
.2 Canon Canada Inc.
.3 Xerox Corporation

2.7 GRAPHICAL USER INTERFACE

.1 Provide functionality to support up to 8 simultaneous independent users/operators.
.2 Remote Access
.1 Provide secured remote access to GUI interface from remote windows based workstation.
.2 Provide secured remote access to BAS from remote mobile based devices running Android, Apple IOS, and Blackberry operating systems.
.3 Coordinate remote access with Owner's information technology staff.
.3 Licensing
.1 Provide perpetual site licenses for unlimited software installations, and perpetual user licenses for unlimited simultaneous users per workstation for software including:
.1 Graphical user interface software.
.2 System management tools and utilities.
.3 Programming and configuration software.
.4 Network configuration and management software.
.2 Licenses shall include maintenance updates and upgrades at no additional cost.
.4 Provide customizable, dockable navigation tree allowing hierarchical links to all controllers, sub-controllers, networked objects, and points.
.1 Provide the capability for the operator to add custom navigation trees.
.5 Provide GUI to allow operators to easily view, control, and investigate building environmental systems through uncluttered graphics screens, consistent use of colours and animation, alarming and data visualization techniques.
.6 Provide floor layouts of building with relevant zone information displayed, including:
.1 Site plan.
.1 Floor layout details including elevators, stairwells, partitions, suite numbers, room labels.
.2 Use light shaded background colours to distinctly identify major zone conditioning systems and zones served by various equipment and systems. For each coloured zone, provide a text description of the air handler serving the area. Text description will link to representative equipment graphics screen.
.3 Provide temperature, humidity, and carbon dioxide values, positioned on the floor plan representing actual physical location. Values will link to graphics of space conditioning equipment for corresponding room or area.
.4 Partition floor plans as required to ensure that information is legible on a single screen without scrolling.
.5 Display icons and symbols for equipment in zone. Graphics configured such that single click on zone equipment icons and symbols launches more detailed graphical screen on associated equipment.
.7 Provide schematic representation of each system being controlled. Include all points relevant to each system on the graphic. Schematics to be:
.1 Accurate to actual configuration.
.2 Organized such that major equipment is positioned on the screen in a manner that is representative of the actual physical location and layout.
.3 Partition schematic diagrams as required to ensure information is legible on a single screen without scrolling.
.8 Provide non-graphical based information screens summarizing point information from zone terminal equipment including variable air volume boxes, fan powered boxes, heat pumps.

.1 Group terminal equipment powered by a single air handler on one or more screens.
.2 Present data aligned in tabular format with each column representing a point value.
.3 Include room number, room description, terminal equipment and component identifier, zone temperature, zone setpoint.
.4 Include additional point information indicating status and operation of each point on respective terminal equipment.
.5 Include tables for deisgn settings and values where applicable and as required be Engineer.
.1 Include air terminal settings for minimum and maximum in various modes such as heating and cooling, and show critical zone.
.6 Provide link to graphics screen for each terminal equipment.

.9 Provide the following on all GUI screens:
.1 Detailed sequence of operation available for systems, equipment and components. Configure graphics such that single click on graphical screen launches sequence of operation for associated graphical screen.
.2 Schedules for equipment and systems. Configure graphics such that single click on graphical screen launches summary of schedules for equipment and systems.
.3 Trend logs for equipment and systems. Configure graphics such that clicking on a trend log icon launches trend logs.
.4 Clear written and graphical identification of specific operation(s) and mode(s) occurring.
.5 Units of measurement: Metric.
.6 Navigation links using consistent button graphics, or hyperlink formatted text to allow user to move from one display to another with a single click. Graphics screens shall include a return to previous screen link.

.10 Provide additional user interface functions as requested by Owner to improve operations and maintenance activities.
.11 Provide functionality for modifying setpoints, states, and operator overrides directly from graphics screens.
.12 Provide indication of variables in alarm mode to Owner requirements.

2.8 SECURITY

.1 Provide functionality for multi-level, configurable, password based security hierarchy allowing administrators to assign customized access privileges to different users.
.2 Provide software interface to manage user creation, password management, and assignment of various system management functions and levels of control.
.3 Provide audit trail for changes to user passwords, access, and privilege modification.
.4 Password and user ID definitions shall: be stored in encrypted formats.
.5 Password logins shall not be echoed on any screen or printer. Operators defining passwords shall be required to re-authenticate with old password prior to change.
.6 Provide the following account features:
.1 Scheduled access times by day.
.2 Temporary accounts that expire after a pre-defined date.
.3 Disabling accounts after a pre determined number of incorrect log in attempts.
.4 Provide fields for email addresses, and multiple contact phone numbers.

.7 Provide the following access levels and corresponding privileges:
.1 Administrator: All rights and privileges. Only one user per site.
.2 BAS Tech: All rights and privileges.
.3 Service Tech: Access to schedules, overwrites, status changes, set-point changes, reset schemes, trending and report creation. Access to sequences and programming. Cannot replace or upgrade software.
.4 Operator: Access to schedules, overwrites, status changes, set-point changes, reset schemes, trending and report creation.
.5 View Only: View only. Cannot make changes.

2.9 SYSTEM MANAGEMENT

.1 Provide management functionality including the functionality to delete, edit, or create components of the BAS including:
  .1 Trend logs.
  .2 Alarms.
  .3 Sequences.
  .4 Graphics.
  .5 Point configuration and calibration.
  .6 Reports.
  .7 Schedules.
  .8 Archived data.
.2 Provide full BACnet device and management functionality to ASHRAE-135.
.3 Provide operator transaction archiving including:
  .1 Automatic recording and archiving of operator activities.
  .2 Minimum 1,000 transactions.
  .3 User interface for sorting and reporting by date/time, operator, activity type, and system area.
  .4 Secure access to management capabilities, including viewing, and deletion.

2.10 DIGITAL LIBRARY

.1 Owner will provide paper and digital copies of various building related information, including project drawings and specifications, building drawings and specifications, maintenance manuals and other manuals information, testing and start up reports.
.2 Scan and convert all provided information in addition to project documentation into multiple PDF files.
.3 Organize all files in a directory structure to satisfaction of Owner.
.4 Provide links from a dedicated BAS screen to access files organized to satisfaction of Owner.

2.11 SCHEDULES

.1 Provide the following schedule types:
  .1 Time of Day
  .2 Weekly Schedules
  .3 Annual Holiday Schedules
.2 Provide the ability to temporarily override schedules with the system automatically resetting to original scheduling after a defined time period.
.3 Account for leap years.

2.12 TREND LOGS

.1 Intent
  .1 Logs are an important component of BAS.
  .2 Use logs for commissioning, proof of performance, training, servicing, monitoring and troubleshooting.
.2 Configuration
  .1 Provide logs with information grouped by system in a logical manner to meet intent.
  .2 Provide graphs for trend logs.
  .3 For staged equipment, provide an analog variable representing the number of active stages to allow graphic representation of staging performance.
  .4 Provide trend logs to meet the following:
    .1 15-minute sampling interval, minimum duration 1 month, for:
      .1 Zone temperature and humidity.
      .2 Outdoor air temperature and humidity.
      .3 User adjustable setpoints.
      .4 Other slowly changing analog signals and control.
    .2 5-minute sampling interval, minimum duration 2 weeks, for:
      .1 Duct temperature sensors.

.2 Tank temperatures.
.3 Actuator position control and feedback.
.4 Other moderately changing analog signals and control.
.5 Major equipment command and status.
.6 Number of active equipment stages.
.7 Air handler free cooling status.
.8 Calculated setpoints.

.3 1-minute interval, minimum duration 24 hours, for:
.1 Pressure sensors.
.2 Liquid temperature sensors.
.3 Other rapidly changing analog signals and control.

.4 Run-Time Log/ Change of Value Log, minimum duration 1 month, for:
.1 Equipment on/off status.
.2 Equipment digital commands.
.3 Other digital points.
.4 Modes, including heating/cooling/free cooling, occupied/unoccupied.
.5 Daily schedules.
.6 Digital alarms.

.5 Others Not Listed: As required by Engineer.
.6 Duration: Maintain a continuous record in random access memory.

.5 Provide additional trend logs as required under commissioning requirements, or as requested by Owner or Engineer.

.3 Reporting
.1 Provide graphical plots of trend log reports from random access memory or archive, as required under commissioning requirements, or as requested by Owner or Engineer during Correction Period.

2.13 DATA ARCHIVE SERVER

.1 Provide hardware, software and configuration to automatically archive trend log data to a database.
.1 Database shall be configurable by the end user without programming.
.2 Database shall be seamlessly integrated into the graphical user interface such that historical data can be recalled without additional configuration.
.3 Database data shall be capable of being exported to Microsoft Excel from the user interface without programming or performing custom queries.

.2 Archiving shall not overwrite existing data.

.3 Archive shall represent a complete, continuous record of trend log data without missing data.

PART 3 EXECUTION

3.1 INSTALLERS

.1 Use the following approved installers to configure BAS controllers:
.1 Johnson Controls Canada L.P.
.2 Honeywell Canada
.3 Trane Canada ULC

.2 Alternate installers will not be accepted.

3.2 EXAMINATION

.1 Complete the following examination activities within 20-days after the date of execution of Contract.
.1 Verify type, quantity and condition of existing end devices and controllers.
.2 Confirm the suitability of the points for the specific installation, purpose, goal, and final system installed.
.3 Complete a detailed investigation of existing network architecture and network wiring topology.

.4 Photograph, document and submit descriptions of existing controllers and network components, including:
.1 Main controllers.
.2 Main equipment controllers.
.3 Terminal component controllers, including air terminals.
.4 Panels.
.5 Network components.
.5 Submit written notification of the results of the investigation.
.2 Submit relocation plan, and obtain approval before relocating services, panels, or equipment not indicated.
.3 Complete sufficient examination of existing controllers, sequences, including modifications, to properly implement replacement controls including maintaining existing but undocumented functionality.
.4 Investigate and review point mapping and point naming convention(s).
.5 Investigate entire BAS to verify as-built condition. Mark up copy of existing BAS drawings or create new drawings as required to indicate as-built conditions of the BAS including the following:
.1 Network architecture.
.2 Panel types and locations.
.3 Points list.

3.3 PREPARATION

.1 Demolition and Removal
.1 Patch openings, and refinish surfaces including walls where control equipment is removed.

3.4 COMMON EXECUTION REQUIREMENTS

.1 Provide additional components as required, including repeaters, gateways, interfaces and other equipment.
.2 Locate BAS components in accessible local enclosures.
.3 Complete configuration on site, including programming and GUI.
.4 Provide hard wired interlocks between equipment and safety devices.
.5 Access: Provide passwords and software required to allow full read and write access to all BAS features.
.6 Match or improve upon existing point mapping and point naming convention(s). Ensure consistency.

3.5 CONTROL PANEL ASSEMBLIES

.1 Locate enclosures at an elevation of not less than 610-mm (2-ft) from the bottom edge of the panel to the finished floor, subject to Owner approval.
.2 Ensure panel locations do not interfere with existing electrical panel clearance requirements.
.3 Coordinate plans for panel location with other trades.

3.6 SERVERS

.1 Coordinate with Owner to determine hardware and interfacing requirements before purchase by Contractor, including connection into Owner's network.

3.7 COMPUTER WORKSTATIONS

.1 Coordinate with Owner to determine hardware and interfacing requirements before purchase by Contractor, including connection into Owner's network.

3.8 NETWORKED CONTROLLERS AND INTERFACING

.1 Map all networked points and interfacing points back to supervisory controller with required communications protocol, including for interfacing to equipment, components, controllers, devices.
.1 Follow existing point naming conventions.
.2 Coordinate remote device point naming conventions for consistent point naming.

3.9 WIRING AND CABLES

.1 Make ready for conduit connections for wiring and cables unless otherwise indicated.
.2 Trough Boxes: Use trough boxes to pull field wiring to central panels. Include minimum 610-mm (2-ft) of extra field wire length in the box.
.3 Connections: Terminate signal wires at BAS Controller with screw terminals. Terminate 1 wire to each BAS Controller terminal.
.4 Location: Terminate communications wiring leading to computers, office areas, or other finished areas in a junction box. Match cover plates and wall jacks with existing décor. Refrain from wiring through holes in surfaces including walls or from ceiling plenums.
.5 Clearance: Maintain minimum 610-mm (2-ft) clearance from equipment that may emit electromagnetic fields, including lighting ballasts.
.6 Power: Use dedicated circuits for BAS power to controllers, power supplies, and electronic equipment.
.7 Labelling: Label wiring and cables in same manner as wiring and cables to Section 26 05 00 Wiring and Cables. Follow existing labelling convention if possible.

3.10 LABELLING

.1 Controllers and Panels
  .1 Label with nameplate identifying controller and equipment/system (if applicable).
    .1 Minimum 75-mm (3-in) wide by 25-mm (1-in) high.
    .2 Laminated plastic with black face and white centre.
    .3 Letters engraved.
  .2 Include printed label indicating network address.
  .3 Include laminated printout of points list for all controllers within panel.
  .4 Communicate and obtain confirmation of controller naming convention prior to installation.
  .5 As approved by Owner, create new labelling convention or follow existing labelling convention if possible.
.2 Devices in Occupied Spaces
  .1 Manufacturers
    .1 Thomas & Betts Limited
    .2 Brady Worldwide, Inc.
  .2 Type: 12 character polestar metalized labels.
  .3 Colours: Black lettering on clear backing.

3.11 FIELD QUALITY CONTROL

.1 Field test systems independently and then in unison with other related systems, to ASHRAE-G-11 including:
  .1 New points, and all points on new controllers.
  .2 Hard wired controls, safeties, and interlocks for new equipment.
  .3 Existing points for systems impacted by the Work.
  .4 Hard wired controls, safeties, and interlocks for equipment and systems impacted by the Work.
.2 Complete point by point tests on all points and devices, including digital, analog, input, output, network, independent devices.
  .1 Test and calibrate network points.
  .2 Test and calibrate analog input points.
  .3 Test each digital input switching contacts, and digital input signal.
  .4 Test each digital output to ensure proper operation, fail mode, and lag time.
  .5 Test each analog output to ensure proper operation of controlled devices.
  .6 Stroke actuated devices fully open and fully closed. Verify installation including tight closure, mechanical limit setting, and proper spring return orientation.
  .7 Test and verify fail modes, interlocks, and other software modes of operation.
.3 Test wireless communications devices.

.1 Verify performance of wireless communications, including wirless networks, operations radios, wireless equipment and components.
.2 Confirm performance of 25-% of networked wireless devices in the presence of other electromagnetic emitting devices, including wireless, radios, microwave ovens, transformers.

.4 Adjust, test, and reconfigure the following to maintain original operation:
.1 New control points.
.2 Existing control points for systems impacted by the Work.
.3 New and existing interlocks, third party controllers, and controls

.5 Correct problems with affected systems during the warranty period.
.6 Submit test reports as required.
.7 Fire Testing: Provide assistance as required for the next scheduled fire test.
.8 Coordinate testing activities with Commissioning activities.

3.12 ADJUSTING

.1 Adjust configuration as required, including to meet design intent and performance requirements. Adjust configuration including the following:
.1 Point calibration.
.2 Logic.
.3 Sequences.
.4 Programming.
.5 Settings.
.6 Limits.
.7 Control loops and logic tuning and parameters.
.1 Tune control loops and logic to prevent undershoot and overshoot and to ensure proper response times, including PID control.
.8 Trend logs.
.9 Graphics.

3.13 CLOSEOUT ACTIVITIES

.1 Demonstration
.1 Demonstrate operation of systems including sequence of operations in regular and emergency modes, under normal and emergency conditions, start-up, shut-down interlocks and lock-outs.

.2 Owner's Instructions
.1 On-Line Documentation: After completion of tests and adjustments Contractor shall provide a copy of as-built information and product data to be installed on a customer designated computer workstation or server.

END OF SECTION 25 05 00

SECTION 25 90 00 CONTROL SEQUENCES

PART 1 GENERAL

1.1 SECTION INCLUDES

.1 Control sequences and configuration requirements for controllers, including building automation system, independent controllers, equipment controllers, programmable devices.

.2 Relationship to other Sections:

.1 Various Sections describe additional requirements for equipment, components and services configured and programmed under this Section, including:

.1 Controllers including Section 25 05 00 Building Automation System.

.2 Equipment including Section 15 00 00 Mechanical Equipment, Section 26 00 00 Electrical Equipment.

.3 Components including Section 26 90 00 Control Devices.

1.2 REFERENCED DOCUMENTS

.1 ASHRAE-62.1: ANSI/ASHRAE-62.1-2013 Ventilation for Acceptable Indoor Air Quality, including User's Manual.

.2 ASHRAE-90.1: ANSI/ASHRAE/IES-90.1-2010 Energy Standard for Buildings Except Low-Rise Residential, including User's Manual.

.3 ASHRAE-90.1: ANSI/ASHRAE/IES-90.1-2013 Energy Standard for Buildings Except Low-Rise Residential, including User's Manual.

.4 ASHRAE-G-13: ASHRAE-G-13-2007 Guideline on Specifying Direct Digital Control Systems.

1.3 DEFINITIONS

.1 Refer to other controller sections including Section 25 05 00 Building Automation System.

.2 Air Systems

.1 "Exhaust Air" or "EA": Air exhausted from indoor zones.

.2 "Mixed Air" or "MA": A mixture of Return Air and Outdoor Air.

.3 "Outdoor Air" or "OA": Air from outside the building.

.4 "Return Air" or "RA" and "Entering Air": Air returning to equipment and ductwork systems, usually from indoor zones.

.5 "Supply Air" or "SA": Air leaving equipment and ductwork systems, for the purposes of ventilation and conditioning of air including heating, cooling, humidification, dehumidification.

.3 Liquid Systems

.1 "Heating Boiler Loop" and "Building Heating Loop": "Heating Boiler Loop" refers to the piping directly connected to the heating boilers. "Building Heating Loop" refers to the piping which obtain their heating from the Heating Boiler Loop, and which are typically controlled to a temperature different than the Heating Boiler Loop.

.2 "Return Water" and "Entering Water": Water entering equipment and piping systems including heating and cooling. Same as glycol and liquid.

.3 "Supply Water" and "Leaving Water": Water leaving equipment and piping systems including heating and cooling. Same as glycol and liquid.

.4 Other

.1 "Max(A, B, C, …)": Arithmetic function returning the maximum of all arguments contained within parentheses.

.2 "Min(A, B, C, …)": Arithmetic function returning the minimum of all arguments contained within parentheses.

.3 "Sum(A, B, C, …)": Arithmetic function returning the sum of all arguments contained within parentheses.

1.4 SUBMITTALS

.1 Refer to other controller sections including Section 25 05 00 Building Automation System for submittal requirements.

