



Credit Valley Hospital

**CVH-2D Inpatient Mental Health Spruce
Suite Renovation**

PROJECT MANUAL

VOLUME 2 OF 2

SPECIFICATIONS

Mechanical and Electrical

Stantec Architecture Ltd.

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Project No.: 140019504

Issued for Bid

2024.05.31

Project Directory

1.1 Document Responsibility

- .1 Refer to Project Manual, Section 00 01 10 - Table of Contents, for indication of document responsibility (DR). Abbreviations for entity responsible for document preparation are as follows:
 - .1 A - Denotes documents prepared by Architect.
 - .2 E - Denotes documents prepared by Electrical Engineer.
 - .3 H - Denotes documents prepared by Architectural Hardware Consultant.
 - .4 M - Denotes documents prepared by Mechanical Engineer.

1.2 Project Directory

- .1 Architect (the *Consultant*):
Stantec Architecture Ltd.
200 – 835 Paramount Drive
Stoney Creek, Ontario
L8J 0B4

Tel: 905-385-3234

- .2 Mechanical Engineer:

WSP Toronto
25 York Street
Toronto, Ontario
M5J 2V5

Tel: 416-644-0246

- .3 Electrical Engineer:

WSP Toronto
25 York Street
Toronto, Ontario
M5J 2V5

Tel: 416-644-0246

Project Directory

.4 Architectural Hardware Consultant:

Spyder SC

26 Dale Crescent
Bradford West Gwillimbury, Ontario
L0L 1L0

Tel: 647-271-6489

Contact: Cameron Gibson
Email: cameron.gibson@spydersc.com

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MECHANICAL SPECIFICATION

CVH 2D MENTAL HEALTH PICU RENOVATION

CREDIT VALLEY HOSPITAL

WSP PROJECT NO.: CA0016106.5411

ISSUED FOR TENDER
MAY 31, 2024

WSP
150 COMMERCE VALLEY DRIVE W.
THORNHILL, ON, CANADA L3T 7Z3

TEL.: +1 905 475-7270
FAX: +1 905 475-5994
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END OF SECTION

1 GENERAL

1.01 REFERENCES

- .1 Division 00 and Division 01 apply to and are a part of this Section.

1.02 APPLICATION

- .1 This Section specifies requirements that are common to Mechanical Divisions work Sections and it is a supplement to each Section and is to be read accordingly. Where requirements of this Section contradict requirements of Divisions 00 or 01, conditions of Division 00 or 01 to take precedence, as confirmed with Owner and reviewed with Consultant prior to Bid submission.
- .2 Be responsible for advising product vendors of requirements of this Section.

1.03 DEFINITIONS

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

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

1.04 DOCUMENTS

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

- .7 Drawings are intended to convey the scope of work and do not show architectural and structural details. Provide, at your cost, offsets, fittings, transformations and similar products required as a result of obstructions and other architectural and/or structural details but not shown on Drawings.
- .8 Locations of equipment and materials shown may be altered, when reviewed by Consultant, to meet requirements of equipment and/or materials, other equipment or systems being installed, and of building, all at no additional cost to Contract.
- .9 Specification does not generally indicate specific number of items or amounts of material required. Specification is intended to provide product data and installation requirements. Refer to schedules, Drawings (layouts, riser diagrams, schematics, details) and Specification to provide correct quantities. Singular may be read as plural and vice versa.
- .10 Starter/motor control centre (MCC)/variable frequency drive (VFD) schedule drawings are both mechanical and electrical, and apply to work of Mechanical Divisions and Electrical Divisions. Be responsible for reviewing starter, MCC, VFD, and motor specification requirements prior to Bid submission. Confirm and coordinate exact scope of work and responsibility of work between Mechanical Divisions and Electrical Divisions.
- .11 If there is conflict or discrepancy between, among or within any provisions of Contract Documents, provisions establishing higher quality, manner or method of performing the Work, using more stringent standards, prevails, with intent that provisions which produce higher quality with higher levels of safety, reliability, durability, performance and service prevails.
- .12 Generally, documents govern in following order:
 - .1 Specification.
 - .2 Drawings of larger scale.
 - .3 Drawings of smaller scale.
 - .4 Drawings of later date when scale of drawings is same.
- .13 Upon finding discrepancies in, or omissions from Documents, or having doubt as to their meaning or intent, notify Consultant.
- .14 Drawings and Specifications have been prepared solely for use by party with whom Consultant has entered into a contract and there are no representations of any kind made by Consultant to any other party.

1.05 METRIC AND IMPERIAL MEASUREMENTS

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

1.06 EXAMINATION OF DOCUMENTS AND SITE

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

1.07 WORK STANDARDS

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

- .14 Electrical and Electronic Manufacturers Association of Canada (EEMAC);
- .15 Electrical Safety Authority (ESA);
- .16 Electronic Industries Association (EIA);
- .17 Factory Mutual Systems (FM);
- .18 Illuminating Engineering Society (IES);
- .19 Institute of Electrical and Electronic Engineers (IEEE);
- .20 International Standards Organization (ISO);
- .21 Intertek's Electrical Testing Labs (ETL);
- .22 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS);
- .23 National Building Code of Canada (NBC);
- .24 National Electrical Manufacturers Association (NEMA);
- .25 National Environmental Balancing Bureau (NEBB);
- .26 National Fire Protection Association (NFPA);
- .27 National Standards of Canada;
- .28 NSF International;
- .29 Occupational Health and Safety Act (OHSA);
- .30 Ontario Building Code (OBC);
- .31 Ontario Electrical Safety Code (OESC);
- .32 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA);
- .33 Technical Standards and Safety Authority (TSSA);
- .34 Thermal Insulation Association of Canada (TIAC);
- .35 Underwriters' Laboratories of Canada (ULC);
- .36 Workplace Hazardous Materials Information System (WHMIS);
- .37 Safety Data Sheets by product manufacturers;
- .38 local utility inspection permits;
- .39 Codes, standards, and regulations of local governing authorities having jurisdiction;
- .40 additional codes and standards listed in Trade Sections;
- .41 Owner's standards.

- .4 Provide applicable requirements for barrier free access in accordance with latest edition of local governing building code.
- .5 Where any governing Code, Regulation, or Standard requires preparation and submission of special details or drawings for review they are to be prepared and submitted to appropriate authorities. Be responsible for costs associated with these submittals.
- .6 Unless otherwise specified, install equipment in accordance with equipment manufacturer's recommendations and instructions, and requirements of governing Codes, Standards, and Regulations. Governing Codes, Standards, and Regulations take precedence over manufacturer's instructions. Notify Consultant in writing of conflicts between Contract Documents and manufacturer's instructions.
- .7 Work is to be performed by journeyperson who perform only work that their certificates permit, or by apprentices under direct on site supervision of experienced journeyperson. Journeyperson to apprentice ratio is not to exceed ratio in accordance with requirements of Bill 47, Making Ontario Open for Business Act - 2018.
- .8 Journeyperson are to have a copy of valid trade certificates available at site for review with Consultant at any time.
- .9 Experienced and qualified superintendent is to be on-site at times when work is being performed.
- .10 Protect existing areas above, below and adjacent areas of Work from any debris, noise, or interruptions to existing services to satisfaction of Owner and reviewed with Consultant. Maintain in operation existing services to these areas to allow Owner to continue use of these areas. If services that are required to be maintained run through areas of renovations, provide necessary protection to services or reroute, in coordination with Owner and Consultant. Include for required premium time work to meet these requirements.
- .11 Work being performed within occupied spaces and work affecting surfaces adjacent to occupied spaces may need to be performed after regular business hours. For areas where spaces are used by Owner on a 24 hours basis or over various hours, coordinate hours of work with Owner on a regular basis to suit Owner's schedule. Execute work at times confirmed with and agreed to by Owner and reviewed with Consultant, so as not to inconvenience Owner's occupation or in any way hinder Owner's use of building. Include for required premium time work to meet these requirements.
- .12 Coordinate work inspection reviews and approvals with governing inspection department to ensure construction schedule is not delayed. Be responsible for prompt notification of deficiencies to Consultant and submission of reports and certificates to Consultant.
- .13 Properly protect equipment and materials on site from damage and defacement due to elements and work of trades, to satisfaction of Owner and reviewed with Consultant. Equipment and materials are to be in new condition upon Substantial Performance of the Work.
- .14 Mechanical piping system work, including equipment, must comply with requirements of local technical standards authorities and CSA B51, Boiler, Pressure Vessels and Pressure Piping Code. Where required, mechanical work products are to bear a Canadian Registration Number (CRN) number.

- .15 Electrical items associated with mechanical equipment are to be certified and bear stamp or seal of a recognized testing agency such as CSA, UL, ULC, ETL, etc., or bear a stamp to indicate special electrical utility approval.

1.08 HEALTHCARE FACILITY STANDARDS

- .1 Comply with following standards:
 - .1 CSA Z317.1, Special Requirements for Plumbing Installations in Health Care Facilities.
 - .2 CSA Z317.2, Special Requirements for Heating, Ventilation, and Air-Conditioning (HVAC) Systems in Health Care Facilities.
 - .3 CSA Z317.10, Handling of Health Care Waste Materials .
 - .4 CAN/CSA Z317.13, Infection Control During Construction, Renovation, and Maintenance of Health Care Facilities.
 - .5 CSA Z7396.1 Medical Gas Pipeline Systems - Part 1 Pipelines for Medical Gases, Medical Vacuum, Medical Support Gases, and Anaesthetic Gas Scavenging Systems.
 - .6 CSA Z8000, Canadian Health Care Facilities.
 - .7 CAN/CSA Z8001, Commissioning of Health Care Facilities.
- .2 Prepare a list of areas of the work where infection control procedures are to be in force and review list and procedures with healthcare facility's Infection Control Officer or a designated healthcare facility representative prior to commencing work in aforementioned areas. As work proceeds, ensure infection control procedures are being maintained.
- .3 Comply with healthcare facility's latest policies and procedures regarding infection prevention and decontamination measures during work of project. Refer to additional requirements of Division 01.

1.09 PERMITS, CERTIFICATES, APPROVALS AND FEES

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

1.10 REQUIREMENTS FOR CONTRACTOR RETAINED ENGINEERS

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

1.11 WORKPLACE SAFETY

- .1 Comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage and disposal of hazardous materials. Submit WHMIS SDS (Safety Data Sheets) for products where required, and maintain one copy at site in a visible and accessible location available to personnel.
- .2 Comply with requirements of Occupational Health and Safety Act and other regulations pertaining to health and safety, including worker's compensation/insurance board and fall protection regulations. When working in confined spaces, comply with requirements of Occupational Health and Safety Act - Ontario Regulation 632, "Confined Spaces" and any other applicable Ministry of Labour requirements.
- .3 If at any time during course of existing building work, hazardous materials other than those identified in Documents and pertaining to Project Scope of Work, are encountered or suspected that were not identified as being present and which specific instructions in handling of such materials were not given, cease work in area in question and immediately notify Consultant. Comply with local governing regulations with regards to working in areas suspected of containing hazardous materials. Do not resume work in affected area without approval from Owner and reviewed with Consultant.

1.12 PLANNING AND LAYOUT OF WORK

- .1 Base installation layout, design, terminations, and supply of accessories, on Contract Documents with specific coordination with reviewed shop drawings.
- .2 Plan, coordinate, and establish exact locations and routing of services with affected trades prior to installation such that services clear each other as well as other obstructions. Generally, as coordinated prior to start of Work with each trade and with Owner and reviewed with Consultant, to suit specific project requirements, order of right of way for services to be as follows:
 - .1 piping requiring uniform pitch;
 - .2 piping 100 mm (4") dia. and larger;
 - .3 large ducts (main runs);
 - .4 cable tray and bus duct;
 - .5 conduit 100 mm (4") dia. and larger;
 - .6 piping less than 100 mm (4") dia.;
 - .7 smaller branch ductwork;
 - .8 conduit less than 100 mm (4") dia..
- .3 Unless otherwise shown or specified, conceal work in finished areas, and conceal work in partially finished and/or unfinished areas to extent made possible by the area construction. Install services as high as possible to conserve headroom and/or ceiling space. Notify Consultant where headroom or ceiling space appears to be inadequate prior to installation of work.
- .4 Do not use Contract Drawing measurements for prefabrication and layout of piping, sheet metal work and such other work. Locations and routing are to generally be in accordance with Contract Drawings, however, prepare layout drawings for such work. Use established bench marks for both horizontal and vertical measurements. Confirm inverts, coordinate with and make allowances for work of other trades. Accurately layout work, and be entirely responsible for work installed in accordance with layout drawings. Where any invert, grade, or size is at variance with Contract Drawings, notify Consultant prior to proceeding with work.
- .5 Prepare plan and interference drawings (at a minimum drawing scale of 1:50 or 1/4"=1' 0") of work for coordination with each trade Contractor. Arrange for preparation of detailed section drawings of ceiling spaces of corridors and any other congested areas. Sections are to be cross referenced with plan drawings so that trades may make use of section drawings. Section drawings to indicate lateral and elevation dimensions of major services within ceiling space. Lateral dimensions are to be from grid lines and elevations from top of floor slab. Obtain from Consultant, engineering drawings for this use. Contractors' interference drawings are to be distributed among other Trade Contractors. Submit drawings to Consultant for review. Failure of General Contractor to prepare and coordinate overall interface drawings of trades does not relieve respective Division Contractor of responsibility to ensure that work is properly planned and coordinated.

- .6 Carry out alterations in arrangement of work that has been installed without proper coordination, study, and review, even if in accordance with Contract Documents, in order to conceal work behind finishes, or to allow installation of other work, without additional cost. In addition, make necessary alterations in other work required by such alterations, without additional cost.
- .7 Locate shut-off valves, balancing devices, air vents, equipment and similar products, particularly such products located above suspended ceilings, for easy access for servicing and/or removal. Relocate products which do not meet this location requirement to accessible location, at no additional cost.
- .8 Be responsible for making necessary changes, at no additional cost, to accommodate structural and building conditions that were missed due to lack of coordination.
- .9 Where drawings indicate that acoustic tile ceiling is being suspended below structural ceiling, coordinate design of framework used to support suspended ceiling, diffusers, and other Divisions components that are mounted within or through ceiling. Do not mount devices to suspended ceiling. Secure and mount to ceiling slab above. Seal ceiling openings to maintain required fire rating.

1.13 PHASING

- .1 Include for scheduling, coordination, and construction phasing to suit project as specified in Division 01 and on drawings. Review exact phasing requirements with Consultant prior to start of Work.
- .2 Phasing and scheduling of Work is required in order to maintain existing building operations. Include costs (including costs for "off hours" work) for scheduling, coordination, and construction phasing to suit this project as specified in Division 01 and on drawings. Review phasing requirements with Consultant prior to start of Work.
- .3 Project partial occupancy permits to be required throughout project. Provide for each partial permit, required local governing authority certificate and any other testing/verification certificates for systems.

1.14 COORDINATION OF WORK

- .1 Review Contract Documents and coordinate work with work of each trade. Coordination requirements are to include but not be limited to following:
 - .1 requirements for openings, sleeves, inserts and other hardware necessary for installation of work;
 - .2 concrete work such as housekeeping pads, sumps, bases, etc., required for work, and including required dimensions, operating weight of equipment, location, etc.;
 - .3 depth and routing of excavation required for work, and requirements for bedding and backfill;
 - .4 wiring work required for equipment and systems but not specified to be done as part of mechanical work, including termination points, wiring type and size, and any other requirements.

- .2 Ensure materials and equipment are delivered to site at proper time and in such assemblies and sizes so as to enter into building and be moved into spaces where they are to be located without difficulty.
- .3 Wherever possible, coordinate equipment deliveries with manufacturers and/or suppliers so equipment is delivered to site when it is required, or so it can be stored within building, subject to available space as confirmed with Owner and reviewed with Owner, and protected from elements.
- .4 Ensure proper access and service clearances are maintained around equipment, and, where applicable, access space for future equipment removal or replacement is not impeded. Comply with code requirements with regards to access space provision around equipment. In coordination with Owner and review with Consultant, relocate equipment which does not meet this requirement.
- .5 Where work is to be integrated, or is to be installed in close proximity with work of other trades, coordinate work prior to and during installation.

1.15 PRODUCTS

- .1 Order products (equipment and materials) in a timely manner to meet project-scheduling timelines. Failure to order products to allow manufacturers sufficient production/delivery time to meet project-scheduling timelines is unacceptable reason to request for use of other suppliers or substitutions.
- .2 Provide Canadian manufactured products wherever possible or required and when quality and performance is obtainable at a competitive price. Products are to be supplied from manufacturer's authorized Canadian representative, unless otherwise noted. Unless otherwise specified, products are to be new.
- .3 Products are to comply with applicable respective Canadian standards, and typically with Canadian Standards Association (CSA) approvals and/or Underwriters Laboratories of Canada (ULC) listings markings. References to UL listings of products to include requirements that products are to be also Underwriters Laboratories of Canada ULC / cUL listed for use in Canada. Other certification organizations accredited by Standards Council of Canada to approve electrical equipment may be acceptable subject to approval from local governing electrical authority and review with Consultant. Applicable products are to meet or exceed latest ANSI/ASHRAE/IES 90.1 standards enforced by local governing authorities.
- .4 Systems and equipment of this Project are to be "State of the Art" and be most recent and up to date series/version of product that is available at time of shop drawing review process. Products that have been stored or "on shelf" for an extended period of time will not be accepted. Software is to be of latest version available and be provided with updates available at time of shop drawing review process. Systems are to be designed such that its software is backwards compatible. Future upgrades are not to require any hardware replacements or additions to utilize latest software.

- .5 Products scheduled and/or specified have been selected to establish a performance and quality standard, and, in some instances, a dimensional standard. In most cases, base specified manufacturers are stated for any product specified by manufacturer's name and model number. Where acceptable manufacturers are listed, first name listed is base specified company. Bid Price may be based on products supplied by any of manufacturers' base specified or named as acceptable for particular product. If acceptable manufacturers are not stated for a particular product, base Bid Price on product supplied by base specified manufacturer.
- .6 Documents have been prepared based on product available at time of Bidding. If, after award of Contract, and if successful manufacturer can no longer supply a product that meets base specifications, notify Consultant immediately. Be responsible for obtaining other manufacturers product that complies with base specified performance and criteria and meets project timelines. Proposed products are subject to review and consideration by Consultant and are considered as substitutions subject to a credit to Contract. In addition, if such products require modifications to room spaces, mechanical systems, electrical systems, etc., include required changes. Such changes are to be submitted in detail to Consultant for review and consideration for acceptance. There will be no increase in Contract Price for revisions. Above conditions supplement and are not to supersede any specification conditions with regards to substitutions or failure to supply product as per issued documents.
- .7 Listing of a product as "acceptable" does not imply automatic acceptance by Consultant and/or Owner. It is responsibility of Contractor to ensure that any price quotations received and submittals made are for products that meet or exceed specifications included herein.
- .8 If products supplied by a manufacturer named as acceptable are used in lieu of base specified manufacturer, be responsible for ensuring that they are equivalent in performance and operating characteristics (including energy consumption if applicable) to base specified products. It is understood that any additional costs (i.e. for larger starters, larger feeders, additional spaces, etc.), and changes to associated or adjacent work resulting from provision of product supplied by a manufacturer other than base specified manufacturer, is included in Bid Price. In addition, in equipment spaces where equipment named as acceptable is used in lieu of base specified equipment and dimensions of such equipment differs from base specified equipment, prepare and submit for review accurately dimensioned layouts of rooms affected, identifying architectural and structural elements, systems and equipment to prove that equipment in room will fit properly meeting design intent. There will be no increase in Contract Price for revisions.
- .9 Where products are listed as "or approved equal", certify in writing that product to be used in lieu of base specified product, at least meets space, power, design, energy consumption, and other requirements of base specified product and is equivalent or better than base specified product. When requested by Consultant, provide full design detail drawings and specifications of proposed products. Acceptance of these "or approved equal" products is at sole discretion of Consultant. It is understood that there will be no increase in Contract Price by reason of any changes to associated equipment, mechanically, electrically, structurally or architecturally, required by acceptance of approved equal product. There must be no increase in Contract price due to Consultant's rejection of proposed equivalent product.

- .10 Whenever use of product other than base specified product is being supplied, ensure corresponding certifications and product information (detailed catalogue and engineering data, fabrication information and performance characteristics) are submitted to Consultant for review. Failure of submission of these documents to Consultant in a timely manner to allow for review will result in base specified product to be supplied at Consultant's discretion, at no additional cost to Contract.
- .11 In addition to manufacturer's products base specified or named as acceptable, other manufacturers of products may be proposed as substitutions to Consultant for review and consideration for acceptance, listing in each case a corresponding credit for each substitution proposed. However, base Bid Price on products base specified or named as acceptable. Certify in writing to Consultant that proposed substitution meets space, power, design, energy consumption, and other requirements of base specified or acceptable product. It is understood that there will be no increase in Contract Price by reason of any changes to associated equipment, mechanically, electrically, structurally or architecturally, required by acceptance of proposed substitution. Consultant has sole discretion in accepting any such proposed substitution of product. Indicate any proposed substitutions in areas provided on Bid Form. Do not order such products until they are approved by Owner and reviewed in writing with and recommended for acceptance by Consultant.
- .12 Substitutions will not be considered by Consultant during Bid period unless:
 - .1 permitted by Owner;
 - .2 directions and submission areas are provided on Bid Form;
 - .3 or formally requested in writing a minimum of 10 working days prior to Bid closing date.
- .13 When issued with Documents, complete and submit as directed, Appendix - List of Acceptable Manufacturers and Suppliers, or when directed by Consultant submit separate list of proposed manufacturers and suppliers.
- .14 Any proposed changes to list of manufacturers initiated by Contractor after award of Contract may be considered by Consultant at Consultant's discretion, with any additional costs for such changes if approved by Owner and reviewed with and recommended by Consultant, and costs for review, to be borne by Contractor.
- .15 Whenever use of product other than based specified products or named as acceptable is being supplied, allow sufficient time for processing of product submissions and time for Consultant's review, such that there will not be significant impact on contract time or work schedule.

1.16 SHOP DRAWINGS

- .1 At start-up meeting, review with Consultant products to be included in shop drawing submission. Prepare and submit list of products to Consultant for review.
- .2 Submit electronic copies of shop drawings unless otherwise directed by Consultant. Coordinate exact requirements with Consultant.

- .3 Submit for review, drawings showing detail design, construction, and performance of equipment and materials as requested in Specification. Submit shop drawings to Consultant for review prior to ordering and delivery of product to site. Include minimally for preparation and submission of following, as applicable:
 - .1 product literature cuts;
 - .2 equipment data sheets;
 - .3 equipment dimension drawings;
 - .4 system block diagrams;
 - .5 sequence of operation;
 - .6 connection wiring schematic diagrams;
 - .7 functionality with integrated systems.
- .4 Each shop drawing or product data sheet is to be properly identified with project name and product drawing or specification reference. Shop drawing or product data sheet dimensions are to match dimension type on drawings.
- .5 Where any item of equipment is required by Code or Standard or By-Law to meet a specific energy efficiency level, or any other specific requirement, ensure this requirement is clearly indicated on submission.
- .6 Ensure proposed products meet each requirement of Project. Endorse each shop drawing copy "CERTIFIED TO BE IN ACCORDANCE WITH ALL REQUIREMENTS". Include company name, submittal date, and sign each copy. Shop drawings that are received and are not endorsed, dated and signed will be returned to be resubmitted.
- .7 Consultant to review shop drawings and indicate review status by stamping shop drawing copies as follows:
 - .1 "REVIEWED" or "REVIEWED AS NOTED" (appropriately marked) – If Consultant's review of shop drawing is final, Consultant to stamp shop drawing;
 - .2 "REVISE & RESUBMIT" – If Consultant's review of shop drawing is not final, Consultant to stamp shop drawing as stated above, mark submission with comments, and return submission. Revise shop drawing in accordance with Consultant's notations and resubmit.

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

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

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

1.17 ENGINEERED SUBMITTALS

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

- .3 Professional engineer responsible for engineered submittals is to perform periodic field reviews, including review of associated mock-ups where applicable, at locations wherever work as described by engineered submittal is in progress, during fabrication and installation of such work, and submit a field review report after each visit. Submit field review reports to Consultant and authorities having jurisdiction as required.
- .4 Field reviews are to be at intervals as necessary and appropriate to progress of work described by engineered submittal to allow engineer to be familiar with progress and quality of such work and to determine if work is proceeding in general conformity with Contract Documents including reviewed shop drawings and design calculations.
- .5 Upon completion of work as described by engineered submittal, professional engineer responsible for preparation of engineered submittal and for performing periodic field reviews is to prepare and submit to Consultant and, if applicable, authorities having jurisdiction, a letter certifying that work has been supplied and installed in accordance with requirements of Contract Documents, authorities having jurisdiction and engineered submittal.

1.18 EQUIPMENT LOADS

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

1.19 OPENINGS

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

1.20 SCAFFOLDING, HOISTING AND RIGGING

- .1 Unless otherwise specified or directed, supply, erect and operate scaffolding, rigging, hoisting equipment and associated hardware required for work, and subject to approval from Owner and reviewed with Consultant.
- .2 Use scaffolds in such a manner as to interfere as little as possible with work of other trades.

- .3 Do not place major scaffolding/hoisting equipment loads on any portion of structure without approval from Owner and reviewed with Consultant. No supports, clips, brackets or similar devices are to be welded, bolted or otherwise affixed to any finished member or surface without approval from Owner and review with Consultant.
- .4 Immediately remove from site scaffolding, rigging and hoisting equipment when no longer required.

1.21 REQUEST FOR INFORMATION (RFI)

- .1 Review contract documents for information prior to issuance of RFI during performance of Work. Where it is determined, at discretion of Owner and Consultant, that information requested in RFI was readily identifiable as part of contract documents, respective trades Contractor to be back-charged against their contract amount for time spent by Consultant and/or Owner in preparing response to RFI. Minimum amount of \$150 CDN plus GST to be back charged against contract amount for any response to a readily identifiable RFI.

1.22 CHANGES IN THE WORK

- .1 Whenever Consultant proposes in writing to make a change or revision to design, arrangement, quantity or type of work from that required by Contract Documents, prepare and submit to Consultant for review, a quotation detailing proposed cost for executing change or revision.
- .2 Quotation is to be a detailed and itemized estimate of product, labour, and equipment costs associated with change or revision, plus overhead and profit percentages and applicable taxes and duties.
- .3 If overhead and profit percentages are not specified in Division 00 or 01, but allowable under Contract as reviewed with Consultant prior to contract signing, then allowable maximum percentages for overhead and profit are to be 5% for each.
- .4 Unless otherwise specified in Divisions 00 or 01, following additional requirements apply to all quotations submitted:
 - .1 when change or revision involves deleted work as well as additional work, cost of deleted work (less overhead and profit percentages but including taxes and duties) is to be subtracted from cost of additional work before overhead and profit percentages are applied to additional work;
 - .2 material costs are not to exceed those published in local estimating price guides with additional reductions as follows:
 - .1 steel pipe: 50%;
 - .2 copper pipe: 45%;
 - .3 cast iron soil pipe: 45%;
 - .4 stainless steel pipe and fittings: 45%;
 - .5 welded fittings: 50%;
 - .6 grooved fittings: 30%

- .7 threaded fittings: 40%;
- .8 cast iron screwed fittings: 40%;
- .9 copper fittings: 45%;
- .10 cast iron MJ fittings: 35%;
- .11 valves: 25%;
- .12 insulation materials: 35%;
- .13 all other materials: 20%.
- .3 mechanical labour unit costs are to be in accordance with Mechanical Contractors Association of America Labor Estimating Manual, less 25%;
- .4 electrical labour unit costs are to be in accordance with National Electrical Contractors Association Manual of Labor Units at difficult level, less 25%;
- .5 costs for journeyman and apprentice labour must not exceed prevailing rates at time of execution of Contract and must reflect actual personnel performing work;
- .6 cost for site superintendent must not exceed 10% of total hours of labour estimated for change or revision, and change or revision must be such that site superintendent's involvement is necessary;
- .7 costs for rental tools and/or equipment are not to exceed local rental costs;
- .8 overhead percentage will be deemed to cover quotation costs other than actual site labour and materials, and rentals;
- .9 quotations, including those for deleted work, to include a figure for any required change to Contract time.
- .5 Quotations submitted that are not in accordance with requirements specified above will be rejected and returned for re-submittal. Failure to submit a proper quotation to enable Consultant to expeditiously process quotation and issue a Change Order will not be grounds for any additional change to Contract time.
- .6 Make requests for changes or revisions to work in writing to Consultant and, if accepted by Owner, Notice of Change or Change Directive to be issued.
- .7 Do not execute any change or revision until written authorization for the change or revision has been obtained from Consultant.

1.23 PROGRESS PAYMENT BREAKDOWN

- .1 Prior to submittal of first progress payment draw, submit a detailed breakdown of work cost to assist Consultant in reviewing and approving progress payment claims.

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

1.24 NOTICE FOR REQUIRED FIELD REVIEWS

- .1 Whenever there is a requirement for Consultant to perform a field review prior to concealment of any work, to inspect/re-inspect work for deficiencies prior to Substantial Performance of the Work, for commissioning demonstrations, and any other such field review, give minimum 7 working days' notice in writing to Consultant.
- .2 If Consultant is unable to attend a field review when requested, arrange an alternative date and time.
- .3 Do not conceal work until Consultant advises that it may be concealed.
- .4 When Consultant is requested to perform a field review and work is not ready to be reviewed, reimburse Consultant for time and travel expenses.