1.5 ADMINISTRATIVE REQUIREMENTS

.1 Sequences Review Meeting
- .1 Schedule and conduct sequences review meeting as required. Adhere to project meeting procedures as described in Section 01 00 00 Project Procedures.
- .2 Provide written detailed justification for choice of control strategy when requested by Engineer.
- .3 Meet with Engineer to review sequences in detail before implementation.
- .4 Walk through sequences in detail, and provide step by step commentary on control assumptions.
- .5 Demonstrate how intent and programming requirements will be achieved.
- .6 Notify Engineer of problems or concerns with meeting design intent.
- .7 Follow request for clarification procedures to clarify issues regarding design intent.
- .8 Submit work in progress sequences, and walk through programming logic with Engineer upon request.

PART 2 PRODUCTS

2.1 EXISTING PRODUCTS

.1 Refer to other controller sections including Section 25 05 00 Building Automation System.

PART 3 EXECUTION

3.1 EXAMINATION

.1 Evaluation and Assessment
- .1 Evaluate and inspect existing controller configuration, performance, and functionality.

3.2 COMMON REQUIREMENTS

.1 Configure controllers as required to meet design intent, including supervisory controllers, distributed controllers, independent controllers and programmable devices.

.2 Unless otherwise indicated, controllers shall be configured, including programming, testing and commissioning, to achieve the following control stability and accuracy tolerances:
- .1 Zone Air Pressures: +/-3-Pa (+/-0.01-inWC)
- .2 Zone Air Temperatures: +/-1.0-°C (+/-2.0-°F)
- .3 Air Flows: +/-10-% of full scale
- .4 Air Duct Static Pressures: +/-50-Pa (+/-0.2-inWC)
- .5 Air Duct Temperatures: +/-1.5-°C (+/-3.0-°F)
- .6 Air Humidities: +/-5-%RH
- .7 Liquid Pressures
  - .1 +/-10-kPa (+/-1.5-psi) for pressure ranging from 0-MPa to 1-MPa (1-psi to 150-psi)
  - .2 +/-250-Pa (+/-1.0-inWC) for pressure ranging from 0-kPa to 12.5-kPa (0-inWC to 50-inWC)
- .8 Liquid Temperatures: +/-1.5-°C (+/-3.0-°F)
- .9 Minimize the number of equipment on/off cycles.
- .10 Maximize the duration of equipment cycles.
- .11 Eliminate unnecessary staging of equipment.
- .12 Prevent undershoot and overshoot on modulating equipment and actuator control.
- .13 Maximize systems and equipment longevity.
- .14 Control systems and equipment to maximize energy efficiency.
- .15 Minimize concurrent heating and cooling including for humidification, dehumidification.
- .16 Automatically handle failed components, including equipment and end devices, by starting backup devices, and taking actions to minimize consequences.
- .17 Automatically prevent damage from failed components, including equipment and end devices.
- .18 Minimize occupant discomfort in case of failed components, including equipment and end devices.

.19 Maximize occupant comfort.

.3 Configure controllers to meet requirements of:
  .1 ASHRAE-62.1
  .2 ASHRAE-90.1

.4 Create user adjustable variables used in programming logic, including for setpoints, limits, delays, offsets, scaling factors, and other constants. Minimize the number of such variables where possible.

.5 Complete necessary tests, trending, debugging, observation, and adjustments required to fine tune, adjust and modify controller configuration to meet design intent.

.6 Indicated equipment operating limits should be considered as starting points or guidelines only. Consult with equipment manufacturer regarding recommended limits and operating constraints. Coordinate water pressure, air pressure, and flow setpoints with TAB and commissioning requirements. Notify Engineer of any conflicts that may arise in meeting design intent.

.7 Indicated sequences are intended to communicate suggested control strategies, and in no way absolve Contractor of responsibility as outlined in Contract Documents.

.8 Provide automatic switchover between specified modes of operation without manual user intervention.

.9 Configure controllers to coordinate with safeties, safety systems, independent controls and interlocks.

.10 Configure controllers to coordinate and account for responses and interactive effects of existing or affected systems with controls.

.11 Schedule equipment based on occupancy schedules, outdoor air temperature switch-point, or on demand.

.12 Document sequences to ASHRAE-G-13, Article 5.3.3., using the operating mode method.

.13 Summarize sequences, limits and settings, including interfaces to equipment and components.

3.3 EXISTING SEQUENCES

.1 Duplicate other existing functionality when changing or replacing controllers.

.2 Coordinate and adjust sequences to account for responses and interactive effects of existing or affected systems.

3.4 COMMON SEQUENCES

.1 Demand Limiting
  .1 Provide sequences to coordinate the start-up of electricity using equipment to minimize impact on building systems, including electric meter demand, standby power systems, transformer loading, other electrical distribution systems.
  .2 Stagger start-up of electrical equipment to minimize overall instantaneous electrical demand by including an adjustable random start delay feature on equipment having the same schedule.
  .3 Coordinate with Owner to determine areas and systems subject to demand limiting.
  .4 Provide single button activation of demand limiting strategies including the following:
    .1 Temperature Setback: Add a user configurable offset to designated zones, to reduce cooling electrical demand.
    .2 Fan Setback: Reduce the supply duct static pressure setpoint by a pre-determined amount to reduce fan electrical demand.
    .3 VFD Limitation: Add a user configurable speed offset on designated VFDs.
    .4 Non-essential equipment shutdown.

.2 Occupancy Override
  .1 Occupancy Override allow users to override default schedules and force zone into occupied mode for a user adjustable duration.
  .2 Start all required equipment in proper sequence, and maintain zone climate at occupied setpoint for the duration of the override.

.3 Occupant Adjustment

.1 Occupant Adjustment allows users to adjust zone temperature setpoints using features of the zone temperature sensor.
.2 Provide adjustable maximum and minimum limits to allowable adjustments for each zone.
.3 Provide feature to automatically reset adjustments on an adjustable time period per zone. Provide feature to allow operator to disable this reset feature per zone.

.4 Equalized Run Time
.1 Equalize the run time of equipment where possible by rotating the sequence to which staged equipment are enabled unless otherwise indicated.
.2 For lead/lag equipment, alternate lead equipment weekly.
.3 Schedule switchover during unoccupied periods, where possible.

.5 Automatic Failover
.1 Provide sequences to automatically and gracefully handle failure by starting backup equipment, including equipment, components, end devices.

.6 Trim and Respond Logic
.1 Trim and respond is an alternative to PID control and is used in cases where a central controller must adjust to information from multiple distributed controllers. Includes less complex tuning and ability to remove “rogue” zones.
.2 Where PID control or tuned controllers are indicated, trim and respond logic may be used as an alternative where PID control is impractical or not possible to achieve performance.
.3 Variables and Constants
.1 SP: Dynamically adjusted setpoint.
.2 SPo: Initial setpoint.
.3 SPmin: Minimum setpoint.
.4 SPmax: Maximum setpoint.
.5 Td: Delay timer (minutes).
.6 T: Time step (seconds).
.7 I: Number of ignored requests.
.8 R: Number of requests from zones/systems.
.9 SPtrim: Trim amount.
.10 SPres: Respond amount (must be opposite sign of SPtrim).
.11 SPres-max: Maximum response within time interval.
.4 Setpoint Adjustment
.1 When associated device is off, set SP to SPo.
.2 When associated device is on wait for Td minutes before initiating logic.
.3 Once activated, every T seconds:
.1 SP = SP + SPtrim
.2 SP = SP + Max(SPres * Max(R - I, 0) , SPres-max)
.3 SP = Max(SP, SPmax)
.4 SP = Min(SP, SPmin)
.5 Default Values
.1 Unless otherwise specified, use the following values:
.1 SPo, SPmin, SPmax: Setpoint as determined by TAB contractor.
.2 Td: 10-minutes
.3 T: 120-seconds
.4 I: 2
.5 SPtrim: 5-% * (SPmax - SPmin)
.6 SPres: SPtrim * 1.1
.7 SPres-max: SPtrim * 3
.6 Adjust and tune variables and constants as required to meet performance requirements.

3.5 MODES OF OPERATION

.1 Occupied Mode

.1 This mode optimizes central equipment and distribution system reset schedules and enable/disable switch-points for occupied loads and zone temperatures.
.2 Scheduled based on daily, weekly and annual schedules.

.2 Unoccupied Mode
.1 This mode optimizes central equipment and distribution system reset schedules and enable/disable switch-points for unoccupied loads and zone temperatures.
.2 Scheduled based on daily, weekly and annual schedules.

.3 Morning Start-up
.1 This mode is used to bring the building out of setback to achieve occupied setpoint temperatures.
.2 Scheduled based on daily, weekly and annual schedules, and adjusted for optimal start algorithms.

.4 Optimal Start Mode
.1 This mode optimizes start-up of equipment to minimize energy use while ensuring zone temperatures are at setpoint during occupancy.
.2 Based on occupancy schedules, adjusted by calculating the minimum amount of time required to run equipment before occupancy to meet occupied space conditions.
.3 Time may vary based on outdoor air conditions, a recorded past history of heating and cooling times, and zone temperature feedback.
.4 Maintain unoccupied sequences for outdoor airflow requirements.
.5 GUI override button.

.5 Optimal Stop Mode
.1 This mode optimizes the early shutdown of equipment to minimize energy use by taking advantage of building thermal mass.
.2 Based on occupancy schedules, adjusted by calculating the maximum amount of time possible to disable equipment before vacancy, while meeting occupied space requirements.
.3 Time may vary based on outdoor air conditions, a recorded past history of heating and cooling times, and zone temperature feedback.
.4 Maintain unoccupied sequences for outdoor airflow requirements.
.5 GUI override button.

.6 Heating Mode
.1 This mode is active when the building may require heating, and is used to enable heating equipment.
.2 Based on outdoor air temperature, having separate setpoints for both occupied and unoccupied modes.
.3 Include a deadband to prevent cycling.

.7 Cooling Mode
.1 This mode is active when the building may require cooling, and is used to enable cooling equipment.
.2 Based on outdoor air temperature, having separate setpoints for both occupied and unoccupied modes.
.3 Include a deadband to prevent cycling.

3.6 SUPPLY VARIABLE AIR VOLUME BOXES

.1 Background and Intent
.1 The VAV boxes are controlled by independent local controllers networked together.
.2 Control sequences are intended to meet ASHRAE-62.1 and ASHRAE-90.1, including "Dual Maximum Control Logic" to ASHRAE-90.1, Article 6.5.2 Simultaneous Heating and Cooling Limitation.

.2 Variables and Constants
.1 Vdz: Measured VAV box air discharge volume measured from the VAV box airflow sensor.
.2 Vmaxclg: Design maximum airflow required for cooling shown on VAV schedule.

.3 Vmaxhtg: Design maximum airflow required for heating shown on VAV schedule.
.4 Vmin: Minimum airflow setpoint.
.5 Vsp: Air volume setpoint.

.3 Air Volume Control (Occupied Cooling Mode)
.1 Cooling mode is active when zone temperature is above cooling setpoint.
.2 Reset air volume setpoint (Vsp) between Vmin and Vmaxclg depending on cooling PID loop.
.3 Modulate damper to maintain Vdz at Vsp.
.4 Close hot water reheat valve and/or perimeter control valve.

.4 Air Volume Control (Occupied Deadband Mode)
.1 Deadband mode is active when ZNT is between cooling setpoint and heating setpoint, and cooling mode is off.
.2 Set air volume setpoint (Vsp) at Vmin.
.3 Modulate damper to maintain Vdz at Vsp.
.4 Close hot water reheat valve and/or perimeter control valve.

.5 Air Volume and Perimeter Heating Control (Occupied Heating Mode - VAV with no reheat)
.1 Heating mode is active when ZNT is below heating setpoint, and cooling mode is off.
.2 Modulate perimeter heating valve from 0-% to 100-% open as heating loop controller ranges from 0-% to 100-%.
.3 Set air volume setpoint (Vsp) at Vmin.

.6 Air Volume and Perimeter Heating Control (Occupied Heating Mode - VAV with reheat)
.1 Heating mode is active when ZNT is below heating setpoint, and cooling mode is off.
.2 Reset air temperature setpoint (DATsp) from air handler supply air temperature to DATmax as heating loop controller ranges from 0-% to 50-%.
.3 Modulate reheat valve to maintain DAT at setpoint.
.4 Modulate perimeter heating valve from 0-% to 100-% open as heating loop controller ranges from 0-% to 50-%.
.5 Set air volume setpoint (Vsp) at Vmin as heating loop controller ranges from 0-% to 50-%.
.6 Reset air volume setpoint (Vsp) between Vmin and Vmaxhtg as heating loop controller ranges from 50-% to 100-%.

.7 Supply Air Temperature Adjustments
.1 Air handler supply air temperatures may be reset from VAV box calls for heating and cooling.
.2 Set call for cooling request (CFC) = Zone importance factor (ZIF) when ZNT rises above setpoint plus deadband for more than 30-minutes, otherwise set CFC = 0.
.3 Set call for heating request (CFH) = Zone importance factor (ZIF) when ZNT drops below setpoint minus deadband for more than 30-minutes (adjustable), otherwise set CFH = 0.

.8 Unoccupied Cooling Mode
.1 Unoccupied mode is active when scheduled.
.2 Set air volume setpoint (Vsp) to 0 when ZNT is between unoccupied cooling setpoint and unoccupied heating setpoint.
.3 Set air volume setpoint (Vsp) to Vmaxclg when ZNT rises above unoccupied cooling setpoint.
.4 Modulate damper to maintain Vdz at Vsp when air handler is on.
.5 Close damper when air handler is off.

.9 Unoccupied Heating Mode
.1 Unoccupied mode is active when scheduled.
.2 Modulate perimeter heating valve to maintain ZNT at unoccupied setpoint.
.3 Close VAV dampers.

.10 Zone Static Pressure Requests

.1 Set call for pressure variable (CFP) = 0 when:
.1 VAV damper position drops below 90-% open for more than 5-minutes.
.2 Vdz is greater than Vsp.
.3 Zone is unoccupied.
.2 Set call for pressure variable (CFP) = 1 when:
.1 VAV damper position is greater than 95-% open, and Vdz is less than Vsp for more than 5-minutes.
.2 Zone is occupied.

.11 Provide the following functionality:
.1 Occupancy Override
.2 Optimal Start/Stop

3.7 ROOFTOP AIR HANDLER CONTROL

.1 Background and Intent
.1 The 5 rooftop air handler comprises a supply/powered exhaust unit. The air handler has a dedicated outdoor air duct and damper system that is used to measure and control outdoor air volumes at varying supply fan speeds. The air handler controls a system with VAV's on supply ductwork.
.2 The air handler is controlled by a local controller networked to the BAS system.

.2 Variables and Constants
.1 Vex: Measured zone exhaust volume.
.2 Vps = Sum(Vdz), for all VAV boxes served.

.3 Supply Air Temperature Setpoint
.1 Reset supply air temperature setpoint using Trim and Respond Logic using sum of zone call for cooling (CFC) requests.

.4 Supply Fan Speed Control
.1 Reset supply air pressure setpoint using Trim and Respond Logic using sum of VAV call for pressure (CFP) requests.
.2 Modulate supply fan speed to maintain duct static pressure at setpoint.

.5 Powered Exhaust Fan Speed Control
.1 Control powered exhaust fan PID loop to maintain exhaust air volume equal to Vps - Vex.
.2 Reset powered exhaust fan PID loop to adjust for zone static pressure.
.3 Modulate relief air damper, then powered exhaust fan, in sequence to powered exhaust fan PID loop.

.6 Outdoor Air Volume Control (Minimum OA Mode)
.1 Minimum OA Mode is active when outdoor air temperature is above 21-°C.
.2 Modulate outdoor air damper from 0-% to 100-%, and mixed air damper from 100-% to 0-%, in sequence, to maintain measured OA volume at setpoint.

.7 Outdoor Air Volume Control (Economizer Mode)
.1 Economizer Mode is active when outdoor air temperature is below 20-°C (adjustable).
.2 Open heat recovery bypass dampers.
.3 Stop heat recovery.
.4 Modulate outdoor damper from 0-% to 100-% open and mixed air damper from 100-% to 0-% open, in sequence, to maintain supply air temperature at setpoint.

.8 Heating Control
.1 Modulate heat recovery and heating gas valve, in sequence, to maintain supply air temperature at setpoint.

.9 Cooling Control
.1 Stage and modulate cooling compressors to maintain supply air temperature at setpoint.

.10 Heat Recovery Control
.1 Control heat recovery as first stage of heating.
.2 Control heat recovery to prevent frost buildup on wheel.

.11 Unoccupied Mode

.1 Stop all fans.
.2 Close outdoor air dampers.
.3 Start air handlers on a call for heating or call for cooling request from zones.

.12 Optimal Start (Heating Mode)
.1 Close outdoor air dampers.

.13 Optimal Start (Cooling Mode)
.1 Enable economizer cooling during morning cooldown, otherwise, close outdoor air dampers.

.14 Unoccupied Mode Startup (Heating Mode)
.1 Start fans when any zone falls below unoccupied setpoint for more than 30-minutes.
.2 Override fan speed setpoint to 50-% (adjustable).

3.8 HEATING PLANT

.1 Intent
.1 Improve energy efficiency:
.1 Eliminate flow through boiler when off.
.2 Reduce secondary loop distribution temperatures.
.3 Prevent excess staging.
.2 Improve equipment longevity:
.1 Maintain boiler return water temperature above the manufacturer's minimum recommended inlet temperature to prevent acidic flue gas condensation.
.2 Prevent excess staging.
.3 Maintain constant flow through boilers.

.2 Considerations
.1 Maintain water temperatures above manufacturer's minimum return temperature (typically 50-°C) when boilers are firing to prevent flue gas condensation.
.2 Low mass primary loops can cause issues with short cycling if careful attention is not given to staging control and mixing valve coordination. Consider staging boiler to control the secondary loop return water temperature which typically reacts slowly to boiler staging.
.3 Condensing boilers are more efficient at lower return water temperatures. Reduce boiler return water temperature as low as possible without compromising comfort.
.4 Reduce distribution temperatures as low as possible to maximize efficiency.
.5 Most condensing boilers are more efficient at low firing rates. Incorporate part load performance into staging sequences.
.6 The heat output from terminal units respond in a non-linear fashion to inlet water temperature (refer to ASHRAE Handbooks). Optimal water temperature control may require a non-linear response of water temperature to heating load.
.7 Boiler pump shall be controlled by individual boiler controller.

.3 Modes of Operation
.1 Summer Mode
.1 This mode conserves energy by lowering primary loop temperatures during mild and warm weather.
.2 Control primary return water temperature to adjustable setpoint of 50-°C (122-°F).
.3 Set based on outdoor air temperature.
.2 Winter Mode
.1 This mode provides heating to all equipment.
.2 Control primary return water temperature to adjustable setpoint of 70-°C (158-°F).
.3 Set based on outdoor air temperature.
.3 Early Morning Warm-up
.1 This mode allows higher distribution temperatures to quickly heat zones to setpoint in the morning.

.2 Scheduled based on daily, weekly and annual schedules, and adjusted for optimal start algorithms.
.4 Sterilization Mode
.1 This mode allows high temperatures to sterilize domestic water tanks.
.2 Manually started.
.4 Provide sequences as required including the following functionality:
.1 Outdoor air reset of water temperature: Reset water temperature based on outdoor air. Base this temperature on observation of the existing system and discussion with Owner.
.2 Non-linear outdoor air reset of water temperature: Reset water temperature in a non-linear fashion based on outdoor air. Provide an approximate linear response of zone terminal unit heat output to outdoor air temperature.
.3 Zone feedback reset: Reset water temperature based on representative zone feedback.
.4 Low water protection: Protect the return water temperature to the boilers from falling below manufacturer recommended minimum operating temperature.
.5 Warm weather shutdown: Disable boiler plant and pumps when heating is not required. Provide separate switch-points for different occupancy modes.
.6 Residual heat removal: Delay stopping pumps to remove residual heat from exchanger.
.7 Boiler flow control: Modulate pumps and/or control valves to maintain constant flow through operating boilers.
.8 On-demand pump control: Control heating distribution pumps on demand to conserve pump energy.
.9 Low zone temperature protection: Start heating plant to prevent zones from falling below a minimum temperature.
.10 Freeze protection: Start heating plant to protect equipment from freezing.

3.9 OTHER EQUIPMENT

.1 Greenhouse Heating Control
.1 Modulate greenhouse heating control valve to maintain zone air temperature at setpoint.
.2 Enable electric heating on heating plant failure.
.2 Exhaust Fan (EF1, 2, 3, 4) Control
.1 Schedule exhaust fans.
.2 Open/close dampers when occupied/unoccupied.
.3 Wait for damper open prior to starting fan.
.3 Elevator Machine Room/Boiler Room Temperature Control
.1 Start fan F1 whe elevator machine room temperature or boiler room temperature is above setpoint.
.2 Open/close dampers OAD1 and OAD2.
.3 Wait for dampers to open prior to starting fan.
.4 Cabinet Heater Control
.1 When zone temperature drops below setpoint:
.1 Start fan
.2 Modulate heating valve to maintain zone temperature at setpoint.
.2 When zone temperature rises above setpoint for more than 60-min, stop fan.
.3 When in Cooling Mode, stop fan and close heating valve.
.5 IT Room Split Heat Pump System Control
.1 Enable/disable indoor unit if heating/cooling not required.
.2 When ventilation system supply air temperature 2-°C is above IT room setpoint close zone damper, ZD1.
.6 Archives Closed Stacks Split Heat Pump System Control
.1 Enable/disable indoor unit if heating/cooling not required.
.2 When ventilation system supply air temperature 2-°C is above close VAV box serving zone.
.7 Split Heat Pump System Control

.1 Enable/disable indoor unit if heating/cooling not required.
.2 When

3.10 ALARMING

.1 Alarming of points shall be assigned priorities as follows:
  .1 Priority 1 alarms are reserved for “life and death safety” situations.
  .2 Priority 2 alarms are reserved for “building damage” situations such as sump levels, etc.
  .3 Priority 3-5 alarms are dependent on system by system parameters.
.2 BAS operators with access level 3 or higher (based on system having 6 or more levels of access) will be able to acknowledge alarms.

3.11 ADJUSTING

.1 Adjust configuration as required including sequences.
.2 To Section 25 05 00 Building Automation System.

3.12 CLOSEOUT ACTIVITIES

.1 To Section 25 05 00 Building Automation System.

END OF SECTION 25 90 00

SECTION 26 00 00 ELECTRICAL EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

.1 Disconnects, breakers, over-current protection, motor starters, motors, variable frequency drives.

.2 Relationship to other Sections:

.1 Section 15 00 00 Mechanical Equipment describes equipment and components supplied with equipment and components from this Section, and installed to this Section, including motors and variable frequency drives.

.2 Section 25 05 00 Building Automation System describes additional requirements for control of equipment and components provided under this Section.

.3 Section 25 90 00 Control Sequences describes additional requirements for control of equipment and components provided under this Section.

.4 Section 26 05 00 Wiring and Cables describes installation requirements of equipment installed under this Section.

.5 Section 26 90 00 Control Devices describes additional requirements of components provided under this Section.

1.2 REFERENCED DOCUMENTS

.1 ASHRAE-90.1: ANSI/ASHRAE/IES-90.1-2010 Energy Standard for Buildings Except Low-Rise Residential, including User's Manual.

.2 ASHRAE-90.1: ANSI/ASHRAE/IES-90.1-2013 Energy Standard for Buildings Except Low-Rise Residential, including User's Manual.

.3 ASHRAE-135: ANSI/ASHRAE-135-2012 BACnet - A Data Communication Protocol for Building Automation and Control Networks.

.4 CSA-C22.2: CSA-C22.2 Canadian Electrical Code, Part 2.

.5 CSA-O80: CSA-O80-Series-97 Wood Preservation.

.6 CSA-O80: CSA-O80-Series-08 (R2012) Wood Preservation.

.7 IEC-60529: ANSI/IEC-60529-2013 Degrees of Protection Provided by Enclosures (IP Code).

.8 NEMA-MG-1: ANSI/NEMA-MG-1-2011 Motors and Generators.

.9 ULC-S102: CAN/ULC-S102-10 Surface Burning Characteristics of Building Materials and Assemblies.

1.3 DEFINITIONS

.1 As defined by ESA-OESC and CSA-C22.1, unless otherwise defined.

.2 "BACnet": A communications protocol adhering to ASHRAE-135.

.3 "VFD": Variable frequency drive.

1.4 SUBMITTALS FOR ACTION

.1 Product Data

.1 Manufacturers' product literature, specifications, and datasheets. Include product characteristics, performance criteria, options, and limitations.

.2 Shop Drawings

.1 Layout and Interference Plans: Isometric sketches indicating clearances, interferences, and relocation of interfering services, components, objects, and structures.

.2 Interlocks: Schematic and wiring diagrams detailing electrical interlocks.

.3 Disconnecting Means: Schematic and wiring diagrams detailing methods of disconnecting means.

.4 Mounting: Submit layout drawings for equipment mounting, including splitters, starters, disconnects, VFDs. Detail equipment mounting methods, including pads, stands, backing boards.

.5 Suspension systems for all suspended equipment. Indicate the following:

.1 Location of suspension.

.2 Maximum load at each of the suspension points.
.3 Size of suspension rods or members.
.4 Details of supplementary structural steel framing members.
.6 Distribution panels documentation including:
.1 Schematics and wiring diagrams.
.2 Motor starter and component schedule.
.3 Front view elevation, top view.
.4 Nameplate schedule.
.5 Conduit entry and exit locations.
.6 Assembly ratings including short circuit rating, voltage, continuous current.
.7 Major component ratings including voltage, continuous current, interrupting ratings.
.8 Key interlock scheme drawing and sequence of operation.
.7 VFD documentation including:
.1 List of VFD configuration settings.

1.5 SUBMITTALS FOR INFORMATION

.1 Certificates
.1 Letter from supplier of refurbished over-current devices, confirming extent of refurbishment, test results, and certification of suitability for intended use.
.2 Letter from a qualified factory-trained manufacturer's representative certifying equipment has been installed, adjusted and tested in accordance with the manufacturer's recommendations.
.3 Seismic certification and equipment anchorage details.
.4 Certified production test results.
.2 Manufacturer Information
.1 Operating and Maintenance Manuals
.2 Installation Instructions
.3 Test and Evaluation Reports
.1 Load Balance Report: Report detailing line to line, and line to neutral currents, voltage, and power factor, before and after adjustments.
.2 Motor Starter Report: Report detailing motor inrush currents, full load current, and overload setting.
.3 Power Quality Report: Report detailing harmonic analysis of waveforms and total harmonic distortion measurement.
.4 Insulation Testing Report
.1 Meg-ohm meter (megger) measurements.
.2 Visual inspection of insulation.
.3 Summary and recommendations.
.4 Qualification Statements
.1 Electrical: Proof of licences for company and personnel.
.2 Professional Engineering: Proof of licences for company and personnel.
.5 Documentation
.1 Single line power diagram.

1.6 QUALITY ASSURANCE

.1 Qualifications
.1 Electrical: Company and personnel to be licensed electricians.
.2 Professional Engineering
.1 Company and personnel licensed to practice Professional Engineering by PEO.
.2 Subject to approval.

PART 2 PRODUCTS

2.1 COMMON PRODUCT REQUIREMENTS

.1 Designed, manufactured, tested and certified in accordance with the latest applicable standards including ANSI, CSA, NEMA, UL and ULC.
.2 The precise type, rating, quantity and location of electrical products depend, in part, on routing and installation choices made by Contractor.
.1 Provide electrical products meeting relevant standards, including CSA-C22.2 and NEMA.
.3 Match fault current ratings equal to that of upstream over-current protection.
.4 Provide electrical products rated to suit environment.

2.2 EQUIPMENT MOUNTING

.1 Provide mounting as required including pads, stands, backing boards, frames, supports.

2.3 PANELBOARDS

.1 Provide as indicated.
.2 Manufacturers
.1 Eaton Corporation, Cutler-Hammer
.2 Schneider Electric
.3 Siemens Canada Limited
.4 General Electric
.3 Type
.1 Sprinkler proof.
.4 Substitution Limitations
.1 Substitutions may be accepted under substitution provisions described in Contract Documents.
.2 Substitutions may be limited by various requirements and may require re-design, including:
.1 Physical characteristics, including weight, height, length, width.
.2 Maintaining similar components within equipment.
.3 Re-design differences as a result of substitution to delegated design requirements described in Contract Documents.Acceptable Substitution Manufacturers
.1 Eaton Corporation, Cutler-Hammer
.2 Schneider Electric
.3 General Electric

2.4 MOTOR CONTROLLERS

.1 Provide as indicated.
.2 Manufacturers
.1 Motor controllers installed in motor control centres:
.1 Same manufacturer and series as the motor control center.
.2 Motor controllers not installed in motor control centres:
.1 Eaton Corporation, Cutler-Hammer
.2 Schneider Electric
.3 Siemens Canada Limited
.3 Type
.1 Solid State Overload Relays
.1 Self-powered.
.2 Phase loss protection.
.3 Visible trip indication.
.4 Test trip feature.
.5 Ambient temperature compensated.
.2 Selector switch for HAND-OFF-AUTO.
.3 Fused control power transformer.
.4 Indicating lights for RUN and FAULT.
.5 Size: As required.

2.5 MANUAL MOTOR STARTER

.1 Provide as indicated.
.2 Manufacturers
  .1 Eaton Corporation, Cutler-Hammer
  .2 Schneider Electric
  .3 Siemens Canada Limited
.3 Type
  .1 Bi-metallic Overload Relays
    .1 Single phase sensitivity.
    .2 Visible trip indication.
    .3 Test trip feature.
  .2 Indicating lights for RUN and FAULT.
  .3 Size: As required.

2.6 DISCONNECTS

.1 Provide as indicated.
.2 Manufacturers
  .1 Eaton Corporation, Cutler-Hammer
  .2 Schneider Electric
  .3 Siemens Canada Limited
.3 Type
  .1 Fused or unfused as required.
  .2 Industrial heavy duty, quick-make, quick-break, arc quenching.
  .3 Lockout rings for “ON” and “OFF” position.
  .4 Ratings: Horsepower rated to twice the disconnect load unless otherwise indicated.

2.7 OVER-CURRENT PROTECTION

.1 Provide as required.
.2 Manufacturers
  .1 Eaton Corporation, Cutler-Hammer
.3 Type
  .1 Match manufacturer, features, type, quality, and interrupting current rating of existing over-current protection where possible.
  .2 Breakers 300-A or larger: Adjustable.

2.8 VARIABLE FREQUENCY DRIVES

.1 Provide as indicated.
.2 Manufacturers
  .1 Allen Bradley, PowerFlex Series
  .2 Danfoss Inc., VLT HVAC FC-102 Series
  .3 General Electric Company, AF-600 FP Series
.1 Size: Minimum size of motor(s) nameplate full load amps, multiplied by motor(s) service factor, to allow motor(s) to be capable of operating into service factor ratings. Motor(s) service factor used in sizing to be greater of 1.15 or actual motor(s) service factor.
.2 Features
  .1 Output Switching: Pulse Width Modulation (PWM), Insulated Gate Bipolar Transistor (IGBT) output, rise time 200-ns or longer.
  .2 Controls
    .1 HAND-OFF-AUTO operating modes, complete with indication lights. Auto control shall maintain existing ON/OFF control of VFD.
    .2 AUTO operating mode to be controlled remotely by both independent switches and BAS.
  .3 User Interface Panel
    .1 Accessible, backlit, LCD display and controls.
    .2 Mounted on front face of VFD.

.3 Removable and capable of being installed in a remote flush mounted location up to 3-m (10-ft) away with standard conversion kit supplied by VFD manufacturer. Provide remote user interface panel kit from VFD manufacturer as required to maintain accessibility of user interface panel without opening enclosure.
.4 Readily available parameters to include speed, frequency, current, power, load, totalized energy including start date and time, alarms, flags, warnings, faults.

.4 Communications: Capability of fully interfacing VFD to BAS and other control systems to which VFD may be connected, compliant with all of the following:
.1 BACnet
.2 Modbus RTU
.3 N2 Metasys
.4 FLN Apogee
.5 FC Protocol

.5 Programming: Programming VFD while VFD is operating shall allow programming to become active without resetting or stopping VFD.

.6 Variable Load Optimization: Automatic adjusts output voltage at lower speeds to improve efficiency.

.7 Automatic Restart: Automatic restarting, including after power failure.

.8 Scheduling: Capability of setting multiple daily and weekly schedules to operate at set frequencies. Minimum 4 time periods per day, 7 day schedule.

.9 Carrier Frequency: Adjustable from 2-kHz to 16-kHz.

.10 Skipped Frequencies: Capability of setting multiple ranges of skipped frequencies.

.11 Thermistor Input: Integral temperature monitoring and thermal protection of motor temperature(s) from motor thermistor input(s).

.12 Programmable Inputs/Outputs
.1 Analog Input: Integral analog inputs for 2 separate external signals of 4-mA to 20-mA or 0-VDC to 10-VDC.
.2 Digital Input: Integral digital inputs for 6 separate external signals, 2 of which can be used as digital outputs.
.3 Analog Output: Integral analog output for 1 separate external signal of 4-mA to 20-mA.
.4 Relay Outputs: 2 integral standard Form C relays, 240-400-VAC, 2-A.

.13 Control: Capability of PID control tuning based on analog inputs, time duration, and response requirements.

.14 Data Storage: Capability of storing readings and status of all data points at 1-hour intervals for 1-week.

.15 Protection: Output current limiting, adjustable overload settings, adjustable speed ramping, flying start.

.16 Output Circuit Protection: VFD shall not be damaged by the following:
.1 Disconnecting motor(s) while under power.
.2 Output short circuit.
.3 Starting into a rotating load (flying start).
.4 Disconnecting VFD power while motor(s) is rotating.

.17 Enclosure
.1 Provide as indicated. Provide as follows where not indicated.
.1 Minimum IP21, certified to IEC-60529, for indoor dry locations.
.2 Minimum IP55, certified to IEC-60529, for indoor locations that may be subject to water dripping or light splashing, including near piping services or condensation.
.3 Minimum IP66, certified to IEC-60529, for outdoor locations, locations exposed to outdoor or high ambient temperatures and/or humidities, or locations that may be subject to moderate or severe water splashing.

.2 Provide enclosure heating and cooling as required for environment, including for VFD not operating, VFD operating at various loads including into motor(s) service factor, VFD configured with various settings including carrier frequencies.

.3 Options: Provide the following as required unless otherwise indicated:

.1 Bypass

.1 Manufacturers: Same as VFD manufacturer.

.2 Function: Connects electrical power directly to motor(s).

.3 Type

.1 3 Contactor Electro-mechanical, unless otherwise indicated. Disconnects power to VFD when operating in bypass mode.

.4 Protection: Motor(s) overload protection independent of VFD.

.2 LC Load Filter: Provide LC load filter, sized and selected by VFD manufacturer, to limit peak to peak voltage spikes (Vpp), measured at motor(s), to 1000-Vpp.

2.9 MOTORS - 1-HP AND LARGER

.1 Provide as indicated.

.2 Manufacturers

.1 Baldor Electric Company

.2 Leeson Electric

.3 Weg Electric Corp.

.3 Type

.1 Motor Type

.1 Induction motor, squirrel cage.

.2 Motor Enclosure

.1 Provide as required for environment.

.2 For replacement motors with existing enclosures rated to exceed environment, match existing.

.3 Bearings: Sealed

.4 Vertical Oriented Motors: Lock Bearing Construction

.5 Thermal Protection: Use Automatic Thermal Overloads for motors less than 1-hp, Manual Thermostats for larger motors.

.6 Thermistors: Provide thermistors in windings for motors greater than or equal to 40-hp.

.7 Condensation Protection: For motors at risk of condensation, provide integral strip heaters and paint to Section 09 91 00 Painting.

.8 Frame

.1 Provide as required.

.2 Match existing frame where applicable.

.3 Provide frame conversion kit as required.

.9 Coupling and Shaft

.1 Provide as required.

.2 Match existing coupling and shaft where applicable.

.3 Provide conversion kit and custom modify shaft as required.

.10 Inverter Ready and General Purpose

.1 For variable frequency drive and non-variable frequency drive applications.

.2 To NEMA-MG-1, Part 31.4.4.2.

.3 Insulation: Minimum Class F.

.4 Turndown Ratio: Minimum 20:1 rated for variable torque applications.

.5 Windings: Capable of withstanding 1,860-V single amplitude zero to peak line to line voltage spikes when subjected to a minimum 0.1-microsecond rise time.

.4 Performance

.1 Speed: 1800-rpm

.2 Service Factor: Minimum 1.15.

.3 Efficiency: To greater of the following:

.1 ASHRAE-90.1 minimum nominal full load efficiency for motor type and purpose.
.2 ASHRAE-90.1 minimum average full load efficiency for motor type.
.3 NEMA-MG-1 premium efficiency.

2.10 MOTORS - SMALLER THAN 1-HP

.1 Provide as indicated.
.2 Match requirements of larger motors to this Section, except as follows.
.3 Type
.1 Motor Type
.1 Fans: To ASHRAE-90.1, Article 6.5.3.5, including exceptions.
.4 Performance
.1 Speed: As indicated, otherwise as follows where not indicated.
.1 Pumps: Maximum 3600-rpm for motors less than 1/2-hp.
.2 Other: Maximum 1800-rpm
.2 Service Factor: Minimum 1.15.
.3 Efficiency
.1 To ASHRAE-90.1, Table 10.8-4 and Table 10.8-5, with dates in tables to be ignored and based on current date.

2.11 STANDS

.1 Provide as required.
.2 Type: Prefabricated metal channel, weldless connections.
.3 Manufacturer: Atkore International, Inc., Unistrut Metal Framing
.4 Size: Minimum 19-mm (3/4-in) thick.
.5 Finish: Painted including for corrosion protection to Section 09 91 00 Painting.