1.25 PRELIMINARY TESTING

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

1.26 PROVISIONS FOR SYSTEMS/EQUIPMENT USED DURING CONSTRUCTION

- .1 Permanent building mechanical systems are not to be used for temporary heating or cooling purposes during construction.
- .2 Confirm with Consultant what equipment can be used during construction.

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

1.27 TEMPORARY SERVICES

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

1.28 MAINTAINING EQUIPMENT PRIOR TO ACCEPTANCE

- .1 Maintain equipment in accordance with manufacturer's instructions prior to start-up, testing and commissioning.
- .2 Employ a qualified millwright to check and align shafts, drives, and couplings on all base mounted split coupled motor driven equipment.
- .3 Where equipment lubrication fittings are not easily accessible, extend the fittings to accessible locations using copper or aluminium tubing.
- .4 All filters are to be new upon Substantial Performance of the Work. This is in addition to any spare filters specified.

1.29 CLEANING

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

1.30 RECORD AS-BUILT DRAWINGS

- .1 Drawings for this project have been prepared on a CAD system using AutoCAD software of release version reviewed with Consultant. For purpose of producing record "as built" drawings, copies of Contract Drawings can be obtained from Consultant. Drawings may also be used for preparation of layouts and interference drawings.
- .2 As work progresses at site, clearly mark in red in a neat and legible manner on a set of bound white prints of Contract Drawings, changes and deviations from routing of services and locations of equipment shown on Contract Drawings, on a daily basis. Changes and deviations include those made by addenda, change orders, and site instructions. Use notes marked in red as required. Maintain white print red line as-built set at site for exclusive use of recording as-built conditions, keep set up-to-date at all times, and ensure set is always available for periodic review. As-built set is also to include the following:
 - .1 dimensioned location of inaccessible concealed work;
 - .2 locations of control devices with identification for each;
 - .3 for underground piping and ducts, record dimensions, invert elevations, offsets, fittings, cathodic protection and accessories if applicable, and locate dimensions from benchmarks to be preserved after construction is complete;
 - .4 for fire protection systems, record actual locations of equipment, sprinkler heads, and valves, drains, and test locations, and deviations of pipe routing and sizing from that shown on the drawings;
 - .5 location of piping system air vents;
 - .6 location of concealed services terminated for future extension and work concealed within building in inaccessible locations.
- .3 Before applying for a Certificate of Substantial Performance of the Work, update a clean copy of Contract Drawing set in accordance with marked up set of "as-built" white prints including deviations from original Contract Drawings, thus forming an "as-built" drawing set. Submit "as-built" site drawing prints to Consultant for review. Make necessary revisions to drawings as per Consultant's comments, to satisfaction of Consultant.
- .4 Use final reviewed "as-built" drawing set to provide CAD files of drawings thus forming true "as-built" set of Contract Drawings. Identify set as "Project Record Copy". Load digital copies of final reviewed by Consultant as-built drawings onto USB type flash drive. Provide 2 complete sets of "as-built" drawings on separate USBs. Submit "as-built" sets of white prints and USBs to Consultant. Save drawings as AutoCAD files and in pdf format and such that each drawing is not x-referenced but as complete drawing.
- .5 Submitted drawings are to be of same quality as original Contract Drawings. CAD drawing files are to be compatible with software release version reviewed with Consultant.
- .6 Unless otherwise noted in Divisions 00 or 01, failure to maintain accurate record drawings will incur additional 5% holdback on progress claims until drawings are brought up to date to satisfaction of Owner and reviewed with Consultant.
- .7 For projects with phased turnover of project (refer to Division 01), review with Consultant completeness of as-built drawings prior to turn over of an area. Copies of hand drawn interim as-built drawings to be made available to Owner's maintenance personnel.

- .8 Requirements regarding medical gas piping system as-built record drawings are as follows:
 - .1 obtain from Owner/Consultant, existing medical gas piping record drawings and, on a day-to-day basis, record alteration work and new work, including location of concealed piping, and, provide a separate record CAD files on USB type flash drive, in accordance with requirements of CAN/CSA Z7396.1.

1.31 OPERATING AND MAINTENANCE MANUALS

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

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

1.32 COMMISSIONING

- .1 After successful start-up and prior to Substantial Performance of the Work, commission the mechanical work. Commissioning work is the process of Contractor demonstrating to Owner and Consultant, for purpose of final acceptance, by means of successful and documented functional performance testing, that systems and/or subsystems are capable of being operated and maintained to perform in accordance with requirements of Contract Documents, as further described below.
 - .1 Retain services of a testing, adjusting, and balancing agency to perform testing and balancing of mechanical system air/fluid flows and capacities, prior to operational performance testing. Refer to Section entitled Testing, Adjusting and Balancing.

- .2 Test, adjust and operate equipment and systems after start-up but before functional performance testing, to confirm operations are in accordance with requirements of Contract Documents. Verify modes and sequences of control and monitoring, interlocks, and responses to emergency conditions. Complete commissioning data sheets to document successful operational performance testing.
 - .3 Repeat successful operational performance testing with completed commissioning data sheet documentation in the presence of Consultant and Owner to validate and verify equipment and systems are complete in all respects, function correctly, and are ready for acceptance.
 - .4 Submit final commissioning data sheets, TAB reports as specified in Section entitled Testing, Adjusting and Balancing, project closeout documents, and other required submittals.
- .2 An independent Commissioning Agent is to be retained by Contractor to perform equipment and system commissioning work as specified in Division 01, and in Section entitled Mechanical Work Commissioning. Where commissioning specifications are included as part of Division 01, requirements of Section entitled Mechanical Work Commissioning are to supplement commissioning requirements of Division 01. Where variances or contradictions exist, more stringent requirement will apply unless otherwise directed by Consultant.

1.33 PROJECT CLOSEOUT SUBMITTALS

- .1 Prior to application for Substantial Performance of the Work, submit required items and documentation specified, including following:
 - .1 O & M Manuals;
 - .2 as-built record drawings and associated data;
 - .3 extended warranties for equipment as specified;
 - .4 operating test certificates, i.e. Sprinkler Test Certificate;
 - .5 final commissioning report and TAB report;
 - .6 identified keys for equipment and/or panels for which keys are required, and other items required to be submitted;
 - .7 other data or products specified.
- .2 Refer to additional requirements in Division 01.

1.34 INSTRUCTIONS TO OWNER

- .1 Refer to equipment and system operational and maintenance training requirements specified in Division 01.
- .2 Train Owner's designated personnel in aspects of operation and maintenance of equipment and systems as specified. Demonstrations and training are to be performed by qualified technicians employed by equipment/system manufacturer/supplier. Supply hard copies of training materials to each attendee.

- .3 Unless where specified otherwise in trade Sections, minimum requirements are for manufacturer/suppliers of each system and major equipment, to provide minimum two separate sessions each consisting of minimum 4 hours on site or in factory training (at Owner's choice), of Owner's designated personnel (for up to 6 people each session), on operation and maintenance procedures of system.
- .4 For each item of equipment and for each system for which training is specified, prepare training modules as specified below. Use O&M Manuals during training sessions. Training modules include but are not limited to:
 - .1 Operational Requirements and Criteria: Equipment function, stopping and starting, safeties, operating standards, operating characteristics, performance curves, and limitations;
 - .2 Troubleshooting: Diagnostic instructions, test and inspection procedures;
 - .3 Documentation: Equipment/system warranties, and manufacturer's/supplier's parts and service facilities, telephone numbers, email addresses, and the like;
 - .4 Maintenance: Inspection instructions, types of cleaning agents to be used as well as cleaning Methods, preventive maintenance procedures, and use of any special tools;
 - .5 Repairs: Diagnostic instructions, disassembly, component removal and repair instructions, instructions for identifying parts and components, and review of any spare parts inventory.
- .5 Before instructing Owner's designated personnel, submit to Consultant for review preliminary copy of training manual and proposed schedule of demonstration and training dates and times. Incorporate Consultant's comments in final copy.
- .6 Obtain in writing from Consultant list of Owner's representatives to receive instructions. Submit to Consultant prior to application for Certificate of Substantial Performance of the Work, complete list of systems for which instructions were given, stating for each system:
 - .1 date instructions were given to Owner's staff;
 - .2 duration of instruction;
 - .3 names of persons instructed;
 - .4 other parties present (manufacturer's representative, consultants, etc.).
- .7 Obtain signatures of Owner's staff to verify they properly understood system installation, operation and maintenance requirements, and have received operating and maintenance instruction manuals and "as-built" record drawings.
- .8 Submit to Consultant, copy of electronic version of training materials loaded on USB flash drive. Include in operating and maintenance manuals submission.
- .9 Provide recording on a USB type flash drive of the operating and instructions training for following systems:
 - .1 building automation system.

- .10 Provide a custom video in on a USB type flash drive that details on site systems and equipment operations and includes following:
 - .1 professional videographer on site to capture training session; use wireless lavalier microphone to capture crystal clear audio of trainer in association with video footage; edit video to remove unnecessary footage;
 - .2 File to include custom site specific system/equipment screens that outline key information about system/equipment and devices used on site only;
 - .3 File to also include custom site specific video that details programming procedures in conjunction with a voiceover from on-site technician;
 - .4 File created with a main menu screen and authored with chapters to allow operator to access specific areas of training instantly.
- .11 Supply minimum quantity of 3 copies of USB type flash drive for each system/equipment.

1.35 FINAL INSPECTION

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

2 PRODUCTS

2.01 NOT USED

3 EXECUTION

3.01 NOT USED

END OF SECTION

1 GENERAL

1.01 APPLICATION

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

1.02 SUBMITTALS

- .1 Submit shop drawings/product data sheets for:
 - .1 pressure gauges and thermometers;
 - .2 electric motors (submit with equipment they are associated with).
- .2 Submit weight loads for selected equipment (upon request).
- .3 Submit copy of architectural reflected ceiling plan drawings and elevation drawings to indicate proposed access door locations.
- .4 Submit sample of each proposed type of access door if supplied under work of this Division.
- .5 Submit samples of materials and any other items as specified in Sections of Mechanical Divisions.
- .6 Submit list of equipment identification nameplates indicating proposed wording and sizes.
- .7 Submit list of pipe and duct identification colour coding and wording.
- .8 Submit proposed valve tag chart and a list of proposed valve tag numbering and identification wording.
- .9 Submit drawings indicating size and location of required sleeves, recesses and formed openings in poured or precast concrete work.
- .10 As specified in Part 2 of this Section, submit spare belt set, tagged and identified, for each belt driven piece of equipment.
- .11 Submit any other submittals specified in this Section or other Sections of Mechanical Divisions.

1.03 EQUIPMENT WITHSTAND RATINGS

- .1 Coordinate with Electrical Divisions Contractor with regards to obtaining calculations of short circuit current ratings (SCCR) and available fault currents at each level of electrical distribution system that serves major mechanical equipment.
- .2 Select mechanical equipment able to withstand and labeled with required appropriate SCCR sufficient for voltage employed and fault current at terminals of equipment.

- .3 Where SCCR are not identified, assume for pricing minimum 35 kA for small equipment and 65 kA for larger HVAC units.
- .4 Review with Consultant and Division 26 Electrical Contractor, prior to ordering equipment, and identify required SCCR on shop drawings.

2 PRODUCTS

2.01 PIPE SLEEVES

- .1 Galvanized Sheet Steel: Minimum #16 gauge galvanized steel with an integral flange at one end to secure sleeve to formwork construction.
- .2 Polyethylene: Factory fabricated, flanged, high density polyethylene sleeves with reinforced nail bosses.
- .3 Waterproof Galvanized Steel Pipe: Schedule 40 mild galvanized steel pipe with a welded-on square steel anchor and water stop plate at sleeve midpoint.
- .4 Galvanized Steel or Cast Iron Pipe: Schedule 40 mild galvanized steel, or Class 4000 cast iron.

2.02 FIRESTOPPING AND SMOKE SEAL MATERIALS

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

2.03 WATERPROOFING SEAL MATERIALS

- .1 Modular, mechanical seal assemblies consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and pipe sleeve or wall opening, assembled with stainless steel bolts and pressure plates and designed so when bolts are tightened the links expand to seal the opening watertight. Select seal assemblies to suit pipe size and sleeve size or wall opening size.
- .2 Acceptable products are:
 - .1 Thunderline Corp. (Power Plant Supply Co.) "LINK SEAL" Model S-316;
 - .2 The Metraflex Co. "MetraSeal" type ES.

2.04 PIPE ESCUTCHEON PLATES

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

2.05 PIPING HANGERS AND SUPPORTS

- .1 Pipe hanger and support materials, including accessories, are to be, unless otherwise specified, in accordance with Manufacturers Standardization Society (MSS) Standard Practice Manual SP-58, Pipe hangers and Supports-Materials, Design and Manufacture, and where possible, MSS designations are indicated with each product specified below. Conform to following requirements:
 - .1 unless otherwise specified, ferrous hanger and support products are to be electro-galvanized;
 - .2 hangers and supports for insulated piping are to be sized to fit around insulation and insulation jacket.
- .2 Hangers and supports for horizontal suspended piping as follows:
 - .1 adjustable steel clevis hanger – MSS Type 1;
 - .2 adjustable swivel ring band hanger – MSS Type 10;
- .3 Supports for horizontal pipe on vertical surfaces as follows:
 - .1 steel offset pipe clamp – Anvil Fig. 103 or Myatt Fig. 170;
 - .2 heavy-duty steel pipe clip – MSS Type 26;
 - .3 single steel pipe hook – Myatt Fig. 156;
 - .4 epoxy coated steel pipe stays are not permitted.
- .4 Floor supports for vertical risers as follows:
 - .1 copper tubing riser clamp – MSS Type 8;
 - .2 heavy-duty steel riser clamp – MSS Type 8.
- .5 Supports for vertical piping on vertical surfaces as follows:
 - .1 steel offset pipe clamp – Anvil Fig. 103 or Myatt Fig. 170;
 - .2 heavy-duty steel pipe bracket or soil pipe bracket – MSS Type 26;
 - .3 extension split pipe clamp – MSS Type 12;
 - .4 epoxy coated steel pipe stays are not permitted.
- .6 For horizontal pipe on racks, Unistrut or approved equal galvanized steel pipe racks with pipe securing hardware as follows:
 - .1 standard galvanized steel U-bolts/clamps supplied by rack manufacturer;

- .7 Special hangers and supports for various applications as follows:
 - .1 vibration isolated riser supports – black steel riser clamps as specified above, complete with neoprene–steel–neoprene sandwich type vibration isolation pads between clamp and floor;
 - .2 for groups of pipes having same slope – MSS Type 32 welded steel brackets, Anvil Fig. 46 universal trapeze assemblies, or Unistrut or approved equal support assemblies, all with U-bolts, clamps, etc., to secure pipes in place;
 - .3 for sections of piping connected to vibration isolated equipment – hangers and supports as specified above but complete with MSS Type 48 spring cushions;
 - .4 for plastic piping – generally as specified above but in accordance with pipe manufacturer's recommendations;
 - .5 for fire protection piping – generally as above but ULC listed and/or FM approved, and in accordance with Chapter requirements of NFPA Standard applicable to piping system;
 - .6 for bare horizontal copper piping – generally as above but factory vinyl coated to prevent direct copper/steel contact;
 - .7 for bare copper vertical piping – corrosion resistant ferrous clamps with flexible rubber gasket type material (not tape) to isolate pipe from clamp;
- .8 Hanger rods are to be electro-galvanized carbon steel (unless otherwise specified), round, threaded, to ASTM A36, complete with captive machine nuts with washers at hangers, sized to suit loading in accordance with Table 3 in MSS SP-58, but minimum 9.5 mm (3/8") diameter.
- .9 Acceptable manufacturers are:
 - .1 E. Myatt & Co. Inc.;
 - .2 Anvil International Inc.;
 - .3 Empire Industries Inc.;
 - .4 Hunt Manufacturing Ltd.;
 - .5 Unistrut Canada Ltd.;
 - .6 Nibco Inc. "Tolco";
 - .7 Taylor Pipe Supports.

2.06 ACCESS DOORS

- .1 Coordinate consistency of look and finish of access doors on project with each Division of Work. Coordinate exact requirements with General Trades Contractor.

- .2 Access doors to be rust resistant steel door panels, with concealed hinges and positive locking and self-opening screwdriver operated lock. Wall type frame to be suitable for wall installation and have integral keys for plaster walls. Doors in tile wall to be stainless steel and in ceilings to be suitable for plaster covering with only frame joint showing. Other doors to be prime painted steel.
- .3 Size access doors to suit the concealed work for which they are supplied, and wherever possible they are to be of standard size for all applications, but minimum 300 mm x 300 mm (12" x 12") for hand entry and 600 mm x 600 mm (24" x 24") for body entry.
- .4 Lay-in type tiles, properly marked, may serve as access panels. Coordinate marking of ceiling tiles with Consultant. Panels in glazed tile walls to be 12 gauge, 304 alloy stainless steel, No. 4 finish, with recessed frame secured with stainless steel counter-sunk flush head screws.
- .5 Panels in plaster surfaces to have dish-shaped door and welded metal lath, ready to take plaster. Provide a plastic grommet for door key access.
- .6 Other access doors to be welded 12 gauge steel, flush type with concealed hinges, lock and anchor straps, complete with factory prime coat. Submit to Consultant for review, details of non-standard door construction details.
- .7 Access doors in fire rated ceilings, walls, partitions, structures, etc., to be ULC listed and labelled and of a rating to maintain fire separation integrity.
- .8 Where access doors are located in surfaces where special finishes are required, they are to be of a recessed door type capable of accepting finish in which they are to be installed so as to maintain final building surface appearance throughout.
- .9 Acceptable manufacturers include Le Hage, SMS, Pedlar and Acudor.

2.07 PRESSURE GAUGES AND THERMOMETERS

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

- .3 pressure gauges in fire protection piping must be ULC listed and labelled;
- .4 pressure gauges in medical gas piping systems are to conform to CSA Z7396.1 and are to be identified with name of service it is provided for as well as "USE NO OIL".
- .3 Thermometers as follows:
 - .1 round, 125 mm (5") diameter, adjustable (90°) angle bimetal dial type thermometers, each accurate to within 1% of full scale;
 - .2 hermetically sealed stainless steel case with stainless steel ring;
 - .3 dampened bimetal coil;
 - .4 calibration adjustment screw;
 - .5 white aluminum dual scale dial with black and blue markings and a range such that working temperature of system is approximate mid-point of the scale;
 - .6 black aluminum pointer;
 - .7 double strength glass window;
 - .8 12 mm (½") NPT connection with 6.4 mm (¼") diameter stainless steel stem;
 - .9 suitable thermowell.
- .4 Acceptable manufacturers are:
 - .1 H.O. Trerice Co.;
 - .2 Weiss Instruments;
 - .3 Ashcroft.

2.08 EQUIPMENT BELT DRIVES

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

2.09 EQUIPMENT DRIVE GUARDS AND ACCESSORIES

- .1 For V-Belt Drives: Removable, 4-sided, fully enclosed, galvanized sheet steel guards to OSHA standards, cleaned, factory primed and painted with yellow equipment enamel, complete with a 2-piece full length hinged front panel to permit belt maintenance or replacement without removing guard, and 40 mm (1-½") diameter tachometer openings at each shaft location.
- .2 For Flexible Couplings: Removable "U" shaped galvanized steel guards to OSHA Standards with a 2.3 mm (3/32") thick frame and expanded mesh face.
- .3 For Unprotected Fan Inlets and Outlets: Unless otherwise specified, removable 20 mm (¾") galvanized steel wire mesh with galvanized steel frames, all to OSHA Standards.

2.10 ELECTRIC MOTORS

- .1 Unless otherwise specified, motors are to conform to NEMA Standard MG1, applicable IEEE Standards, and applicable CSA C22.2 Standards, and are to meet NEMA standards for maximum sound level ratings under full load. Confirm motor voltages prior to ordering.
- .2 Vertically mounted and submersible motors are to be purposely designed for mounting in this attitude.
- .3 Efficiency of 1-phase motors to 1 HP is to be in accordance with CAN/CSA C747. Efficiency of 3-phase motors 1 HP and larger is to be in accordance with CAN/CSA C390 or IEEE 112B.
- .4 Unless otherwise specified, 1-phase motors smaller than ½ HP are to be 115 volt, continuous duty capacitor start type with an NEMA 48 or 56 frame size, solid base, heavy-gauge steel shell with solid die-cast end shields, dynamically balanced die-cast rotor, integral automatic reset thermal overload protection, Class "B" insulation, and a 1.15 service factor at 40°C (105°F) ambient temperature.
- .5 Explosion-proof 1-phase motors are to be totally enclosed, fan cooled, 115 volt continuous duty capacitor start type in accordance with CSA C22.2 No. 145, as specified for standard 1-phase motors but suitable for use in Class 1 Group D hazardous locations and complete with a rolled steel shell and a 1.0 service factor at 40°C (105°F) ambient temperature.
- .6 Unless otherwise specified, motors ½ HP and larger are to be totally enclosed, fan cooled, 3-phase, T-frame, squirrel cage continuous duty induction motors suitable for voltages indicated on Drawings, NEMA Design "B" for normal starting torque or Design "C" for high starting torque as required by the application, each complete with Class "B" insulation, a 1.15 service factor at 40°C ambient temperature, grease lubricated open ball bearings with grease fittings to permit re-lubrication without dismantling motor, a cast iron frame with cast iron feet where required, cast iron end bracket and precision machined bearing fit, and balanced carbon steel shaft assembly with die-cast aluminum rotor windings.
- .7 Explosion-proof 3-phase motors are to be totally enclosed fan cooled motors in accordance with CSA C22.2 No. 145, generally as specified above for standard 3-phase motors but suitable for use in Class 1 Group D hazardous locations and with a 1.0 service factor at 40°C (105°F) ambient temperature.

- .8 Motors for equipment with variable frequency drives are to be generally as specified above but inverter duty type to NEMA Standard MG-1 Part 31, quantified by CSA for operation from a variable frequency drive of type specified, and complete with Class "H" insulation. Motors are to be equipped with AEGIS, or approved equal, shaft grounding ring system to protect bearings from damage by diverting harmful shaft voltages and bearing currents to ground.
- .9 Acceptable manufacturers are:
 - .1 TECO-Westinghouse Motors (Canada) Inc.;
 - .2 Canadian General Electric;
 - .3 Baldor Electric Co.;
 - .4 U.S. Electrical Motors;
 - .5 WEG Electric Corp.;
 - .6 Marathon Electric;
 - .7 Toshiba Corp.;
 - .8 Leeson Canada.

2.11 MOTOR STARTERS AND ACCESSORIES

- .1 Motor starters to be capable of starting associated motors under imposed loads. Confirm starter voltage matches motor prior to ordering.
- .2 Unless otherwise specified, starters for 1-phase motors are to be 115 volt, thermal overload protected manual starting switches with neon pilot light, surface or recessed enclosure to suit application, and, where automatic operation is required, separate H-O-A switch in enclosure to match starter enclosure.
- .3 Unless otherwise specified, starters for 3-phase motors less than 50 HP are to be combination "quick-make" and "quick-break" fused disconnects and full voltage non-reversing across-the-line starters, each complete with overload relay per phase, enclosure to suit application, and accessories in accordance with motor starter schedule.
- .4 Unless otherwise specified, starters for 3-phase motors 50 HP to 150 HP are to be reduced voltage, non-reversing, auto-transformer type starters complete with one overload relay per phase, enclosure to suit application, and accessories in accordance with motor starter schedule.
- .5 Unless otherwise specified, starters for 3-phase motors 150 HP and larger are to be reduced voltage, non-reversing, closed transition "wye-delta" starters complete with one overload relay per phase, enclosure to suit application, and accessories in accordance with motor starter schedule.
- .6 Starters for 2-speed double winding motors are to be generally as specified above but suitable for motor and equipped with 45 second time delay to permit equipment to coast down to low speed before it is operated at low speed.

- .7 Starters for 2-speed single winding motors are to be generally as specified above but suitable for motor and equipped with 45 second time delay to permit equipment to coast down to low speed before it is operated at low speed.
- .8 Starters for reversible motors for cooling towers are to be generally as specified above but suitable for motor and equipped with 45 second time delay to allow fan(s) to coast down to stop before being operated in reverse rotation.
- .9 Unless otherwise specified, motor starter enclosures are to be in accordance with following NEMA ratings:
 - .1 enclosures located in sprinklered areas – Type 2;
 - .2 enclosures exposed to the elements – Type 3R, constructed of stainless steel;
 - .3 enclosures inside the building in wet areas – Type 3R, constructed of stainless steel;
 - .4 enclosures in explosion rated area – Type 7 with exact requirements to suit the area and application;
 - .5 enclosures except as noted above – Type 1;
 - .6 enclosures located in finished areas – as above but recess type with brushed stainless steel faceplate.
- .10 Motor control centres are to be multi-unit, 2.28 m (9') high, NEMA Class 1, type "B", factory assembled, dead front, floor mounted, free-standing motor control centre with tin plated copper bus and NEMA Type 1 or Type 2 enclosure as for loose starters specified above. Each motor control centre is to be complete with starters as specified above, load and control wiring terminal boards, and required facilities for line and load side power wiring connections.
- .11 Disconnect switches for motor control centres are to be heavy-duty, CSA certified, front operated switches as per motor starter schedule, each complete with a handle suitable for padlocking in "off" position and arranged so that door cannot be opened with handle in "on" position and an NEMA enclosure as specified for loose starters. Fusible units are to be complete with fuse clips to suit fuse types specified below.
- .12 Fuses are to be, unless otherwise scheduled or specified, English Electric Ltd. HRC fuses, Form I Class "J" for constant running equipment and Form II Class "C" for equipment that cycles on and off.
- .13 Acceptable manufacturers are:
 - .1 Rockwell Automation Inc. - Allen-Bradley;
 - .2 Eaton;
 - .3 Siemens Canada;
 - .4 Schneider Electric.

2.12 SPRINKLER PROTECTION

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

2.13 MECHANICAL WORK IDENTIFICATION MATERIALS

- .1 Equipment nameplates are to be minimum 1.6 mm (1/16") thick 2-ply laminated coloured plastic plates, minimum 12 mm x 50 mm (½" x 2") for smaller items such as damper motors and control valves, minimum 25 mm x 65 mm (1" x 2-½") for equipment, and minimum 50 mm x 100 mm (2" x 4") for control panels and similar items. Additional requirements are as follows:
 - .1 unless otherwise specified or required, each nameplate is to be white, complete with bevelled edges and black engraved wording to completely identify equipment and its use with no abbreviations;
 - .2 wording is generally to be as per drawings, i.e. Fan EF-1, and is to include equipment service and building area/zone served, but must be reviewed with Consultant prior to engraving;
 - .3 supply stainless steel screws for securing nameplates in place;
 - .4 nameplates for equipment suspended above floor level or generally not within easy viewing from floor level are to be increased in size so as to be easily readable from floor level.

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

VALVE V12
200 mm (8")
CHILL. WATER
NORMALLY OPEN

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

PIPE SERVICE	IDENTIFICATION COLOUR	LEGEND
domestic cold water	green	DOM. COLD WATER
domestic hot water supply	green	DOM. HW SUPPLY
domestic hot water recirculation	green	DOM. HW RECIRC.
tempered domestic water	green	TEMP. DOM. WATER
chilled drinking water	green	CH. DRINK WTR.
storm drainage	green	STORM
sanitary drainage	green	SAN.
plumbing vent	green	SAN. VENT
fire protection sprinklers	red	F.P. SPRINKLER
heating water supply	yellow	HTG. WTR. SUPPLY
heating water return	yellow	HTG. WTR. RETURN

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

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

- .6 Medical gas piping identification materials and requirements are specified in Section entitled Medical Gas Piping Systems.

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

3 EXECUTION

3.01 GENERAL PIPING AND DUCTWORK INSTALLATION REQUIREMENTS

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

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

3.02 PIPE JOINT REQUIREMENTS

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

- .8 Unless otherwise specified make soldered joints in copper piping using flux suitable for and compatible with type of solder being used. Clean outside of pipe end and inside of fitting, valve, or similar accessory prior to soldering.
- .9 Joints in medical gas system piping are to be silver brazed in accordance with requirements of CAN/CSA Z7396.1.
- .10 Install mechanical joint fittings and couplings in accordance with manufacturer's instructions.
- .11 Grooves are to be rolled. Make arrangements with coupling and fitting manufacturer for shop and/or site instructions and demonstrations as required, and adhere to manufacturer's instructions with respect to pipe grooving, support, type of gasket required, anchoring and guiding grooved piping system.
- .12 If pressure crimped couplings and fittings are used, ensure gaskets are fully compatible with piping fluid, and valves and piping accessories are suitable. Use only fitting manufacturer supplied crimping equipment. Comply with manufacturer's latest published specification, instructions, and recommendations with respect to pipe, coupling, and fitting preparation and installation, and support, anchoring and guiding of piping system.
- .13 Solvent weld PVC piping in 2 parts, primer stage and cementing stage, in accordance with manufacturer's recommendations, ASTM D2855, and CSA requirements.
- .14 Install PVC piping with gasketed joints in accordance with manufacturer's current published specifications, instructions and recommendations, and CSA requirements.

3.03 INSTALLATION OF PIPE SLEEVES

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

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

3.04 INSTALLATION OF WATERPROOF MECHANICAL SEALS

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

3.05 DUCT OPENINGS

- .1 Duct openings, air inlet and outlet openings, fire damper and similar openings will be provided in new poured concrete work, masonry, drywall and other building surfaces by trade responsible for particular construction in which opening is required.
- .2 Size openings for fire dampers to 600 mm (24") high to suit damper arrangement with folding blade out of air stream.
- .3 For duct openings except where fire dampers are required, pack and seal space between duct or duct insulation and duct opening as specified above for pipe openings in non-fire rated construction.