2.12 BACKING BOARD

.1 Provide as required.
.2 Materials: Pressure impregnated treated plywood with fire-retardant chemicals to CSA-O80.
.3 Performance
.1 Flame-Spread: Maximum 25 tested to ULC-S102.
.4 Size: 19-mm (3/4-in) thick.
.5 Finish: Painted to match panels and equipment to Section 09 91 00 Painting.

2.13 STANDOFFS

.1 Provide as required.
.2 Type: Prefabricated metal channel, weldless connections.
.3 Manufacturer: Atkore International, Inc., Unistrut Metal Framing
.4 Size: Minimum 19-mm (3/4-in) thick.
.5 Finish: Painted including for corrosion protection to Section 09 91 00 Painting.

2.14 SOURCE QUALITY CONTROL

.1 Complete factory tests in accordance with NEMA, UL and ULC standards.
.2 Complete all laboratory and manufacturer testing required to refurbish existing over-current protection devices, and obtain required re-certification.
.3 Submit documentation and certified copies of test results.

PART 3 EXECUTION

3.1 EXAMINATION

.1 Photograph, document and submit descriptions of existing deficiencies in affected systems, equipment, services and surrounding areas prior to commencing Work.
.2 Confirm the condition, installation, location, quantity and type of applicable equipment.
.3 Complete x-ray scans, consultation, and other investigative work as required to verify structural member construction, verify suitable locations, and ensure drilling and coring through structural members will not affect integrity.
.4 Investigate affected fire separations for existing improperly sealed or defective fire stopping.
.5 Verify circuits on affected panels.

3.2 EXISTING MOTOR CONTROL CENTERS AND PANELBOARDS

.1 Pre-installation Measurement
  .1 Energize all loads to simulate full load conditions.
  .2 Measure line to line, and line to neutral currents, voltage, and power factor before installation.
  .3 Report on panels that may become loaded more than 80-%.

3.3 COMMON EXECUTION REQUIREMENTS

.1 Provide services, including mechanical, to equipment as required.
.2 Provide equipment with identification as indicated. Nameplates to match quality and style of existing.
.3 Replace services around equipment to fit equipment and to suit equipment requirements, including piping, ductwork, venting, wiring.
.4 Install products in locations providing appropriate ambient conditions for its operation, and allowing for adequate ventilation.
.5 Provide clearances around systems, equipment and components for inspection, servicing and maintenance and as required. Minimum clearance of 300-mm (1-ft).
.6 Provide clearances around products to prevent interference with adjacent systems, equipment and components.
.7 Noise and Vibration Control
  .1 Install vibration control hardware in accordance with manufacturer's instructions (and supervision where required) and only by workmen experienced in the installation of such systems.
  .2 Provide anti-vibration mounts or anti-vibration couplings when connecting wiring, conduit, or enclosures to mechanical equipment.
  .3 Replace isolation pads, and modify supports as required to mitigate vibration and noise to Owner's satisfaction.
.8 Repair/Restoration
  .1 Use new original manufacturer parts for replacement where possible.
  .2 Obtain all registrations or certifications required for original parts sent to a third party for refurbishment. Submit parts re-certification as required.
  .3 Obtain all certifications and testing required when modifying existing equipment.
.9 The precise type, rating, quantity and location of electrical products depend, in part, on routing and installation choices made by Contractor.
  .1 Verify specified cable size, raceway size, insulation type, and over-current protection.
  .2 Adjust sizing and selection of products as required.
.10 Provide equipment safeties and interlocks as required.
.11 Disconnecting Means: Provide disconnecting means as required, including disconnects.
.12 Power Surges: Protect upstream electrical equipment from power line, voltage transients and damage during construction power surges.
.13 Should complications arise due to incorrect selection, Contractor shall be responsible for costs incurred in replacing damaged components.
.14 Manufacturer Services
  .1 Supervision: Manufacturer to supervise field assembly of equipment to ensure warranty and performance provisions are met.
  .2 Start-up: Manufacturer to approve installation, to supervise start-up, and to instruct Owner, unless otherwise indicated.
  .3 Adjusting: Adjust for optimal performance, under manufacturer supervision.

3.4 EQUIPMENT MOUNTING

.1 Intent: Contractor responsibility as requirements depend in part on final selection and installation location.
.2 Design mounting as required where not indicated, including pads, stands, backing boards, frames, supports.

.3 Support equipment such that no loads are transmitted to services including piping, ductwork, venting, wiring.
.4 Provide concrete housekeeping pads for base-mounted equipment.
.1 Size: Minimum 100-mm (4-in) high, larger in width and depth by 75-mm (3-in).
.5 Provide stands for equipment that can be wall mounted but are not located on walls unless otherwise indicated. Anchor bolt to surfaces.
.6 Provide backing boards with standoffs for wall mounted equipment unless otherwise indicated. Anchor bolt to surfaces.
.7 Provide standoffs for wall mounted equipment as indicated, or in environments and locations not suitable for backing boards. Anchor bolt to surfaces. Use of standoffs only instead of backing boards as approved by Engineer.
.8 Performance: Design equipment mounting:
.1 To make equipment level.
.2 To protect equipment from water damage.
.3 To withstand seismic events with seismic restraint as required.
.4 To minimize noise and vibration transmitted to services and building structure.
.5 To withstand concentrated loads of 2-kN (450-lbf) applied at any point in any direction.

3.5 PANELBOARDS

.1 Install as required.
.2 Provide manufacturer's services for start-up and testing.

3.6 MOTOR CONTROLLERS

.1 Install as required.
.2 Modify as required, including:
.1 Provide manual override (HAND-OFF-AUTO) functionality.
.2 Remove and blank off spaces from abandoned components including HAND-OFF-AUTO controls when new motor starters including VFDs are installed downstream.

3.7 MANUAL MOTOR STARTER

.1 Install as required.
.2 Adjust overload settings as required.

3.8 DISCONNECTS

.1 Install as required.

3.9 OVER-CURRENT PROTECTION

.1 Install as required.
.2 Coordinate over-current protection with upstream over-current devices. Set adjustable settings for proper coordination.

3.10 VARIABLE FREQUENCY DRIVES

.1 Install as required.
.2 Configuration: Configure VFD to:
.1 Protect VFD over-loading by not allowing VFD to operate past limits including VFD overloads, nameplate ratings.
.2 Protect motor(s) over-loading by not allowing motor to operate past limits including motor overloads, nameplate rating, service factor.
.3 Protect motor(s) over-temperature based on setting minimum allowable VFD frequency for each specific motor application.
.4 Protect equipment by operating VFD to reduce frequency to avoid exceeding limits.
.5 Provide preheating when motor(s) are off to protect motors at risk of condensation.
.6 Reduce noise, vibration and resonance issues to Owner's satisfaction, including setting carrier frequency as required and skipped frequencies as approved by Owner.
.7 Restart motor(s) automatically after power failure.
.3 Submit programmable settings for review.

.4 Wiring
  .1 Wire VFD to be powered at all times even when VFD is controlled off.
  .2 Motor Thermisters: Wire to VFDs.
  .3 External Devices: Power external devices wired to VFD from separate power sources.
.5 Disconnects after VFDs:
  .1 Provide disconnects after VFDs as indicated.
  .2 Provide disconnects after VFDs where not indicated in the following locations:
    .1 Not clearly visible from VFD with all room doors closed.
    .2 Greater than 9-m (30-ft) straight horizontal distance from VFD.
    .3 Greater than 1-m (40-in) vertical height difference from VFD.
  .3 Provide disconnect labels as follows:
    .1 Construction: Laminated plastic with a different coloured core and engraved lettering to clearly show lettering with style as follows, unless otherwise specified:
    .2 Style: White capital letters, minimum 12-mm (1/2-in) high, equal character spacing, centered (not justified), black background.
    .3 Text
      .1 UNDER NORMAL OPERATION: DO NOT DISCONNECT WHILE UNDER POWER FROM FREQUENCY DRIVE.
  .4 In addition to disconnects, provide remote control of VFDs at motor(s) using ENABLE-DISABLE buttons.
.6 Interface available points to BAS using BACnet.
.7 Start-up: Manufacturer to complete start-up.

3.11 MOTORS

.1 Install as required.
.2 Wire thermisters to VFDs.
.3 Measure inrush and full load current upon start-up of motors.
.4 Adjust overload settings or replace overloads as required.
.5 Replace upstream over-current protection as required to prevent nuisance tripping on motor start-up and operation.

3.12 LABELLING

.1 Nameplates: Affix manufacturer's nameplates to equipment in a readily visible location.
.2 Identification: Provide lamacoid nameplates for identification on each enclosure, panel, or field equipment, including existing.
  .1 Construction: Laminated plastic with a different coloured core and engraved lettering to clearly show lettering with style as follows, unless otherwise specified:
    .1 Style: Capital letters, minimum 12-mm (1/2-in) high, equal character spacing, centered (not justified).
    .2 Colours: Colours of letters and background may change for each type of equipment or component. Provide colours to Owner requirements, otherwise provide white letters and black background.
  .2 Nameplate Content
    .1 Equipment: Name tag of equipment.
    .2 Panels, switchoards, transformers, or other distribution equipment: Name tag of equipment and location of electrical power feed(s).
.3 Warning: Provide warning labels as required, including:
  .1 Warning of automatic control.
  .2 Warning of enclosures containing multiple voltages or multiple voltage sources.
.4 Directories: Prepare updated written circuit directory on affected panels. Affix updated circuit directory to panel door, enclosed in a plastic protective sleeve.
.5 Ceiling Labelling
  .1 Provide coloured labels on ceiling surfaces to indicate equipment and components including the following:
    .1 Disconnects.

.2 Transformers.
.3 Emergency lighting.
.2 Label colours and/or styles may change for each type of equipment or component.
.3 Provide labels as acceptable to Owner, including label type, material, size and colour.
.4 Mark each label as acceptable to Owner, including equipment label, type, power circuit.

3.13 START-UP

.1 Motor Control Centers and Panelboards
.1 After installation of new circuits, energize all loads to simulate full load conditions.
.2 Measure line to line, and line to neutral currents, voltage, and power factor.
.2 Transformer Testing
.1 Complete logging of transformer harmonic content at 10-%, 25-%, 50-%, and 100-% equipment loading.
.2 Monitor winding temperature during start-up. Stop testing immediately if maximum hot spot transformer temperature rises above 90-°C (200-°F).
.3 Insulation Testing
.1 Test insulation integrity on circuits before powering:
.1 Visually inspect insulation.
.2 Complete sufficient meg-ohm meter (megger) measurements to confirm quality and integrity of insulation.
.4 Provide services of qualified factory-trained manufacturer's representative to assist with installation and start-up.
.1 Submit manufacturer's start-up report, and written certification that the equipment has been installed, adjusted and tested in accordance with the manufacturer's recommendations.

3.14 ADJUSTING

.1 Adjusting: Adjust settings as required before Total Performance and throughout Correction Period to address performance issues, including safeties, operating limits, noise, vibration, efficiency, equipment longevity.

3.15 CLEANING

.1 Cleaning: Clean and vacuum enclosures and junction boxes after completion of work.

3.16 CLOSEOUT ACTIVITIES

.1 Documentation
.1 Provide new single line power diagram for affected areas, including new systems and existing systems. Verify existing systems. Coordinate diagram style and notations with existing and new diagrams. Provide appropriately sized frames with glass cover for each affected area. Match existing single line power diagram frames unless otherwise approved by Owner. Mount single line power diagram in frames on walls of affected areas in locations approved by Owner.

END OF SECTION 26 00 00

SECTION 26 05 00 WIRING AND CABLES

PART 1 GENERAL

1.1 SECTION INCLUDES

.1 Wiring and cables for power, communication networks, control, raceway.
.2 Relationship to other Sections:
  .1 Various Sections describe equipment and components installed under this Section, including:
    .1 Controllers including Section 25 05 00 Building Automation System.
    .2 Equipment including Section 15 00 00 Mechanical Equipment, Section 26 00 00 Electrical Equipment.
    .3 Components including Section 26 90 00 Control Devices.

1.2 REFERENCED DOCUMENTS

.1 ASHRAE-90.1: ANSI/ASHRAE/IES-90.1-2010 Energy Standard for Buildings Except Low-Rise Residential, including User's Manual.
.2 ASHRAE-90.1: ANSI/ASHRAE/IES-90.1-2013 Energy Standard for Buildings Except Low-Rise Residential, including User's Manual.
.3 CSA-C22.1: CSA-C22.1-12 Canadian Electrical Code, Part 1 (22nd Edition), Safety Standard for Electrical Installations, including Handbook.
.4 CSA-C22.2: CSA-C22.2 Canadian Electrical Code, Part 2.
.5 CSA-C22.2-0.3: CSA-C22.2 No. 0.3-09 Test Methods for Electrical Wires and Cables.
.6 CSA-C22.2-45.2: CSA-C22.2 NO. 45.2-08 (R2013) Electrical Rigid Metal Conduit - Aluminum, Red Brass, and Stainless Steel.
.7 CSA-C22.2-56: CSA-C22.2 No. 56-04 (R2009) Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
.8 CSA-C22.2-83: CSA-C22.2 No. 83-M1985 (R2013) Electrical Metallic Tubing.
.9 CSA-C22.2-83.1: CSA-C22.2 No. 83.1-07 (R2012) Electrical Metallic Tubing - Steel.
.10 CSA-C22.2-211.2: CSA-C22.2 No. 211.2-06 (R2011) Rigid PVC (Unplasticized) Conduit.
.11 CSA-C22.2-227.1: CSA-C22.2 No. 227.1-06 (R2011) Electrical Nonmetallic Tubing.
.12 CSA-C22.2-262: CAN/CSA-C22.2 No. 262-04 (R2013) Optical Fiber Cable and Communication Cable Raceway Systems.
.13 CSA-C22.2-2420: CSA-C22.2 No. 2420-09 (R2014) Belowground Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.
.14 CSA-C22.2-2515: CSA-C22.2 No. 2515-09 (R2014) Aboveground Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.
.15 ESA-OESC: ESA Ontario Electrical Safety Code, 2012 (25th Edition).
.16 NECA-1: ANSI/NECA-1-2010 Standard for Good Workmanship in Electrical Construction.
.17 NEMA-250: NEMA-250-2008 Enclosures for Electrical Equipment (1000 Volts Maximum).
.18 TIA-568: ANSI/TIA-568-2012 Commercial Building Telecommunications Cabling Standard.
.19 ULC-S115: CAN/ULC-S115-11 Standard Method of Fire Tests of Firestop Systems.
.20 ULC-S139: CAN/ULC-S139-12 Standard Method of Fire Test for Evaluation of Integrity of Electrical Cables.

1.3 DEFINITIONS

.1 As defined by ESA-OESC and CSA-C22.1, unless otherwise defined.
.2 "Cable": An assembly of conductors.
.3 "Conduit": A type of raceway.
.4 "Raceway": A type of protection for wiring and cables.
.5 "Tubing": A type of raceway.
.6 "VFD": Variable frequency drive.

1.4 SUBMITTALS FOR ACTION

.1 Product Data
  .1 Manufacturers' product literature, specifications, and datasheets. Include product characteristics, performance criteria, options, and limitations.
.2 Shop Drawings
  .1 Layout and Interference Plans: Isometric sketches indicating clearances, interferences, and relocation of interfering services, components, objects, and structures.
  .2 Single Line: Single line electrical schematic showing:
    .1 Cable sizes and quantities.
    .2 Conductor types and quantities per cable.
    .3 Insulation types and temperature ratings per conductor and cable.
    .4 Raceway types, dimensions.
    .5 Maximum current capacity.
    .6 Overcurrent protection details.
    .7 Other code requirements.
    .8 Other regulatory requirements.
  .3 Interlocks: Schematic and wiring diagrams detailing electrical interlocks.
  .4 Disconnecting Means: Schematic and wiring diagrams detailing methods of disconnecting means.
  .5 Fire Separations: Location of penetrations through fire separations and other assemblies.
  .6 Fire Stopping and Smoke Seals
    .1 Locations and types marked on plan drawing.
    .2 ULC assembly number certification.
    .3 Required temperature rise and flame rating.
    .4 Hose stream rating where applicable.
    .5 Materials of fire stopping and smoke seals, primers, reinforcements, damming materials, reinforcements, and anchorages/fastenings.
    .6 Assembly and penetration type and required ratings, adjacent materials.
    .7 Openings size, thickness, dimensions.
    .8 Proposed installation methods.
    .9 Summaries of similar types of penetrations, assembly type and construction, service penetrating assembly, adjacent materials, fire stopping and smoke seal type, ratings, other work required.
    .10 Copies of ULC certifications for proposed systems and designs for specific devices and materials.
    .11 Image of sample tag.

1.5 SUBMITTALS FOR INFORMATION

.1 Certificates
  .1 Production test results.
  .2 Seismic certification and equipment anchorage details.
  .3 Letter from fire stopping and smoke seals installer certifying that fire stopping and smoke seals have been installed in accordance with regulatory requirements and Contract Documents.
.2 Manufacturer Information
  .1 Installation Instructions
.3 Test and Evaluation Reports
  .1 Load Balance Report: Report detailing line to line, and line to neutral currents, voltage, and power factor, before and after adjustments.
  .2 Power Quality Report: Report detailing harmonic analysis of waveforms and total harmonic distortion measurement.
  .3 Insulation Testing Report
    .1 Meg-ohm meter (megger) measurements.
    .2 Visual inspection of insulation.

.3 Summary and recommendations.

.4 Qualification Statements

.1 Electrical Work: Company and personnel to be licensed electricians.

1.6 QUALITY ASSURANCE

.1 Qualifications

.1 Electrical Work: Company and personnel to be licensed electricians.

.2 Fire Stopping and Smoke Seals: Company member of FCIA.

PART 2 PRODUCTS

2.1 COMMON PRODUCT REQUIREMENTS

.1 Designed, manufactured, tested and certified in accordance with the latest applicable standards including ANSI, CSA, NEMA, UL and ULC.

.2 The precise type, rating, quantity and location of electrical products depend, in part, on routing and installation choices made by Contractor.

.1 Provide electrical products meeting relevant CSA-C22.2 standards.

.3 Match fault current ratings equal to that of upstream over-current protection.

.4 Provide electrical products rated to suit environment.

2.2 POWER WIRING AND CABLES

.1 Provide as required.

.2 Materials

.1 Copper for all conductors including integral ground wires.

.2 Stranded for #10-AWG and larger.

.3 Size

.1 Size feeders to handle maximum rated current to accommodate future expansion, including equipment and loads.

.2 Minimum #12-AWG for power wiring otherwise.

.4 Ratings

.1 Temperature: Minimum 90-°C (200-°F) unless otherwise required.

.2 Voltage

.1 Minimum 1,000-V for cables between 575-V rated variable frequency drives and motors.

.2 Minimum 600-V otherwise.

.3 Flame Test Rating

.1 FT6 to CSA-C22.2-0.3 as required by local building code, including for plenums, combustible construction.

.2 FT4 to CSA-C22.2-0.3 otherwise.

.4 Fire Rating: Minimum 1-hour fire rating certified to ULC-S139 where fire rating is indicated.

.5 Cable Types

.1 RW90-XLPE: Chemically cross linked thermosetting polyethylene material with CSA type RW90. Suitable for wet and dry locations.

.2 RWU90-XLPE: Chemically cross linked thermosetting polyethylene material with CSA type RWU90. Suitable for underground burial.

.3 T90/TWN75: Thermoplastic insulation with CSA type TWH, with nylon jacket. Suitable for wet and dry locations.

.4 TECK90: Armoured cable, polyvinyl chloride jackets on the outside and inside of the armour. Suitable for wet and dry locations.

.1 Armour: Interlocked aluminum.

.2 Conductor Insulation: Chemically cross linked thermosetting polyethylene material with CSA type RW90.

.5 ACWU90: Armoured cable, polyvinyl chloride jacket, suitable for wet and dry locations.

.1 Armour: Interlocked aluminum.

.2 Conductor Insulation: Chemically cross linked thermosetting polyethylene material with CSA type RW90.

.6 AC90: Armoured cable, no jacket, CSA type AC90. Suitable for dry locations.
.1 Armour: Interlocked aluminum.

.7 RA90: Aluminum sheathed cable, CSA type RA90, polyvinyl chloride jacket. Suitable for wet and dry locations.
.1 Armour: Continuous aluminum sheath.
.2 Conductor Insulation: Chemically cross linked thermosetting polyethylene material with CSA type RW90.

.8 FAS: CSA type FAS and applicable UL ratings.

.9 VFD: Application specific cable design for variable frequency drive applications.
.1 Voltage: 1,000-V
.2 Construction: 3 bare bonding conductors symmetrically located within cable and/or 100-% coverage foil, braided, or taped shields.

2.3 COMMUNICATION NETWORKS WIRING AND CABLES

.1 Provide as required.

.2 Coordinate requirements as required, including for communication network repeaters, gateways, boosters, interfaces, and other equipment, components and accessories.

.3 Cable Types
.1 CAT5, CAT5e, CAT6 - Category #: To TIA-568, multiple shielded twisted pair.
.2 STP - Shielded Twisted Pair: #18 AWG, 100-ohm to 130-ohm impedance, capacitance less than 30-pF per foot.

.4 Ratings
.1 Flame Test Rating
.1 FT6 to CSA-C22.2-0.3 as required by local building code, including for plenums, combustible construction.
.2 FT4 to CSA-C22.2-0.3 otherwise.

2.4 CONTROL WIRING AND CABLES

.1 Provide as required.

.2 Coordinate requirements as required, including for signal conditioning and isolation, and other equipment, components and accessories.

.3 Cable Types
.1 CLA1 - Class 1: To TIA-568, shielded twisted pair.
.2 STP - Shielded Twisted Pair: #18 AWG, 100-ohm to 130-ohm impedance, capacitance less than 30-pF per foot.

.4 Size
.1 Size control wires to manufacturer's recommendations.
.2 Minimum #18-AWG unless otherwise specifically required by manufacturer.

.5 Materials: Copper.

.6 Ratings
.1 Temperature: Minimum 90-°C (200-°F) unless otherwise required.
.2 Flame Test Rating
.1 FT6 to CSA-C22.2-0.3 as required by local building code, including for plenums, combustible construction.
.2 FT4 to CSA-C22.2-0.3 otherwise.

2.5 RACEWAYS

.1 Provide as required.

.2 Size: Minimum 21-mm (3/4-in).

.3 Type
.1 EMT - Electrical Metallic Tubing: To CSA-C22.2-83.1.
.1 Materials: Hot dipped galvanized steel.
.2 ENT - Electrical Nonmetallic Tubing: To CSA-C22.2-227.1.

.1 Flame Test Rating
.1 FT6 to CSA-C22.2-262 and as required by local building code, including for plenums, combustible construction.
.2 FT4 to CSA-C22.2-262 otherwise.
.3 FMC - Flexible Metal Conduit: To CSA-C22.2-56.
.4 FMC-LT - Liquid Tight Flexible Metal Conduit: To CSA-C22.2-56.
.5 PVC - Rigid PVC (Unplasticized) Conduit: To CSA-C22.2-211.2.
.6 RMC - Rigid Metal Conduit: To CSA-C22.2-45.2.
.1 Materials: Aluminum.
.7 RTRC-AG - Aboveground Reinforced Thermoset Rigid Conduit, or Fibreglass Conduit: To CSA-C22.2-2515.
.8 RTRC-BG - Belowground or Reinforced Thermoset Rigid Conduit Type Below Ground, or Fibreglass Conduit: To CSA-C22.2-2420.

2.6 SUPPORTS AND HANGERS

.1 Design of wiring and cables support depends, in part, on routing and installation choices made by Contractor. Design of wiring and cables support is Contractor responsibility.
.2 Provide as required.
.3 Materials: Metal, corrosion resistant.
.4 Unacceptable
.1 Wire lashing.
.2 Perforated straps.

2.7 ACCESS HATCHES

.1 Provide access hatches:
.1 At concealed electrical components.
.2 At equipment and components requiring maintenance, inspections and for convenience purposes.
.3 In fixed surfaces including walls, ceilings.
.4 At other locations as required.
.2 Type: Quick opening hardware. Lockable.
.3 Fasteners
.1 General: Provide countersunk holes where fasteners are not concealed.
.2 Size: Square with minimum free opening 0.1-m2 (1-ft2). Other shapes to be approved by Owner.
.4 Finish: To match fixed surfaces to Section 09 91 00 Painting.

2.8 OTHER ACCESSORY PRODUCTS

.1 Receptacles
.1 Provide at the following locations:
.1 As required.
.2 Where mounts are ready for receptacles.
.2 Provide types as required.
.2 Receptacle Weatherproof Covers
.1 Provide at the following locations:
.1 As indicated.
.2 Damp, wet, outdoor.
.2 Manufacturers: Hubbell Electrical Systems, Hubbell Wiring Device-Kellems, Metallic Outlet Box Hoods
.3 Selection: Suitable for horizontal and vertical mounting as required.
.4 Features
.1 Latching cover with large cord openings.
.2 Mounting drill points in 4 corners.
.3 Padlock hole 6.4-mm (0.25-in) diameter.
.5 Materials

.1 Cover: Die cast A360 aluminum with less than 0.004-% copper content.
.2 Finish: Baked aluminum lacquer.
.3 Gasket: Closed-cell foam.
.6 Other Ratings
.1 Ingress Protection
.1 Minimum NEMA Type 3R rated to NEMA-250.
.2 Maintain ratings while in use.
.7 Certifications, Listings and Registrations
.1 CSA certified.
.2 UL listed.

2.9 FIRE STOPPING AND SMOKE SEALS

.1 Asbestos-free materials and systems capable of maintaining effective barrier against flame, smoke and gases to ULC-S115.
.2 Manufacturers: 3M, Fire Protection Products
.3 Materials
.1 Fire stopping and smoke seal components: Certified by test laboratory to ULC-S115.
.2 In assemblies: Systems tested to ULC-S115.
.3 In wet environments, waterproof assemblies, or exterior assemblies including foundations and below grade floors: Waterproof, non-hardening.
.4 Penetrations requiring vibration control: Elastomeric seal.
.5 Damming and backup materials, supports and anchoring devices: To manufacturer's recommendations, and in accordance with tested assembly being installed as acceptable to authorities having jurisdiction.
.6 Other locations: As required.
.4 Performance: Rating: 2-hours, unless otherwise required.

PART 3 EXECUTION

3.1 EXAMINATION

.1 Photograph, document and submit descriptions of existing deficiencies in the affected wiring, raceway.and support systems prior to commencing Work.
.2 Complete x-ray scans, consultation, and other investigative work as required to verify structural member construction, verify suitable locations, and ensure drilling and coring through structural members will not affect integrity.
.3 Investigate fire separations and non-fire-resistance rated assemblies in affected areas for existing fire stopping or smoke sealing that is improperly sealed or defective, as well as for penetrations not fire stopped or smoke sealed.
.4 Verify characteristics of indicated components, including sizes and types, including raceways, wiring and cables, insulation, and over-current protection. Adjust sizing and selection as required.

3.2 PREPARATION

.1 Demolition and Removal
.1 Remove existing unused plenum cable in affected areas.
.2 Remove existing unused and obsolete services and components including wiring, raceway, and support systems.

3.3 COMMON EXECUTION REQUIREMENTS

.1 The precise type, rating, quantity and location of electrical products depend, in part, on routing and installation choices made by Contractor.
.2 Complete Work:
.1 To ESA-OESC.
.2 To CSA-C22.1.
.3 To NECA-1 unless otherwise indicated.
.3 Locations

.1 Install products in locations providing appropriate ambient conditions for its operation, and allowing for adequate ventilation.
.2 Install products to allow maintenance access and to prevent interference with adjacent equipment.
.3 Install products to facilitate various activities including maintenance and inspection:
.1 Provide sufficient additional wiring lengths.
.2 Provide wiring quick disconnecting means.
.4 Install in a manner to not interfere with normal traffic patterns.
.5 Install above 150-mm (6-in) of floor and other similar surfaces, including surface of housekeeping pads and other similar horizontal surfaces.
.6 Install above snow drift region, including surface of ground and roof and other similar surfaces, including equipment mounting curbs and flashing.
.7 Install and layout to account for extremes of expansion and contraction that system may be subject to.
.4 Grounding and Bonding: Provide a separate grounding and bonding conductor in raceways containing power circuits.
.5 Power Surges: Protect upstream loads and equipment from power line, voltage transients and damage during construction power surges.
.6 Enclosures
.1 Use dedicated enclosures.
.2 Document enclosures that contain mixed voltages, and/or circuits operating under separate control.
.7 Junctions and Splicing: Unless otherwise indicated or required:
.1 When modifying or extending existing wiring and cables, maximum 1 junction or splice allowed for each wire and cable, excluding terminations at required equipment, components and accessories.
.2 Otherwise, install wiring and cables in continuous lengths, free from junctions and splices, except for terminations at required equipment, components and accessories.

3.4 POWER WIRING AND CABLES

.1 Install as required.
.2 Sizing: To ASHRAE-90.1 in addition to ESA-OESC, to CSA-C22.1.
.3 Locations: Provide the following.
.1 Outdoor, fully exposed to elements:
.1 RW90-XLPE cable in RTRC-AG raceway.
.2 Outdoor, wet, or damp locations except for underground burial:
.1 RW90-XLPE cable in RMC raceway.
.3 Concrete encased:
.1 RW90-XLPE cable in PVC raceway.
.2 Allow expansion space at each end of linear sections of PVC raceways to allow for thermal expansion prior to pouring.
.4 Underground burial:
.1 RWU90-XLPE cable in raceway that matches existing when connecting with no greater than 2-m (6-ft) of raceway.
.2 Otherwise, RWU90-XLPE cable in RTRC-BG raceway.
.5 Service traffic areas, including corridors and hallways and pathways within rooms, subject to mechanical damage from moving objects including forklifts, carts, and vehicles:
.1 RW90-XLPE cable in RMC raceway.
.6 Service areas, including rooms, exposed:
.1 #10-AWG and smaller:
.1 RW90-XLPE cable in EMT raceway.
.2 Service areas, including rooms, #8-AWG and larger:
.1 RW90-XLPE cable in EMT raceway.

.7 Walls, concealed:
.1 RW90-XLPE cable in FMC raceway.
.8 Concealed chases, service areas, behind other surfaces:
.1 RW90-XLPE cable in EMT raceway.
.9 Ceiling cavities, non-ducted return air plenums:
.1 #12-AWG and smaller:
.1 RW90-XLPE cable in FMC raceway.
.2 #10-AWG and larger:
.1 TECK90

.4 Loads, Equipment and Systems Served: Provide the following additional requirements.
.1 VFD: Wiring and cables between variable frequency drives and motors at 575-V or higher:
.1 VFD cable in EMT raceway.
.2 Life Safety Other: Wiring and cables for communications and control serving or related to fire alarm or other life safety systems wiring:
.1 FAS cable in minimum EMT raceway or stronger raceways as required.

.5 Terminations to Loads and Equipment: Provide the following additional requirements.
.1 Concealed Luminaire Terminations
.1 T90 or RW90-XLPE cable in FMC raceway.
.2 AC90
.3 Maximum length 3-m (10-ft), with junction boxes.
.2 Other Loads and Equipment Terminations
.1 Provide junction boxes from raceways located not more that 3-m (10-feet) from equipment.
.3 Vibration Terminations: Wiring and cables serving vibrating loads and equipment:
.1 FMC-LT raceway.
.4 Vibration Isolation: Terminations intended for vibration isolation:
.1 Provide minimum 1-m (40-in) in length.
.2 Provide anti-vibration mounts or anti-vibration couplings at equipment.
.5 Removable: Wiring and cables serving devices or components that are expected to normally be removed from mounting, regardless of frequency of removal, including for service or inspection:
.1 FMC-LT raceway.

.6 Other
.1 For other locations, terminations, and parts served, match to most similar indicated above, with minimum as follows:
.1 RW90-XLPE cable in EMT raceway.
.2 Specifically Prohibited
.1 Exposed wiring and cables.
.2 Exposed raceways unless specifically indicated above.

3.5 COMMUNICATION NETWORKS WIRING AND CABLES

.1 To power wiring and cables in this Section, with specific modifications and additional requirements under this Article.
.2 Communication Network Types: Provide the following:
.1 Ethernet:
.1 CAT5e or CAT6, installed to TIA-568.
.2 RS-232, RS-485, and proprietary MS/TP networks:
.1 CAT5e or CAT6, installed to TIA-568.
.3 Communication Network Types Modified: If controller product manufacturer has specific requirements that are of a lesser quality than as indicated above, submit for review and agreement.
.4 Raceways Modified: Raceway requirements not required for the following conditions, when all conditions met, unless otherwise required by regulation:

.1 Raceways are waived.
.5 Components: Provide required additional components including repeaters, gateways, boosters, interfaces, and other equipment and accessories.
.6 Locations: Minimum 1-m (3.2-ft) separation from power and control wiring.
.7 Spare Lengths: Provide spare 3-m (10-ft) length at each termination.

3.6 CONTROL WIRING AND CABLES

.1 To power wiring and cables in this Section, with specific modifications and additional requirements under this Article.
.2 Control Types: Provide the following:
.1 All: CLA1, installed to TIA-568.
.3 Control Types Modified: If controller product manufacturer has specific requirements that are of a lesser quality than as indicated above, submit for review and agreement.
.4 Raceways: Install in separate raceways from power and communication network wiring and cables.
.5 Raceways Modified: Raceway requirements not required for the following conditions, when all conditions met, unless otherwise required by regulation:
.1 Raceways waived:
.6 Components: Provide required additional components including signal conditioning and isolation, and other equipment and accessories.
.7 Spare Lengths: Provide spare 0.5-m (1.6-ft) length at each termination.

3.7 RACEWAYS

.1 Size: Fill raceways to the lesser of 50-% of free area, to ESA-OESC, to CSA-C22.1.
.2 Installation and Routing
.1 Conceal raceways, except within mechanical, electrical or service rooms.
.2 Install and lay out raceways for drainage.
.3 Maintain 150-mm (6-in) minimum clearance from piping, ductwork or venting.
.4 Install raceways level, plumb, at right angles to building lines. Follow contours of supporting surfaces.
.5 Install bends and offsets uniformly without flattening.
.1 Bend raceways with minimum radius of 10-times nominal size of raceway.
.3 Fittings
.1 Connections and Couplings: Provide throughout raceway installation, including at enclosures, boxes, and final terminations.
.2 Liquid Tight Connectors: Use as follows:
.1 Locations: Damp, wet, corrosive.
.2 Terminations: Final terminations to motors and vibrating equipment.
.3 Ends
.1 Provide insulated bushings on raceway ends.
.2 Cap and seal top end of vertical raceways.
.4 Expansion: Provide telescoping joints where raceways cross building expansion joints, complete with flexible copper ground jumper.
.4 Pull Wire: Provide non-abrasive pull wire in each raceway, with 300-mm (12-in) of slack at either end, and ends terminated under a screw.
.5 Enclosures and Boxes
.1 Pull Boxes: Provide pull boxes in raceways such that no wiring or cable will have to be pulled more than 2 90-degree bends or 30-m (100-ft) of raceways in 1 pulling operation.
.2 Junction Boxes: Provide as required, including for junctions and splices.
.3 Covers: Provide new covers to enclosures or boxes missing covers. Use proper screws to secure covers.
.4 Supports: Support enclosures and boxes independently of raceways and wiring and cables.

3.8 SUPPORTS AND HANGERS

.1 Design and provide supports and hangers as required.
.2 Support components and accessories independently of raceways.
.3 Adjust support system including hangers to equalize load.

3.9 ACCESS HATCHES

.1 Install as required.

3.10 OTHER ACCESSORY PRODUCTS

.1 Receptacles
  .1 Install as required.
.2 Receptacle Weatherproof Covers
  .1 Install as required.
  .2 Finish: Paint as follows:
    .1 As required by Owner, including colour and gloss or matte finish.
    .2 To match surrounding surfaces, including colour and gloss or matte finish.

3.11 PENETRATIONS

.1 Provide sleeves at penetrations and where wiring passes through assemblies including walls, floors and ceilings.
.2 Pack sleeves with resilient packing or fire rated packing and materials as required.
.3 Flash parts built into or passing through to wet environments, waterproof assemblies, or exterior assemblies including roofs, outside walls.
.4 Patch holes to match existing surfaces.
.5 Provide minimum clearances as required between sleeves and uninsulated or insulated wiring with minimum of:
  .1 Below Grade: 25-mm (1-in)
  .2 Other Locations: 13-mm (1/2-in)
.6 Sleeve Materials
  .1 Exterior Assemblies: Carbon steel schedule 40, primed and painted to Section 09 91 00 Painting.
  .2 Masonry and Concrete Assemblies: Carbon steel schedule 40, primed and painted to Section 09 91 00 Painting.
  .3 Interior Frame Construction Assemblies in Conditioned Spaces: Carbon steel schedule 10.
  .4 Other Frame Construction Assemblies: Carbon steel schedule 10 primed and painted to Section 09 91 00 Painting.
.7 Extend floor sleeves 38-mm (1-1/2-in) above floor surface.
.8 Seal floor sleeves with an approved stiff setting caulking compound to serve as a water dam.

3.12 FIRE STOPPING AND SMOKE SEALS

.1 Fire stop and smoke seal at fire-resistance rated assemblies including:
  .1 Penetrations through masonry, concrete, and frame construction including gypsum board partitions and walls.
  .2 Penetrations through floor slabs, ceilings and roofs.
  .3 Openings and sleeves installed for future use.
  .4 Services, including mechanical and electrical.
  .5 As indicated.
.2 Fire stop and smoke seal at non-fire-resistance rated assemblies including:
  .1 Assemblies not fire-resistance rated but constructed as such.
  .2 As indicated.
.3 Install fire stopping and smoke seal material and components in accordance with manufacturer's certified tested system listing.
.4 Install to allow for movement and thermal expansion of services including piping and ducting.