3.06 SLEEVE AND FORMED OPENING LOCATION DRAWINGS

- .1 Prepare and submit for review, drawings indicating size and location of required sleeves, recesses and formed openings in poured or precast concrete work.

- .2 Such drawings are to be completely and accurately dimensioned and relate sleeve, recesses, and formed openings to suitable grid lines and elevation datum, and are to take into account structural items such as grade beams, column caps, and column drop slabs.
- .3 Begin to prepare such drawings immediately upon notification of acceptance of bid and award of Contract.

3.07 INSTALLATION OF PIPE ESCUTCHEON PLATES

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

3.08 INSTALLATION OF FASTENING AND SECURING HARDWARE

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

3.09 INSTALLATION OF PIPE HANGERS AND SUPPORTS

- .1 Provide required pipe hangers and supports.
- .2 Provide any additional structural steel channels, angles, inserts, beam champs and similar accessories required for hanging or supporting pipe. Unless otherwise shown or specified, hang or support pipes from structure only.
- .3 For insulated pipe, size hanger or support to suit diameter of insulated pipe and install hanger or support on outside of insulation and insulation finish.

- .4 Unless otherwise shown or specified, hang and/or support horizontal pipe above ground by means of hangers and/or supports specified in Part 2 of this Section. Unless otherwise shown or specified, hangers for suspended pipe less than or equal to 25 mm (1") dia. are to be clevis type or adjustable ring type, and hangers for suspended pipe greater than or equal to 40 mm (1-½") dia. are to be adjustable clevis type.
- .5 Space hangers and supports in accordance with following:
- .1 cast iron pipe – hang or support at every joint with maximum 2.4 m (8') spacing;
- .2 plastic pipe – conform to pipe manufacturer's recommended support spacing;
- .3 copper and steel pipe – hang or support at spacing in accordance with following schedule:

PIPE DIA.	MAX. SPACING STEEL (meters)	MAX. SPACING COPPER (meters)
to 25 mm (1")	2.4 m (8')	1.8 m (6')
40 mm (1-½")	2.7 m (9')	2.4 m (8')
50 mm (2")	3.0 m (10')	2.7 m (9')
65 mm (2-½")	3.6 m (12')	3.0 m (10')
75 mm (3")	3.6 m (12')	3.0 m (10')
90 mm (3-½")	3.6 m (12')	3.6 m (12')
100 mm (4")	4.2 m (14')	3.6 m (12')
250 mm (10")	6.0 m (20')	
300 mm (12")	6.7 m (22')	

- .4 flexible grooved pipe/coupling joint piping – as above but with not less than one hanger or support between joints.
- .6 Where pipes change direction, either horizontally or vertically, provide a hanger or support on horizontal pipe not more than 300 mm (12") from elbow, and where pipes drop from tee branches, support tees in both directions not more than 50 mm (2") on each side of tee.
- .7 When pipes with same slope are grouped and a common hanger or support is used, space hanger or support to suit spacing requirement of smallest pipe in group and secure pipes in place on common hanger or support.
- .8 Provide roller hangers or supports for heat transfer piping greater than or equal to 150 mm (6") diameter and conveying a material 75°C (170°F) or greater to facilitate pipe movement due to expansion and contraction, and at each hanger or support tack weld a steel protection saddle to pipe to protect piping insulation.
- .9 Unless otherwise shown or specified, support vertical piping by means of supports specified in Part 2 of this Section, spaced in accordance with following:
- .1 support vertical pipes at maximum 3 m (10') intervals or at every floor, whichever is lesser;

- .2 for sections of vertical piping with a length less than 3 m (10'), support pipe at least once;
- .3 for vertical cast iron plain end pipe (mechanical joint type), secure riser or pipe clamp around pipe under a flange integral with pipe for vertical support purposes, or provide a length of hub and spigot pipe to facilitate proper support;
- .4 for vertical steel pipe risers in excess of 3 m (10'), weld shear lugs to pipe to carry load;
- .5 for vibration isolated piping risers, provide rubber-steel-rubber vibration isolation pads between riser clamps and floor.
- .10 Each hanger, support or securement for horizontal bare copper tubing is to be plastic coated to prevent direct contact between pipe and ferrous hanger. Each wall or floor clamp for vertical bare copper piping is to be isolated from pipe by means of strips of flexible rubber inserts. Use of painted ferrous hangers and supports, including those painted with copper coloured paint, is not acceptable. Site application of tape or other types of isolation is not acceptable.
- .11 For insulated horizontal piping less than or equal to 40 mm (1-½") diameter, provide galvanized steel insulation protection shields between insulation and hanger or support. Install shields immediately after pipe is insulated.
- .12 Do not support piping from steel deck without written consent from Owner and review with Consultant.

3.10 SUPPLY OF ACCESS DOORS

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

- .8 Identify access doors supplied for concealed medical gas system shut-off valves or equipment with a permanent label in accordance with requirements of CAN/CSA Z7396.1.

3.11 INSTALLATION OF VALVES

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

3.12 INSTALLATION OF PRESSURE GAUGES AND THERMOMETERS

- .1 Provide pressure gauges in following locations:
 - .1 in valved tubing across suction, suction strainer (if applicable), and discharge piping of each circulating pump;
 - .2 in supply and return piping connections to main mechanical plant equipment such as boilers, chillers, heat exchangers, main coils, etc.;
 - .3 in expansion tank(s);
 - .4 in separate domestic hot water storage tank(s);
 - .5 at top most outlet in each standpipe fire protection system riser;
 - .6 in piping at each side of a pressure reducing valve;
 - .7 in potable water service piping downstream of meter;
 - .8 wherever else shown and/or specified.
- .2 Provide thermometers in following locations:
 - .1 in supply and return piping connections to main mechanical plant equipment such as boilers, chillers, cooling towers, heat exchangers, main coils, etc., unless temperature indication is supplied with equipment;

- .2 wherever else shown and/or specified.
- .3 Conform to following installation requirements:
 - .1 for installation of thermometers in piping wells, provide a coat of metallic base heat transfer paste or grease in piping well;
 - .2 for pressure gauges in piping at equipment locations, install pressure gauge between equipment and first pipe fitting;
 - .3 locate, mount and adjust instruments so they are easily readable;
 - .4 where pressure gauges and/or thermometers are located at high level or in an area where they cannot be easily seen, provide remote reading instruments.

3.13 INSTALLATION OF EQUIPMENT DRIVE GUARDS AND ACCESSORIES

- .1 Provide OSHA guards for exposed accessible rotating parts such as belt drives, couplings, fan wheels, and shaft ends on mechanical equipment.
- .2 Install belt guards to allow movement of motors for adjusting belt tension.
- .3 Provide a means to permit lubrication and use of test instruments with guards in place.
- .4 Secure guards to equipment or equipment base but do not bridge sound or vibration isolation.
- .5 Where equipment oil level gauges, oil reservoirs, grease cups, or grease gun fittings are integral with equipment but are not easily accessible for service, extend to an accessible location using aluminium or copper tubing.

3.14 MECHANICAL WORK IDENTIFICATION

- .1 Identify new exposed piping and ductwork as per Part 2 of this Section in locations as follows:
 - .1 at every end of every piping or duct run;
 - .2 adjacent to each valve, strainer, damper and similar accessory;
 - .3 at each piece of connecting equipment;
 - .4 on both sides of every pipe and duct passing through a floor, wall or partition, unless otherwise specified;
 - .5 at 6 m (20') intervals on pipe and duct runs exceeding 6 m (20') in length;
 - .6 at least once in each room, and at least once on pipe and duct runs less than 6 m (20') in length.
- .2 Unless otherwise specified identify new concealed piping and ductwork as per Part 2 of this Section in locations as follows:
 - .1 at points where pipes or ducts enter and leave rooms, shafts, pipe chases, furred spaces, and similar areas;

- .2 at maximum 6 m (20') intervals on piping and ductwork above suspended accessible ceilings, and at least once in each room;
 - .3 at each access door location;
 - .4 at each piece of connected equipment, automatic valve, etc.
- .3 Provide an identification nameplate for equipment provided as part of this project, including items such as control valves, motorized dampers, instruments, and similar products. Secure nameplates in place, approximately at eye level if possible, with stainless steel screws unless such a practice is prohibitive, in which case use epoxy cement applied to cleaned surfaces. Locate nameplates in the most conspicuous and readable location.
- .4 Provide an identification nameplate for each motor starter or disconnect switch located in a motor control centre or on a motor starter panel, and on each individually mounted starter provided as part of mechanical work, and on each disconnect switch provided as part of the electrical work for motorized equipment provided as part of mechanical work.
- .5 Tag valves and prepare a valve tag chart in accordance with following requirements:
- .1 attach a valve tag to each new valve, except for valves located immediately at equipment they control;
 - .2 prepare a computer printed valve tag chart to list tagged valves, with, for each valve, the tag number, location, valve size, piping service, and valve attitude (normally open or normally closed);
 - .3 If an existing valve tag chart is available at site, valve tag numbering is to be an extension of existing numbering and new valve tag chart is to incorporate existing chart;
 - .4 frame and glaze one copy of chart and, unless otherwise directed, affix to a wall in each main Mechanical and/or Equipment Room;
 - .5 include a copy of valve tag chart in each copy of operating and maintenance instruction manuals;
 - .6 hand an identified CD of valve tag chart to Owner at same time O&M Manuals are submitted.
- .6 Where shut-off valves, control dampers, sensors, and similar items which will or may need maintenance and/or repair are located above accessible suspended ceilings, provide round coloured ceiling tacks in ceiling panel material, or stickers equal to Brady "Quick Dot" on ceiling grid material to indicate locations of items. Unless otherwise specified, ceiling tack or sticker colours are to be as follows:
- .1 HVAC piping valves and equipment: yellow
 - .2 fire protection valves and equipment: red
 - .3 plumbing valves and equipment: green
 - .4 HVAC ductwork dampers and equipment: blue

- .5 control system hardware and equipment: orange

3.15 FINISH PAINTING OF MECHANICAL WORK

- .1 Finish paint exposed mechanical work as specified and/or scheduled in accordance with requirements of Division 09.
- .2 Touch-up paint damaged factory applied finishes on mechanical work products.

3.16 PIPE LEAKAGE TESTING

- .1 Before piping has been insulated or concealed, and before equipment, fixtures and fittings have been connected, test piping for leakage.
- .2 Tests are to be witnessed by Consultant and/or Owner's representative, and, where required, representatives of governing authorities. Give ample notice (minimum 7 working days) of tests in writing and verify attendance. Have completed test report sheets dated and signed by those present to confirm proper test results.
- .3 When circumstances prevent scheduled tests from taking place, give immediate and adequate notice of cancellation to all who were scheduled to attend.
- .4 Gravity Drainage and Vent Piping
 - .1 Test piping in accordance with local governing building code.
 - .2 After fixtures and fittings are set and pipes are connected to building drain or drains, turn on water into pipe, fixtures, fittings and traps in order to detect any imperfect material or workmanship. Perform smoke test if required by local governing authorities.
- .5 Pumped Drainage Piping
 - .1 Test piping with cold water at a pressure of 1-½ times normal working pressure and maintain pressure for minimum of 2 hours.
- .6 Domestic Water Piping
 - .1 Test piping with cold water at a pressure of 1-½ times normal working pressure and maintain pressure for minimum of 2 hours.
- .7 Sprinkler System Piping
 - .1 Test system piping in accordance with requirements of NFPA No. 13, "Installation of Sprinkler Systems", and in accordance with any additional requirements of governing authorities.
- .8 Heat Transfer (HVAC) System Piping
 - .1 Test piping with cold water at pressure of 1035 kPa (150 psi) for minimum of 2 hours.
- .9 Medical Gas System Piping
 - .1 Perform leakage and flow tests for piping using oil-free compressed air or oil-free dry nitrogen in accordance with requirements of CAN/CSA Z7396.1.

.10 Following requirements apply to all testing:

- .1 ensure piping has been properly flushed, cleaned and is clear of foreign matter prior to pressure testing;
- .2 temporarily remove or valve off piping system specialties or equipment which may be damaged by test pressures prior to pressure testing systems, and flush piping to remove foreign matter;
- .3 when testing is carried out below highest level of particular system, increase test pressure by the hydrostatic head of 7 kPa (1 psi) for every 600 mm (24") below high point;
- .4 include for temporary piping connections required to properly complete tests;
- .5 piping under test pressure is to have zero pressure drop for length of test period;
- .6 make tight leaks found during tests while piping is under pressure, and if this is impossible, remove and refit piping and reapply test until satisfactory results are obtained;
- .7 where leaks occur in threaded joints in steel piping, no caulking of these joints will be allowed under any conditions;
- .8 perform tests in reasonably sized sections so as to minimize number of tests required;
- .9 in addition to leakage tests specified above, demonstrate proper flow throughout systems including mains, connections and equipment, as well as proper venting and drainage, and include for any necessary system adjustments to achieve proper conditions.

3.17 SUPPLY OF MOTOR STARTERS AND ACCESSORIES

- .1 Unless otherwise shown or specified, supply starter for each item of motorized equipment. Refer to Motor Starter Schedule.
- .2 Where 3-phase starters are indicated in motor control centres, supply motor control centres with starters and bolt to concrete housekeeping pad.
- .3 Where package type equipment with integral starters, or equipment with starters integral in loose power and control panels supplied with equipment is fed from motor control centre, provide disconnect switch in motor control centre in lieu of motor starter.
- .4 Where 3-phase starters are indicated and/or scheduled to be mounted on a motor starter panel, starters will be mounted and connected, complete with panels and splitter trough, as part of electrical work. Hand starters to electrical trade at site when they are required.
- .5 Where package type equipment with integral starters, or equipment with starters integral in loose power and control panels supplied with equipment is fed from motor starter panel, disconnect switch will be provided on motor starter panel as part of electrical work.
- .6 Unless otherwise specified or shown on drawings, 1-phase motor starters will be mounted adjacent to equipment they serve and connected complete as part of electrical work. Hand starters to electrical trade at site at proper time.

3.18 ELECTRICAL WIRING WORK FOR MECHANICAL WORK

- .1 Coordinate requirements and responsibilities for electrical wiring with Electrical Division 26 Contractor. Provide low voltage control wiring not provided under work of Division 26.
- .2 Unless otherwise specified or indicated, following electrical wiring work for mechanical equipment will be done as part of electrical work:
 - .1 "line" side power wiring to motor starters or disconnect switches in motor control centres and starters or disconnects on motor starter panels, and "load" side wiring from starters or disconnects to equipment;
 - .2 "line" side power wiring to individual wall mounted starters, and "load" side wiring from starters to equipment;
 - .3 "line" side power wiring to pre-wired power and control panels and variable frequency drives (VFD), and "load" side power wiring from the panels and VFD's to equipment;
 - .4 provision of receptacles for plug-in equipment;
 - .5 provision of disconnect switches for motors in excess of 9 m (30') from starter location, or cannot be seen from starter location, and associated power wiring;
 - .6 motor starter interlocking in excess of 24 volts;
 - .7 wiring from motor winding thermistors in motors 30 HP and larger to motor starter contacts;
 - .8 120 volt power connections to electrical receptacles integral with small ceiling exhaust fans, including wiring through light switches or speed controllers;
 - .9 120 volt wiring connections to lighting fixture/switch combinations integral with air handling units;
 - .10 120 volt wiring connections to duplex receptacles integral with air handling unit control panels.
- .3 Mechanical wiring work not listed above or specified herein or on drawings to be done as part of electrical work is to be installed in conduit and is to be done as part of mechanical work in accordance with wiring requirements specified for electrical work.

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

- .1 Coordinate shut-down and interruption to existing mechanical systems with Owner. Include for costs of premium time to perform work during nights, weekends or other times outside of normal working hours, which may be necessary to comply with stipulations specified herein this Article and as specified in Division 00 and 01. Services for operation of existing non-renovated areas of building are to be maintained. Allow for premium time work in the following areas:
 - .1 Areas in the Laboratory space in Block H Level 2. Before 6am and after 5pm during working week.
 - .2 Day Surgery A. After 3:30pm on weekdays or on weekends.

- .3 Areas within Tim Hortons.
- .2 Upon award of a Contract, submit a list of anticipated shut-down times and their maximum duration.
- .3 Prior to each shut-down or interruption, inform Owner and Consultant in writing minimum 10 working days in advance of proposed shut-down or interruption and obtain written consent to proceed. Do not shut-down or interrupt any system or service without such written consent. Shutdowns of some essential services may require additional advance notification time.
- .4 Perform work associated with shut-downs and interruptions as continuous operations to minimize shut-down time and to reinstate systems as soon as possible, and, prior to any shut-down, ensure materials and labour required to complete the work for which shut-down is required are available at site.
- .5 Pipe freezing may be used to connect new piping to existing piping without draining existing piping. Pipe freeze equipment is to be equal to "NORDIC FREEZE" equipment supplied by Mag Tool Inc. (1-800-661-9983) or Rigid Tool Co. RIGID "SuperFreeze".
- .6 Confirm any methods of procedures with Owner and review with Consultant prior to start of work.

3.20 CUTTING, PATCHING AND CORE DRILLING

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

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

3.21 PACKING AND SEALING CORE DRILLED PIPE OPENINGS

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

3.22 FLASHING FOR MECHANICAL WORK PENETRATING ROOF

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

3.23 CLEANING MECHANICAL WORK

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

3.24 CONNECTIONS TO OTHER EQUIPMENT

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

3.25 FAN NOISE LEVELS

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

3.26 EQUIPMENT AND SYSTEM MANUFACTURER'S CERTIFICATION

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

3.27 EQUIPMENT AND SYSTEM START-UP

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

3.28 INTEGRATED SYSTEMS TESTING

- .1 Perform testing of integrated systems and equipment in accordance with CAN/ULC-S1001 to ensure that fire protection and life safety systems (i.e. fire alarm systems, sprinklers, standpipe, smoke control, ventilation, pressurization, door hold-open device, elevator recalls, smoke and fire dampers, emergency power, emergency lighting, fire pumps, generators, etc.), including their interconnections with other building systems, are functioning according to the intent of their design.
- .2 Engage respective systems or equipment vendors or trades to be onsite during inspection and testing work to perform adjustments or remedial work to correct issues identified by inspection and testing work.

3.29 CONCRETE WORK FOR MECHANICAL EQUIPMENT BASES/PADS

- .1 Concrete work required for mechanical equipment bases/pads will be provided as part of concrete work of Division 03.

- .2 Exactly locate bases/pads at site and be present during concrete pour to ensure anchor bolts, inserts, plates and similar hardware are not damaged or dislodged.

END OF SECTION

1 GENERAL

1.01 APPLICATION

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

1.02 DEFINITIONS

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

1.03 SUBMITTALS

- .1 Submit a product data sheet for each insulation system product. Include identification that product has also been tested to CAN/ULC S102.

1.04 QUALITY ASSURANCE

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

2 PRODUCTS

2.01 FIRE HAZARD RATINGS

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

2.02 THERMAL PERFORMANCE

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

2.03 PIPE INSULATION MATERIALS

- .1 Horizontal Pipe Insulation at Hangers and Supports
 - .1 Equal to Belform Insulation Ltd. "Koolphen K-Block" insulated pipe support inserts consisting of minimum 150 mm (6") long, pre-moulded, rigid, sectional phenolic foam insulation (of same thickness as adjoining insulation) with a reinforced foil and kraft paper vapour barrier jacket and a captive galvanized steel saddle.
- .2 Flexible Foam Elastomeric
 - .1 Closed cell, sleeve type, longitudinally split self-seal, foamed plastic pipe insulation with a water vapour transmission rating of 0.10 in accordance with ASTM E96, Procedure B, and required installation accessories.
 - .2 Acceptable products are:
 - .1 Armacell AP/Armaflex;
 - .2 IK Insulation Group K-Flex "LS" Self-Seal Pipe Insulation.
- .3 Pre-Moulded Mineral Fibre
 - .1 Rigid, sectional, sleeve type insulation to ASTM C547, with a factory applied vapour barrier jacket.
 - .2 Acceptable products are:
 - .1 Johns Manville Inc. "Micro-Lok AP-T Plus";
 - .2 Knauf Fiber Glass "Pipe Insulation" with "ASJ-SSL" jacket;
 - .3 Manson Insulation Inc. "ALLEY K APT";
 - .4 Owens Corning "Fiberglas" Pipe Insulation.
- .4 Blanket Mineral Fibre
 - .1 Blanket type roll insulation to ASTM C553, 24 kg/m³ (1-½ lb/ft³) density, with a factory applied vapour barrier facing.
 - .2 Acceptable products are:
 - .1 Johns Manville Inc. Microlite FSK Duct Wrap Type 150;
 - .2 Knauf Fiber Glass Blanket Insulation FSK Duct Wrap Type III;
 - .3 Manson Insulation Inc. ALLEY WRAP FSK Duct Wrap Type III;

- .4 Certainteed Corporation Softtouch FSK Duct Wrap Type 150.
- .5 Pre-Moulded Weatherproof Jacketed Mineral Fibre
 - .1 Knauf Insulation "Redi-Klad 1000" sectional, sleeve type pipe insulation with a self-sealing weatherproof jacket and a 100 mm (4") butt joint sealing strip with each section.

2.04 BARRIER-FREE LAVATORY PIPING INSULATION KITS

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

2.05 EQUIPMENT INSULATION MATERIALS

- .1 Blanket Mineral Fibre
 - .1 Blanket type roll form insulation to ASTM C553, 24 kg/m³ (1-½ lb/ft³) density, with a factory applied vapour barrier facing.
 - .2 Acceptable products are:
 - .1 Johns Manville Inc. Microlite FSK Duct Wrap Type 150;
 - .2 Knauf Fiber Glass Blanket Insulation FSK Duct Wrap Type III;
 - .3 Manson Insulation Inc. ALLEY WRAP FSK Duct Wrap Type III;
 - .4 Certainteed Corporation Softtouch FSK Duct Wrap Type 150.
- .2 Semi-Rigid Mineral Fibre Board
 - .1 Roll form, moulded insulation to ASTM C1393, with a factory applied vapour barrier facing consisting of laminated aluminium foil and kraft paper.
 - .2 Acceptable products are:
 - .1 Knauf Fiber Glass Pipe and Tank Insulation;
 - .2 Manson Insulation Inc. "AK FLEX";
 - .3 Johns Manville Inc. Pipe and Tank Insulation "Micro-Flex";
 - .4 Multi-Glass Insulation Ltd. "MULTI-FLEX MF";
 - .5 Owens Corning Pipe and Tank Insulation.

2.06 REMOVABLE/REUSABLE INSULATION COVERS

- .1 Covers for equipment 12 mm (½") to less than 150 mm (6"):
 - .1 Valve, etc. covers are to be NO SWEAT reusable insulation wraps with vapour barrier jacket and self-sealing ends and longitudinal seam, with a length to suit application and an insulation thickness equal to adjoining insulation.
- .2 Covers for equipment greater than or equal to 150 mm (6"):
 - .1 Custom manufactured equipment covers conforming to shape of item to be insulated, designed to be easily removable and replaceable to suit use and maintenance procedures of particular item, and to provide adequate personnel protection. Covers are to be complete with minimum 95 kg/m³ (6 lb/ft³) density ceramic fibre insulation sewn between minimum 542.5 g/m² (1.8 oz/ft²) weight silicone impregnated fibreglass fabric in a quilted pattern using double stitches made with Kelvar or Teflon coated fibreglass thread. Overlap flaps are to be secured using laces, snaps, or Velcro double stitched in place.
 - .2 Acceptable manufacturers are:
 - .1 Crossby Dewar Inc.;
 - .2 Insufab Systems Inc.;
 - .3 ADL Insulflex Inc.;
 - .4 Firwin Corp.;
 - .5 GlassCell Isofab Inc.

2.07 DUCTWORK SYSTEM INSULATION MATERIALS

- .1 Rigid Mineral Fibre Board
 - .1 Pre-formed board type insulation to ASTM C612, 48 kg/m³ (3 lb/ft³) density, with a factory applied reinforced aluminum foil and kraft paper facing.
 - .2 Acceptable products are:
 - .1 Knauf Fiber Glass Insulation Board with FSK facing;
 - .2 Manson Insulation Inc. "AK BOARD FSK";
 - .3 Johns Manville Inc. Type 814 "Spin-Glas";
 - .4 Owens Corning 703.
- .2 Semi-Rigid Mineral Fibre Board
 - .1 Roll form insulation to ASTM C1393, consisting of cut strips of rigid mineral board insulation glued to an aluminium foil and kraft paper facing.

- .2 Acceptable products are:
 - .1 Multi-Glass Insulation Ltd. "Multi-Flex MKF";
 - .2 Owens Corning Pipe and Tank Insulation;
 - .3 Johns Manville Inc. Pipe and Tank Insulation "Micro-Flex".
- .3 Blanket Mineral Fibre
 - .1 Blanket type roll form insulation to ASTM C553, 24 kg/m³ (1-½ lb/ft³) density, 40 mm (1-½") thick, with a factory applied vapour barrier facing.
 - .2 Acceptable products are:
 - .1 Johns Manville Inc. Microlite FSK Duct Wrap Type 150;
 - .2 Knauf Fiber Glass Blanket Insulation FSK Duct Wrap Type III;
 - .3 Manson Insulation Inc. ALLEY WRAP FSK Duct Wrap Type III;
 - .4 Certainteed Corporation Softtouch FSK Duct Wrap Type 150.
- .4 Flexible Foam Elastomeric
 - .1 Sheet form, CFC free, closed cell, self-adhering elastomeric nitrile rubber insulation with a water vapour permeability rating of 0.08 in accordance with ASTM E96 Procedure A.
 - .2 Acceptable products are:
 - .1 Armacell "AP Armaflex";
 - .2 IK Insulation Group "K-Flex Duct Wrap", S2S.

2.08 INSULATING COATINGS

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

2.09 INSULATION FASTENINGS

- .1 Wire
 - .1 Minimum #15 gauge galvanized annealed wire.
- .2 Aluminium Banding
 - .1 Equal to ITW Insulation Systems Canada "FABSTRAPS" minimum 12 mm (½") wide, 0.6 mm (1/16") thick aluminium strapping.

.3 Stainless Steel Banding

- .1 Equal to ITW Insulation Systems Canada "FABSTAPS" 0.6 mm (1/16") thick, minimum 12 mm (1/2") wide type 304 stainless steel strapping.

.4 Duct Insulation Fasteners

- .1 Weld-on 2 mm (3/32") diameter zinc coated steel spindles of suitable length, complete with minimum 40 mm (1-1/2") square plastic or zinc plated steel self-locking washers.

.5 Tape Sealant

- .1 Equal to 3M 1520-CW self-adhesive insulation tapes, types PAF, FSK, ASJ, or SWV as required to match surface being sealed.

.6 Mineral Fibre Insulation Adhesive

- .1 Clear, pressure sensitive, brush consistency adhesive, suitable for a temperature range of -20°C to 82°C (-4°F to 180°F), compatible with type of material to be secured, and WHMIS classified as non-hazardous.

.7 Flexible Elastomeric Insulation Adhesive

- .1 Armacell "Armaflex" #520 air-drying contact adhesive.

.8 Screws

- .1 No. 10 stainless steel sheet metal screws.

2.10 INSULATION JACKETS AND FINISHES

.1 Flexible Insulation Jacketing

- .1 Equal to 3M VentureClad 1577CW Series, flexible, laminated, self-adhering, protective jacketing, vapour barrier with 0.00 permeability rating and weatherproofing membrane, having a high performance acrylic adhesive capable of installation with no additional mechanical attachment and with a maximum flame spread/smoke developed rating of 25/50 when tested in accordance with ULC S102. Review finish colour requirements with Consultant before ordering.

.2 Roll Form Sheet and Fitting Covers

- .1 Minimum 15 mm (1/2") thick white PVC, maximum 25/50 fire/smoke rated tested in accordance with ULC S102, complete with installation and sealing accessories. Acceptable products are:
 - .1 Johns Manville Inc. "Zeston" 300;
 - .2 Proto Corp. "LoSMOKE".

.3 Rigid Aluminium Jacket

- .1 Equal to ITW Insulation Systems Canada "Lock-on" 0.406 mm (0.016") thick embossed aluminium jacket material to ASTM B209, factory cut to size and complete with polysurlyn moisture barrier and continuous modified Pittsburgh Z-Lock, butt straps with "Fabstraps" to weatherproof the end to end joints, and 2-piece epoxy coated pressed aluminium fittings with weather locking edges.

.4 Coating for Flexible Foam Elastomeric Insulation

- .1 Flexible foam elastomeric insulation protective coating equal to Armacell "WB Armaflex" weatherproof, water-based latex enamel finish.

3 EXECUTION

3.01 GENERAL INSULATION APPLICATION REQUIREMENTS

- .1 Unless otherwise specified, do not insulate following:
 - .1 factory insulated equipment and piping;
 - .2 heating piping within radiation unit enclosures, including blank filler sections of enclosures;
 - .3 heating piping in soffits and/or overhang spaces and connected to bare element radiation in spaces;
 - .4 branch potable water piping located under counters to serve counter mounted plumbing fixtures and fittings, except barrier-free lavatories;
 - .5 exposed chrome plated potable water angle supplies from concealed piping to plumbing fixtures and fittings, except barrier-free lavatories;
 - .6 heated liquid system pump casings, valves, strainers and similar accessories;
 - .7 heating system expansion tanks;
 - .8 fire protection pump casings;
 - .9 manufactured expansion joints and flexible connections;
 - .10 acoustically lined ductwork and/or equipment;
 - .11 factory insulated flexible branch ductwork;
 - .12 fire protection system water storage tanks;
 - .13 piping unions, except for unions in "cold" category piping.
- .2 Install work generally in accordance with TIAC National Insulation Standards Manual except conform to manufacturer's instructions and recommendations, and requirements specified in this Section.
- .3 Install insulation directly over pipes and ducts, not over hangers and supports.

- .4 Install piping insulation and jacket continuous through pipe openings and sleeves.
- .5 Install duct insulation continuous through walls, partitions, and similar surfaces except at fire dampers.
- .6 For insulation thicknesses greater than or equal to 75 mm (3"), provide double layer of insulation to achieve required insulation thickness and stagger joint locations.
- .7 When insulating "cold" piping and equipment, extend insulation up valve bodies and other such projections as far as possible, and protect insulation jacketing from condensation at its junction with metal.
- .8 When insulating vertical piping risers 75 mm (3") diameter and larger, use insulation support rings welded directly above lowest pipe fitting, and thereafter at 4.5 m (14.7') centres and at each valve and flange. Insulate in accordance with Thermal Insulation Association of Canada National Insulation Standards, Figure No. 9.
- .9 Where existing insulation work is damaged as a result of mechanical work, repair damaged insulation work to Project work standards.
- .10 Where mineral fibre rigid sleeve type insulation is terminated at valves, equipment, unions, etc., neatly cover exposed end of insulation with a purpose made PVC cover on "cold" piping, and with canvas jacket material on "hot" piping.
- .11 Carefully and neatly gouge out insulation for proper fit where there is interference between weld bead, mechanical joints, etc., and insulation. Bevel away from studs and nuts to permit their removal without damage to insulation, and closely and neatly trim around extending parts of pipe saddles.
- .12 Where thermometers, gauges, and similar instruments occur in insulated piping, and where access to heat transfer piping balancing valve ports and similar items are required, create a neat, properly sized hole in insulation and provide a suitable grommet in the opening.

3.02 INSULATION FOR HORIZONTAL PIPE AT HANGERS AND SUPPORTS

- .1 At each hanger and support location for piping 50 mm (2") diameter and larger to be insulated, except where roller hangers and/or supports are required, and unless otherwise specified, supply a factory fabricated section of phenolic foam pipe insulation with integral vapour barrier jacket and captive galvanized steel shield. Supply insulation sections to piping installers for installation as pipe is erected.

3.03 PIPE INSULATION REQUIREMENTS – MINERAL FIBRE

- .1 Insulate following pipe inside building and above ground with mineral fibre insulation of thickness indicated:
 - .1 domestic cold water piping, less than 100 mm (4") dia. – 25 mm (1") thick;
 - .2 domestic cold water piping, greater than or equal to 100 mm (4") dia. – 40 mm (1-½") thick;
 - .3 domestic hot water piping, less than 40 mm (1-½") dia. – 25 mm (1") thick;

- .4 domestic hot water piping, greater than or equal to 40 mm (1½") dia. – 40 mm (1½") thick;
- .5 tempered domestic water piping, supply and return, less than 40 mm (1½") dia. – 25 mm (1") thick;
- .6 tempered domestic water piping, supply and return, greater than or equal to 40 mm (1½") dia. – 50 mm (2") thick;
- .7 storm drainage piping from roof drains to the point where main vertical risers extend straight down, without offsets, and connect to horizontal underground mains – 25 mm (1") thick;
- .8 condensate drainage piping from fan coil unit or any other air conditioning system/unit drain pans to main vertical drain risers or to indirect drainage point – 25 mm (1") thick;
- .9 drainage piping from refrigerated drinking fountains to nearest 75 mm (3") dia. or larger drain pipe – 25 mm (1") thick;
- .10 hot water heating piping, supply and return, less than 40 mm (1½") dia. – 40 mm (1½") thick;
- .11 hot water heating piping, supply and return, greater than or equal to 40 mm (1½") dia. – 50 mm (2") thick;
- .12 chilled domestic cold water piping from remote water cooler(s) to drinking fountain(s) – 40 mm (1½") thick;
- .2 Secure overlap flap of sectional insulation jacket tightly in place. Cover section to section butt joints with tape sealant.
- .3 Insulate fittings with sectional pipe insulation mitred to fit tightly, and cover butt joints with tape sealant, or, alternatively, wrap fittings with blanket mineral fibre insulation to a thickness and insulating value equal to sectional insulation, secure in place with adhesive and/or wire, and cover with PVC fitting covers.
- .4 Unless otherwise specified, insulate unions, valves, strainers, and similar piping system accessories in "cold" piping with cut and tightly fitted segments of sectional pipe insulation with joints covered with tape sealant, or, alternatively, wrap piping union, valve, strainer, etc., with blanket mineral fibre and cover with PVC covers as for paragraph above.
- .5 Terminate sectional insulation approximately 50 mm (2") from flange or coupling on each side of flange or coupling. Cover flange or coupling with a minimum 50 mm (2") thickness of blanket mineral fibre insulation wide enough to butt tightly to ends of adjacent sectional insulation. Secure blanket insulation in place and cover with a purpose made PVC coupling cover.
- .6 Take special care at concealed water rough-in piping at plumbing fixtures to ensure piping is properly insulated. If necessary due to space limitations, use 12 mm (½") thick sectional pipe insulation in lieu of 25 mm (1") thick insulation.

3.04 PIPE INSULATION REQUIREMENTS – FIRE-RATED INSULATION

- .1 Where pipe (inside building and above ground) which is to be insulated penetrates fire rated construction, provide fire-rated, non-combustible sectional insulation on portion of pipe in fire barrier and for a distance of 50 mm (2") on either side of fire barrier. Insulation thickness is to be as specified, but in any case minimum 25 mm (1").

3.05 INSTALLATION OF BARRIER-FREE LAVATORY INSULATION KITS

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

3.06 EQUIPMENT INSULATION REQUIREMENTS – BLANKET TYPE MINERAL FIBRE

- .1 Insulate following equipment with mineral fibre blanket type insulation of thickness indicated:
 - .1 chilled water and/or domestic cold-water pump casings – 40 mm (1-½") thick;
 - .2 roof drain sumps where inside the building – 25 mm (1") thick;
 - .3 water meter(s) – 40 mm (1-½") thick;
 - .4 top of radiant ceiling panels – 50 mm (2") thick.
- .2 Unless otherwise noted, wrap equipment to a thickness and insulating value equal to an equivalent thickness of rigid sectional pipe insulation. Laminate insulation in place with a full coverage of adhesive and secure with wire. Apply a jacket of insulation vapour barrier material secured in place with adhesive or sealant tape.
- .3 Cover roof drain sumps with purpose made PVC fitting covers.
- .4 Lay fibreglass blanket on radiant ceiling panels after testing is complete.

3.07 INSTALLATION OF REMOVABLE/REUSABLE INSULATION COVERS

- .1 Provide "wrap type" removable and reusable insulation covers for "cold" circuit balancing valves, backflow preventers, and similar items, and for steam traps and similar items requiring service in piping less than 150 mm (6") dia.

3.08 DUCTWORK INSULATION REQUIREMENTS – MINERAL FIBRE

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

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

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

3.09 DUCTWORK INSULATION REQUIREMENTS – FLEXIBLE ELASTOMERIC

- .1 Insulate exterior ductwork (except fresh air intake ductwork) and associated plenums and/or casings outside building with minimum 75 mm (3") thick flexible elastomeric sheet insulation to achieve minimum R-12 (h ft² °F/Btu). Apply in accordance with manufacturer's instructions.
- .2 Install with adhesive in strict accordance with manufacturer's instructions to produce a weather-proof installation. Ensure sheet metal work joints are sealed watertight prior to applying insulation.

3.10 APPLICATION OF INSULATING COATINGS

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

3.11 INSULATION FINISH REQUIREMENTS

- .1 PVC Pipe and Fittings Covers
 - .1 Jacket exposed pipe insulation work inside building with white sheet PVC and fitting covers. Install sheet PVC and fitting covers tightly in place with overlapped circumferential and longitudinal joints arranged to shed water. Seal joints to produce a neat, water-tight installation. Provide slip-type expansion joints where required by manufacturer's instructions.
 - .2 Install rigid aluminium jacket material tightly in place with overlapped circumferential joints positioned to shed water and covered with butt straps supplied with jacket. Provide aluminium jacket for following insulation:
 - .1 All exterior ductwork.

.2 Coating for Flexible Foam Elastomeric Insulation

- .1 Apply 2 coats (with 24 hr. between coats) of specified coating to flexible elastomeric insulation outside building.

END OF SECTION

1 GENERAL

1.01 APPLICATION

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

2 PRODUCTS

Not Used

3 EXECUTION

3.01 DISCONNECTION AND REMOVAL OF EXISTING MECHANICAL WORK

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

3.02 HAZARDOUS WASTE

- .1 Be advised that items such as drainage sumps, catch basins, interceptors, and the like may contain unidentified hazardous waste and caution is to be taken when disconnecting and removing these items.
- .2 If hazardous waste not listed in Specification is found, notify Owner and Consultant immediately and await directions.

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

- .1 Co-ordinate shut-down and interruption to existing mechanical systems with Owner. Include for costs of premium time to perform work during nights, weekends or other times outside of normal working hours, which may be necessary to comply with stipulations specified herein this Article and as specified in Division 00 and 01. Services for operation of existing non-renovated areas of building are to be maintained. Allow for premium time work in the following areas:
 - .1 Areas in the Laboratory space in Block H Level 2. Before 6am and after 5pm during working week.
 - .2 Day Surgery A. After 3:30pm on weekdays or on weekends
 - .3 Areas within Tim Hortons.
- .2 Upon award of contract, submit a list of anticipated shut-down times and their maximum duration.
- .3 Prior to each shut-down or interruption, inform Owner in writing minimum 10 business days in advance of proposed shut-down or interruption and obtain written consent to proceed. Do not shut-down or interrupt any system or service without such written consent. Shutdowns of some essential services may require additional advance notification time.
- .4 Perform work associated with shut-downs and interruptions as continuous operations to minimize shut-down time and to reinstate systems as soon as possible, and, prior to any shut-down, ensure materials and labour required to complete the work for which shut-down is required are available at site.
- .5 Pipe freezing may be used to connect new piping to existing piping without draining existing piping. Pipe freeze equipment is to be equal to "NORDIC FREEZE" equipment supplied by Mag Tool Inc. or Rigid Tool Co. RIGID "SuperFreeze".

END OF SECTION

1 GENERAL

1.01 APPLICATION

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

1.02 DEFINITIONS

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

1.03 SUBMITTALS

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

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

1.04 QUALITY ASSURANCE

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

2 PRODUCTS

Not Used

3 EXECUTION

3.01 SCOPE OF WORK

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

- .1 TAB of domestic water systems (all piping extended from Municipal main) is to include:
 - .1 domestic hot water recirculation piping;
 - .2 tempered water piping flows.
- .2 TAB of medical gas systems is not part of TAB work and is specified in Section entitled Medical Gas Piping Systems.
- .3 TAB of heating systems is to include piping and equipment fluid temperatures, flows and control, and if TAB is not done during heating season, a follow-up site visit during heating season will be required to confirm proper flows and temperatures, and any required system "fine tuning".
- .4 TAB of air handling systems is to include equipment and ductwork air temperatures, capacities and flows.
- .5 Following existing systems, revised as part of mechanical work, are to be tested, adjusted and balanced as for new systems:
 - .1 Existing air handling system served by ACS-5A and RF-5A;
 - .2 Existing air handling system served by ACS-1H and .
 - .3 Existing sanitary exhaust system served by TE(H)-1.
 - .4 Existing sanitary exhaust system served by TE-1A.

3.02 TESTING, ADJUSTING AND BALANCING

- .1 Conform to following requirements:
 - .1 as soon as possible after award of Contract, Agency is to carefully examine a white print set of mechanical drawings with respect to routing of services and location of balancing devices, and is to issue a report listing results of the evaluation;
 - .2 set of drawings examined by Agency is to be returned with evaluation report, with red line mark-ups to indicate locations for duct system test plugs, and required revision work such as relocation of balancing devices and locations for additional devices;
 - .3 after review of mechanical work drawings and specification, Agency is to visit site at frequent, regular intervals during construction of mechanical systems, to observe routing of services, locations of testing and balancing devices, workmanship, and anything else that will affect testing, adjusting and balancing;
 - .4 after each site visit, Agency is to report results of site visit indicating date and time of visit, and detailed recommendations for any corrective work required to ensure proper adjusting and balancing;
 - .5 testing, adjusting and balancing is not to begin until:
 - .1 building construction work is substantially complete and doors have been installed;

- .2 mechanical systems are complete in all respects, and have been checked, started, adjusted, and then successfully performance tested.
- .6 mechanical systems to be tested, adjusted and balanced are to be maintained in full, normal operation during each day of testing, adjusting and balancing;
- .7 obtain copies of reviewed shop drawings of applicable mechanical plant equipment and terminals, and temperature control diagrams and sequences;
- .8 Agency is to walk each system from system "head end" equipment to terminal units to determine variations of installation from design, and system installation trades will accompany Agency;
- .9 Agency is to check valves and dampers for correct and locked position, and temperature control systems for completeness of installation before starting equipment;
- .10 wherever possible, Agency is to lock balancing devices in place at proper setting, and permanently mark settings on devices;
- .11 for belt-driven equipment, Agency is to report to Commissioning Agent who in turn is to inform Contractor and Consultant of any situation where sheaves have to be replaced to suit testing and balancing, and replacements are to be done by Contractor at no cost;
- .12 Agency is to leak test ductwork as specified in Section entitled HVAC Air Distribution in accordance with requirements of SMACNA "HVAC Air Duct Leak Test Manual", coordinate work with work of aforementioned Sections, provide detailed sketch(es) to Sheet Metal Contractor and Consultant identifying ductwork not in accordance with acceptable leakage values specified in aforementioned Sections, and retest corrected ductwork;
- .13 Agency is to balance systems with due regard to objectionable noise which is to be a factor when adjusting fan speeds and performing terminal work such as adjusting air quantities, and should objectionable noise occur at design conditions, Agency is to immediately report problem and submit data, including sound readings, to permit an accurate assessment of noise problem to be made;
- .14 Agency is to check supply air handling system mixing plenums for stratification, and where variation of mixed air temperature across coils is found to be in excess of $\pm 5\%$ of design requirements, Agency is to report problem and issue a detail sketch of plenum baffle(s) required to eliminate stratification;
- .15 Agency is to perform testing, adjusting and balancing to within $\pm 5\%$ of design values, and make and record measurements which are within $\pm 2\%$ of actual values;
- .16 for air handling systems equipped with air filters, test and balance systems with simulated 50% loaded (dirty) filters by providing a false pressure drop;
- .17 test, adjust and balance air conditioning systems during summer season and heating systems during winter season, including at least a period of operation at outside conditions within 2.8°C (5°F) wet bulb temperature of maximum summer design condition, and within 5.5°C (10°C) dry bulb temperature of minimum winter design condition, and take final temperature readings during seasonal operation.

- .2 Prepare reports as indicated below.
 - .1 Upon completion of testing, adjusting, and balancing procedures, prepare draft reports on AABC or NEBB forms. Draft reports may be hand written, but must be complete, factual, accurate, and legible. Organize and format draft reports in same manner specified for final reports. Submit 2 complete sets of draft reports. Only 1 complete set of draft reports will be returned.
 - .2 Upon verification and approval of draft reports, prepare final reports, type written, and organized and formatted as specified below. Submit 2 complete sets of final reports. Use units of measurement (SI or Imperial) as used on Project Documents.
 - .3 Report forms are to be those standard forms prepared by the referenced standard for each respective item and system to be tested, adjusted, and balanced. Bind report forms complete with schematic systems diagrams and other data in reinforced, vinyl, 3-ring binders. Provide binding edge labels with project identification and a title descriptive of contents. Divide contents of binder into divisions listed below, separated by divider tabs:
 - .1 General Information and Summary;
 - .2 Air Systems;
 - .3 Hydronic Systems;
 - .4 Temperature Control Systems;
 - .4 Agency is to provide following minimum information, forms and data in report:
 - .1 inside cover sheet to identify Agency, Contractor, and Project, including addresses, and contact names and telephone numbers and a listing of instrumentation used for procedures along with proof of calibration;
 - .2 remainder of report is to contain appropriate forms containing as a minimum, information indicated on standard AABC or NEBB report forms prepared for each respective item and system;
 - .3 Agency is to include for each system to be tested, adjusted and balanced, a neatly drawn, identified (system designation, plant equipment location, and area served) schematic "as-built" diagram indicating and identifying equipment, terminals, and accessories;
 - .4 Agency is to include report sheets indicating building comfort test readings for all rooms.
- .3 After final testing and balancing report has been submitted, Agency is to visit site with Contractor and Consultant to spot check results indicated on balancing report. Agency is to supply labour, ladders, and instruments to complete spot checks. If results of spot checks do not, on a consistent basis, agree with final report, spot check procedures will stop and Agency is to then rebalance systems involved, resubmit final report, and again perform spot checks with Contractor and Consultant.

- .4 When final report has been accepted, Contractor is to submit to Owner, in name of Owner, a certificate equal to AABC National Guaranty Certification or a NEBB Quality Assurance Program Bond, and in addition, Contractor is to submit a written extended warranty from Agency covering one full heating season and one full cooling season, during which time any balancing problems which occur, with exception of minor revision work done during scheduled site visits, will, at no cost, be investigated by Agency and reported on to Owner, and if it is determined that problems are a result of improper testing, adjusting and balancing, they are to be immediately corrected without additional cost to Owner.
- .5 After acceptance of final report, Agency is to perform post testing and balancing site visits in accordance with following requirements:
 - .1 post testing and balancing site visits are to be made:
 - .1 once during first month of building operation;
 - .2 once during third month of building operation;
 - .3 once between fourth and tenth months in a season opposite to first and third month visit.
 - .2 during each return visit and accompanied by Owner's representative, Agency is to spot rebalance terminal units as required to suit building occupants and eliminate complaints;
 - .3 Agency is to schedule each visit with Contractor and Owner, and inform Consultant;
 - .4 after each follow-up site visit, Agency is to issue to Contractor and Consultant a report indicating any corrective work performed during visit, abnormal conditions and complaints encountered, and recommended corrective action.

END OF SECTION

1 GENERAL

1.01 APPLICATION

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

1.02 SUBMITTALS

- .1 Submit a product data sheet and WHIMIS sheet for each firestopping and smoke seal product.
- .2 Submit for review, full company name and experience of proposed firestopping and smoke seal system applicator.
- .3 Submit letter of proper firestopping and smoke seal certification as specified in Part 3 of this Section.
- .4 Refer to Architectural Specifications Section 01 33 00 Submittal Procedures Article 1.8 Project Firestopping Manual and Coordination for additional submittal requirements and procedures.

1.03 QUALITY ASSURANCE

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

2 PRODUCTS

2.01 FIRESTOPPING AND SMOKE SEAL SYSTEM MATERIALS

- .1 Asbestos-free, elastomeric materials and intumescent materials, tested, listed and labelled by ULC in accordance with CAN/ULC S115, and CAN/ULC S101 for installation in ULC designated firestopping, and smoke seal systems to provide a positive fire, water and smoke seal and a fire resistance rating (flame, hose stream and temperature) no less than fire rating for surrounding construction.
- .2 Firestopping and smoke seal material system to be specifically ULC certified with designated reference number for its specific installation. As part of shop drawing submission, submit copies of firestopping drawings with ULC certificate and system number for each specific installation.
- .3 Smoke and fire seal materials and manufacturers must be specifically approved for each application of penetrated surfaces, as approved by FM Global and listed in FM Global Approval Guide. Listed companies herein and other manufacturers are only acceptable if compliant with these requirements. As part of shop drawing submission, submit copies of firestopping drawings with FM Global Approval Guide.

- .4 Materials are to be compatible with abutting dissimilar materials and finishes and complete with primers, damming and back-up materials, supports, and anchoring devices in accordance with firestopping manufacturer's recommendations and ULC tested assembly. Coordinate material requirements with trades supplying abutting areas of materials.
- .5 Submit schedule of opening locations and sizes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance ratings.
- .6 Typically, for openings of up to 250 mm (10") in diameter, provide putty pad type firestop materials equivalent to Specified Technologies Inc. "SpecSeal" intumescent, non-hardening, water resistant putties containing no solvents, inorganic fibres or silicone compounds.
- .7 Typically, for openings of greater than 250 mm (10") in diameter, and for rectangular openings, provide pillow type firestop materials equivalent to Specified Technologies Inc. "SpecSeal" re-enterable, non-curing, mineral fibre core encapsulated on six sides with intumescent coating contained in a flame retardant poly bag.
- .8 Pipe insulation forming part of a fire and smoke seal assembly is specified in Section entitled Mechanical Insulation.
- .9 Supply products of a single manufacturer for use on work of this Division.
- .10 Include for manufacturer's authorized representative to inspect and verify each installation and application. Submit test report signed and verified by system installer's authorized representative and manufacturer's representative.
- .11 Acceptable certification to also include certification by Underwriters Laboratories of Northbrook IL, using tests conforming to ULC-S115 and given cUL listing published by UL in their "Products Certified for Canada (cUL) Directory".
- .12 Acceptable manufacturers are:
 - .1 Specified Technologies Inc.;
 - .2 3M Canada Inc.;
 - .3 Tremco;
 - .4 A/D Fire Protection Systems;
 - .5 Nelson;
 - .6 Hilti Canada.

3 EXECUTION

3.01 INSTALLATION OF FIRESTOPPING AND SMOKE SEAL MATERIALS

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

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

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

END OF SECTION

1 GENERAL

1.01 SUBMITTALS

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

1.02 QUALITY ASSURANCE

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

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

1.03 DESIGN REQUIREMENTS

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

2 PRODUCTS

2.01 PIPE, FITTINGS AND JOINTS

- .1 Pipe, fittings and joints are to be as follows, with exceptions as specified in Part 3 of this Section:
 - .1 Schedule 40 Steel – Grooved Coupling Joints
 - .1 Schedule 40 mild black carbon steel, ASTM A53, Grade B, complete with grooved ends and mechanical fittings and couplings, Victaulic "FireLock" fittings and Victaulic Style 009N, 107H, and 107N QuickVic and 005 or approved equal, rigid coupling joints. Strap type outlet fittings such as Victaulic "Snap-Let" are not acceptable.

.2 Schedule 40 Steel – Screwed and Welded Joints

- .1 Schedule 40 mild black carbon steel, ASTM A53, Grade B. Screwed piping complete with Class 125 cast iron screwed fittings to ANSI/ASME B16.4. Welded piping complete with factory made seamless carbon steel butt welding fittings to ASTM A234, Grade WPB, long sweep pattern wherever possible.

.3 Schedule 10 Steel – Grooved Coupling Joints

- .1 Schedule 10 mild black carbon steel, ASTM A53, Grade B, complete with grooved ends and fittings and couplings, Victaulic "FireLock" fittings and Victaulic Style 009N, 107H, and 107N QuickVic and 005, or approved equal, rigid coupling joints.

.4 Schedule 10 Steel – Screwed Joints

- .1 Schedule 10 mild black carbon steel, ASTM A53, Grade B, complete with mill or site threaded ends, Class 125 cast iron screwed fittings to ANSI/ASME B16.4, and screwed joints.

.5 "Lightwall" Steel – Grooved Coupling Joints

- .1 Commercial quality. "Lightwall" rolled mild carbon steel pipe to ASTM A135, Grade A, complete with a galvanized exterior, grooved ends, and fittings and couplings, Victaulic "Fire Lock" grooved fittings and Victaulic Style 009N QuickVic or 005 rigid coupling joints or approved equal.

.6 "Lightwall" Steel – Screwed Joints

- .1 Commercial quality, "Lightwall" rolled mild carbon steel pipe to ASTM A135, Grade A, ULC listed, mill or site threaded, complete with galvanized exterior, Class 125 cast iron screwed fittings to ANSI/ASME B16.4, and screwed joints.

.7 Standard Mechanical Couplings: Equal to Victaulic

- .1 Manufactured in two segments of cast ductile iron, conforming to ASTM A-536, Grade 65-45-12. Gaskets are to be pressure-responsive synthetic rubber, grade to suit intended service, conforming to ASTM D-2000. Mechanical coupling bolts are to be zinc plated (ASTM B-633) heat treated carbon steel track head conforming to ASTM A-449 and ASTM A-183. Couplings are to comply with ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications.
- .2 Rigid Type: Coupling housings with offsetting, angle-pattern bolt pads are to be used to provide system rigidity and support and hanging in accordance NFPA-13. Couplings are to be fully installed at visual pad-to-pad offset contact. Couplings that require exact gapping of bolt pads at specific torque ratings are not permitted.
- .3 Flexible Type: Use in locations where vibration attenuation and stress relief are required; Victaulic Style 177 (Quick-Vic™) or approved equal, flexible coupling.

2.02 SHUT-OFF VALVES

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

2.03 CHECK VALVES

- .1 Minimum 1725 kPa (250 psi) resilient seat check valves, suitable for vertical or horizontal installations. Standard of Acceptance: Victaulic Series 717.
- .2 Check valves associated with Fire Department connections and fire pump test connection are to be tapped for site installation of a 20 mm ($\frac{3}{4}$ ") diameter ball drip.

2.04 SPRINKLER HEADS

- .1 Sprinkler heads, unless otherwise specified, are to be as scheduled in Part 3 of this Section.
- .2 Sprinkler body is to be die-cast, with hex-shaped wrench boss integrally cast into sprinkler body to reduce risk of damage during installation. Wrenches are to be provided by sprinkler manufacturer that directly engages wrench boss.
- .3 For locations where corrosive resistant coatings are required, body is to be coated with ULC listed and FM approved anti-corrosion VC-250 coating (silver colouring).
- .4 Sprinkler heads for healthcare facilities are to be quick response type.
- .5 Recessed sprinkler heads in finished areas are to be chrome plated unless otherwise specified. Concealed sprinkler head ceiling plates are to match ceiling colour.
- .6 Where exposed pendent heads occur in areas with suspended ceilings, they are to be complete with chrome plated escutcheon plates. Similarly, sidewall heads with concealed piping are to be complete with chrome plated escutcheon plates.
- .7 Sprinkler heads which are exposed in areas where they may be subject to damage are to be complete with wire guards, chrome plated where in finished areas.
- .8 Escutcheons and guards are to be listed, supplied, and approved for use with sprinkler by sprinkler manufacturer.

- .9 Sprinkler heads located in areas or over equipment where high ambient temperature is present are to be, unless otherwise specified, 93°C (200°F) heads. Other heads, unless otherwise specified or required, are to be 68°C (155°F) rated.
- .10 Acceptable manufacturers are:
 - .1 Victaulic Co.;
 - .2 Tyco Fire Suppression & Building Products;
 - .3 The Viking Corporation;
 - .4 The Reliable Automatic Sprinkler Co.

3 EXECUTION

3.01 MONITORING OF SYSTEMS

- .1 Daily monitor and supervise existing sprinkler system serving renovated areas to ensure that each respective system is left in proper operating condition at end of each working day. Include for but not be limited to performing following:
 - .1 Under presence of Owner's representative, check each morning and evening (start and end of work) of each day, sprinkler system to ensure that it is in proper working condition;
 - .2 If portions of sprinkler system is not in proper working order, provide temporary provisions subject to approval of local fire authority or local governing authority, to ensure that proper sprinkler coverage is provided and/or provide supervisory personnel to monitor areas where sprinkler system is not operational;
 - .3 Document and sign off with Owner's representative signing off also, each respective daily check condition;
 - .4 Ensure that work to sprinkler system does not affect portion of system serving areas outside of renovation areas.

3.02 DEMOLITION

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

3.03 PIPING INSTALLATION REQUIREMENTS

- .1 Provide required sprinkler system piping.
- .2 Perform piping work in accordance with requirements of NFPA 13, governing regulations, and "Reviewed" shop drawings.
- .3 Piping, unless otherwise specified, is as follows:
 - .1 for piping inside building and above ground except as noted below – Schedule 40 grooved end black steel with Victaulic or equal fittings and coupling joints, or, for piping to and including 50 mm (2") diameter, screwed fittings and joints, or, for piping 65 mm (2-½") diameter and larger, welding fittings and welded joints;

- .2 for wet system piping inside building and above ground – at your option, CPVC sprinkler pipe and fittings;
- .3 for piping downstream of "head end" alarm valve(s) and equipment – Schedule 10 or "Lightwall" black steel pipe with Victaulic or equal fittings and coupling joints or screwed fittings and joints;
- .4 Exceptions to piping requirements specified above are as follows:
 - .1 dry pipe zone steel piping, fittings, unions, couplings and flanges are to be galvanized;
 - .2 wet zone steel piping, fittings, unions, couplings and flanges for sprinkler work exposed to weather either inside or outside building (including parking garages), are to be galvanized;
 - .3 PVC piping is not to be used above grade;
 - .4 ferrous pipe hangers, supports, and similar hardware used for galvanized steel piping are to be electro-galvanized.
- .5 Pipe sizes, pipe routing, sprinkler head quantities and locations, and layout of work shown on drawings are to assist during Bid period. Ensure adequate head coverage, head quantities and pipe sizing as specified in Part 1 of this Section. Do not reduce size of sprinkler main or re-route main unless reviewed with Consultant and accepted by Owner.
- .6 Install grooved joints in accordance with manufacturer's latest installation instructions. Grooved ends are to be clean and free from indentations, projections and roll marks. Gaskets are to be moulded and produced by coupling manufacturer, and verified as suitable for intended service. Have factory-trained representative from mechanical joint manufacturer provide on-site training in proper use of grooving tools and installation of grooved piping products. Have factory-trained representative periodically review product installation and ensure best practices are being followed. Remove and replace any improperly installed products.
- .7 Clean pipe, fittings, couplings, flanges and similar components after erection is complete. Wire brush clean any ferrous pipe, fitting, coupling, flange, hanger, support and similar component which exhibit rust and carefully coat with suitably coloured primer.
- .8 When sprinkler work is complete, test system components and overall system(s) and submit completed test certificate and other documentation in accordance with Chapter 8 of NFPA 13.