.5 Ensure integrity of fire stopping and smoke seals such that passage of flame, smoke and gases is prevented including to unexposed side of assembly of single sided fire stopping and smoke seals. Repair as required.
.6 Ensure integrity of insulation and vapour barriers. Repair as required.
.7 Repair holes, gaps, openings and improperly fire stopped and smoke sealed penetrations in affected assemblies.
.8 Provide tags for each fire stopping and smoke seal. Include relevant information on tags including installer name, company, trade license, installation date, fire stopping and smoke seal ULC assembly number certification. Mount at locations as approved by Owner or as required by authorities having jurisdiction.

3.13 LABELLING

.1 Labelling to match existing labelling scheme if possible and if approved by Owner, otherwise to meet Owner requirements.
.2 Wiring and Cables
  .1 Maintain consistent color-coding.
  .2 Match colour coding of internal wiring and cables of pre-wired components where possible.
  .3 Provide wire markers at the following locations.
    .1 Both ends.
    .2 At enclosures and boxes, including junction and pull boxes.
    .3 At other terminations.
.3 Controls and Communications Wiring and Cables
  .1 Label with point or controls or network name with 3 rows of characters per label.
  .2 Locations
    .1 Both ends.
    .2 At enclosures and boxes, including junction and pull boxes.
    .3 At other terminations.
  .3 Manufacturers
    .1 Thomas & Betts Limited
    .2 Brady Worldwide, Inc.
  .4 Type: 12 character polestar metalized labels.
.4 Enclosures and Boxes
  .1 Label enclosures and boxes with permanent means, including junction and pull boxes.
  .2 Identify purpose and power circuit(s).
.5 Directories: Prepare updated written circuit directory on affected panels. Affix updated circuit directory to panel door, enclosed in a plastic protective sleeve.

3.14 STARTUP

.1 Insulation Testing
  .1 Test insulation integrity on circuits before powering:
    .1 Visually inspect insulation.
    .2 Complete sufficient meg-ohm meter (megger) measurements to confirm quality and integrity of insulation.

END OF SECTION 26 05 00

SECTION 26 90 00 CONTROL DEVICES

PART 1 GENERAL

1.1 SECTION INCLUDES

.1 Control devices, end devices, actuators, transmitters, transducers, sensors, probes.
.2 Relationship to other Sections:
  .1 Section 15 05 00 Piping describes additional requirements of components provided under this Section, including control valves, fluid sensors, thermowells.
  .2 Section 23 30 00 Ductwork describes additional requirements of components provided under this Section, including control dampers.
  .3 Section 25 90 00 Control Sequences describes additional requirements of components provided under this Section, including configuration and programming of controllers.
  .4 Section 26 05 00 Wiring and Cables describes installation requirements of components provided under this Section.

1.2 REFERENCED DOCUMENTS

.1 ASHRAE-135: ANSI/ASHRAE-135-2012 BACnet - A Data Communication Protocol for Building Automation and Control Networks.
.2 ASHRAE-G-11: ASHRAE-G-11-2009 Guideline on Field Testing of HVAC Controls Components.
.3 CSA-C22.2-94: CSA-C22.2 No. 94-93 (R2013) Temperature-Indicating and -Regulating Equipment.
.4 CSA-E60730-1: CAN/CSA-E60730-1-13 Automatic Electrical Controls for Household and Similar Use - Part 1: General Requirements.
.5 EUL-RoHS: European Union Legislation 2002/95/EC Restriction of Hazardous Substances Directive (RoHS).
.6 IEC-60529: ANSI/IEC-60529-2013 Degrees of Protection Provided by Enclosures (IP Code).
.7 NEMA-250: NEMA-250-2008 Enclosures for Electrical Equipment (1000 Volts Maximum).
.8 UL-873: UL-873-2007 Standard for Temperature-Indicating and -Regulating Equipment.

1.3 DEFINITIONS

.1 “Affected Systems”: Systems, equipment, services and control systems that are not part of Work but whose operation may be impacted by Work.
.2 “BACnet”: A communications protocol adhering to ASHRAE-135.
.3 “Device”: Transmitters, sensors, probes, and any other device or component in whole or in part that either provides a signal as an input to a controller, or accepts a control signal from a controller, whether or not the device or component may itself act as a controller.
.4 “NTC”: Negative temperature coefficient.
.5 “RTD”: Resistance temperature detector.

1.4 SUBMITTALS FOR ACTION

.1 Product Data
  .1 Manufacturers’ product literature, specifications, and datasheets. Include the following information:
    .1 Product characteristics.
    .2 Performance criteria.
    .3 Options.
    .4 Limitations.
    .5 Photographs.
    .6 Supplier information.
  .2 Performance criteria for end devices includes accuracy, operating environment tolerances, and stability criteria.
  .3 Detailed bill of material list for each system or application, identifying quantities, part numbers, descriptions, and optional features.

.2 Shop Drawings
  .1 Floor plan drawings showing location of system components.
  .2 System schematics and flow diagrams indicating point location, name, and hardware address.
  .3 Device list describing location, function, power supplies, signal conditioning.
  .4 Wiring and ladder logic diagrams detailing required interfaces and hardware interlocks.
  .5 Wiring and ladder logic diagrams describing important existing undocumented interfaces and hardware interlocks.
  .6 Interlocks: Schematic and wiring diagrams detailing electrical interlocks and life safety system interfaces.

1.5 SUBMITTALS FOR INFORMATION

.1 Manufacturer Information
  .1 Operating and Maintenance Manuals
  .2 Installation Instructions
.2 Testing Report: A report detailing the results of testing activities including the following:
  .1 Dates of testing activities.
  .2 Names and contact information of testing technician.
  .3 Point Calibration Results: Include points and devices tested, method for testing, potential variances, observations including point values, measured values, discrepancies, and a description of corrective action taken.
  .4 Output Testing Results: Include points and devices tested, method for testing, potential variances, observations including point values, measured values, discrepancies, and a description of corrective actions taken.
  .5 Failure Mode Test Results
  .6 Software State Test Results
  .7 Interlocks Test Results
  .8 Completed Testing Check List

1.6 SUBMITTALS FOR CLOSEOUT

.1 Tools and Software
  .1 4 sets of common keys to enclosures.
  .2 Control device test kits and calibration kits.

1.7 ADMINISTRATIVE REQUIREMENTS

.1 Testing Plan Review
  .1 Submit Testing Plan for approval 20-days prior to testing.
  .2 Revise the Testing Plan as required to the satisfaction of the Engineer.
  .3 Submit the Testing Report demonstrating results of testing activities.
  .4 Coordinate testing activities with Commissioning activities.

1.8 WARRANTY

.1 Special Warranty
  .1 Update site documentation including paper and electronic versions as required.

PART 2 PRODUCTS

2.1 COMMON PRODUCT REQUIREMENTS

.1 Select and size devices to be suitable for the application, including compatibility with controllers, power supplies, signal conditioning hardware, wiring and other equipment, ease of maintenance, adjustability, tolerances, signal resolution, inrush currents, and operating environment.
.2 Devices including sensors to be complete with transmitters unless otherwise indicated.
.3 Select device scale ranges to suit the application, including operating temperatures, pressure or vacuum, with readings at approximately mid-point on the scale where applicable.
.4 Options
  .1 Available product options are defined for each device.

.2 Provide devices with the specific product options indicated in Contract Documents.
.3 Where specific product options are not indicated elsewhere in Contract Documents, including where a product options field is blank or not present, provide all options for that device.
.1 In cases of inconsistency(s) or conflict(s) between options, provide options of greater quality or that meet more stringent requirements as determined by Engineer.
.5 Indicated device accuracies and stability include errors associated with the sensor, including lead wire, and analog to digital conversion, unless otherwise indicated.

2.2 ADP - AIR DIFFERENTIAL PRESSURE TRANSMITTERS

.1 Provide as indicated.
.2 Type
.1 Low differential pressure for air or similar non-conducting gases.
.3 Manufacturers
.1 Setra Systems, Inc., 267 Series
.4 Features
.1 Transmitter Enclosure: Hinged.
.2 Probes: 6.3-mm (0.25-in) diameter with baffles to prevent velocity pressure errors.
.3 Settings
.1 Field selectable pressure ranges.
.1 Selectable to 25-Pa, 63-Pa, 125-Pa, 250-Pa, 623-Pa, 2,490-Pa (0.1-inWC, 0.25-inWC, 0.5-inWC, 1.0-inWC, 2.5-inWC, 10-inWC).
.2 Bidirectional and unidirectional.
.2 Field selectable signal outputs.
.3 Field zeroing.
.4 Bidirectional output at zero.
.4 Connections
.1 Strain reliefs and raceways openings as required.
.5 Materials
.1 Transmitter Enclosure: Polycarbonate, painted finish.
.2 Probes: Extruded aluminum.
.3 Pressure Fittings: Brass.
.6 Options
.1 Transmitter
.1 AC02
.1 Accuracy: +/-0.25-% full scale of root sum square for non-linearity, hysteresis, and non-repeatability.
.2 Non-Linearity: +/-0.22-% full scale of best fit line method.
.2 AC04
.1 Accuracy: +/-0.4-% full scale of root sum square for non-linearity, hysteresis, and non-repeatability.
.2 Non-Linearity: +/-0.38-% full scale of best fit line method.
.3 AC05
.1 Accuracy: +/-0.5-% full scale of root sum square for non-linearity, hysteresis, and non-repeatability.
.4 AC1
.1 Accuracy: +/-1.0-% full scale of root sum square for non-linearity, hysteresis, and non-repeatability.
.2 Non-Linearity: +/-0.98-% full scale of best fit line method.
.2 Sensor
.1 UNI: Unidirectional.
.2 BID: Bidirectional.
.3 Display

.1 LCD: Liquid crystal display of line pressure and differential pressure, minimum 3 digits.

.7 Performance
- .1 Hysteresis: +/-0.10-% full scale.
- .2 Non-Repeatability: +/-0.5-% full scale.

.2 Thermal Effects: Maximum thermal error calibrated at nominal 21-°C (70-°F).
- .1 Compensated Temperature Range: 5-°C to 65-°C (40-°F to 150-°F)
- .2 Zero/Span Shift: +/-0.06-°C (+/-0.033-°F) full scale.
- .3 Long Term Stability: 0.1-% full scale.

.8 Ratings
- .1 Housing: Minimum IP65, certified to IEC-60529.
- .2 Pressures
  - .1 Line Pressure: Upper limit of 69-kPa (10-psi) or greater.
  - .2 Over Pressure: Upper limit of 69-kPa (10-psi) or greater at maximum range.
- .3 Temperatures
  - .1 Transmitter: Ambient: -18-°C to 65-°C (0-°F to 150-°F)
  - .2 Sensor: Pressure Media: Wider range than ambient temperature for transmitter.

.9 Certifications, Listings and Registrations
- .1 NIST traceable calibration.

2.3 DAF - DUCT AIR FLOW TRANSMITTER

.1 Provide as indicated.

.2 Manufacturers
- .1 Ebtron Inc., EB-Flow Series
- .2 GreenTrol Automatic Inc.., GF-2000 Series

.3 Type
- .1 Thermal dispersion sensors.

.4 Features
- .1 Capability: Remotely located 16 airflow inputs, 16 temperature inputs, 2 analog outputs.
- .2 Mounting
  - .1 Transmitter Mounting: Outside of duct.
  - .2 Probe Mounting: In duct.
- .3 Transmitter: Pushbutton, LCD display.
- .4 Probes: Quantity as recommended by manufacturer for opening size.
- .5 Sensors
  - .1 Quantity 2 thermistors per sensor, hermetically sealed and potted in marine grade waterproof epoxy, with 1 self-heated thermistor and 1 zero power thermistor at each sensing node.
  - .2 Total quantity of sensors as recommended by manufacturer for opening size.

.5 Materials
- .1 Transmitter: Aluminum enclosure.
- .2 Probe Tubes: Gold anodized, 6063 aluminum alloy.
- .3 Probe Mounting Brackets: 304 stainless steel.

.6 Options
- .1 BACN: Communications via BACnet MS/TP.

.7 Performance
- .1 Range Capability
  - .1 Air Velocity: 0-m/s to 25.4-m/s (0-fpm to 5,000-fpm).
- .2 Accuracy
  - .1 Air Flow: +/-2-% of reading, +/-0.25-% repeatability.
  - .2 Temperature: +/-0.08-°C (0.15-°F)
- .3 Pressure Drop: Negligible.
- .4 Sound Level: Negligible.

.8 Ratings
  .1 Transmitter
    .1 Temperature: -28.9-°C to 48.9-°C (-20-°F to 120-°F).
    .2 Humidity: 5-%RH to 95-%RH.
  .2 Probes
    .1 Temperature: -28.9-°C to 71.1-°C (-20-°F to 160-°F).
    .2 Humidity: 0-%RH to 100-%RH.
.9 Certifications, Listings and Registrations
  .1 BTL listed.
  .2 CSA-C22.2-94 and UL-873 listed.
  .3 EUL-RoHS compliant.

2.4 DAFT - DUCT AIR FLOW AND TEMPERATURE TRANSMITTERS

.1 Provide as indicated.
.2 Manufacturers
  .1 Ebtron Inc., EB-Flow Series, Model EF-x2000
.3 Type
  .1 Thermal dispersion sensors.
.4 Features
  .1 Capability: Remotely located components per transmitter of 2 airflow inputs, 2 temperature inputs, 2 analog outputs.
  .2 Mounting
    .1 Transmitter Mounting: Outside of duct.
    .2 Probe Mounting: In duct insertion or in air stream standoff as required.
  .3 Transmitter: 16 character LCD display, 4 button interface.
  .4 Probes
    .1 Quantity and Length: As recommended by manufacturer for opening size, to best measure average conditions across full area, and subject to being increased by 100-% as determined by Engineer, minimum quantity 2.
  .5 Sensors
    .1 Flow Sensor: Bead-in-glass thermistor, self-heated, per sensing node.
    .2 Temperature Sensor: Encapsulated zero power thermistor with parylene coating, per sensing node.
    .3 Sensor Housings: Hermetically sealed and potted in marine grade waterproof epoxy.
    .4 Total quantity of sensors as recommended by manufacturer for opening size, and subject to being increased by 100-% as determined by Engineer.
  .6 Alarm
    .1 Dry contact with onboard jumper, LCD display.
    .2 Configuration: Normally open or normally closed configurable, low and high flow alarm settings configurable.
    .3 Rating: 30-VDC or 24-VAC at 3-amp.
.5 Materials
  .1 Sensor Node Internal Wiring: Polyvinylidene fluoride (Kynar) coated copper.
  .2 Transmitter: Aluminum enclosure.
  .3 Probe Tubes: Mill finish 6063 aluminum alloy.
  .4 Probe Mounting Brackets: 304 stainless steel or 5052 aluminum alloy.
.6 Options
  .1 BACN: Communications via BACnet MS/TP.
    .1 Certifications, Listings and Registrations
      .1 BTL listed.
.7 Performance
  .1 Range Capability
    .1 Air Velocity: 0-m/s to 15.2-m/s (0-fpm to 3,000-fpm).

.2 Accuracy
.1 Air Flow: +/-3-% of reading.
.2 Temperature: +/-0.2-°C (0.36-°F)
.3 Certifications: NIST traceable.
.3 Pressure Drop: Negligible.
.4 Sound Level: Negligible.
.8 Ratings
.1 Transmitter
.1 Temperature: -28.9-°C to 48.9-°C (-20-°F to 120-°F).
.2 Humidity: 5-%RH to 95-%RH.
.2 Probes
.1 Temperature
.1 -17.8-°C to 71.1-°C (-20-°F to 160-°F) at 0-m/s to 10.2-m/s (0-fpm to 2,000-fpm).
.2 -28.9-°C to 71.1-°C (0-°F to 160-°F) at 0-m/s to 15.2-m/s (0-fpm to 3,000-fpm).
.2 Humidity: 0-%RH to 100-%RH.
.9 Certifications, Listings and Registrations
.1 CSA-60730-1 and CSA-60730-2-9 listed.

2.5 DAH - DUCT AIR HUMIDITY TRANSMITTERS

.1 Provide as indicated.
.2 Manufacturers
.1 Greystone Energy Systems Inc., RH200/210 Series
.3 Features
.1 Sensor: Thermoset polymer based capacitive sensor.
.2 Transmitter Enclosure
.1 Hinged.
.2 Filter to protect sensor from contaminants, 60-micron, HDPE.
.3 Protection Circuitry: Reverse voltage protected and output limited.
.4 Materials
.1 Probe: 304 stainless steel.
.5 Options
.1 Sensor
.1 AC2: Accuracy +/-2-%RH at 25-°C (77-°F).
.2 AC3: Accuracy +/-3-%RH at 25-°C (77-°F).
.3 NTC: NTC thermistor temperature sensor. Additional to humidity sensor.
.1 Accuracy: +/-0.2-°C (-0.4-°F) over range.
.4 RTD: Platinum RTD temperature sensor. Additional to humidity sensor.
.1 Accuracy: +/-0.3-°C (+/-0.54-°F) at 0-°C (32-°F).
.2 Display
.1 LCD: Liquid crystal display of temperature, configurable to display in Celsius and Fahrenheit, minimum 3 digits.
.3 Transmitter Enclosure
.1 ABS1: ABS enclosure. Minimum IP61, certified to IEC-60529.
.2 ABS5: ABS weatherproof enclosure. Minimum IP65, certified to IEC-60529.
.3 GS: Galvanized steel enclosure. Minimum IP50, certified to IEC-60529.
.4 ALU: Cast aluminum weatherproof enclosure. Minimum IP64, certified to IEC-60529.
.6 Performance
.1 Sensor Range Capability: 0-%RH to 100-%RH.
.2 Temperature Dependence: Maximum +/-0.05-%RH/°C.
.3 Hysteresis: Maximum +/-1.5-%RH.
.4 Repeatability: Maximum +/-0.5-%RH.

.5 Linearity: Maximum +/-0.5-%RH.
.6 Stability: Maximum +/-1-%RH at 50-%RH in 5-year.
.7 Sensor Response Time: Maximum 15-sec.
.8 Sensitivity: Minimum 0.1-%RH.
.7 Ratings
.1 Ambient Temperature: -40-°C to 85-°C (-40-°F to 185-°F)
.2 Ambient Humidity: 0-%RH to 95-%RH non-condensing.
.8 Certifications, Listings and Registrations
.1 EUL-RoHS compliant.