3.04 INSTALLATION OF SHUT-OFF VALVES AND CHECK VALVES

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

3.05 INSTALLATION OF SPRINKLER HEADS

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

APPLICATION	SPRINKLER HEAD TYPE
Healthcare Facility Type I rooms/areas as per CAN/CSA-Z317.2, Table 1, HVAC Design Criteria, first two columns	Victaulic V38/V39 or Tyco Series RFI "Royal Flush II" concealed pendent
Healthcare Facility Type II rooms/area as per CAN/CSA-Z317.2, Table 1, HVAC Design Criteria, first two columns	Victaulic V27 or Tyco Series TY-FRB recessed pendent
Healthcare Facility Type III rooms/areas as per CAN/CSA-Z317.2, Table 1, HVAC Design Criteria, first two columns	Victaulic V27 or Tyco Series TY-FRB recessed pendent

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

END OF SECTION

1 GENERAL

1.01 SUBMITTALS

- .1 Submit shop drawings and product data sheets for products specified in Part 2 of this Section except for pipe, fittings, and chlorine.
- .2 Submit laboratory water purity test results indicating chlorine residual prior to application for Substantial Performance of the Work. Submit certification details of laboratory.
- .3 Submit signed test results and inspection and test log cards for each backflow preventer as specified in Part 3 of this Section.
- .4 As specified in Part 3 of this Section, submit letter from anchor design engineer stating anchor installation has been examined at site and anchors are properly fabricated and installed.

1.02 QUALITY ASSURANCE

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

2 PRODUCTS

2.01 PIPE, FITTINGS AND JOINTS

- .1 Hard Copper - Solder Joint
 - .1 Type "L" hard drawn seamless copper to ASTM B88, complete with copper solder type fittings to ASME/ANSI B16.18 and soldered joints using Canada Metal Co "SILVABRITE 100 lead-free solder for cold water pipe, and 95% tin/ 5% Antimony or "SILVABRITE 100" solder, for other services, or approved equal.

.2 Copper Pressure Coupled Joint

- .1 Type "L" hard drawn seamless copper to ASTM B88, with Viega "ProPress with Smart Connect feature", CSA approved, copper fittings with EDPM seals, and pressure type crimped joints made by use of manufacturer recommended tool.

.3 Hard Copper – Grooved Joint

- .1 Bolted grooved connection type system, suitable and approved for application intended, 50 mm to 200 mm (2" - 8") hard copper tubing, with Victaulic QuickVic Style 607 rigid coupling consisting of ductile iron cast housings, with Grade 'P' fluoroelastomer compound gasket of pressure-responsive design, with plated nuts and bolts to secure unit together.

.4 Semi-Rigid Polyethylene Tubing

- .1 Versa Fittings, or approved equal, 13 mm (½") dia., high density, semi-rigid include polyethylene tubing, 1380 kPa (200 psi) rated.

.5 CPVC

- .1 Ipex "Aquarise", or approved equal, CPVC pipe and fittings to CAN/CSA B137.6, 25/50 flame spread and smoke developed rated in accordance with CAN/ULC S102.2, and complete with primer/solvent weld joints.
- .2 Victaulic PGS-300 grooved piping system for schedule 40 and schedule 80 CPVC pipe, sizes 50 mm to 300 mm (2" - 12"). With Style 857 rigid couplings consisting of ductile iron cast housings, with grade "P" fluoroelastomer compound gasket of pressure-responsive design, with zinc electroplated carbon steel oval neck track plated nuts and bolts to secure unit together. Include for pressure rating requirements in accordance with manufacturer recommendations.

.6 Cross-Linked Polyethylene (PEX) Tubing

- .1 Uponor or approved equal, non-barrier type PEX piping in accordance with CAN/CSA B137.5, ASTM F876 and tested for compliance by independent third-party agency for end use application, 25/50 flame spread/smoke developed rated when tested to CAN/ULC S102.2 and complete with brass inserts and crimp-ring or cold-expansion joint fittings and couplings.

.7 Manufacturer Services

- .1 Include manufacturers factory trained representative to:
 - .1 For special piping applications such as PEX, grooved piping, crimping: Train installing Contractors on special installation practices and use of special tools for installations.
 - .2 For grooved piping systems: Periodically visit job site to review installation, prepare inspection report, advise installing Contractor of deficiencies and re-examine, till corrections are made.

2.02 SHUT-OFF VALVES

.1 Ball Valves

- .1 Class 600, 4140 kPa (600 psi) WOG rated, lead-free, full port ball type valves.
- .2 Forged brass body with solder ends, forged brass cap, blowout-proof stem, solid forged brass chrome plated ball, "Teflon" or "PTFE" seat. and removable lever handle.
- .3 Valves in insulated piping are to be complete with stem extensions.
- .4 Acceptable manufacturers are:
 - .1 Toyo Valve;
 - .2 Milwaukee Valve;
 - .3 Kitz Corporation;
 - .4 Apollo Valves;
 - .5 Watts Canada.

.2 Butterfly Valves: Grooved End

- .1 Victaulic Series 608N, for copper pipe rated to 2068 kPa (300 psi) and be both bi-directional and dead-end service capable to full rated pressure. Body of brass castings and disc of aluminum-bronze casting. Seat material is Grade P fluoroelastomer. UL Classified in accordance with ANSI/NSF 61 for ambient 30°C (86°F) and hot 82°C (180°F) potable water service and ANSI/NSF 372. With lever lock handle and gear type operators as required for intended applications.
- .2 Victaulic Series 461, for stainless steel pipe rated to 2068 kPa (300 psi) and be both bi-directional and dead-end service capable to full rated pressure. Body and disc of stainless steel. Seat material is Grade P fluoroelastomer or EDPM to suit intended applications. UL Classified in accordance with ANSI/NSF 61 for ambient 30°C (86°F) and hot 82°C (180°F) potable water service and ANSI/NSF 372. With lever lock handle and gear type operators as required for intended applications.

2.03 CHECK VALVES

.1 Horizontal

- .1 Lead-free, Class 125, bronze, 1380 kPa (200 psi) WOG rated horizontal swing type check valves with solder ends.
- .2 Bronze body, cap and disc holder.
- .3 PTFE disc
- .4 Acceptable manufacturers are:
 - .1 Toyo Valve;

- .2 Milwaukee Valve;
 - .3 Kitz Corporation;
 - .4 Apollo Valves.
- .2 Vertical
- .1 Lead-free, 1725 kPa (250 psi) WOG rated, silent type, spring loaded, vertical lift check valve with soldering ends.
 - .2 Cast bronze body, cap disc holder and phosphor bronze spring.
 - .3 Acceptable manufacturers are:
 - .1 Toyo Valve;
 - .2 Milwaukee Valve;
 - .3 Kitz Corporation;
 - .4 Apollo Valves.

2.04 DRAIN VALVES

- .1 Lead free, minimum 2070 kPa (300 psi) water rated, 20 mm ($\frac{3}{4}$ ") dia., straight pattern full port bronze ball valves.
- .2 Threaded outlet suitable for coupling connection of 20 mm ($\frac{3}{4}$ ") dia. garden hose, and a cap and chain.
- .3 Acceptable manufacturers are:
 - .1 Crane -Jenkins;
 - .2 Kitz Corporation;
 - .3 Apollo Valves;
 - .4 Milwaukee Valve;
 - .5 Dahl Bros.

2.05 DOMESTIC HOT WATER PIPING BALANCING VALVES

- .1 Lead free, solder or NPT screwed end type as required, ball style, circuit balancing valves.
- .2 Designed to facilitate precise flow measurement, precision flow balancing, and positive shut-off.
- .3 Capped and valved drain connection, and capped ports for connection to differential pressure meter.

.4 Acceptable manufacturers are:

- .1 Bell & Gossett;
- .2 Victaulic;
- .3 Watts Canada.

2.06 CHLORINE

.1 Sodium hypochlorite to AWWA B300.

2.07 FLOOR DRAIN TRAP SEAL PRIMERS

.1 Primer Valve Type

- .1 Precision Plumbing Products Inc. Model P2-500, or approved equal, trap primer valve, constructed of brass, adjustable to high or low water pressures and complete with "O" ring seals, 12 mm (½") threaded inlet and outlet connections, and, for priming two traps from the same primer, DU-2 dual outlet distribution unit.

.2 Primer Valve Type with Manifold

- .1 Precision Plumbing Products Inc. Model P1-500, or approved equal, trap primer valve constructed as specified above for Model P2-500 primer valve, complete with Model DU-3 or DU-4, 3 or 4 outlet distribution unit for priming 3 or 4 traps, and at Model "YS-8" supply tube with combinations of Model DU-3 and DU-4 distribution units for priming from 5 to 6 traps.

2.08 SHOCK ABSORBERS

- .1 Type 304 stainless steel piping shock absorbers.
- .2 Maximum Working Pressure: 862 Kpa (125 psi).
- .3 Maximum Static Pressure: 1724 Kpa (250 psi).
- .4 Nesting type bellows and casing of sufficient displacement volume to dissipate kinetic energy generated in piping system.
- .5 Sized to suit connecting potable water pipe and equipment to which it is provided.
- .6 Acceptable manufacturers are:
 - .1 Watts Canada;
 - .2 Jay R. Smith;
 - .3 Zurn;
 - .4 Mifab.

2.09 WATER HAMMER ARRESTORS

- .1 Jay R. Smith 5000 Series, water hammer arrestors with following features:
 - .1 piston type, sealed, lead free, stainless steel construction;
 - .2 or upright vertical installations;
 - .3 factory pre-charged and sealed, pressurized compression chamber;
 - .4 welded nesting-type expansion bellows surrounded by non-toxic mineral oil;
 - .5 male treaded nipple connection.
- .2 Acceptable manufacturers are:
 - .1 Jay R. Smith;
 - .2 Precision Plumbing Products;
 - .3 Or approved equal.
- .3 Watts Canada, LM15M2/S Series, water hammer arrestors with features as follows:
 - .1 piston type, sealed, lead free, maintenance free;
 - .2 factory pre-charged and sealed, and pressurized;
 - .3 threaded or soldered connections to suit intended applications;
 - .4 suitable for either horizontal or vertical installation;
 - .5 hard drawn copper body;
 - .6 "O"-ring piston seals, air charge, and inlet opening equal to diameter of pipe in which arrestor is required.
- .4 Acceptable manufacturers are:
 - .1 Watts Canada;
 - .2 Zurn;
 - .3 Precision Plumbing Products;
 - .4 Mifab.

2.10 BACKFLOW PREVENTERS

- .1 Reduced Pressure Zone Assembly
 - .1 Watts Canada, lead-free reduced pressure zone assembly backflow preventers:
 - .1 No. LF009QT-S for 12 mm (½") sizes;

- .2 No LF909QT-S for 20 mm to 50 mm ($\frac{3}{4}$ " to 2") sizes;
 - .3 No. LF909-NRS-S for 65 mm (2- $\frac{1}{2}$ ") and larger sizes;
 - .4 in accordance with CAN/CSA B64 (including supplements);
 - .5 bronze or epoxy coated cast iron bronze fitted construction depending on size;
 - .6 inlet strainer, inlet and outlet shut-off valves, intermediate relief valve, ball valve type test cocks, and proper air gap fitting.
- .2 Acceptable manufacturers are:
- .1 Watts Canada;
 - .2 Zurn;
 - .3 Apollo Valves;
 - .4 Danfoss Flomatic Corp.

2.11 LAVATORY SUPPLY FITTING TEMPERING VALVES

- .1 Powers "HydroGuard" Series 490, model LM490, 12 mm ($\frac{1}{2}$ ") dia. or model LM491 20 mm ($\frac{3}{4}$ ") dia., or approved equals, as required, each CSA B125 certified, forged brass, tamper-proof thermostatic mixing valves, adjustable for water supply between 29°C and 49°C (85°F and 120°F), sized to suit number of lavatories in grouping, and complete with stop and check valve and lockable handle.
- .2 Each mixing valve includes stainless steel flush wall mounting cabinet with vandal-proof hinged door.

2.12 AIR VENTS

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

3 EXECUTION

3.01 DEMOLITION

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

3.02 PIPING INSTALLATION REQUIREMENTS

- .1 Provide required domestic water piping. Install piping in accordance with local governing codes and standards and for special piping, also follow manufacturer instructions to suit intended applications.
- .2 Piping, unless otherwise specified, is as follows:
 - .1 for 12 mm ($\frac{1}{2}$ ") dia. trap seal primer tubing located underground or in concrete or masonry construction: semi-rigid polyethylene;

- .2 for pipe inside building and aboveground in sizes to 100 mm (4") dia., except in vertical shafts and through fire barriers: rigid CPVC;
- .3 option for branch hot and cold piping aboveground from mains and risers to fixtures, fittings, and equipment where fire rated construction is not penetrated: PEX tubing installed and joined in accordance with manufacturer instructions, and installer trained and certified by manufacturer or manufacturer representative;
- .4 for pipe inside building and aboveground in sizes to 100 mm (4") dia: Type "L" hard copper with solder joints or Type "L" hard copper with pressure coupled mechanical joints.
- .3 Slope piping so it can be completely drained.
- .4 Provide cast brass dielectric type adapters/unions at connections between ferrous and copper pipe or equipment.
- .5 Clean grooved pipe ends free from indentations, projections and roll marks in area from pipe end to groove for proper gasket sealing. Provide couplings and gasket style and elastomeric material (grade) suitable for intended service in accordance with manufacturers requirements. Install in accordance with manufacturers instructions. Engage manufacturer representative to periodically visit job site to inspect work. Correct deficiencies.

3.03 INSTALLATION OF SHUT-OFF AND CHECK VALVES

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

3.04 INSTALLATION OF DRAIN VALVES

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

3.05 INSTALLATION OF DOMESTIC HOT WATER PIPING BALANCING VALVES

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

3.06 INSTALLATION OF DOMESTIC HOT WATER THERMOSTATIC MIXING VALVES

- .1 Provide domestic hot water thermostatic mixing valve assembly and wall mount.
- .2 Adjust each valve to design requirements and check and test operation. Set maximum temperature limit stops.
- .3 Identify each valve and its water temperature delivery setting with engraved nameplate.

3.07 INSTALLATION OF TRAP SEAL PRIMERS

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

3.08 INSTALLATION OF SHOCK ABSORBERS

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

3.09 INSTALLATION OF WATER HAMMER ARRESTORS

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

3.10 INSTALLATION OF BACKFLOW PREVENTERS

- .1 Provide reduced pressure zone assembly backflow preventer in each direct domestic water connection to equipment other than plumbing fixtures and fittings.
- .2 Locate each backflow preventer on floor or wall between 765 mm and maximum 1.5 m (30" and 60") above floor such that it is easily accessible for maintenance and testing. Equip each backflow preventer with air gap fitting and pipe reduced pressure zone water outlet to drain.
- .3 Test operation of each backflow preventer in accordance with requirements of CAN/CSA B64 by personnel certified for such testing by governing authorities, and submit signed test results and a properly and clearly identified and marked inspection and test record card for each backflow preventer.

3.11 INSTALLATION OF LAVATORY SUPPLY FITTING TEMPERING VALVES

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

3.12 INSTALLATION OF AIR VENTS

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

3.13 FLUSHING AND DISINFECTING PIPING

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

END OF SECTION

1 GENERAL

1.01 SUBMITTALS

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

2 PRODUCTS

2.01 PIPE, FITTINGS AND JOINTS

- .1 PVC - DWV
 - .1 Low Buildings:
 - .1 IPEX System 15 rigid PVC drain, waste and vent pipe and fittings in accordance with CAN/CSA B181.2, complete with flame spread rating not more than 25 when tested in accordance with CAN/ULC-S102.2, with solvent welded joints or MJ Grey mechanical joint couplings, and, for fire barrier penetration, approved firestop in accordance with CAN/ULC-S115.
- .2 Copper - Solder Joint
 - .1 Type DWV hard temper to ASTM B306, with forged copper solder type drainage fittings and 50% lead - 50% tin solder joints.
- .3 Cast Iron
 - .1 Class 4000 cast iron pipe, fittings, and mechanical coupling joints to CAN/CSA B70.
- .4 Copper - Victaulic Coupling Joint
 - .1 Type DWV hard temper to ASTM B306, with factory or site rolled grooved ends (with grooving rolls designed for copper) and Victaulic "Copper Connection" wrought copper or cast bronze fittings and Style 606 gasket type couplings.

2.02 VENT STACK COVERS

- .1 Lexcor Model "Flash-Tite" seamless, spun aluminum, insulated vent stack covers with caps and a factory applied asphalt primer coating on top and bottom of flange.

2.03 CLEANOUTS

- .1 Horizontal Piping
 - .1 TY pipe fitting with an extra heavy brass plug screwed into the fitting.
- .2 Vertical Piping
 - .1 Bronze or copper cleanout tees in copper piping, each complete with a bronze ferrule, and, for cast iron piping, "BARRETT" type cast iron cleanout tees, each gas and water-tight and complete with a bolted cover.

2.04 FLOOR CLEANOUT TERMINATIONS

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

2.05 FLOOR DRAINS, FUNNEL FLOOR DRAINS AND HUB DRAINS

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

3 EXECUTION

3.01 DEMOLITION

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

3.02 DRAIN AND VENT PIPING INSTALLATION REQUIREMENTS

- .1 Provide required drainage and vent piping. Pipe, unless otherwise specified, as follows:
 - .1 for pipe inside building and aboveground in sizes less than or equal to 65 mm (2-½") dia. – type DWV copper;

- .2 for pipe inside building and aboveground in sizes greater than or equal to 75 mm (3") dia. – Class 4000 cast iron;
- .3 for pipe inside building and aboveground in lieu of type DWV copper and cast iron, at your option and where permitted by governing Codes and Regulations – rigid PVC DWV;
- .2 Unless otherwise specified, slope horizontal drainage piping aboveground in sizes to and including 75 mm (3") dia. 25 mm (1") in 1.2 m (4'), and pipe 100 mm (4") dia. and larger 25 mm (1") in 2.4 m (8').
- .3 Install and slope underground drainage piping to inverts or slopes indicated on drawings to facilitate straight and true gradients between points shown. Verify available slopes before installing pipes.
- .4 Unless otherwise specified, slope horizontal branches of vent piping down to fixture or pipe to which they connect with a minimum pitch of 25 mm (1") in 1.2 m (4').
- .5 Extend vent stacks up through roof generally where shown but with exact locations to suit site conditions and in any case a minimum of 3 m (10') from fresh air intakes. Terminate vent stacks a minimum of 330 mm (13") above roof (including roof parapets) in vent stack covers. Where not shown on drawings, route vent piping from source to building exterior as required in order to satisfy local governing codes and authority. Coordinate vent routing with other building services and ensure there is no architectural impact.
- .6 Provide cast brass dielectric unions at connections between copper pipe and ferrous pipe or equipment.

3.03 SUPPLY OF VENT STACK COVERS

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

3.04 INSTALLATION OF CLEANOUTS

- .1 Provide cleanouts in drainage piping in locations as follows:
 - .1 in building drain or drains as close as possible to inner face of outside wall, and, if a building trap is installed, locate cleanout on downstream side of building trap;
 - .2 at or as close as practicable to the foot of each drainage stack;
 - .3 at maximum 15 m (50') intervals in horizontal pipe 100 mm (4") dia. and smaller;
 - .4 at maximum 30 m (100') intervals in horizontal pipe larger than 100 mm (4") dia.;
 - .5 wherever else shown on drawings.
- .2 Cleanouts are to be same diameter as pipe in piping to 100 mm (4") dia., and not less than 100 mm (4") dia. in piping larger than 100 mm (4") dia.

- .3 Where cleanouts in vertical piping are concealed behind walls or partitions, install cleanouts near floor and so cover is within 25 mm (1") of the finished face of the wall or partition.

3.05 INSTALLATION OF FLOOR CLEANOUT TERMINATIONS

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

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

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

END OF SECTION

1 GENERAL

1.01 SUBMITTALS

- .1 Submit product data sheets (fixture cuts) for all plumbing fixtures and fittings, including accessories.
- .2 Submit fixture manufacturer's standard colour charts for fixtures where colours are available but a particular colour is not specified.

2 PRODUCTS

2.01 GENERAL RE: PLUMBING FIXTURES AND FITTINGS

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

- .13 Water piping as specified, complete with ball type shut-off valves as specified with water piping or Dahl Bros. Canada Ltd. ¼ turn Mini Ball Valves.

2.02 PLUMBING FIXTURES AND FITTINGS

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

- .1 Toilet - Wall Hung – Stainless-Steel Anti-Ligature (WC-1):

- .1 Whitehall WH2105BAR-W-1-1.28 Toilet - Bariatric toilet, Off-floor, wall outlet, High Efficiency HET 4.8 LPF (1.28 GPF), All exposed surfaces shall have a satin finish Stainless steel toilet bowl and internal sub-frame, Elongated bowl, Siphon jet flush action, 38 mm (1-1/2") wall inlet connection, Complete with -FV manual flush valve (push button), Trap will pass a 54 mm (2-1/8") ballpass, is fully enclosed with a minimum 89 mm (3-1/2") seal, Rated at 454 kg (1000 lb), Integral contoured seat (standard), 356 mm (14") wide, 737 mm (29") from finished wall, 476 mm (18-3/4") high bowl. Compliances: ASME A112.19.3 compliant, CSA B45.4 compliant.
- .2 Watts ISCA-101-L/R Carrier - Closet Carrier, Industry Standard single Horizontal adjustable Closet Carrier, Adjustable for standard and wheelchair height, 102 mm (4") no hub waste, 51 mm (2") no hub vent connections, patented compression seal faceplate assembly, epoxy coated cast iron, with incremental measurements embossed onto legs to easily adjust height of carrier to most commonly used fixture requirements, epoxy coated cast iron foot support, neoprene bowl gasket, epoxy coated cast iron, integral test cap, chrome cap nuts, Plated hardware, Adjustable ABS nipple, Codes and Compliances: Carrier complies with requirements of ASME A112.6.1M up to a 500 lb (227 kg) static load.
- .3 Mission BAND-SEAL® P SERIES Coupling - BAND-SEAL® shielded transition Specialty transition coupling, For non-pressure gravity flow applications only, Recommended for above ground installations, (2 or 4) Type 301 stainless steel worm drive clamps, Type 301 stainless steel shield, One-piece molded elastomeric sealing gasket, Tightened to 69 kgf.cm (60 lbf.in) max.. Compliances and certifications: Stainless steel conforms to ASTM A240/A240M, Meets & exceeds performance standard ASTM C1460, Rubber conforms to ASTM C564, Conforms to CSA CLASS 7021 (B602), IAPMO FILE 11464 listed.

- .2 Toilet - Wall Hung – Bariatric – Stainless-Steel Anti-Ligature (WC-2):

- .1 Whitehall WH2105BAR-W-1-1.28 Toilet - Bariatric toilet, Off-floor, wall outlet, High Efficiency HET 4.8 LPF (1.28 GPF), All exposed surfaces shall have a satin finish Stainless steel toilet bowl and internal sub-frame, Elongated bowl, Siphon jet flush action, 38 mm (1-1/2") wall inlet connection, Complete with -FV manual flush valve (push button), Trap will pass a 54 mm (2-1/8") ballpass, is fully enclosed with a minimum 89 mm (3-1/2") seal, Rated at 454 kg (1000 lb), Integral contoured seat (standard), 356 mm (14") wide, 737 mm (29") from finished wall, 476 mm (18-3/4") high bowl. Compliances: ASME A112.19.3 compliant, CSA B45.4 compliant.

- .2 Watts ISCA-102-L/R Carrier - Horizontal, Closet Carrier, Industry standard single Horizontal 1000 lb closet carrier, 1000 lb (454 kg), 102 mm (4") no hub waste, 51 mm (2") no hub vent connections, patented compression seal faceplate assembly, epoxy coated ductile iron, with incremental measurements embossed onto legs to easily adjust height of carrier to most commonly used fixture requirements, epoxy coated ductile iron foot support, rod support assembly, adjustable for standard and wheelchair height, stainless steel support, neoprene bowl gasket, ductile iron rear anchor support, epoxy coated cast iron, integral test cap, chrome-plated cap nuts, stainless steel hardware, Adjustable ABS nipple, Codes and Compliances: Carrier complies with requirements of ASME A112.6.1M up to a 1000 lb. (454 kg) static load.
- .3 Mission BAND-SEAL® P SERIES Coupling - BAND-SEAL® shielded transition Specialty transition coupling, For non-pressure gravity flow applications only, Recommended for above ground installations, (2 or 4) Type 301 stainless steel worm drive clamps, Type 301 stainless steel shield, One-piece molded elastomeric sealing gasket, Tightened to 69 kgf.cm (60 lbf.in) max..
Compliances and certifications: Stainless steel conforms to ASTM A240/A240M, Meets & exceeds performance standard ASTM C1460, Rubber conforms to ASTM C564, Conforms to CSA CLASS 7021 (B602), IAPMO FILE 11464 listed.
- .3 Corner Basin - Wall Hung – Stainless-Steel Anti-Ligature (L-1):
 - .1 Whitehall WH3741L Basin - Wall-hung Ligature resistant basin, Type 304 16 gauge Stainless steel, Powder coated Blanco (white) finish, 102 mm (4") centerset, Left corner, Rear overflow, With faucet ledge, Ligature resistant side splashes made from type 304 stainless steel, Grid strainer and waste piping included, For Wall Plate Carrier, Trap enclosure fabricated from 18 gauge (1 mm) type 304 stainless steel with powder coated white finish, Compliance is subject to the interpretation and requirements of the local code authority, Overall Dimensions: 737 mm (29") long, 552 mm (21-3/4") wide, 559 mm (22") high, Bowl Dimensions:
 - .2 Whitehall WH3375-HC-SO Faucet - BESTCARE, Counter mounted, Automatic no-touch, Two push buttons, one for hot and one for cold supply, Plug-in, Lavatory faucet, Chrome-plated finish, 102 mm (4") centerset, Lead free compliant, Lead free brass construction, 1.9 LPM (0.5 GPM) maximum flowrate, Non-aerated and non-splashing spray outlet, Fixed spout, 60 mm (2-3/8") spout reach, Infrared sensor, Solenoid valve manifold, Vandal-resistant flow nozzle.
 - .3 McGuire LFCK175 Supply - ICV DEFENDER, Lead Free, with Chrome-plated finish, Integral check supply kit, Faucet, Sweat to compression connection, 1/2" Sweat x 3/8" O.D connection, Shallow wall flange, Wheel handle, Full turn brass stem, 305 mm (12") chrome-plated risers, Purple EPDM peroxide cured washers, Codes and compliances: NSF/ANSI 61 & 372, UPC
 - .4 Watts CA-421-HFH Carrier - Vertical, Floor mounted, Lavatory/Water Cooler carrier, Single, Wall Plate, Heavy duty foot support, Heavy duty fixture hanger supporting plate, Heavy duty rectangular steel structural uprights, Plated hardware.

- .5 Lawler 570-86820 Mixing Valve - Point of Use and Master controlled fixtures, Thermostatic master water mixing control valve, Lead free brass body construction, Nickel plated finish, 1.9 - 30 LPM (0.5 - 8 GPM) range for flowrate , To adjust the mixed outlet temperature of the valve, remove the cap to gain access to the adjusting spindle. The spindle should be rotated-clockwise to reduce the temperature, counter-clockwise to increase the temperature until the desired set point is reached, 11 LPM (3 GPM) tempered flowrate @ 5 PSI pressure drop, The temperature is adjusted with the help of Spindle, 4-7/8" (124 mm) Height, ASSE 1070 approved Certified to CSA B125.3 for ASSE 1070 applications, 3/8" MNPT (9.5 mm) inlet, 95-115 °F outlet water temperature range, 3/8" MNPT (9.5 mm) outlet, internal checks, Offers choice of temperature settings from 95° through 115 °F., 125 PSI max hydrostatic pressure, ±20% pressure variation, 40-80 °F, 10 °F, 180 °F max, ±5 °F, Protects against scalding and chilling, 7 GPM flowrate @ 45 PSI.
- .4 Basin - Wall Hung – Bariatric – Stainless-Steel Anti-Ligature (L-2):
 - .1 Whitehall WH3740BAR-MC Basin - Wall-hung Ligature resistant basin, 16 gauge Stainless steel, Powder coated Blanco (white) finish, 102 mm (4") centerset, Rear overflow, With faucet ledge, Ligature resistant side splashes made from corterra solid surface polymer resin, Grid strainer and waste piping included, For Wall Plate Carrier, 14 gauge stainless steel subframe, Wall-mounting carrier, Trap enclosure fabricated from 18 gauge (1 mm) type 304 stainless steel with powder coated white finish, Compliance is subject to the interpretation and requirements of the local code authority, Overall Dimensions: 565 mm (22-1/4") long, 572 mm (22-1/2") wide, 645 mm (25-3/8") high, Bowl Dimensions:
 - .2 Whitehall WH3375-HC-SO Faucet - BESTCARE, Counter mounted, Automatic no-touch, Two push buttons, one for hot and one for cold supply, Plug-in, Lavatory faucet, Chrome-plated finish, 102 mm (4") centerset, Lead free compliant, Lead free brass construction, 1.9 LPM (0.5 GPM) maximum flowrate, Non-aerated and non-splashing spray outlet, Fixed spout, 60 mm (2-3/8") spout reach, Infrared sensor, Solenoid valve manifold, Vandal-resistant flow nozzle.
 - .3 McGuire LFCK175 Supply - ICV DEFENDER, Lead Free, with Chrome-plated finish, Integral check supply kit, Faucet, Sweat to compression connection, 1/2" Sweat x 3/8" O.D connection, Shallow wall flange, Wheel handle, Full turn brass stem, 305 mm (12") chrome-plated risers, Purple EPDM peroxide cured washers, Codes and compliances: NSF/ANSI 61 & 372, UPC
 - .4 Lawler 570-86820 Mixing Valve - Point of Use and Master controlled fixtures, Thermostatic master water mixing control valve, Lead free brass body construction, Nickel plated finish, 1.9 - 30 LPM (0.5 - 8 GPM) range for flowrate , To adjust the mixed outlet temperature of the valve, remove the cap to gain access to the adjusting spindle. The spindle should be rotated-clockwise to reduce the temperature, counter-clockwise to increase the temperature until the desired set point is reached, 11 LPM (3 GPM) tempered flowrate @ 5 PSI pressure drop, The temperature is adjusted with the help of Spindle, 4-7/8" (124 mm) Height, ASSE 1070 approved Certified to CSA B125.3 for ASSE 1070 applications, 3/8" MNPT (9.5 mm) inlet, 95-115 °F outlet water temperature range, 3/8" MNPT (9.5 mm) outlet, internal checks, Offers choice of temperature settings from 95° through 115 °F., 125 PSI max hydrostatic pressure, ±20% pressure variation, 40-80 °F, 10 °F, 180 °F max, ±5 °F, Protects against scalding and chilling, 7 GPM flowrate @ 45 PSI.

.5 Component Shower – Anti-Ligature (SH-1):

- .1 Whitehall WH538-CSH-SRCH Complete Shower Trim - Chrome-plated brass, Showerhead and valve trim, 14 gauge type 304 stainless steel white mounting flange powder coated and provides a vandal and ligature resistant shower head with a conical shape, 5.7 LPM (1.5 GPM) showerhead flowrate, Tri-Lever Handles, The T/P Mixing Valve automatically mixes hot and cold water to deliver blended water within a specific range

.6 Sink – Hand Hygiene Sink (S-1):

- .1 American Standard 9118111.020 Basin - ICU SINK, Wall-hung Infection control sink, Vitreous china, EverClean® antimicrobial surface, White finish, Single hole centerset, Sealed overflow, With faucet ledge, Includes offset grid drain with Saniguard® coating, For floor-mounted carrier (by others), Removable acrylic shroud (with mounting hardware) provided, Overall Dimensions: 508 mm (20") long, 432 mm (17") wide, 663 mm (26-3/32") high, Bowl Dimensions: 260 mm (10-1/4") long, 419 mm (16-1/2") wide, 235 mm (9-1/4") deep
- .2 Chicago Faucets 116.427.AB.1 Faucet - HYTRONIC®, Counter mounted, Automatic no-touch, Hardwired, Lavatory faucet, Polished chrome finish, Single hole centerset, Lead Free ANSI/NSF 61 and ANSI/NSF 372 compliant, ECAST® brass construction, Stainless steel hoses included, 5.7 LPM (1.5 GPM) maximum flowrate, Plain end outlet with laminar flow control insert in spout inlet, Gooseneck spout, 133 mm (5-1/4") spout reach, 289 mm (11-3/8") high, Dual infrared sensor, 12 volt AC transformer required (to be ordered separately).
- .3 Chicago Faucets 243.260.00.1/242.340.00.1 Faucet and Flush Valve Power Kit - Hardwired AC transformer, Transformer and wire.
- .4 Lawler 570-86820 Mixing Valve - Point of Use and Master controlled fixtures, Thermostatic master water mixing control valve, Lead free brass body construction, Nickel plated finish, 1.9 - 30 LPM (0.5 - 8 GPM) range for flowrate , To adjust the mixed outlet temperature of the valve, remove the cap to gain access to the adjusting spindle. The spindle should be rotated-clockwise to reduce the temperature, counter-clockwise to increase the temperature until the desired set point is reached, 11 LPM (3 GPM) tempered flowrate @ 5 PSI pressure drop, The temperature is adjusted with the help of Spindle, 4-7/8" (124 mm) Height, ASSE 1070 approved Certified to CSA B125.3 for ASSE 1070 applications, 3/8" MNPT (9.5 mm) inlet, 95-115 °F outlet water temperature range, 3/8" MNPT (9.5 mm) outlet, internal checks, Offers choice of temperature settings from 95° through 115 °F., 125 PSI max hydrostatic pressure, ±20% pressure variation, 40-80 °F, 10 °F, 180 °F max, ±5 °F, Protects against scalding and chilling, 7 GPM flowrate @ 45 PSI
- .5 McGuire LFCK170 Supply - ICV DEFENDER, Lead Free, with Chrome-plated finish, Integral check supply kit w/5" sweat extension, Faucet, Sweat to compression connection, 1/2" Sweat w/5" Sweat extension x 3/8" O.D connection, Deep bell wall flange, Wheel handle, Full turn brass stem, 305 mm (12") chrome-plated risers, Purple EPDM peroxide cured washers, Codes and compliances: NSF/ANSI 61 & 372, UPC
- .6 Watts CA-421 Carrier - Lavatory support, Single, Wall Plate, Integral welded feet, Universal steel hangar support plate, Heavy gauge steel offset uprights, Plated hardware.

.7 Countersink (CS-1):

- .1 Franke Commercial UCS4610-316P-1 Sink - Single compartment sink, Commercial sinks, with overall dimension 460 mm (18-1/8") long, 410 mm (16-1/8") wide, 254 mm (10") high, constructed from 18 gauge Type 316 Stainless steel, Bowl dimensions are 406 mm (16") long, 356 mm (14") wide, 254 mm (10") deep, Polished to #4 satin finish, Factory installed EZ TORQUE™ fasteners, Factory applied rim seal, Center back waste location, 38 mm (1-1/2") (DN38) type 316 stainless steel tailpiece, 89 mm (3-1/2") type 316 stainless steel crumb cup strainer, waste fittings included, Undercoated to reduce condensation and resonance, Codes and Compliances: ASME A112.19.3 compliant, CSA B45.4 compliant.
- .2 Chicago Faucets 786-GN8FCXKABCP Faucet - Counter mounted, Manual, Two handles, Sink faucet, Chrome-plated finish, 203 mm (8") centerset, Lead Free ANSI/NSF 61 and ANSI/NSF 372 compliant, ECAST® brass construction, -377-XKAB ceramic 1/4 turn cartridge, 5.7 LPM (1.5 GPM) maximum flowrate, -FC 5.7 LPM (1.5 GPM) laminar flow control insert in spout inlet, plain end outlet, Gooseneck spout, 203 mm (8") spout reach, -317-PR vandal-resistant 102 mm (4") metal wrist blade handles with red & blue index, Grid drain included, 13 mm (1/2") NPSM supply inlet for 10 mm (3/8") or 13 mm (1/2") flexible riser.
- .3 Lawler 570-86820 Mixing Valve - Point of Use and Master controlled fixtures, Thermostatic master water mixing control valve, Lead free brass body construction, Nickel plated finish, 1.9 - 30 LPM (0.5 - 8 GPM) range for flowrate, To adjust the mixed outlet temperature of the valve, remove the cap to gain access to the adjusting spindle. The spindle should be rotated-clockwise to reduce the temperature, counter-clockwise to increase the temperature until the desired set point is reached, 11 LPM (3 GPM) tempered flowrate @ 5 PSI pressure drop, The temperature is adjusted with the help of Spindle, 4-7/8" (124 mm) Height, ASSE 1070 approved Certified to CSA B125.3 for ASSE 1070 applications, 3/8" MNPT (9.5 mm) inlet, 95-115 °F outlet water temperature range, 3/8" MNPT (9.5 mm) outlet, internal checks, Offers choice of temperature settings from 95° through 115 °F., 125 PSI max hydrostatic pressure, ±20% pressure variation, 40-80 °F, 10 °F, 180 °F max, ±5 °F, Protects against scalding and chilling, 7 GPM flowrate @ 45 PSI
- .4 McGuire LFCK170 Supply - ICV DEFENDER, Lead Free, with Chrome-plated finish, Integral check supply kit w/5" sweat extension, Faucet, Sweat to compression connection, 1/2" Sweat w/5" Sweat extension x 3/8" O.D connection, Deep bell wall flange, Wheel handle, Full turn brass stem, 305 mm (12") chrome-plated risers, Purple EPDM peroxide cured washers, Codes and compliances: NSF/ANSI 61 & 372, UPC
- .5 McGuire 8912CBSAN P-Trap - Cast brass body material, Chrome-plated finish, 1-1/2x1-1/2 p-trap, 304 mm (12") length, With cleanout plug, Steel box flange, Neoprene gasket, Slipnuts, 17 gauge seamless tubular wall bend

.8 Eye-wash Station (EW-1):

- .1 EFBF-16* – Barrier Free, recessed, wall mounted, eye/face wash with swing-down stainless steel drain pan. Unit construction shall be welded 16-gauge type 304 stainless steel with #4 brushed satin finish. Unit shall include chrome-plated brass eye/face wash supply fittings, ½" IPS brass rotating plug-type valve with PTFE coated O-ring seals, in-line strainer to protect valve and spray heads from debris in water line, and 2" IPS drain. Unit shall have (2) polypropylene FS-Plus™ spray heads with integral filters and 3.2 GPM flow control orifices. Activate valve by rotating 90° from stored position. Unit shall include ANSI compliant sign.
- .2 Performance: Unit complies with ADA requirements for accessibility by handicapped persons. Unit shall be fully factory assembled and hydrostatically tested to meet or exceed ANSI Z358.1 – 2014, and come with a full 2-year warranty.
- .3 Fixture: Guardian GBF1735DP & Guardian Equipment G6020 thermostatic mixing valve.

2.03 ACCEPTABLE MANUFACTURERS

- .1 Subject to compliance with requirements, manufacturers that may be incorporated into the Work include, but are not limited to, following:
 - .1 Flush Valves:
 - .1 Sloan.
 - .2 Delta Commercial.
 - .3 Zurn Industries.
 - .2 Plumbing Brass:
 - .1 Sloan.
 - .2 Acorn Engineering.
 - .3 American Standard.
 - .4 Delta Commercial.
 - .5 Chicago Faucet.
 - .3 Drain Fittings, Angle Supplies, and Traps:
 - .1 McGuire.
 - .2 American Standard.
 - .3 Delta Commercial.
 - .4 Zurn Industries.
 - .4 Fixture Carriers:

- .1 Watts Industries.
- .2 Jay R. Smith.
- .3 Zurn Industries.
- .5 Water Closets, Lavatories, and Urinal:
 - .1 American Standard.
 - .2 Zurn Industries.
 - .3 Kohler.
- .6 Thermostatic Mixing Valves:
 - .1 Lawler.
 - .2 Delta Commercial.
 - .3 Leonard.
- .7 Shower and Associated Trim:
 - .1 American Standard.
 - .2 Delta Commercial.
 - .3 Zurn Industries.
- .8 Toilet Seats:
 - .1 Olsonite.
 - .2 Centoco.
 - .3 Bemis Commercial.
- .9 Electronic “No Touch” Faucets:
 - .1 Sloan.
 - .2 Delta Commercial.
 - .3 Zurn Industries.

2.04 CAULKING

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

3 EXECUTION

3.01 DEMOLITION

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

3.02 INSTALLATION OF PLUMBING FIXTURES AND FITTINGS

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

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

- .4 Confirm exact location of plumbing fixtures and trim prior to roughing-in. Refer to architectural plan and elevation drawings.
- .5 When installation is complete, check and test operation of each fixture and fitting. Adjust or repair as required.
- .6 For barrier-free fixtures, comply with mounting height and other requirements of governing Code(s).
- .7 Supply templates for counter mounted fixtures and trim and hand to trades who will cut the counter. Ensure openings in counter are properly located.

- .8 Locate control panels for electronic faucets under lavatories and recessed into wall. Coordinate panel installations with electrical trade who will provide 115 volt power wiring to panels. Install flexible conduit (supplied with box) and extend cord from faucet through the flexible conduit to control box. Connect hot and cold water piping to mixing valve in each box, and tempered water piping from each mixing valve to faucet. Set mixing valve maximum temperature limit stops to 43°C (110°F) after domestic water systems (hot and cold) are complete. Ensure each programmable controller is properly programmed and water off after deactivation is set for 3 seconds.
- .9 Confirm exact mixing valve and shower head locations prior to roughing-in.
- .10 Install refrigerated drinking fountains in accordance with manufacturer's instructions. Plug into a wall receptacle provided as part of electrical work. Coordinate receptacle installation with electrical trade on site.

3.03 CAULKING AT PLUMBING FIXTURES AND FITTINGS

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

END OF SECTION

1 GENERAL

1.01 SUBMITTALS

- .1 Submit shop drawings/product data sheets for all products specified in this Section except pipe and fittings. Appropriate CRN assigned to each component is to be clearly indicated on component shop drawing/product data sheet.
- .2 Submit product data sheets for motors, and certified wiring diagrams for equipment requiring power, control and/or alarm wiring connections.
- .3 Submit, prior to work commencing on site, a detailed account of proposed pipe joint brazing procedures including pre- and post-nitrogen purging.
- .4 Submit written certification by equipment manufacturers/suppliers confirming equipment is properly installed, has been tested, and is in proper operating condition, all as specified in Part 3 of this Section.
- .5 Submit manufacturer's start-up reports as specified in Part 3 of this Section.
- .6 Submit 3 identified keys for cabinet/panel lockable doors prior to Substantial Performance of the Work.
- .7 For each zone valve box assembly and combination zone valve box and alarm, submit for review a typed list of rooms and areas with medical gas terminal units controlled by each zone valve.
- .8 Submit record as-built drawings in accordance with requirements specified in Section entitled Mechanical Work General Instructions.

1.02 DESIGN PRESSURE AND TEMPERATURE REQUIREMENTS

- .1 System design pressures are as follows:
 - .1 oxygen, carbon dioxide, nitrous oxide, medical air:
 - .1 maximum system pressure, 380 kPa (55 psi);
 - .2 maximum pressure at terminal unit, 345 kPa (50 psi).
 - .2 vacuum:
 - .1 minimum system vacuum, -54 kPa (-15.94 "Hg);
 - .2 maximum vacuum at terminal unit, -68 kPa (-20.08 "Hg).
 - .3 AGSS:
 - .1 minimum system AGSS vacuum, -45 kPa (-13 "Hg).
 - .2 maximum system AGSS vacuum at terminal unit, -55 kPa (-16 "Hg).
- .2 Design temperature for all services will be ambient temperature.

1.03 QUALITY ASSURANCE

- .1 Products and work must comply in all respects with requirements of CAN/CSA Z7396.1 and related Standards, and, where applicable, requirements of local governing authorities.
- .2 Contractor is responsible for registration, inspection, and/or approval for medical gas system work, as required, with local regulatory authority.
- .3 Medical gas systems work must be performed by journeyman plumber / pipefitter / steamfitter tradesmen completely familiar with requirements of CAN/CSA Z7396.1, and who are qualified and certified (with jurisdictional authority issued Certificate) for silver brazing with nitrogen backing without using flux in accordance with Clause 4.5 in Part 1 of CSA B51. Jurisdictional authority is the authority designated by the province of the work to perform oversight functions cited in Clause 4.5 in Part 1 of CSA B51.
- .4 Consultant reserves right to ask for and review Certificate of any tradesman, and only tradesmen with valid Certificates may perform work on systems.

2 PRODUCTS

2.01 GENERAL RE: PIPING SYSTEM MATERIALS AND COMPONENTS

- .1 Pipe, fittings, and piping system components are to be factory washed and degreased. Pipe is to be capped. Fittings and components are to be packaged.
- .2 Piping system components to be site connected with piping are to be complete with factory installed, washed, degreased and capped Type "K" hard copper piping stubs with joints silver brazed while component and piping is full of nitrogen.
- .3 Unless otherwise specified, acceptable medical gas system product manufacturers/suppliers are:
 - .1 Class 1 Inc.;
 - .2 Amico Corp.;
 - .3 Vitlaire.

2.02 PIPE, FITTINGS AND JOINTS

- .1 Aboveground
 - .1 Type "L" or type "K" (as specified in Part 3) hard temper copper tubing to ASTM B819, "Standard Specification for Seamless Copper Tube for Medical Gas Systems", complete with wrought copper, brass or bronze "Silver Braze" fittings and silver brazed joints made with Silvaloy 15 or equal brazing alloy conforming to ANSI/AWS Standard A5.8 Classification BcuP-5.

2.03 SHUT-OFF VALVES

- .1 Full flow bronze body ball type valves, 4140 kPa (600 psi) rated, ¼ turn on-off from a fully closed to a fully open position, in-line serviceable, blow-out proof, factory pressure tested, and complete with a chrome plated brass or stainless steel ball depending on valve size, a double Teflon seal, a Teflon seat, O-ring packing, lever handle capable of locking in open or closed position, and colour coded permanent identification labels.

2.04 LOCAL EMERGENCY ALARM PANEL/ZONE VALVE BOX ASSEMBLIES

- .1 Flush wall mounting combination zone valve box and local emergency alarm panels and zone valve box assemblies incorporating a zone valve box and an area alarm panel in one enclosure. Each assembly is to be complete with:
 - .1 enamelled steel box sized to suit components installed, complete with adjustable steel mounting brackets to accommodate various wall thicknesses, an anodized aluminium frame, and pull-out removable window with silk-screen bilingual wording to read "CAUTION: MEDICAL GAS CONTROL VALVES - CLOSE VALVES ONLY IN EMERGENCY";
 - .2 ball type shut-off valves as specified in this Section but less the handle lock feature, sized as shown, complete with tube extensions, and secured to back of box;
 - .3 gauge connection brazed onto pipe stub at downstream (patient) side of each valve assembly, with a 40 mm (1-1/2") diameter pressure (or vacuum) gauge conforming to requirements specified in Section entitled Basic Mechanical Materials and Methods, and with ranges as follows:
 - .1 vacuum – 0 to 100 kPa (0 to 28.5 "Hg);
 - .2 all other services – 0 to 700 kPa (0 to 100 psi).
 - .4 modular, microprocessor-based, gas specific alarm units with large LED universal (psi, kPa, "Hg, Bar) pressure/vacuum displays, LED trend display, high and low alarms with dry contacts for connection to a master alarm panel, 90 dBA audible alarm with silence button and adjustable alarm reminder, alarm history recall, identified sensors with DISS connection located in back box, and required remote monitoring hardware.

2.05 SCAVENGING TERMINAL UNITS

- .1 AGSS evacuation terminal units for low pressure gas scavenging, single, modular, recessed wall or ceiling mounted, surface mounted, or ceiling column mounted as shown, each complete with a permanently colour coded faceplate sealed behind a Lexan faceplate, a 20 mm (3/4") diameter Type "L" inlet supply tube, and a 20 mm (3/4") diameter and 30 mm (1-3/16") diameter taper fitting for connection to standard anaesthesia gas disposal tubing.

2.06 TERMINAL UNITS

- .1 DISS type, gas specific, non-interchangeable, modular, flush mounting terminal units, either singular or in groups as shown on drawings, each designed to accommodate mounting surface thickness variations of up to 12 mm (1/2"), complete with a CRN and following:
 - .1 die-cast outlet box;
 - .2 cartridge type primary check valve and stainless steel ball type secondary check valve;
 - .3 chrome plated brass outlet body with permanently embossed gas identification nameplate with bilingual labelling, all sealed behind a protective cover with chrome plated trim;

- .4 required centreline spacing between multiple terminal units;
- .5 temporary protective covers, and standing pressure test caps.

3 EXECUTION

3.01 DEMOLITION

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

3.02 GENERAL RE: PIPING INSTALLATION

- .1 Perform pipe joint brazing work in accordance with CAN/CSA Z7396.1 and reviewed brazing procedures submitted to Consultant prior to start of work.
- .2 Consultant reserves right to cut-out and examine piping joints during course of work or after work is complete, and if interior of cut-out sample and/or fittings are found to be contaminated with oxidation or any other material, piping will be considered unacceptable and must be cleaned or replaced.
- .3 Where low pressure connecting assemblies are used in retractable gas columns, articulating arms, or any other dispensing assembly, DISS body or terminal unit which is used to connect it to copper pipeline must be brazed to piping system.
- .4 Refer to architectural drawing plans and elevations for exact locations of terminal units, zone valve boxes, alarm panels, and other such items.

3.03 INSTALLATION OF MEDICAL GAS SYSTEM PIPING

- .1 Provide required medical gas system piping. Unless otherwise shown or specified, vacuum piping is to be minimum 20 mm ($\frac{3}{4}$ ") diameter, and piping for all other services is to be minimum 12 mm ($\frac{1}{2}$ ") diameter.
- .2 Piping aboveground, unless otherwise specified, is to be Type "L" hard copper.
- .3 Perform pipe brazing operations in strict accordance with requirements of CAN/CSA Z7396.1.
- .4 Ensure tools used during erection of piping systems are kept clean and free from oil and grease.
- .5 Support piping by means of support materials specified in Section entitled Basic Mechanical Materials and Methods, in accordance with requirements of article entitled "Pipeline Supports" in CAN/CSA Z7396.1 and with support spacing in accordance with table entitled "Spacing of Piping Supports" in CAN/CSA Z7396.1.
- .6 Prepare a separate set of as-built white prints on a daily basis. Identify piping system work, including valves, concealed and exposed, in accordance with requirements of CAN/CSA Z7396.1. Submit record as-built drawings in accordance with requirements in Section entitled Mechanical Work General Instructions.

- .7 Install vacuum piping sloped to low points. Equip each low point, including bottom of vertical risers, with drip pockets consisting of a full size pipe tee with one leg capped with a removable cap. Ensure drip points are accessible and indicated on as-built record drawings.
- .8 Provide DISS identified riser outlet piping connections in ceiling and/or wall spaces for connection to terminal outlets integral with manufactured equipment such as articulated arms (with riser plates) provided as part of this Section of the work or as part of the work of other Divisions of the Specification. Terminal units will be pre-piped by equipment manufacturer to an accessible location. Carefully rough-in piping and coordinate equipment connections, particularly for flush mounted and/or ceiling mounted equipment.
- .9 Provide identified piping connections to ceiling columns and/or headwalls provided as part of this Section or as part of the work of other Divisions.
- .10 Provide valved and capped connections for future extension. Clearly and permanently identify each capped connection and ensure they are exactly located on as-built record drawings.
- .11 In accordance with CAN/CSA Z7396.1, provide a full size branch tee with shut-off valve for each gas source (including vacuum) downstream of main isolation valve.
- .12 Perform revision/retrofit work as shown and in accordance with CAN/CSA Z7396.1.

3.04 INSTALLATION OF VALVES

- .1 Provide shut-off/isolation valves where shown and/or required by CAN/CSA Z7396.1. Shut-off valves, unless otherwise specified, are to be ball type.
- .2 Provide check valves where shown and/or required by CAN/CSA Z7396.1.
- .3 Ensure valves are located for easy access and operation.

3.05 INSTALLATION OF COMBINATION ZONE VALVE/AREA ALARM BOXES

- .1 Provide combination zone valve box/area alarm assemblies. Provide a service isolation valve in piping immediately upstream of each zone valve and on same floor.
- .2 Accurately install boxes with reference to wall finish, and confirm exact locations prior to roughing-in.
- .3 At each zone valve box location provide a typed, framed and glazed list of all rooms and areas controlled by each zone valve. Submit lists and wording for review prior to framing and glazing.

3.06 INSTALLATION OF SCAVENGING TERMINAL UNITS

- .1 Provide medical gas scavenging terminal units and mount. Confirm exact locations prior to roughing-in. Refer to architectural drawings.
- .2 Connect each terminal unit assembly with copper tubing extended to zone valve boxes to vacuum pump set.

3.07 INSTALLATION OF TERMINAL UNITS

- .1 Provide wall mounted medical gas terminal units, either singular or in groups as indicated. Leave temporary caps in place.
- .2 Confirm exact locations prior to roughing-in. Refer to architectural drawings.
- .3 Equip each terminal unit with a faceplate.
- .4 Supply medical gas terminal units for factory installation in consoles, headwalls, articulating arms, ceiling service columns, and other such manufactured assemblies, and ship terminal units to manufacturer's plant.

3.08 PIPING SYSTEM LEAKAGE TESTING

- .1 Refer to Section entitled Basic Mechanical Materials and Methods. Ensure governing authorities are informed well in advance of scheduled tests so they may witness tests as required.

3.09 POWER AND CONTROL WIRING

- .1 Line voltage power wiring to equipment, unless otherwise specified, will be done as part of electrical work.
- .2 Control and alarm wiring, unless otherwise specified, is to be installed in conduit as part of medical gas system work in accordance with electrical work wiring requirements, and manufacturer's/supplier's certified wiring schematics.
- .3 Generally, power wiring (part of electrical work) and control and alarm wiring (part of mechanical work) is to be as follows:

EQUIPMENT	LINE VOLTAGE POWER WIRING	CONTROL AND/ OR ALARM WIRING
combo zone valve and area alarm units	115 volt to panel	

3.10 EQUIPMENT START-UP AND CERTIFICATION

- .1 When installation of medical gas system equipment from source of supply up to but not including outlets is complete, and piping leakage testing is complete, but prior to certification as specified below, and in accordance with article entitled "Commissioning of Supply Systems" in CAN/CSA Z7396.1, arrange for equipment manufacturers/suppliers to visit site for length of time necessary to:
 - .1 check installation of equipment and recommend any adjustments required to be performed immediately;
 - .2 start-up equipment, test operation, recommend any adjustments required to be performed immediately, check and verify safeties, operational sequences, controls and alarms to ensure they are operating properly, and ensure equipment performs as intended;

- .3 obtain letter(s) from system manufacturer(s)/supplier(s) certifying above requirements have been successfully completed, have letter(s) signed by system manufacturer(s)/supplier(s), and submit to Consultant.

3.11 MEDICAL GAS SYSTEM CERTIFICATION

- .1 When equipment start-up and certification as specified above is complete, notify Owner and Consultant that systems are ready for certification in accordance with CAN/CSA Z7396.1.
- .2 Arrange for system installer to be part of certification team.
- .3 Should Owner's Certification Agency ("Agency") be delayed by your default or by the fact that you are not ready for certification procedure, or if scheduled certification is cancelled with less than 2 days' notice because systems are not ready, you will be responsible for all costs for the Agency to repeat tests, remain on site longer than could reasonably be expected, or reschedule tests, as applicable.
- .4 Owner's Certification Agency will make interim site visits during construction to review medical gas system work. Cooperate with and reasonably assist the Agency, and immediately correct any deficient work reported by the Agency.

END OF SECTION

1 GENERAL

1.01 REFERENCE STANDARDS

- .1 National Air Duct Cleaners Association (NADCA)
 - .1 ACR Standard, The NADCA Standard, Assessment, Cleaning and Restoration of HVAC Systems.
- .2 Canadian Standard Association (CSA)
 - .1 CAN/CSA Z317.13, Infection Control During Construction, Renovation, And Maintenance of Health Care Facilities.
 - .2 CAN/CSA-Z317.2, Special Requirements for Heating, Ventilation, and Air-Conditioning (HVAC) Systems in Health Care Facilities.
- .3 North American Insulation Manufacturers Association (NAIMA)
 - .1 NAIMA, Cleaning Fibrous Glass Insulated Duct Systems - Recommended Practices.
- .4 American National Standards Institute/Institute of Inspection Cleaning and Restoration Certification (ANSI/IICRC)
 - .1 ANSI/IICRC S520 - Standard for Professional Mold Remediation.
- .5 National Fire Protection Association (NFPA)
 - .1 NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.
 - .2 NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
- .6 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
 - .1 HVAC Duct Construction Standards - Metal and Flexible.

1.02 DEFINITIONS

- .1 HVAC System: complete air duct system from outside air intake louvers to furthest air supply terminal unit and including:
 - .1 Rigid supply and return ductwork;
 - .2 Mixing plenum boxes;
 - .3 Cooling and heating coils and compartments;
 - .4 Condensate drain pans, eliminator blades and humidifiers;
 - .5 Fans, fan blades and fan housing;
 - .6 Filter housing and frames;
 - .7 Silencers;

- .8 Reheat coils;
- .9 Diffusers and registers;
- .10 Dampers and controls.

1.03 ADMINISTRATIVE REQUIREMENTS

- .1 Coordination:
 - .1 Coordinate the Work of this section with the work of other trades, and the work of different contractors.
- .2 Precleaning Meeting:
 - .1 Conduct precleaning meeting with NL Healthcare Partners stamping Professional Engineer and Contractors.
- .3 Sequencing:
 - .1 Perform duct cleaning work after HVAC system construction and duct leakage testing are complete.
- .4 Scheduling:
 - .1 Prepare and submit HVAC system cleaning activities schedule.

1.04 SUBMITTALS

- .1 Provide submittals in accordance with Division 01 requirements.
- .2 Regulatory Agency Sustainability Approvals.
- .3 Qualifications.
 - .1 Manufacturers.
 - .2 Suppliers.
 - .3 Fabricators.
 - .4 Installers/Applicators/Erectors.
 - .5 Testing Agencies.
 - .6 Licensed Professionals.
- .4 Product Data:
 - .1 Submit manufacturer's printed product literature and data sheets for antimicrobial agents and include product characteristics, performance criteria and limitations.
 - .2 Provide WHMIS SDS for antimicrobial agents or coatings.