2.6 DAT - DUCT AIR TEMPERATURE TRANSMITTERS

.1 Provide as indicated.
.2 Manufacturers
.1 Greystone Energy Systems Inc., TE500/511/512 Series
.3 Features
.1 Transmitter Enclosure: Hinged.
.2 Protection Circuitry: Reverse voltage protected and output limited.
.4 Options
.1 Sensor
.1 Probe or cable length as required including quantity of multiple points where applicable.
.2 NTC: NTC thermistor.
.1 Accuracy: +/-0.2-°C (-0.4-°F) over range.
.3 RTD: Platinum RTD.
.1 Accuracy: +/-0.3-°C (+/-0.54-°F) at 0-°C (32-°F).
.4 MPC-F: Multi-point probe with flexible cable.
.1 Materials: FT6 plenum rated cable.
.5 MPP-F: Multi-point flexible probe.
.1 Materials: Copper.
.6 MPP-R: Multi-point rigid probe.
.1 Materials: 304 stainless steel.
.7 SPP-R: Single point rigid probe.
.1 Materials: 304 stainless steel.
.2 Display
.1 LCD: Liquid crystal display of temperature, configurable to display in Celsius and Fahrenheit, minimum 3 digits.
.3 Transmitter Enclosure
.1 ABS1: ABS enclosure. Minimum IP61, certified to IEC-60529.
.2 ABS5: ABS weatherproof enclosure. Minimum IP65, certified to IEC-60529.
.3 GS: Galvanized steel enclosure. Minimum IP50, certified to IEC-60529.
.4 ALU: Cast aluminum weatherproof enclosure. Minimum IP64, certified to IEC-60529.
.5 Performance
.1 Sensor Range Capability: -20-°C to 105-°C (-4-°F to 221-°F)
.2 Transmitter Accuracy: +/-0.1-% of span, including linearity.
.6 Ratings
.1 Ambient Temperature: 0-°C to 70-°C (32-°F to 158-°F), or -40-°C to 85-°C (-40-°F to 185-°F) if required by location.
.2 Ambient Humidity: 0-%RH to 95-%RH non-condensing.
.7 Certifications, Listings and Registrations
.1 EUL-RoHS compliant.

2.7 EC - ELECTRICAL CURRENT SENSORS

.1 Provide as indicated.
.2 Type: Split core current sensor.

.3 Manufacturers
.1 Setra Systems, Inc., CTC Series
.4 Features
.1 Self powered from conductor cable.
.2 Field selectable current ranges.
.3 Normally open status switch.
.4 LED indication.
.5 Options
.1 OUT: Output relay module. SPST-NO relay rated at 10-A@260-VAC and 5-A@30-VDC.
.6 Performance
.1 Accuracy: +/-2.0-% of selected range.
.2 Sensor Response Time: Maximum 2-sec.
.7 Ratings
.1 Current: Maximum 120-A continuous.
.2 Ambient Temperature: -15-°C to 60-°C (5-°F to 140-°F)
.3 Ambient Humidity: 0-%RH to 95-%RH

2.8 ECS - ELECTRICAL CURRENT SWITCHES

.1 Provide as indicated.
.2 Type: Split core current switch.
.3 Manufacturers
.1 Setra Systems, Inc., CSC Series
.4 Features
.1 Self powered from conductor cable.
.2 Field adjustable current trip setpoint.
.3 Over/under current sensing switching mode.
.4 Normally open status switch.
.5 LED indication.
.5 Options
.1 OUT: SPST-NO relay rated at 10-A@260-VAC and 5-A@30-VDC.
.6 Performance
.1 Current: 1.25-A to 135-A
.7 Ratings
.1 Output Relay
.2 Ambient Temperature: -15-°C to 60-°C (5-°F to 140-°F)
.3 Ambient Humidity: 0-%RH to 95-%RH
.8 Certifications, Listings and Registrations
.1 EUL-RoHS compliant.

2.9 LDP - LIQUID DIFFERENTIAL PRESSURE TRANSMITTERS

.1 Provide as indicated.
.2 Type
.1 Dual sensor wet-to-wet differential pressure.
.3 Manufacturers
.1 GE Measurement & Control Solutions, part of GE Energy Solutions, M/T/W Series Differential Pressure Transmitters
.2 Greystone Energy Systems Inc., ULP/LP2/WP Series Pressure Transducers
.3 Honeywell International Inc., P7640/PWT Series Differential Pressure Transmitters
.4 Setra Systems, Inc., 231 Series
.4 Features
.1 Transmitter Enclosure: Hinged.
.2 Settings
.1 Field selectable pressure limits and ranges.
.1 Maximum line pressures of 50-psi, 100-psi or 250-psi.

.2 Differential pressure ranges adjustable to 10-%, 20-%, 50-% or 100-% based on maximum line pressure settings.
.2 Field selected sensors response times.
.1 Maximum response time ranges 1-sec through to 5-sec.
.3 Field selectable signal outputs.
.4 Field zeroing.
.5 Materials
.1 Transmitter Enclosure: Die cast aluminum, powder coated finish.
.2 Probes: Stainless steel.
.6 Options
.1 Display
.1 LCD: Liquid crystal display of line pressure and differential pressure, minimum 3 digits.
.2 Probes
.1 RP-F: Remote probe with flexible cable.
.2 RP-R: Remote flexible probe. Armoured jacket.
.1 Materials: Stainless steel.
.3 VM3: 3 valve manifold assembly.
.1 Features: Multiple valves mounted in a manifold block as follows:
.1 Shutoff valve for connection to positive port.
.2 Shutoff valve for connection to negative port.
.3 Shunt valve between device and shutoff valves for equalizing pressure.
.2 Materials: Manifold Block: Brass.
.4 VM5: 5 valve manifold assembly.
.1 Features: Multiple valves mounted in a manifold block as follows:
.1 Shutoff valve for connection to positive port.
.2 Shutoff valve for connection to negative port.
.3 Shunt valve between device and shutoff valves for equalizing pressure.
.4 Shutoff valve for connection to external gauge or alternate plumbing configuration on positive port side.
.5 Shutoff valve for connection to external gauge or alternate plumbing configuration on negative port side.
.2 Materials: Manifold Block: Brass.
.7 Performance
.1 Accuracy: Root sum square at constant temperature of non-linearity, hysteresis, and non-repeatability:
.1 +/-2.0-% full scale at differential pressure range setting of 100-%.
.2 +/-1.0-% full scale at differential pressure range setting of less than 100-%.
.2 Thermal Effects: Maximum thermal error calibrated at nominal 21-°C (70-°F).
.1 Compensated Temperature Range: 0-°C to 54-°C (32-°F to 130-°F)
.2 Sensor Response Time: Maximum 5-sec.
.3 Warm-up Shift: Less than 0.12-% full scale.
.4 Zero/Span Shift: Differential less than 1.8-°C (2.0-°F) per 50-°C (100-°F).
.5 Proof Pressure: 2-times full scale.
.8 Ratings
.1 Housing: Minimum NEMA Type 4 rated to NEMA-250.
.2 Pressures
.1 Line Pressure: Upper limit of 1.73-MPa (250-psi) or greater.
.2 Burst Pressure
.1 15-times full scale at 50-psi maximum line pressure setting.
.2 10-times full scale at 100-psi maximum line pressure setting.
.3 8-times full scale at 250-psi maximum line pressure setting.
.3 Temperatures

.1 Transmitter: Ambient: -20-°C to 85-°C (-4-°F to 185-°F)
.2 Sensor: Pressure Media: Upper limit of 104-°C (220-°F) or greater.
.4 Shock: Withstand minimum 200-g.
.5 Vibration: Withstand minimum 10-g from 50-Hz to 2,000-Hz.
.9 Certifications, Listings and Registrations
.1 EUL-RoHS compliant.
.2 NIST traceable calibration.

2.10 LT - LIQUID TEMPERATURE TRANSMITTERS

.1 Provide as indicated.
.2 Manufacturers:
.1 Greystone Energy Systems Inc., TE500C/511C/512C Series
.3 Features
.1 Transmitter Enclosure: Hinged.
.2 Protection Circuitry: Reverse voltage protected and output limited.
.4 Materials
.1 Probe: 304 stainless steel.
.5 Options
.1 Sensor
.1 Probe length as required.
.2 NTC: NTC thermistor.
.1 Accuracy: +/-0.2-°C (-0.4-°F) over range.
.3 RTD: Platinum RTD.
.1 Accuracy: +/-0.3-°C (+/-0.54-°F) at 0-°C (32-°F).
.2 Display
.1 LCD: Liquid crystal display of temperature, configurable to display in Celsius and Fahrenheit, minimum 3 digits.
.3 Transmitter Enclosure
.1 ABS1: ABS enclosure. Minimum IP61, certified to IEC-60529.
.2 ABS5: ABS weatherproof enclosure. Minimum IP65, certified to IEC-60529.
.3 GS: Galvanized steel enclosure. Minimum IP50, certified to IEC-60529.
.4 ALU: Cast aluminum weatherproof enclosure. Minimum IP64, certified to IEC-60529.
.6 Performance
.1 Sensor Range Capability: -20-°C to 105-°C (-4-°F to 221-°F)
.2 Transmitter Accuracy: +/-0.1-% of span, including linearity.
.7 Ratings
.1 Ambient Temperature: 0-°C to 70-°C (32-°F to 158-°F), or -40-°C to 85-°C (-40-°F to 185-°F) if required by location.
.2 Ambient Humidity: 0-%RH to 95-%RH non-condensing.
.8 Certifications, Listings and Registrations
.1 EUL-RoHS compliant.

2.11 OAH - OUTDOOR AIR HUMIDITY TRANSMITTERS

.1 Provide as indicated.
.2 Manufacturers
.1 Greystone Energy Systems Inc., RH300A Series
.3 Features
.1 Sensor: Thermoset polymer based capacitive sensor.
.2 Transmitter Enclosure
.1 Hinged.
.2 Filter to protect sensor from contaminants, 60-micron, HDPE.
.3 Protection Circuitry: Reverse voltage protected and output limited.
.4 Options
.1 Sensor

.1 AC2: Accuracy +/-2-%RH at 25-°C (77-°F).
.2 AC3: Accuracy +/-3-%RH at 25-°C (77-°F).
.3 NTC: NTC thermistor temperature sensor. Additional to humidity sensor.
.1 Accuracy: +/-0.2-°C (-0.4-°F) over range.
.4 RTD: Platinum RTD temperature sensor. Additional to humidity sensor.
.1 Accuracy: +/-0.3-°C (+/-0.54-°F) at 0-°C (32-°F).
.2 Transmitter Enclosure
.1 ABS5: ABS weatherproof enclosure. Minimum IP65, certified to IEC-60529.
.5 Performance
.1 Sensor Range Capability: 0-%RH to 100-%RH.
.2 Temperature Dependence: Maximum +/-0.05-%RH/°C.
.3 Hysteresis: Maximum +/-1.5-%RH.
.4 Repeatability: Maximum +/-0.5-%RH.
.5 Linearity: Maximum +/-0.5-%RH.
.6 Stability: Maximum +/-1-%RH at 50-%RH in 5-year.
.7 Sensor Response Time: Maximum 15-sec.
.8 Sensitivity: Minimum 0.1-%RH.
.6 Ratings
.1 Ambient Temperature: -40-°C to 85-°C (-40-°F to 185-°F)
.2 Ambient Humidity: 0-%RH to 95-%RH non-condensing.
.7 Certifications, Listings and Registrations
.1 EUL-RoHS compliant.

2.12 OAT - OUTDOOR AIR TEMPERATURE TRANSMITTERS

.1 Provide as indicated.
.2 Manufacturers
.1 Greystone Energy Systems Inc., TE500F Series
.3 Features
.1 Transmitter Enclosure: Hinged.
.2 Protection Circuitry: Reverse voltage protected and output limited.
.4 Options
.1 Sensor
.1 NTC: NTC thermistor.
.1 Accuracy: +/-0.2-°C (-0.4-°F) over range.
.2 RTD: Platinum RTD.
.1 Accuracy: +/-0.3-°C (+/-0.54-°F) at 0-°C (32-°F).
.2 Transmitter Enclosure
.1 ABS5: ABS weatherproof enclosure. Minimum IP65, certified to IEC-60529.
.5 Performance
.1 Sensor Range Capability: -40-°C to 85-°C (-40-°F to 185-°F)
.2 Transmitter Accuracy: +/-0.1-% of span, including linearity.
.6 Ratings
.1 Ambient Temperature: -40-°C to 85-°C (-40-°F to 185-°F)
.2 Ambient Humidity: 0-%RH to 95-%RH non-condensing.
.7 Certifications, Listings and Registrations
.1 EUL-RoHS compliant.

2.13 TAF - AIR TERMINAL UNIT AIR FLOW DEVICES

.1 Provide as indicated. To requirements of ADP devices of this Section except as follows.
.2 Manufacturers
.1 Same as building automation system manufacturer.
.3 Features
.1 Probes
.1 Provide as required, including probe types for purposes of measuring flow.

2.14 TAT - AIR TERMINAL UNIT AIR TEMPERATURE DEVICES

.1 Provide as indicated. To requirements of DAT devices of this Section.

2.15 ZAH - ZONE AIR HUMIDITY TRANSMITTERS

.1 Provide as indicated.
.2 Manufacturers
  .1 Greystone Energy Systems Inc.
.3 Features
  .1 Sensor: Thermoset polymer based capacitive sensor.
  .2 Protection Circuitry: Reverse voltage protected and output limited.
.4 Options
  .1 Sensor
    .1 AC2: Accuracy +/-2-%RH at 25-°C (77-°F).
    .2 AC3: Accuracy +/-3-%RH at 25-°C (77-°F).
    .3 NTC: NTC thermistor temperature sensor.
      .1 Accuracy: +/-0.2-°C (-0.4-°F) over range.
      .2 Sensor Range Capability: 0-°C to 50-°C (32-°F to 122-°F)
  .2 MFE: Multi-function enclosure.
    .1 Colour: White.
    .2 Materials: ABS
    .3 Ratings: Minimum IP20, certified to IEC-60529.
    .4 Dimensions: 84-mm x 119-mm x 29-mm (3.3-in x 4.7-in x 1.15-in)
    .5 Display Options
      .1 LCD: Liquid crystal display of temperature, configurable to display in Celsius and Fahrenheit, minimum 3 digits.
      .2 LED-G: LED indicator, green colour.
      .3 LED-R: LED indicator, red colour.
      .4 LED-Y: LED indicator, yellow colour.
      .5 SPA-H: Humidity setpoint adjustment. Front panel mount, slide potentiometer.
      .6 SPA-T: Temperature setpoint adjustment. Front panel mount, slide potentiometer.
    .6 Other Options
      .1 ORS: Override switch. Front panel mount, momentary push-button, 2 wire dry contact (NO SPST 50-mA@12-VDC).
      .2 SSS5: Speed selector switch. Side panel mount, 5 position switch. Typically used for fans. Range: Off, Auto, Low, Medium, High.
      .3 COMJ: Communications jack. 4-pin header connector to 4-pin terminal block.
      .4 BACN: Communications via BACnet MS/TP.
      .5 MODB: Communications via ModBus.
    .7 Performance
      .1 Sensor Range Capability: 0-%RH to 100-%RH.
      .2 Hysteresis: Maximum +/-3-%RH.
      .3 Stability: Maximum +/-1.2-%RH at 50-%RH in 5-year.
      .4 Sensor Response Time: Maximum 15-sec.
    .8 Ratings
      .1 Ambient Temperature: 0-°C to 50-°C (32-°F to 122-°F)
      .2 Ambient Humidity: 0-%RH to 95-%RH non-condensing.
  .3 SPE: Moisture resistant steel plate enclosure.
    .1 Materials: 304 stainless steel plate.
    .2 Ratings: Minimum IP20, certified to IEC-60529.
    .3 Dimensions: 71-mm x 114-mm (2.78-in x 4.5-in)
    .4 Features: Neoprene gasket. Filter to protect sensor from contaminants, 100-micron, sintered stainless steel.

.5 Performance
.1 Sensor Range Capability: 0-%RH to 100-%RH.
.2 Hysteresis: Maximum +/-3-%RH.
.3 Stability: Maximum +/-1.2-%RH at 50-%RH in 5-year.
.4 Sensor Response Time: Maximum 15-sec.
.6 Ratings
.1 Ambient Temperature: 0-°C to 70-°C (32-°F to 158-°F)
.2 Ambient Humidity: 0-%RH to 95-%RH non-condensing.
.4 DSE: Décor style enclosure.
.1 Colour: White.
.2 Materials: ABS
.3 Ratings: Minimum IP20, certified to IEC-60529.
.4 Dimensions: 70-mm x 114-mm x 32-mm (2.75-in x 4.5-in x 1.25-in)
.5 Performance
.1 Sensor Range Capability: 0-%RH to 100-%RH.
.2 Temperature Dependence: Maximum +/-0.05-%RH/°C.
.3 Hysteresis: Maximum +/-1.5-%RH.
.4 Repeatability: Maximum +/-0.5-%RH.
.5 Linearity: Maximum +/-0.5-%RH.
.6 Stability: Maximum +/-1-%RH at 50-%RH in 5-year.
.7 Sensor Response Time: Maximum 15-sec.
.8 Sensitivity: Minimum 0.1-%RH.
.6 Ratings
.1 Ambient Temperature: 0-°C to 70-°C (32-°F to 158-°F)
.2 Ambient Humidity: 0-%RH to 95-%RH non-condensing.
.5 Certifications, Listings and Registrations
.1 EUL-RoHS compliant.

2.16 ZAT-N - NETWORK ZONE AIR TEMPERATURE DEVICES

.1 Provide as indicated. To requirements of ZAT devices of this Section except as follows.
.2 Manufacturers
.1 Same as building automation system manufacturer.

2.17 ZAT - ZONE AIR TEMPERATURE TRANSMITTERS

.1 Provide as indicated.
.2 Manufacturers
.1 Greystone Energy Systems Inc.
.3 Features
.1 Protection Circuitry: Reverse voltage protected and output limited.
.4 Options
.1 Sensor
.1 NTC: NTC thermistor temperature sensor. Additional to humidity sensor.
.1 Accuracy: +/-0.2-°C (-0.4-°F) over range.
.2 Sensor Range Capability: 0-°C to 50-°C (32-°F to 122-°F)
.2 RTD: Platinum RTD temperature sensor. Additional to humidity sensor.
.1 Accuracy: +/-0.3-°C (+/-0.54-°F) at 0-°C (32-°F).
.2 MFE: Multi-function enclosure.
.1 Colour: White.
.2 Materials: ABS
.3 Ratings: Minimum IP20, certified to IEC-60529.
.4 Dimensions: 84-mm x 117-mm x 29-mm (3.3-in x 4.6-in x 1.15-in)
.5 Display Options
.1 LCD: Liquid crystal display of temperature, configurable to display in Celsius and Fahrenheit, minimum 3 digits.
.2 LED-G: LED indicator, green colour.