- .5 Duct cleaning plan: Before commencing cleaning work, submit written work plan including following information:
 - .1 Scope of Work identifying HVAC components are to be cleaned, as well as those components not to be cleaned.
 - .2 Itemize specific environmental engineering controls required for workspace, and special work requirements.
 - .3 Detail cleaning work means and methods.
 - .4 Name, contact information, and functional tasks performed by each representative of each firm and contractor involved with the work.
- .6 Manufacturer's Instructions: Submit cleaning agent product installation instructions.
- .7 Field Quality Control Submittals:
 - .1 Submit laboratory analysis results, if NADCA Vacuum Test is used for cleanliness verification.
 - .2 Submit documentation detailing chain of custody for test samples, if outside laboratories or testing agencies performed sample analysis or testing.
- .8 Qualification Statements: Show membership status, project experience, and certifications for:
 - .1 HVAC Cleaning Contractor.
 - .2 Supervisor.
 - .3 Inspector.
 - .4 Hygienist.
 - .5 Testing Agency.
- .9 Record Documentation: Submit documentation verifying compliance with this specification for work performed. This documentation may include:
 - .1 Completion of cleaning work, as verified by NL Healthcare Partners stamping Professional Engineer visual inspection and verification of cleanliness.
 - .2 Photo images, HVAC plans and other supporting documents such as submittal forms for materials used and/or warranties or guarantees.
 - .3 System areas found to be damaged or in need of repair.

2 PRODUCTS

2.01 TREATMENT MATERIALS

- .1 Antimicrobial Agents: Type recommended by Certified Industrial Hygienist (CIH), determined from biological contamination test results.

- .2 Use antimicrobial agents registered with US EPA-40 CFR.

2.02 SYSTEM FILTERS

- .1 Supply and install new filters for each HVAC System cleaned.

2.03 HEPA FILTER EVACUATION FAN

- .1 Evacuation Fan: includes fan, HEPA filter, flexible hose and motor capable of maintaining debris and particulates airborne in airstream until they reach evacuation fan and maintaining system under negative pressure.
 - .1 Ensure HEPA filters are clean and maintain evacuation fan and HEPA filter to run efficiently.

2.04 HEPA VACUUM UNIT

- .1 Vacuum Unit: includes vacuum fan, integral HEPA filter, suction hose and vacuum head, capable of maintaining HVAC System debris and particulates airborne in air stream until they reach vacuum unit and maintaining system under negative pressure.
 - .1 Ensure HEPA filters are clean and maintain vacuum unit and HEPA filter to run efficiently.

3 EXECUTION

3.01 EXAMINATION

- .1 HVAC System Assessment and Site Survey:
 - .1 Before commencing work, assess HVAC system condition to determine appropriate engineering controls, safety measures, tools, equipment and cleaning products and methods required to complete the work.
 - .2 Perform HVAC system assessment by ASCS, Certified Ventilation Inspector (CVI), or equivalent.
 - .3 If microbial testing or sampling are required, engage services of technicians trained and acceptable to authorities having jurisdiction.
- .2 Work Plans:
 - .1 Project Schedule: Outline starting date, dates and times when work will take place, and completion date.
 - .1 Determine sequence of cleaning each system or portion of the work and coordinate with work of other trades and activities.
 - .2 Product Data and Safety Data Sheets: Product data submittals listing general use and specific chemical cleaning products and coatings used while performing the work, along with Safety Data Sheets for chemical products used to perform the work.
 - .3 Safety Plan: Define responsibilities of each organization's designated representative involved with executing work plan throughout project.

3.02 PROTECTION OF IN-PLACE CONDITIONS

- .1 Protect structures, surfaces, and systems from damage resulting from duct cleaning work.
- .2 Report damage caused by this work to Mechanical and General Contractors.

3.03 HVAC SYSTEM PREPARATION

- .1 Service Openings:
 - .1 Access duct cleaning work through existing or new service openings, allowing safe access and thorough cleaning throughout specified components.
 - .2 Work through service openings sized to allow mechanical tool entry and visual inspection, as required for cleaning activities.
 - .3 Where possible, work through existing service openings.
 - .4 Where new service openings are required, install openings as follows:
 - .1 Do not degrade structural, thermal, or functional system integrity, and comply with applicable SMACNA duct construction methods.
 - .2 Install service openings complying with UL and NFPA standards, federal, state, and local code requirements, and requirements of Authorities Having Jurisdiction.
 - .3 Where required, install duct access doors complying with UL Standard 181, and fabricated with materials classified for flammability and smoke developed.
 - .4 Where required, install tapes complying with UL 181A.
 - .5 Where required, install closure panels fabricated from equivalent material and same or heavier gage.
 - .6 Mechanically fasten closure panels over service openings with screws or rivets at perimeter, maximum 100 mm spacing.
 - .7 Fabricate closure panel to overlap duct opening perimeter, minimum 25 mm.
 - .8 Insulate closure panels to match adjacent duct interior and exterior surfaces.
 - .9 Seal rigid fibrous glass duct systems in accordance with NAIMA recommended practices.
 - .1 Install closure techniques: UL Standard 181 or UL Standard 181A.
 - .10 Close service openings installed in rigid fibrous glass ductwork and metal ductwork with fibrous glass liner with no exposed fibrous glass edges exposed to airstream.
 - .5 Install service openings that can be reopened for future inspection or remediation.
 - .1 Mark outside of duct and report service opening locations to in project closeout documents.

3.04 CLEANING EQUIPMENT MAINTENANCE AND USE

- .1 Maintain equipment employed in work performance in good working order, consistent with equipment manufacturer's written instructions and applicable jurisdictional requirements.
- .2 Clean and inspect equipment before bringing to work site.
- .3 Do not introduce contaminants from cleaning equipment into indoor environment or HVAC system.
- .4 Service equipment to limit possible HVAC system contamination from insufficient service equipment cleaning, and unsafe operating conditions for service personnel and building occupants.
- .5 Perform activities requiring opening contaminated vacuum collection equipment on-site, including servicing or filter maintenance, in appropriate containment area or outside building.
- .6 Clean and seal collection devices, vacuums and other tools and devices before relocating to different building areas, moving equipment through occupied spaces, and before removing equipment from building.
- .7 Locate fuel-powered equipment to prevent combustion emissions and air exhaust emissions from entering building envelope.
 - .1 Monitor and manage equipment operation and location to prevent introduction of combustion emissions into occupied space.
- .8 Furnish HEPA-filtered equipment with minimum collection efficiency of 99.97 percent at 0.3 micron particle size, when vacuum collection equipment exhausts within building envelope.

3.05 CLEANING - GENERAL

- .1 Perform HVAC system cleaning in accordance with ACR, The NADCA Standard.
- .2 Remove visible non-adhered particulates.
 - .1 Clean HVAC components employing agitation device to dislodge contaminants from HVAC component surface, and then capturing contaminants with vacuum collection device.
 - .1 Acceptable methods include those that do not damage integrity of ductwork and other system components.
 - .2 Clean HVAC components using source removal mechanical cleaning methods designed to extract contaminants from within HVAC system and safely remove contaminants from facility.
 - .3 Select source removal methods rendering HVAC system visibly clean and capable of passing cleanliness verification methods as described in ACR, The NADCA Standard.
 - .4 Do not employ cleaning method, or combination of methods, that can damage HVAC system components or negatively alter system integrity.

- .5 Do not damage HVAC system and components with wet cleaning, power washing, steam cleaning and other wet process cleaning.
- .3 Apply cleaning materials in accordance with manufacturer's instructions.
 - .1 Do not apply cleaning agents or water to electrical, fibrous glass or other porous HVAC system components.
- .4 Capture removed contamination and cleaning materials and legally dispose.
- .5 Verify HVAC system surface and component cleanliness in accordance NADCA Standard.
- .6 Particulate Collection:
 - .1 Employ contaminant removal methods incorporating vacuum collection devices operated continuously during cleaning.
 - .1 Connect vacuum collection device to component being cleaned through service opening.
 - .2 Employ vacuum collection device of sufficient capacity to maintain areas being cleaned under negative pressure, containing debris is contained and preventing contaminant migration to adjacent areas.
 - .2 When possible, discharge ducted exhaust air from vacuum collection devices outdoors, keeping discharge air clear of outdoor air intakes, operable windows, and other locations allowing outdoor air entry.
 - .1 Do not violate outdoor environmental standards, codes or regulations.
 - .2 Do not discharge unfiltered air from vacuum collection devices outdoors.
 - .3 When necessary to exhaust vacuum collection devices indoors, including hand-held and wet-vacuum machines, keep discharge air in work area, and provide machine air discharge HEPA filtration, rated at 99.97 percent collection efficiency for 0.3 micron particles and larger.

3.06 AIR HANDLING UNIT (AHU) CLEANING

- .1 Clean existing ACS-5A and RF-5A.
- .2 Clean supply, return, and exhaust fans and blowers.
 - .1 Clean blowers, fan housings, ducted plenums, scrolls, blades, or vanes, shafts, baffles, dampers and drive assemblies.
 - .2 Remove visible non-adhered particulate deposits in accordance with ACR, The NADCA Standard.
- .3 Clean air handling unit (AHU) internal surfaces, components and condensate pans, and drains.
- .4 Clean heat transfer coils, fans, condensate pans, drains and similar non-porous surfaces in conjunction with mechanical methods as described in ACR, The NADCA Standard.

- .5 Control water spray and extraction are sufficient to collect debris and prevent water damage to HVAC components and surrounding equipment.
- .6 Capture, contain, test and dispose of waste water generated while performing wet cleaning in accordance with applicable federal, state, and local regulations, and requirements of Authorities Having Jurisdiction.
- .7 After cleaning, verify HVAC system surface and component cleanliness in accordance ACR, The NADCA Standard.

3.07 AIR DUCT SYSTEMS:

- .1 Clean all new supply air and return air ductwork connected to existing ACS-5A and RF-5A.
- .2 Clean all new supply air and return air ductwork connected to existing ACS-1H, ACRE-1H and ACRE-1H-1.
- .3 Clean air ducts to remove non-adhered substances.
- .4 Access air duct interiors through service openings in system that are large enough to accommodate mechanical cleaning procedures and allow for cleanliness verification.
- .5 Use mechanical agitation methods to remove particulate, debris, and non-adhered particulate.
- .6 Capture dislodged substances with vacuum collection device.
- .7 Do not employ cleaning methods that damage HVAC components.
- .8 Mark position of dampers and air-directional mechanical devices inside HVAC system prior to cleaning.
- .9 When cleaning is complete, restore dampers and devices to their marked positions.
- .10 After cleaning, verify cleanliness of HVAC system surfaces and components in accordance ACR, The NADCA Standard.

3.08 AHU COILS

- .1 Perform visual coil and drain pan inspection to determine whether Type 1 dry cleaning, or Type 2 wet cleaning is required.
- .2 Employ cleaning methods rendering coil visibly clean in accordance with ACR, The NADCA Standard.
- .3 Isolate coil from duct system during cleaning process. Do not allow removed particles to migrate to, or redeposit on, unintended areas.
- .4 Apply coil cleaning products in accordance with manufacturer's published data and labeling.
- .5 Clean and flush condensate drain pan and drain line. Verify proper drainage operation before and after cleaning.

- .6 Apply cleaning methods and products that do not cause damage to, or erosion of, coil surface or fins.

3.09 TYPE 1 DRY CLEANING METHOD

- .1 Operate HEPA-filtered negative air machines that discharge continuously during Type 1 cleaning process.
- .2 Mechanically remove adhered dirt and contaminants in accordance with ACR, The NADCA Standard.

3.10 TYPE 2 WET CLEANING METHOD

- .1 Employ Type 2 wet cleaning method when visual inspection reveals suspect microbial matter on coil or drain pan. Access both upstream and downstream sides of each coil section for cleaning.
- .2 Employ engineering controls required for coil cleaning in accordance with ACR, The NADCA Standard.
- .3 Verify cleanliness after cleaning has been performed as described in ACR, The NADCA Standard.
- .4 Perform Type 2 cleaning if debris still remains on the coil or the coil is impacted after Type 1 cleaning has been completed and post-cleaning inspection has been performed.
- .5 After cleaning, verify cleanliness of HVAC coils in accordance ACR, The NADCA Standard.

3.11 DUCT-MOUNTED INLINE COILS

- .1 Clean all relocated and new reheat coils as part of ACS-1H and ACS-5A duct distribution system.
- .2 Perform visual inspection of coil [and drain pan] to determine whether Type 1 dry cleaning, or Type 2 wet cleaning is required.
- .3 Employ cleaning methods which will render coil visibly clean in accordance with ACR, The NADCA Standard.
- .4 Isolate coil from duct system during cleaning process. Do not allow removed particles to migrate to, or redeposit on, unintended areas.
- .5 Apply coil cleaning products in accordance with manufacturer's published data and labeling.
- .6 Clean and flush coil.
- .7 Apply cleaning methods and products that do not cause damage to, or erosion of, coil surface or fins.
- .8 Type 1 Dry Cleaning Method:
 - .1 Operate negative air machines with HEPA-filtered discharge continuously during Type 1 cleaning process.

- .2 Mechanically remove adhered dirt and contaminants in accordance with ACR, The NADCA Standard.
- .9 Type 2 Wet Cleaning Method:
 - .1 Employ Type 2 wet cleaning method when visual inspection reveals suspect microbial matter on coil or drain pan. Access both upstream and downstream sides of each coil section for cleaning.
 - .2 Employ engineering controls required for coil cleaning in accordance with ACR, The NADCA Standard.
 - .3 Verify cleanliness after cleaning has been performed as described in ACR, The NADCA Standard.
 - .4 Perform Type 2 cleaning if debris still remains on the coil or the coil is impacted after Type 1 cleaning has been completed and post-cleaning inspection has been performed.
 - .5 Capture rinse water when cleaning duct mounted coils without drain pans. Do not allow water to remain in cleaned ductwork.
 - .6 After cleaning, verify cleanliness of HVAC coils in accordance ACR, The NADCA Standard.

3.12 INTERNALLY INSULATED DUCT SYSTEM COMPONENTS AND SOUND ATTENUATORS

- .1 Employ cleaning methods that do not damage internal insulation or sound attenuating components, and that render system capable of passing cleanliness verification tests.
- .2 Clean fibrous glass duct liner or duct board present in equipment or air ducts employing mechanical agitation methods to remove particulate, debris, and non-adhered particulate.
- .3 Do not create abrasions, breaks, or tears to fibrous glass liner or duct board surfaces.
- .4 Maintain HVAC system under constant negative pressure when cleaning internal insulation components.
- .5 Do not wet insulation components.
- .6 Identify for replacement fibrous glass materials with evidence of damage, deterioration, delaminating, friable materials, biological growth, or moisture that cannot be restored by cleaning or resurfacing.
- .7 When required, remediate exposed, damaged insulation exposed to HVAC system air stream.
 - .1 Scrape insulation and adhesive residue from metal duct system surfaces that have undergone degraded insulation removal.
 - .2 Remove loose, visible debris prior to installation of new insulation.

3.13 SPECIAL TECHNIQUES

- .1 Engineering Controls:
 - .1 Employ engineering controls to maintain worker and building occupant safety, and prevent contaminating surfaces outside work area.
 - .1 Comply with government regulations, and industry standards and guidelines relevant to working in the facility environment in which the work is located.
 - .2 Control odors, mists, and aromatic vapors during cleaning process.
- .2 Controlling Product Emissions:
 - .1 Apply cleaning agents and other chemicals in accordance with manufacturer's recommended procedures and product application instructions, including exhaust ventilation.
- .3 Negative Duct Pressurization:
 - .1 Throughout cleaning process, keep HVAC system and associated air ducts at negative differential pressure, relative to indoor non-work area.
 - .2 Maintain negative pressure differential between portion of HVAC duct system being cleaned and surrounding indoor occupant spaces.
 - .3 Continuously monitor and verify correct pressure differential.
 - .4 When performing vacuum collection, employ negative air machine drawing air from equipment being cleaned.
 - .5 When negative air machine is not fitted with HEPA filtration, duct exhaust air from negative air machine to outdoor location, keeping discharge air clear of outdoor air intakes, operable windows, and other locations where outdoor air enters building.
 - .1 Do not violate outdoor environmental standards, codes or regulations by releasing debris.
 - .2 Do not discharge unfiltered air from vacuum collection devices outdoors.
- .4 Microbial Agents:
 - .1 Apply antimicrobial agents only when active biological growth is reasonably suspected, or where unacceptable levels of biological contamination have been verified through testing.
 - .2 Apply antimicrobial agents after removal of surface deposits and debris.
 - .3 Apply antimicrobial agents in accordance with antimicrobial agent manufacturer's written recommendations and associated EPA registration listing.

3.14 FIELD QUALITY CONTROL

- .1 Inspect work to verify cleanliness immediately after HVAC system component cleaning and prior to placing system in operation.

- .2 Do not apply treatment, coating, or antimicrobial agent to cleaned HVAC system or components until the work has been inspected and determined to be acceptable.
- .3 Visual Inspection:
 - .1 When cleaning is complete, perform final inspection in presence of NL Healthcare Partners stamping Professional Engineers.
 - .2 Perform visual inspection of non-porous HVAC system component surfaces. Verify HVAC system is visibly clean as defined in ACR, The NADCA Standard.
 - .3 If no contaminants are evident through visual inspection, HVAC is considered clean and acceptable.
 - .4 If contaminants are evident through visual inspection, repeat cleaning system areas where contaminants are visible.
 - .5 Notify NL Healthcare Partners stamping Professional Engineers to schedule cleanliness re-inspection.
- .4 NADCA Vacuum Test for Non-Porous Surfaces Only:
 - .1 When required, perform Vacuum Test in presence of NL Healthcare Partners stamping Professional Engineers, and in accordance with ACR, The NADCA Standard.
 - .2 Apply NADCA Vacuum Test template to flowing-air side of component's surface.
 - .3 Attach vacuum cassette with filter media to calibrated air sampling pump and pass open face of filter cassette over two 2 cm x 25 cm openings marked on template.
 - .4 Pass vacuum cassette over system surfaces at 2 inches/second.
 - .5 When sampling is complete, prepare filter cassette and weigh it to determine total amount of debris collected.
 - .6 Surface is considered acceptably clean, when net weight of debris collected on filter cassette is less than 0.75 mg/100 cm².

3.15 SYSTEM STARTUP

- .1 Install closures over services access openings before allowing system restart for normal facility operation.
- .2 When system is placed in operation, remove temporary filter elements after minimum 24 hours operation.

END OF SECTION

1 GENERAL

1.01 SUBMITTALS

- .1 Submit shop drawings/product data sheets for all products specified in this Section except piping and unions.
- .2 Submit with delivery of each unit a copy of factory inspection and test report, and include a copy of each report with O&M Manual project close-out data.
- .3 Submit a site inspection and start-up report from manufacturer's representative as specified in Part 3 of this Section.
- .4 Prior to Substantial Performance of the Work, submit a spare seal flush line filter for each pump equipped with a seal flush line.
- .5 Submit a letter from pipe anchor design engineer to stating engineer has visited site to examine installation of pipe anchors and pipe anchor installation is in accordance with reviewed anchor shop drawing.

2 PRODUCTS

2.01 PIPE, FITTINGS AND JOINTS

- .1 Black Steel - Screwed Joint
 - .1 Mild black carbon steel, Grade B, ASTM A53, complete with Class 125 cast iron threaded fittings to ANSI/ASME B16.4, and screwed joints.
- .2 Black Steel - Grooved End Mechanical Joint
 - .1 Mild black carbon steel, Grade B, ASTM A53, factory or site roll grooved, complete with cast ductile iron grooved end fittings, including full flow elbows, and conforming to ASTM A536.
 - .2 Acceptable products are:
 - .1 Victaulic Style 107 "QuickVic" rigid couplings for sizes 50 mm (2") to 200 mm (8"), Style 07 "Zero-Flex" rigid couplings for sizes 250 mm (10") to 300 mm (12"), Style W07 AGS rigid couplings for sizes 350 mm (14") to 1525 mm (60");
 - .2 Gruvlok Fig. 7402 "SlideLOK" for sizes 50 mm (2") to 200 mm (8"), Fig. 7401 "Rigidlok" for sizes 250 mm (10") to 610 mm (24").
- .3 Gaskets for Grooved End Mechanical Joints
 - .1 Unless otherwise noted, type Ethylene Propylene Diene Monomer (EPDM), suiting temperature and chemical compatibility for fluid used in intended applications.
 - .2 Confirm type with respective system manufacturers and review with Consultant.
- .4 Hard Copper - Solder Joint
 - .1 Type "L" hard drawn seamless copper to ASTM B88, complete with wrought copper fittings to ANSI B16.22, and 95% tin / 5% Antimony solder joints.

.5 Hard Copper - Pressure Coupled Joint

- .1 Type "L" hard drawn seamless copper to ASTM B88, complete with Viega "ProPress with Smart Connect feature" system copper fittings with EDPM seals, and pressure type crimped joints made by use of manufacturer recommended tool.

2.02 PIPING UNIONS

.1 Screwed Piping

- .1 Malleable iron, ground joint, bronze or brass to iron or bronze to bronze seat screwed unions and union elbows with a minimum pressure rating of 1725 kPa (250 psi) steam at 260°C (500°F).

.2 Flanged Piping

- .1 Forged carbon steel slip-on type raised faced welding flange unions to ASTM A105, 150 lb. Class for steel pipe, and slip-on type 150 lb. Class bronze flanges for copper pipe.

2.03 SHUT-OFF VALVES

.1 Ball Type

- .1 Class 600, 4140 kPa (600 psi) WOG rated full port ball valves, each complete with a forged brass or bronze body and cap, blowout-proof stem, solid forged brass chrome plated ball, "Teflon" or "PTFE" seat, threaded ends, and removable lever handle.

.2 Acceptable products are:

- .1 Toyo Valve Co. Fig. 5044A;
- .2 Watts Industries (Canada) Inc. #FBV-3;
- .3 Kitz Corp. Code 58;
- .4 Victaulic Co. of Canada Ltd. Series 722;
- .5 Apollo Valve #77-100.

.2 Butterfly Type

- .1 Cast ductile iron, lug body style, 1200 kPa (175 psi) rated butterfly valve, each complete with a neck to permit 50 mm (2") of insulation above the flange, a field replaceable EPDM seat, ductile iron disc, stainless steel shaft with EPDM seal, a lever handle for valves to and including 150 mm (6") diameter, a handwheel and gear type operator for valves larger than 150 mm (6") diameter, and each suitable for bubble-tight dead end service with valve closed and either side of connecting piping removed.

.2 Acceptable products are:

- .1 DeZurik of Canada Ltd., Figure No. 632;
- .2 Victaulic Co. of Canada Ltd. Vic-300 MasterSeal or AGS Vic-300;

- .3 Apollo Valve 143 Series;
- .4 Watts Industries (Canada) Inc. #BF-03;
- .5 Kitz Corp. 6112 Series;
- .6 Toyo Valve Co. 918DESL/G2.

2.04 DRAIN VALVES

- .1 Minimum 2070 kPa (300 psi) WOG rated, 20 mm ($\frac{3}{4}$ ") diameter straight pattern bronze ball valves, each complete with a threaded outlet suitable for coupling connection of 20 mm ($\frac{3}{4}$ ") diameter hose, and a cap and chain.
- .2 Acceptable products are:
 - .1 Toyo Valve Co. Ltd. Fig. 5046;
 - .2 Watts Industries (Canada) Inc. #B-6000-CC;
 - .3 Kitz Corp. Code No. 68AC;
 - .4 Apollo Valves #78-104-01.

2.05 CIRCUIT BALANCING VALVES

- .1 Screwed or flanged as required, globe style, non-ferrous circuit balancing valves designed to facilitate precise flow measurement, precision flow balancing, and positive shut-off, complete with capped and valved drain connection, and valved ports for connection to a differential pressure meter.
- .2 Acceptable products are:
 - .1 S.A. Armstrong Ltd. Series "CBVI" screwed or "CBVII" flanged;
 - .2 Victaulic Co. of Canada Ltd. (Tour & Anderson) Series 787 screwed, Series 788 flanged, and 789 grooved end, and Series 78K "Koil Kit" valves.

2.06 RADIATOR SHUT-OFF AND BALANCING VALVES

- .1 Heavy pattern, straight, 1750 kPa (250 psi) rated at 120°C (250°F) bronze radiator valves, each complete with composition disc, spring loaded packing, and union. Equip inlet valves with a handle for shut-off. Equip outlet valves with a lockshield for shut-off and balancing.
- .2 Acceptable products are:
 - .1 Dahl Brothers Canada Ltd. #11042 and #13013;
 - .2 Spirax Sarco Ltd. Type R.

2.07 AIR VENTS

- .1 Manual Air Vents
 - .1 Equal to Conbraco 27 Series, 3.2 mm ($\frac{1}{8}$ ") diameter with a key handle.

.2 Automatic Air Vents

- .1 Float actuated air vents, each complete with a semi-steel body and cap, a stainless steel float assembly and seat, and a neoprene head.
- .2 Acceptable products are:
 - .1 Spirax Sarco Ltd., Type 13 W for system working pressures to 1035 kPa (150 psi), 13 WH for system working pressures greater than 1035 kPa (150 psi);
 - .2 Armstrong International Inc. No. 1-AV.

2.08 STRAINERS

- .1 Cast iron wye shaped strainers, minimum 890 kPa (125 psi) rated and complete with a removable type 304 stainless steel screen with perforations sized to suit the application, and, for strainers 50 mm (2") diameter and larger, a blowdown pipe connection tapping.
- .2 Acceptable products are:
 - .1 Spirax Sarco Ltd. Type IF-125 screwed or Type AF-250 flanged;
 - .2 Toyo Valve Co. Ltd. Fig. 380A screwed or Fig. 381 flanged;
 - .3 Victaulic Co. of Canada Style 732 or W732 "Vic-Strainer";
 - .4 Armstrong International Inc. A1 Series;
 - .5 Watts Industries (Canada) Inc. #77SCI;
 - .6 Mueller Steam Specialty Products Model 11M screwed or Model 758 flanged.

2.09 CONTROL VALVES

- .1 Ball Valves, 12mm to 50mm:
 - .1 Ball Valves shall have forged brass bodies.
 - .2 Valves shall have available either Chrome Plated Brass Balls or 316 Stainless Steel Balls in all sizes.
 - .3 Valves shall have available either Nickel Plated Brass Stems or 316 Stainless Steel Stems with a blow-out proof stem design in all sizes.
 - .4 Valves shall have Teflon seal seats with Ethylene Propylene Diene Monomer (EPDM) O-ring backing.
 - .5 The 2-way valves shall have EPDM O-rings behind ball seals to allow for a minimum close-off pressure of 100 psi with actuator which provides 35 lb-in. torque for 1/2-to 3-inch sizes. All ball valves with internal pipe thread end connections shall be rated to 360 psi at 250°F (121°C) fluid temperature.
 - .6 All valves shall be rated for service with hot water, chilled water and 50% glycol solutions.

- .7 Flow Characteristics shall be equal percentage on the control port. Bypass port on three-way valves shall have linear flow characteristics.
- .8 ANSI Class IV seat leakage specification (0.01% of CV) for 3-way A port and ANSI Class III seat leakage specification (0.1% of CV) for 3-way B port.
- .9 Valves shall be rated for 100 psi differential close-off pressure.
- .10 Valves shall be Honeywell VBN ball valves or approved equal.
- .2 Globe Type:
 - .1 Valve:
 - .1 Valves shall be available in two- and three-way mixing models with brass bodies and stainless steel stem.
 - .2 Valves must have nominal rangeability of 50:1 or better. Valves must have a leakage rating less than 0.02% of the Cv.
 - .3 Valves shall be usable with hot water, chilled water, or glycol solutions up to 50 percent.
 - .4 Valves must have available insert replacement tools to facilitate changing the cartridge without draining the valve.
 - .2 Actuator:
 - .1 Actuator will operate at 24 Vac (+10/-30%) and 50/60 Hz. Actuator must screw onto compatible valve body without the aid of mounting tools.
 - .2 Actuator must be available in both spring return and non-spring return models.
 - .3 Actuators shall have an ambient temperature rating of 32 to 122°F.
- .3 Valves shall be Honeywell Series globe valves or approved equal.

3 EXECUTION

3.01 DEMOLITION

- .1 Perform required hydronic piping system demolition/revision work. Refer to demolition requirements specified in Section entitled Demolition and Revision Work.

3.02 PIPING INSTALLATION REQUIREMENTS

- .1 Provide required hydronic piping. Pipe, unless otherwise specified, is to be:
 - .1 for pipe to and including 65 mm (2-½") diameter, Schedule 40 black steel, screwed, or type "L" hard copper with solder joints or pressure coupled joints;
- .2 Slope horizontal piping mains to provide a minimum continuous up-grade of 25 mm (1") in 6 m (20') to high points. Slope branch supply and return piping connections to equipment a minimum of 25 mm (1") in 1.2 m (4'). Leave sufficient room at high points for installation and maintenance of air vents.

- .3 Install automatic control valves, piping wells and similar piping and/or equipment mounted control components required for automatic temperature control systems supplied as part of the control work. Refer to drawing control diagrams and details.
- .4 Connect equipment provided as part of the work of other Sections with piping as indicated and/or required. Refer to pipe connection details on drawings.
- .5 Provide screwed unions, removable mechanical joint couplings, or weld-on or solder-on flanges in piping at all connections to valves, strainers and similar piping system components which may need maintenance or repair, at equipment connections, in runs of piping exceeding 9 m (30') at 4.5 m (15') regular intervals to permit removal of sections of piping, and wherever else indicated on drawings.
- .6 Provide shut-off valves in piping connections to equipment, to isolate piping risers, to isolate other sections of systems as shown, and wherever else indicated on drawings. Valves in piping to and including 50 mm (2") dia. are to be ball type. All other shut-off valves are to be ball or butterfly type unless otherwise specified. Locate valves so they are easily accessible. Wherever possible, install valves at uniform height. Provide chain operators for valves which are inaccessible for operation from floor level.
- .7 Provide a check valve in discharge piping of every pump, and elsewhere in piping where shown on drawings. Where check valves are required in vertical piping, ensure they are suitable in all respects for the application. Check valves for vertical in-line and/or base mounted circulating pumps are integral with the discharge accessory.
- .8 Provide a drain valve at base of each piping riser, in drain connections to equipment, in low points of horizontal piping, and wherever else shown and/or specified.
- .9 Provide circuit balancing valves in piping generally where shown on drawings but with exact locations in accordance with instructions of personnel doing system flow balancing work. Confirm locations prior to installation.