.3 LED-R: LED indicator, red colour.
.4 LED-Y: LED indicator, yellow colour.
.5 SPA-T: Temperature setpoint adjustment. Front panel mount, slide potentiometer.
.6 Other Options
.1 ORS: Override switch. Front panel mount, momentary push-button, 2 wire dry contact (NO SPST 50-mA@12-VDC).
.2 SSS5: Speed selector switch. Side panel mount, 5 position switch. Typically used for fans. Range: Off, Auto, Low, Medium, High.
.3 COMJ: Communications jack. 4-pin header connector to 4-pin terminal block.
.7 Ratings
.1 Ambient Temperature: 0-°C to 50-°C (32-°F to 122-°F)
.2 Ambient Humidity: 0-%RH to 95-%RH non-condensing.
.3 SPE: Moisture resistant steel plate enclosure.
.1 Materials: 304 stainless steel plate.
.2 Ratings: Minimum IP20, certified to IEC-60529.
.3 Dimensions: 71-mm x 114-mm (2.78-in x 4.5-in)
.4 Features: Neoprene gasket. Filter to protect sensor from contaminants, 100-micron, sintered stainless steel.
.5 Ratings
.1 Ambient Temperature: 0-°C to 70-°C (32-°F to 158-°F)
.2 Ambient Humidity: 0-%RH to 95-%RH non-condensing.
.4 DSE: Décor style enclosure.
.1 Colour: White.
.2 Materials: ABS
.3 Ratings: Minimum IP20, certified to IEC-60529.
.4 Dimensions: 70-mm x 114-mm x 32-mm (2.75-in x 4.5-in x 1.25-in)
.5 Ratings
.1 Ambient Temperature: 0-°C to 70-°C (32-°F to 158-°F)
.2 Ambient Humidity: 0-%RH to 95-%RH non-condensing.
.5 Performance
.1 Transmitter Accuracy: +/-0.1-% of span, including linearity.
.6 Certifications, Listings and Registrations
.1 EUL-RoHS compliant.

2.18 ACT-E - ELECTRONIC ACTUATORS

.1 Provide as required.
.2 Manufacturers
.1 Belimo Automation AG
.2 Bray International, Inc.
.3 Johnson Controls, Inc.
.3 Features
.1 Motor: Brushless DC motor with overload protection.
.2 Stall Protection: Mechanical or electronic stall protection to prevent damage to actuator throughout rotation of actuator.
.3 Manual Positioning: Manual position override with handwheel if available in product series or 5-mm (3/16-in) hex key.
.4 Adjustable Stop: Accessible, field adjustable mechanical stop to limit travel in either direction.
.5 Compatibility: Ensure compatibility to equipment and components, including valves, dampers, and other devices being positioned by actuator.
.6 Visual Position Indication: Clearly visible position indicator driven directly by actuator shaft.

.4 Options
  .1 Control Input
    .1 3PF: 3 point floating modulating positioning control. 2 digital signals will open or close the actuator accordingly.
    .2 O/O: On/off positioning control. Open or close position based on a digital control signal.
    .3 PRO: Proportional modulating positioning control.
      .1 Repeatable positioning based on a 2-VDC to 10-VDC or 4-mA to 20-mA control signal.
      .2 Resolution/positioning accuracy minimum 80:1.
    .4 PWM: Pulse width modulating positioning control.
    .5 PC: Phasecut modulating positioning control.
  .2 Actuator Speed
    .1 FA: Fast acting. Move full stroke within 10-sec when driven by motor at temperatures above -20-°C (-4-°F), independent of load.
    .2 QA: Quick acting. Move full stroke within 20-sec when driven by motor at temperatures above -20-°C (-4-°F), independent of load.
    .3 SA: Standard acting. Move full stroke within 90-sec when driven by motor temperatures above -20-°C (-4-°F), independent of load.
    .4 SP-ADJ: Adjustable speed. Field adjustable full stroke travel time.
      .1 Minimum range: 40-% to 100-%.
  .3 Position
    .1 ES: End switches. Quantity 2 built-in SPDT auxiliary switches. 1 switch fixed at no more than 10-° actuator position, 1 switch field adjustable between 10-° and 90-°.
    .2 FB: Feedback signal. Built-in true position feedback.
  .4 Failure Positioning
    .1 FS: Fail safe. Upon loss of line power, integral batteries or capacitors drive actuator to field adjustable fail position between 0-° and 90-°.
      .1 Move full stroke within 60-sec at temperatures above -20-°C (-4-°F), independent of load.
    .2 SR: Spring return. Upon loss of line power, an internal spring drives actuator to field adjustable fail position to either full open or full closed.
      .1 Move full stroke within 60-sec at temperatures above -20-°C (-4-°F), independent of load.
    .3 SR-QA: Spring return quick acting. Upon loss of line power, an internal spring drives actuator to field adjustable fail position to either full open or full closed.
      .1 Move full stroke within 20-sec at temperatures above -20-°C (-4-°F), independent of load.
  .5 Enclosure
    .1 ENC: Minimum IP54, certified to IEC-60529.
    .2 ENC5: Minimum IP65, certified to IEC-60529. Provide HTR with this enclosure.
  .6 Other
    .1 HTR: Heater. Line voltage electric heater, sized to prevent condensation on actuator body.
    .2 QM: Quiet motion. Noise level not more than 46-dB(A) under motor power at minimum speed.
.5 Performance
  .1 Torque: Minimum 125-% of recommended torque for application.
  .2 Angle of Rotation: 95-°
.6 Ratings: Without HTR option:
  .1 Temperature: -20-°C to 50-°C (-4-°F to 122-°F).
  .2 Humidity: 0-%RH to 95-%RH, non-condensing.

.7 Certifications, Listings and Registrations
.1 CSA-E60730-1.

2.19 ACT-ET - AIR TERMINAL UNIT ELECTRONIC ACTUATORS

.1 Provide as indicated. To requirements of ACT-E devices of this section except or as additional to as follows.
.2 Additional Acceptable Manufacturers
.1 To same as building automation system manufacturer.

2.20 CON-E - ELECTRIC CONTACTORS

.1 Provide as indicated.
.2 Manufacturer: Cutler Hammer
.3 Features
.1 Screw terminals.
.2 Visible state indicator.
.4 Power: 3 phase unless otherwise required.
.5 Size: Minimum 150-% of circuit rating.

2.21 REL-C - CONTROL RELAYS

.1 Provide as required.
.2 Features
.1 Plug-in relays with separate base.
.2 Light emitting diode indicator.

2.22 FIRE DETECTORS

.1 Provide as required.
.2 Match existing or select fire detectors to be compatible with existing alarm system.
.3 Type
.1 Smoke Detector: Ionization
.2 Other Devices: As required.
.3 Interface: Provide addressable smoke detectors, compatible with existing alarm system.

2.23 ELECTRIC ACCESSORY PRODUCTS

.1 Signal Isolation Transducers
.1 Provide signal isolation transducers for analog output signals to be interfaced as inputs, including to and from controllers and independent control systems.
.2 Signal Conditioning
.1 Provide as required.
.3 Control Transformers
.1 Provide as required.
.2 Type
.1 Fused or current limiting type.
.3 Size: 125-% rated load capacity.
.4 Power Supplies
.1 Provide as required.
.2 Type
.1 Switching or full bridge rectification.
.3 Features
.1 Fused.
.4 Power disconnect switch.
.5 Size: 125-% rated load capacity.
.6 Performance
.1 Line Regulation: +0.05-% for 10-% line change.
.2 Load Regulation: +0.05-% for 50-% load change.
.3 Ripple and Noise: 1-mV rms, 5-mV peak to peak.
.5 Wiring and Cables
.1 Provide interfacing as required.

2.24 PNEUMATIC ACCESSORY PRODUCTS

.1 Air Static Pressure Probes
  .1 Provide as required, including accessories, mounts.
  .2 Insertion depths and arrangements as required for high performance and limited by service size.
  .3 Sensors
    .1 Stainless steel static pressure tips.
    .2 Mounting flanges with integral rubber gasket.
  .4 Gauges and Switches
    .1 Brass static pressure tips.
    .2 Angled tip.
    .3 Minimum 4 radially drilled 1-mm (0.040-in) diameter sensing holes.
.2 Tubing and Piping
  .1 Provide as required.
  .2 Materials
    .1 Copper: Provide unless otherwise required.
    .2 Plastic: Flame retardant PVC tubing with minimum burst gauge pressure of 1.4-MPa (200-psi) at 80-°C (176-°F).

2.25 OTHER ACCESSORY PRODUCTS

.1 Zone Device Guards
  .1 Provide as indicated.
  .2 Manufacturers: Alltemp Company Ltd., 77-MG Series
  .3 Selection: Suitable for horizontal and vertical mounting.
  .4 Features
    .1 Face: Hinged.
    .2 Base: Solid stlyle.
    .3 Additional Components: Heavy duty lock and key, mounting hardware.
  .5 Materials: Metal.
  .6 Options
    .1 Colour: Off white including cover and base.
  .7 Size: As required.
.2 External Manual Override Stations
  .1 Provide external manual override capabilities for points as required.

2.26 FIRE STOPPING AND SMOKE SEALS

.1 Provide as required.
.2 To Section 15 05 00 Piping and to Section 26 05 00 Wiring and Cables.

PART 3 EXECUTION

3.1 EXAMINATION

.1 Complete the following examination activities within 5-days after the date of execution of Contract.
  .1 Verify type, quantity and condition of existing devices and controllers.
  .2 Confirm the suitability of the points for the specific installation, purpose, goal, and final system installed.
  .3 Complete a detailed investigation of existing network architecture and network wiring topology.
  .4 Submit written notification of the results of the investigation.
.2 Submit relocation plan, and obtain approval before relocating services, panels, or equipment not indicated.
.3 Complete sufficient examination of existing controllers or equipment ladder logic, including modifications, to properly interface and interlock controls.

3.2 COMMON EXECUTION REQUIREMENTS

.1 Location

.1 Install devices and related accessories in local enclosures where possible.
.2 Install devices in accessible locations.
.3 Maintain minimum 610-mm (2-ft) clearance from equipment that may emit electromagnetic fields, including transformers, coils.

.2 Provide hard wired interlocks for safety devices, including on equipment, components, devices, controllers.

.3 Interfacing
.1 Controls may require interfacing, including to equipment, components, devices, controllers. Interfacing requirements apply whether or not specific control or end device(s) is provided.
.2 Investigate and report on failed or deficient functionality and capability of existing products, including safeties and interlocks.
.3 Interfacing to be completed in a manner that maintains functionality and capability including safeties, interlocks, whether or not these items were previously functional.
.4 Provide instructions from manufacturers of new and existing products on requirements for interfacing. Manufacturers to complete site investigations as required.

.4 Provide additional components as required, including additional points, end devices, power supplies, signal conditioning, interfaces, piping, tubing, wiring.

.5 Complete configuration on site, including settings, programming and user interface.

.6 Configure device scale ranges to suit the application, including operating temperatures, pressure or vacuum, with readings at approximately mid-point on the scale where applicable.

.7 Provide, test, and calibrate devices as required, including sensors, transmitters, voltage and current measurement devices, analog to digital converters, and other input devices.

3.3 ZONE MOUNTED DEVICES

.1 Mount sensors on surfaces or supports as required. Subject to Owner approval.

.2 Relocate existing devices into zone area as required, including devices incorrectly located in ceiling plenums and ceiling areas.

3.4 OUTDOOR MOUNTED DEVICES

.1 Install sensors that record outdoor environmental conditions (including temperature, humidity, pressure) outdoors on north facing side of building, at highest location on building(for temperature and humidity), or at location closest in elevation to secondary pressure reference point (for pressure), and shielded from sun and wind as well as reflection and other heat or vent sources including ventilation, combustion, piping, plumbing.

.2 Provide aluminum vented sun and wind shield, securely mounted to building, formed to mount above and at top sides of sensor, primed and painted and finished to Section 09 91 00 Painting.

3.5 IMMERSION STYLE MOUNTED DEVICES

.1 Provide thermowells as required.

3.6 DUCT MOUNTED DEVICES

.1 Mount duct sensors in an electrical box through a hole in duct.

3.7 TEMPERATURE AND HUMIDITY DEVICES

.1 Seal openings including signal wiring and cable to prevent air from other areas affecting the readings.

.2 Seal sensors located on walls and other surfaces to prevent air currents from within surface impacting sensor readings.

3.8 DUCT TEMPERATURE SENSORS

.1 Where specific type and options not indicated, select the following probe types:
.1 Provide multi-point flexible probe (MPP-F) sensors for ductwork greater than 1.5-m (5-ft) in width or height and greater than 1.5-m2 (15-ft2), or in conditions with unevenly distributed air, including air temperature stratification and air turbulence.

.2 Provide multi-point rigid probe (MPP-R) sensors for ductwork less than 1.5-m (5-ft) in width or height but greater than 1.0-m (3-ft) in width or height, or in conditions with unevenly distributed air, including air temperature stratification and air turbulence.
.3 Otherwise provide single point rigid probe (SPP-R).

.2 Increase quantity of devices per indicated point to suit duct size and achieve performance as determined by Engineer.

3.9 DUCT AIR FLOW DEVICES

.1 Where specific type and options not indicated, select the following device types:
.1 Provide duct air flow and temperature grid monitoring stations (DAFT-G) for ductwork greater than 0.6-m (2-ft) in width or height and greater than 0.15-m2 (1.5-ft2), or in conditions with unevenly distributed air, including air temperature stratification and air turbulence.
.2 Otherwise provide duct air flow and temperature transmitters (DAFT).

.2 Increase quantity of devices per indicated point to suit duct size and achieve performance as determined by Engineer.

3.10 PRESSURE DEVICES

.1 Unless otherwise indicated, locate devices, including tubing and piping and reference ports, at locations most appropriate for performance and optimum system efficiency. As approved by Engineer. Requirements include:
.1 Suitable for intended use and effect.
.2 Device concealment in specific locations, including occupied zones.
.3 Device mounting locations, including at farthest end of distribution system.
.4 Reference ports to various locations that may be distinctly remote from device.
.5 Accounting for impact on pressure readings due to stack effect, wind, zone pressure. Protection from pressure variations and moving air including ventilation, stack effect, wind effects, elevator doors and lobbies, as well as to protect from debris and insects.
.6 Device mounting in locations for easy reading of any displays.

.2 Provide additional devices and reference tubing and piping components as required, including pitot tubes and probes.

.3 Tubing
.1 Mount outdoor reference tubing and piping in enclosures, minimum NEMA Type 4 rated to NEMA-250, protected from sun, reflection, wind, weather, and other heat or vent sources including ventilation, combustion, piping, plumbing.

.4 Piping
.1 Pipe connections to manufacturers recommended location for pipe orientation.
.2 Provide minimum 50-mm (1/2-in) lines to device. Reduce at device.
.3 Provide enclosure mounted tee fittings and shutoff valves in the high and low sensing pick-up lines to allow permanent, easy-to-use testing, calibration, and maintenance.

3.11 ELECTRICAL CURRENT DEVICES

.1 Motor Status: Calibrate to indicate positive run status only when motor is operating under load. Account for motors running under no or low load. A motor running with a broken belt or coupling shall indicate a negative run status.

3.12 ACTUATORS

.1 Configure as required, including rotation, rotation limits, fail position and direction, speed, signal.
.2 Mount such that rotation indicator is visible from floor.
.3 Feedback Signal: When not connected directly to a controller input, wire back to a terminal strip in the control panel or relevant enclosure for trouble-shooting purposes.

3.13 CONTACTORS

.1 Install as required.
.2 Location: Within enclosures.

3.14 RELAYS

.1 Install as required.
.2 Location: Within enclosures.

3.15 LIMIT SWITCHES

.1 Install as required.
.2 Locate in appropriate locations for full performance and protection of systems.
.3 Provide interlocks as required.

3.16 ELECTRIC ACCESSORY PRODUCTS

.1 Signal Isolation Transducers
  .1 Provide signal isolation transducers for analog output signals to be interfaced as inputs, including to and from controllers and independent control systems.
.2 Signal Conditioning
  .1 Install as required.
.3 Control Transformers
  .1 Install as required.
.4 Power Supplies
  .1 Provide power supplied from site standby power system. Where devices do not automatically resume full functionality following an interruption of their power supply, also provide an uninterruptible power supply (UPS) capable of providing uninterrupted power for minimum duration of 30 minutes.
    .1 Prohibited: Connecting to existing UPS without prior written approval from Owner.
.5 Wiring and Cables
  .1 Make ready for raceway connections for wiring and cables unless otherwise indicated.

3.17 PNEUMATIC ACCESSORY PRODUCTS

.1 Tubing And Piping
  .1 Protection: Mechanically protect tubing and piping from mechanical damage.
  .2 Gauges and Filters: Provide pressure gauges on the output side of each pneumatic output point. Provide disposable cartridge filter (in clear plastic casing) at input (main air side) of each electro-pneumatic transducer (EPT).
  .3 Supports and Hangers: Fasten tubing and piping to walls, ceilings, ductwork, supports, and enclosures as required.
  .4 Labelling: Label tubing and piping in same manner as wiring and cables to Section 26 05 00 Wiring and Cables. Follow existing labelling convention if possible.

3.18 OTHER ACCESSORY PRODUCTS

.1 Zone Device Guards
  .1 Install as required. Obtain approval from Owner.
.2 External Manual Override Stations
  .1 Install as required.

3.19 FIRE STOPPING AND SMOKE SEALS

.1 Install as required.
.2 To Section 15 05 00 Piping and to Section 26 05 00 Wiring and Cables.

3.20 LABELLING

.1 Labelling to match existing labelling scheme if possible and if approved by Owner, otherwise to meet Owner requirements.
.2 Label with point or controls or network name with 3 rows of characters per label.
.3 Manufacturers
  .1 Thomas & Betts Limited
  .2 Brady Worldwide, Inc.
.4 Type: 12 character polestar metalized labels.
.5 Colours: Black lettering on clear backing.

3.21 FIELD QUALITY CONTROL

.1 Field test each system independently and then in unison with other related systems, to ASHRAE-G-11, including non-HVAC systems and points.
.2 Complete point by point tests on all points and devices, including digital, analog, input, output, network, independent devices.
.1 Test and calibrate network points.
.2 Test and calibrate analog input points.
.3 Test each digital input switching contacts, and digital input signal.
.4 Test each digital output to ensure proper operation, fail mode, and lag time.
.5 Test each analog output to ensure proper operation of controlled devices.
.6 Stroke actuated devices fully open and fully closed. Verify installation including tight closure, mechanical limit setting, and proper spring return orientation.
.7 Test and verify fail modes, interlocks, and other software modes of operation.
.3 Adjust, test, and reconfigure affected systems to maintain original operation.
.4 Correct problems with affected systems during the warranty period.
.5 Submit test reports as required.
.6 Fire Testing: Provide assistance as required for the next scheduled fire test.

3.22 ADJUSTING

.1 Set and adjust as required.
.2 Adjust the following as required:
.1 Device settings and adjustable parameters.
.2 Device calibration.
.3 Fluid Level, Low Fluid, Flow Sensors and Switches
.1 Set and coordinate settings with requirements of system and other flow devices including pumps and control valves.
.2 Allow for 4 additional site visits after start-up and during Correction Period for adjustments to flow sensors and switches during system operation and shutdown to achieve desired operation under various conditions including peak and seasonal loads.

3.23 CLOSEOUT ACTIVITIES

.1 Demonstration
.1 Demonstrate operation of systems including sequence of operations in regular and emergency modes, under normal and emergency conditions, start-up, shut-down interlocks and lock-outs.

END OF SECTION 26 90 00