3.03 INSTALLATION OF AIR VENTS

- .1 Provide an air vent in piping mains at all high points, at equipment connections, and wherever else shown and/or specified. Equip each air vent with a ball type shut-off valve. Install vents in 100 mm (4") dia. and larger piping and all vents in mechanical rooms in accordance with drawing detail.
- .2 Provide 9 mm (3/8") dia. copper drain piping from each automatic air vent to nearest suitable drain and terminate so discharge is visible. Identify drain piping.

3.04 INSTALLATION OF STRAINERS

- .1 Provide strainers in piping. Locate strainers so baskets are easily accessible and removable. Clean strainer baskets during and after piping system flushing and cleaning is complete, and before water quantity balancing commences.

3.05 FLUSHING AND CLEANING PIPING

- .1 Flush and clean new piping in accordance with requirements specified in Section entitled HVAC Water Treatment.

3.06 TESTING, ADJUSTING AND BALANCING

- .1 When work is complete and equipment is operating as intended, test, adjust and balance water flows in accordance with requirements specified in Section entitled Testing, Adjusting, and Balancing.

END OF SECTION

1 GENERAL

1.01 SUBMITTALS

- .1 Submit shop drawings/product data sheets for all products specified in this Section except shop fabricated ductwork and fittings.
- .2 Include capacity, throw and terminal velocity, noise criteria, and pressure drops with grille and diffuser shop drawing/product data sheet submission.
- .3 Submit duct leakage test data prior to ductwork being covered from view.
- .4 Submit manufacturer's colour chart(s) for all items for which a finish colour is to be selected.
- .5 Supply and hand to Owner at Substantial Performance of the Work, a minimum of 10 identified (with tags) grille/diffuser volume control damper adjustment keys.

1.02 QUALITY ASSURANCE

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

2 PRODUCTS

2.01 GALVANIZED STEEL DUCTWORK

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

2.02 RECTANGULAR ALUMINUM DUCTWORK

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

2.03 ROUND ALUMINUM DUCTWORK

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

2.04 METAL DUCT SYSTEM JOINT SEALANT

- .1 ULC listed and labelled, premium grade, grey colour, water base, non-flammable duct sealer, brush, or gun applied, with a CAN/ULC S102 tested maximum flame spread rating of 5 and smoke developed rating of 0.
- .2 Acceptable manufacturers are:
 - .1 Duro Dyne Canada Inc.
 - .2 Ductmate Industries.
 - .3 H.B. Fuller Company (Foster).

2.05 ROUND TO RECTANGULAR DUCT CONNECTIONS

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

2.06 AIR TURNING VANES

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

2.07 MANUAL BALANCING (VOLUME) DAMPERS

- .1 Flanged and drilled, single or multiple blade (damper greater than 225mm (9") in height) manual balancing dampers, each constructed of same material as connecting ductwork unless otherwise specified, each designed to maintain internal free area of connecting duct, and each complete with:
 - .1 hexagonal or square shaft extension through frame;
 - .2 non-stick, non-corrosive synthetic bearings for rectangular dampers, flange stainless steel bearings for round dampers;
 - .3 blade stops for single blade dampers, designed to prevent blade from moving more than 90°;
 - .4 linkage for multiple blade dampers;
 - .5 locking hand quadrant damper operator with 50 mm (2") standoff mounting for insulated ducts.
- .2 Rectangular Dampers: Nailor Industries Inc. 1800 Series, maximum size 1.2 m x 1.2 m (4' x 4') for a single damper.

- .3 Round Dampers: Nailor Industries Inc. Model 1890, maximum 600 mm (24") diameter, equipped with a minimum 200 mm (8") deep frame, and blade stiffeners where required.
- .4 Multiple Rectangular Damper Section Assembly: Rectangular assembly supplied with the dampers or site constructed, of same material as damper and designed for tight and secure mounting of individual dampers.
- .5 Acceptable manufacturers are:
 - .1 Nailor Industries Inc.;
 - .2 T.A. Morrison & Co. Inc. "TAMCO";
 - .3 NCA Manufacturing Ltd.;
 - .4 Greenheck Fan Corp.;
 - .5 Ruskin Co.
 - .6 Pottorff.

2.08 BACKDRAFT DAMPERS

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

2.09 FUSIBLE LINK DAMPERS

- .1 Curtain blade type, dynamic, galvanized steel (unless otherwise specified) fusible link dampers, ULC classified to CAN/ULC S112 and in accordance with NFPA 90A requirements, factory tested for closure under airflow, 1-1/2 hour or 3 hour rated as required, and complete with a constant force type 301 stainless steel closure spring, a blade lock assembly, a steel sleeve, retaining angles, and, unless otherwise specified, a 74°C (165°F) rated standard fusible link.
- .2 Fusible link dampers are to be Type "B" or Type "C" (as required) with folded curtain blade out of air stream except where damper size or location requires use of type "A" dampers with curtain blade in air stream.
- .3 Dampers in ductwork other than galvanized steel are to be as specified above but constructed of type 316 stainless steel.
- .4 Acceptable manufacturers are:
 - .1 Nailor Industries Inc.;
 - .2 Greenheck Fan Corp.;
 - .3 NCA Manufacturing Ltd.;
 - .4 Ruskin Co.;
 - .5 Price Industries (E.H. Price).
 - .6 Pottorff.

2.10 COMBINATION FIRE/SMOKE DAMPERS

- .1 Nailor Industries Series 1220, ULC listed to CAN/ULC S112 and CAN/ULC S112.1, meeting requirements of NFPA 80, 90A, 92, 101 and 105, consisting of type A, B, or C fusible link fire dampers as required and a fail-safe, opposed blade, normally closed, motor operated smoke damper complete with factory installed and tested 120 V electric actuator.
- .2 ULC 1-1/2 hour fire rated and ULC Class I leakage rated for smoke, and equipped with a 74°C (165°F) ULC classified fusible link that will cause damper to close and lock independent of actuator when duct temperature reaches maximum temperature of damper assembly.
- .3 Supply damper with factory installed sleeves of minimum 400 mm (16") length, field verified by contractor dependent on wall thickness. Caulk sleeves to ULC requirements and constructed of 20 gauge for sizes up to 2.1 m (84") wide and 18 gauge for sizes greater than 2.1 m (84") wide.
- .4 Dampers in ductwork other than galvanized steel are to be as specified above but constructed of type 316 stainless steel.
- .5 Acceptable manufacturers are:
 - .1 Nailor Industries Inc.;

- .2 Greenheck Fan Corp.;
- .3 NCA Manufacturing Ltd.;
- .4 Ruskin Co.;
- .5 Price Industries (E.H. Price).
- .6 Pottorff.

2.11 SMOKE DAMPERS

- .1 Multi-blade type, fail-safe, dynamic, galvanized steel (unless otherwise specified) smoke dampers, ULC classified to CAN/ULC S112.1, ULC Class I leakage rated for smoke, meeting requirements of NFPA 90A, 92, 101 and 105, normally closed, low pressure drop design, dynamically tested, each complete with jamb and blade seals, linkage concealed in the frame, a steel sleeve to suit the opening, and an electric actuator to automatically close damper upon receiving an external signal, and to automatically open damper when system is reset.
- .2 Dampers in ductwork other than galvanized steel are to be as specified above but constructed of type 316 stainless steel.
- .3 Acceptable manufacturers are:
 - .1 Nailor Industries Inc.;
 - .2 Greenheck Fan Corp.;
 - .3 NCA Manufacturing Ltd.;
 - .4 Ruskin Co.;
 - .5 Price Industries (E.H Price).
 - .6 Pottorff.

2.12 DUCT ACCESS DOORS

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

2.13 DUCTWORK DRAIN POINTS

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

2.14 INSTRUMENT TEST PORTS

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

2.15 GRILLES AND DIFFUSERS

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

3 EXECUTION

3.01 CLEANLINESS REQUIREMENTS FOR HANDLING AND INSTALLATION OF DUCTWORK

- .1 Handle and install ductwork in accordance with CSA Z317.2, Special Requirements for Heating, Ventilation, and Air-Conditioning (HVAC) Systems in Healthcare Facilities and SMACNA's Duct Cleanliness for New Construction Guidelines at the Advanced Level.

3.02 FABRICATION AND INSTALLATION OF GALVANIZED STEEL DUCTWORK

- .1 Provide required ductwork, rectangular, round and/or flat oval. Where rectangular ductwork is shown, round or flat oval ductwork of equivalent cross-sectional area is acceptable.
- .2 It is to be understood that all duct dimensions shown on drawings are clear internal dimensions.
- .3 Unless otherwise specified, construct and install ductwork in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible to suit duct pressure class designation of minimum 500 Pa (2" w.c.) positive or negative as applicable, a minimum velocity of 10 m/s (2000 fpm), and so ductwork does not "drum". Flat surfaces of rectangular ductwork are to be cross-broken. Duct system sealing is to meet ANSI/SMACNA Seal Class A requirements.
- .4 Confirm routing of all ductwork at site and site measure ductwork prior to fabrication. Duct dimensions may be revised to suit site routing and building element requirements, if dimension revisions are reviewed with and approved by Consultant. Duct routing and/or dimension revisions to suit conditions at site are not grounds for a claim for an extra cost.
- .5 Refer to structural drawings. Where ductwork is to be run within or through open web steel joists, ductwork shown on mechanical drawings is schematic only and is to be altered as required to suit steel joist configuration, spacing, panel points, and cross-bridging at no additional cost.

- .6 Wherever ductwork is required at locations where sprayed fireproofing is applied to building construction, install ductwork only after fireproofing work is complete and do not compromise fire rating of sprayed fireproofing.
- .7 Install (but do not connect) duct system mounted automatic control components supplied as part of the automatic control work.
- .8 Where indicated, provide duct connections to fan powered heat transfer equipment with integral coils.
- .9 Flange connect ductwork to hot water reheat coils in accordance with requirements of ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible. Coils will be suspended independent of connecting ductwork as part of the heat transfer work.
- .10 Support horizontal rectangular ducts inside building in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible, but use trapeze hangers with, unless otherwise specified, galvanized steel channels, and galvanized steel hanger rods for exposed ducts and concealed ducts wider than 500 mm (20"). Support hardware constructed of same material as duct for metal duct, and, unless otherwise specified, type 316 stainless steel for non-metal duct. Supports for "heavy" duct such as cementitious core duct is to be suitable in all respects for the application and approved by Consultant.
- .11 Support round and flat oval ducts inside building in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible, but, unless otherwise specified, for both uninsulated and insulated ducts exposed in finished areas, use bands and secure at top of duct to a hanger rod, all similar to Ductmate Canada Ltd. type "BA". If duct is insulated, size strap to suit diameter of insulated duct. Unless otherwise specified, duct support hardware for metal duct is constructed of same material as duct, and for non-metal duct, type 316 stainless steel.
- .12 Where flanged duct joints are used, do not locate joints in wall or slab openings, or immediately at wall or slab openings. Do not use flanged joints for exposed uninsulated ducts in finished areas.
- .13 Where watertight horizontal ductwork is required, construct ducts without bottom longitudinal seams. Solder or weld joints of bottom and side sheets. Seal all other joints with duct sealer. Slope horizontal duct to hoods, risers, or drain points. Provide drain points. Provide watertight ductwork for:
 - .1 shower exhaust ducts from grilles to duct main or riser;
 - .2 wherever else shown.
- .14 Leakage Testing:
 - .1 Ductwork leakage is not to exceed following:
 - .1 ductwork to 2" W.C. Class, 1% of total air quantity handled by respective fans;
 - .2 ductwork exceeding 2" W.C. Class, 2% of total air quantity handled by respective fans.
 - .2 Leakage testing is to be performed by the Testing, Adjusting and Balancing (TAB) agency in accordance with SMACNA HVAC Air Duct Leakage Test Manual and is to be witnessed by Consultant.

- .3 Leakage test following ductwork:
 - .1 All new supply air, return air and exhaust air ductwork.
- .4 Be responsible for following:
 - .1 preparing duct systems for leakage testing prior to installation of external insulation including capping duct runouts and provision of final tap-in for test equipment;
 - .2 schedule testing with TAB agency in advance, be present for all testing and ensure notice is given to Consultant so they may witness testing;
 - .3 resealing and/or replacement of defective ductwork;
 - .4 bearing all costs associated with retesting ductwork which has failed to pass leakage testing.
- .15 Seal all ductwork in accordance with SMACNA Seal Class "A", except for round duct with self-sealing gasketed fittings and couplings which does not require site applied sealant. Apply sealants by brush or gun to cleaned metal surfaces. Where bare ductwork is exposed apply neat uniform lines of sealant. Randomly brushed, sloppy looking sealant applications will be rejected and must be repaired or replaced with a neat application of sealant.
- .16 Apply sealants by brush or gun to cleaned metal surfaces. Where bare ductwork is exposed apply neat uniform lines of sealant. Randomly brushed, sloppy looking sealant applications will be rejected and must be repaired or replaced with a neat application of sealant.
- .17 Clean exterior exposed (uninsulated) ducts and coat with a heavy full coverage of Bakor #410-02 black metal paint.
- .18 Where dissimilar metal ducts are to be connected, isolate ducts by means of flexible duct connection material.

3.03 INSTALLATION OF ALUMINUM DUCTWORK

- .1 Provide aluminum ductwork, rectangular or round.
- .2 Provide aluminium ductwork for:
 - .1 Branch shower exhaust ductwork from the grille to the exhaust main.
- .3 Wherever bare aluminum ductwork comes in contact with ferrous metal or copper, paint ferrous metal or copper surface with a heavy, 100% covering coat of zinc chromate paint, asphalt paint or otherwise isolate direct contact with the bare aluminum.
- .4 Refer to "Commentary on Aluminum Ducts" in ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible, however, do not use drive and S cleats for joining waterproof aluminum ductwork. Use following SMACNA joining methods:
 - .1 T-21 - welded flange;
 - .2 T-22 - companion angle and gasket;

- .3 T-24A - flanged.
- .5 Keep longitudinal joints at top surface of horizontal runs. Provide proper transverse supports to prevent deflection. Ensure duct is rigid.
- .6 When mastic is used for sealing such as sealing longitudinal joints, apply mastic to both surfaces before they are mated. When dry, apply mastic again for a water-tight seal.

3.04 INSTALLATION OF SHEET STEEL KITCHEN GREASE EXHAUST DUCTWORK

- .1 Provide welded sheet steel kitchen grease exhaust ductwork from exhaust hood(s) to roof mounted exhaust fans, all in accordance with requirements of NFPA 96. Construct ductwork watertight with continuous externally welded seams and joints, cleanouts, duct expansion provisions, riser residue traps, etc.
- .2 Clean and prime coat ground welds in black steel ducts.
- .3 Support ductwork at not greater than 1.5 m (5') intervals and ensure fasteners at hangers do not penetrate duct. Install without forming dips, sags or traps where grease residue might collect, and locate access door/cleanouts for ease of maintenance.
- .4 Slope horizontal ductwork 25 mm per 300 mm (1" per foot) back to exhaust hood.

3.05 INSTALLATION OF ROUND TO RECTANGULAR DUCT CONNECTIONS

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

3.06 INSTALLATION OF TURNING VANES

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

3.07 INSTALLATION OF MANUAL BALANCING (VOLUME) DAMPERS

- .1 Provide manual balancing dampers as required to provide a fully balanced system, including but not limited to in all open end ductwork, in all duct mains, and wherever else shown and/or specified.
- .2 Install dampers so operating mechanism is accessible and positioned for easy operation, and so dampers cannot move or rattle. Ensure operating mechanisms for dampers in insulated ducts are complete with stand-off mounting brackets.
- .3 Where a duct for which a balancing damper is required has dimensions larger than dimensions of maximum size volume damper available, provide multiple dampers bolted together in a properly sized assembly, or bolted to a heavy-gauge black structural steel angle or channel framework which is properly sized. Seal to prevent air by-pass, and provide connecting linkage.

- .4 Confirm exact damper locations with personnel doing air quantity balancing testing work and install dampers to suit. Include for providing 5 additional dampers at no additional cost.

3.08 INSTALLATION OF FUSIBLE LINK DAMPERS

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

3.09 INSTALLATION OF COMBINATION FIRE/SMOKE DAMPERS

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

3.10 INSTALLATION OF SMOKE DAMPERS

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

3.11 INSTALLATION OF FLEXIBLE CONNECTION MATERIAL

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

3.12 INSTALLATION OF INSTRUMENTS TEST PORTS

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

3.13 INSTALLATION OF GRILLES AND DIFFUSERS

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

3.14 DUCT SYSTEM PROTECTION, CLEANING AND START-UP

- .1 Temporarily cover all open ends of ducts during construction.
- .2 Clean HVAC system as per requirements specified in Section entitled HVAC Air Distribution System Cleaning.
- .3 Include all labour for a complete site walk-through with testing and balancing personnel following route of all duct systems to be tested, adjusted and balanced for the purpose of confirming proper position and attitude of dampers, location of pitot tube openings, and any other work affecting testing and balancing procedures. Perform corrective work required as a result of this walk-through.

END OF SECTION

1 GENERAL

1.01 SUBMITTALS

- .1 Submit shop drawings/product data sheets for following:
 - .1 all control system components;
 - .2 identified schematic control diagrams with component identification, catalogue numbers, and sequence of operation for all systems;
 - .3 certified wiring diagrams for all systems.
- .2 Submit following samples for review:
 - .1 control damper section with linkage, operator, and certified flow and leakage data;
 - .2 wall mounting control system flow diagram as specified in Part 2 of this Section;
 - .3 each type of thermostat to be used, each identified as to intended use.
- .3 Submit a site inspection and start-up report from manufacturer's representative as specified in Part 3 of this Section.
- .4 Submit written confirmation from control component manufacturer that site installation personnel are qualified and experienced in installation of components, and have parts and service availability on a 24/7 basis.

1.02 QUALITY ASSURANCE

- .1 Control systems are to be installed by control component manufacturer or by licensed personnel authorized by control component manufacturer. Submit written confirmation from control component manufacturer.
- .2 Control system installation company is to have local parts and service availability on 24/7 basis.
- .3 Control wiring work is to be performed by licensed journeyman electricians, or under direct daily supervision of journeyman electricians.

2 PRODUCTS

2.01 AUTOMATIC CONTROL VALVES AND OPERATORS

- .1 Each control valve must be suitable in all respects for application, including system pressure, and have design output and flow rates with maximum pressure drops as follows:
 - .1 heating water valves for reheat and radiation units: 6.9 kPa (1 psi);
- .2 Unless otherwise indicated, control valves for proportional operation are to have equal percentage characteristics, and control valves for open/shut 2-position operation are to have straight line flow characteristics. Valves are to have position indicators. Valves for outdoor applications to be suitable in all respects for application.
- .3 Heating valves are to be normally open, unless otherwise specified.

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

2.02 LOCAL CONTROL PANELS

- .1 NEMA 1 (NEMA 2 in sprinklered areas) wall mounting, enamelled steel barriered enclosures sized to suit the application with 20% spare capacity, perforated sub-panel, numbered terminal strips for all low and line voltage wiring, hinged door, and slotted flush latch.

2.03 CONTROL SYSTEM COMPONENTS

- .1 Components specified below are required for control of equipment and systems in accordance with drawing control diagrams and sequences of operation. Not all required components may be specified.
- .2 Sensor/transmitter input devices to be suitable in all respects for application and mounting location. Devices are as follows:
 - .1 unless otherwise specified, temperature sensors are to be resistance type, either 2-wire 1000 ohm nickel RTD or 2-wire 1000 ohm platinum RTD with accuracy (includes errors associated with sensor, lead wire, and A to D conversion), equipped with type 316 stainless steel thermowells for pipe mounting applications, as follows:
 - .1 chilled water, room temperature, and duct temperature points, $\pm 1^{\circ}\text{C}$ ($\pm 0.5^{\circ}\text{F}$);
 - .2 all other points, $\pm 0.75^{\circ}\text{C}$ ($\pm 1.3^{\circ}\text{F}$).
 - .2 room temperature sensors constructed for surface or recessed wall box mounting, complete with an adjustable set-point reset slide switch with a $\pm 1.66^{\circ}\text{C}$ ($\pm 3^{\circ}\text{F}$) range, individual heating/cooling set-point slide switches as required, momentary override request pushbutton for activation of after-hours operation, an analogue thermometer;
 - .3 outside air sensors designed and constructed for ambient temperatures and to withstand environmental conditions to which they are exposed, complete with NEMA 3R enclosure, solar shield, and a perforated plate surrounding sensor element where exposed to wind velocity pressure;

- .4 insertion duct mounting sensors type with lock nut and mounting plate, designed to mount in an electrical box (weather-proof with gasket and cover where outside) through a hole in duct;
- .5 for ducts greater than 1.2 m (4') or for ducts where air temperature stratification occurs, averaging type sensors with multiple sensing points, and for plenums for applications such as mixed air temperature measurement to account for air turbulence and/or stratification, averaging string of sensors with capillary supports on sides of duct/plenum;
- .6 factory solid-state relative humidity sensors with element that resists contamination, weather-proof with NEMA 3R enclosure for outside air applications, supplied with type 304 stainless steel probe with mounting bracket and hardware for duct mounting, each complete with factory calibrated humidity transmitter which is accurate (including lead loss and analog to digital conversion) to 3% between 20% to 80% RH at 25°C (77°F) and equipped with non-interactive span and zero adjustments, and 2-wire isolated loop powered, 4-20 mA, 0 to 100% linear proportional output;
- .7 carbon dioxide sensors for air quality control purposes having a maximum 20 second response time, suitable for operating conditions from 0°C to 50°C (32°F to 122°F) and 0 to 100% RH non-condensing, complete with a calibration kit (to be handed to Owner) and characteristics as follows:
 - .1 measurement range: 0 to 2000 ppm;
 - .2 accuracy: ± 100 ppm;
 - .3 repeatability: ± 20 ppm;
 - .4 drift: ± 100 ppm per year;
 - .5 output signal: 0 to 10 VDC proportional over the 0 to 2000 ppm range.
- .3 Pressure transmitters are to be constructed to withstand 100% pressure over-range without damage and to hold calibrated accuracy when subject to a momentary 40% over-range input. Pressure transmitters are to transmit a 0 to 5 VDC, 0 to 10 VDC, or 4 to 20 mA output signal. Differential pressure transmitters used for flow measurement are to be sized to the flow sensing device and supplied with a tee fitting and shut-off valves in the high and low sensing pick-up lines to allow permanent ease of use connection for balancing, etc. Transmitter housing is to suit mounting location. Standalone pressure transmitters are to be mounted in a minimum NEMA 1 (NEMA 2 in sprinklered area) by-pass valve assembly panel with high and low connections piped and valved, air bleed units, by-pass valves, and compression fittings. Transmitters are to be as follows:
 - .1 low differential water pressure, 0 to 5 kPa (0 to 20" wc): equal to Setra or Mamac industrial quality transmitter capable of transmitting a linear 4 to 20 mA output in response to variation of flow meter differential pressure or water pressure sensing points, each complete with non-interactive zero and span adjustments adjustable from outside the cover, and performance as follows:
 - .1 maintain accuracy up to 20 to 1 ratio turndown;
 - .2 reference accuracy: +0.2% of full scale.

- .2 medium to high differential water pressure, over 5 kPa (20" wc): Setra or Mamac or approved equal, transmitters as specified above for low pressure transmitters but with a pressure range of from 2.5 kPa (10" wc) to 2070 kPa (300 psi), a reference accuracy of $\pm 1\%$ of full span (includes non-linearity, hysteresis, and repeatability);
- .3 building differential air pressure: Setra or Johnson Controls Inc. or approved equal, industrial quality transmitter with a range suitable for the application, capable of transmitting a linear 4 to 20 mA output in response to variation of differential pressure or air pressure sensing points, each complete with non-interactive zero and span adjustments adjustable from outside the cover, and performance as follows:
 - .1 maintain accuracy up to 20 to 1 ratio turndown;
 - .2 reference accuracy: $+0.2\%$ of full span.
- .4 low differential air pressure, 0 to 1.25 kPa (0" to 5" wc): Setra or Johnson Controls Inc. or approved equal, industrial quality transmitter with a range suitable for the application, capable of transmitting a linear 4 to 20 mA output in response to variation of differential pressure or air pressure sensing points, each complete with non-interactive zero and span adjustments adjustable from outside the cover, and performance as follows:
 - .1 maintain accuracy up to 20 to 1 ratio turndown;
 - .2 reference accuracy: $+0.2\%$ of full span.
- .5 medium differential air pressure, over 1.5 kPa (5" wc): Setra or Johnson Controls Inc. or approved equal, transmitters as specified above for low pressure air transmitters, but performance requirements as follows:
 - .1 zero and span: (c/o F.S./Deg. F); $.04\%$ including linearity, hysteresis, and repeatability;
 - .2 accuracy: 1% F.S. (best straight line); static pressure effect: 0.5% F. S.;
 - .3 thermal effects: $<+0.33$ F.S./ $^{\circ}$ F over 40° F to 100° F (calibrated at 70° F).
- .4 Air and water flow monitoring stations and probes are to be Air Monitor Corp., Tek-Air Systems Inc., Ebtron, or Dietrich Standard products as follows:
 - .1 Fan Inlet Air Flow Measuring Station: At fan inlet and near exit of inlet sound trap, air flow traverse probes are to continuously monitor fan air volume and system velocity pressure, and traverse probes are to be as follows:
 - .1 each probe is to be of a dual manifold, cylindrical, anodized type 3003 extruded aluminium construction probe with sensors located along the stagnation plane of approaching air flow, and the static pressure manifold is to incorporate dual offset static taps on opposing sides of averaging manifold so as to be insensitive to flow angle variations for as much as $\pm 20^{\circ}$ in approaching air stream;
 - .2 each probe is not to introduce a measurable pressure drop, nor is sound level within duct to be amplified by its singular or multiple presence in air stream, and each probe is to contain multiple static and total pressure sensors placed at equal distances along its length in accordance with ASHRAE Standards for duct traversing.

- .2 Single Probe Air Flow Measuring Sensor: Duct mounting hot wire anemometer type which utilizes 2 temperature sensors, one is a heater element temperature sensor and the other is to measure downstream temperature, with temperature differential related directly to air flow velocity. Sensor insertion length is to be adjustable up to 200 mm (8"), and transmitter is to produce a 4 to 20 mA or 0 to 10 VDC signal linear to air velocity.
- .3 Duct Flow Measuring Stations: #14 gauge galvanized steel casing with duct connection flanges of a size to mate with connecting ductwork, and complete with an air directionalizer and a 98% free area parallel cell 20 mm (¾") honeycomb profile suppressor across entering air stream to equalize velocity profile and eliminate turbulent and rotational flow from the air stream prior to measuring point, mechanically fastened to casing so as to withstand velocities of up to 1828 m (6000') per minute. Additional requirements as follows:
 - .1 total pressure measurement side (high side) is to be designed and spaced to requirements of Industrial Ventilation Manual, 16th Edition, page 9-5, and self-averaging manifolding is to be constructed of brass and copper components;
 - .2 static pressure sensing probes (low side) is to be bullet-nose shaped, per detailed radius, as illustrated in Industrial Ventilation Manual referred to above, page 9-5;
 - .3 main take-off point from both total pressure and static pressure manifolds is to be symmetrical, and manifolds are to terminate with external ports for connection to control tubing;
 - .4 each station is to be equipped with a label on casing indicating unit model number, size, area, and specified air flow capacity;
 - .5 each station is to have a self-generated sound rating of less than NC 40, and sound level within duct is not to be amplified nor is additional sound to be generated.
- .4 Static Pressure Traverse Probe: Duct mounting, complete with multiple static pressure sensors located along exterior surface of cylindrical probe.
- .5 Shielded Static Air Probe: Indoor type or outdoor type as required, each with multiple sensing ports, an impulse suppression chamber, and air flow shielding.
- .6 Water Flow Monitoring: Equal to Onicon microprocessor-based electromagnetic water flow meters with an accuracy of 0.25%.
- .5 Power (amps) monitoring is to be performed by a combination of a current transformer and a current transducer with transformer sized to reduce full amperage of monitored circuit to a maximum 5 ampere signal which will be converted to a 4 to 20 mA DDC compatible circuit for use by building automation system. Current transformer and current transducer are as follows:
 - .1 equal to Veris Industries split core current transformer with an operating frequency of from 50 to 400 Hz, 0.6 Kv class, 10 Kv BIL insulation, and 5 ampere secondary;
 - .2 equal to Veris Industries current to voltage or current to mA transducer with an accuracy of ±5%, a minimum load resistance of 30 kOhm, an input of 0 to 20 amperes and an output of 4 to 20 mA, and a 24 VDC regulated power supply.

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

- .10 Each manual override station is to be complete with contacts rated minimum 1 ampere at 24 VAC and is to provide following:
 - .1 integral H-O-A switch to override controlled device pilot relay;
 - .2 status input to building automation system to indicate whenever switch is not in the Auto position;
 - .3 status LED to illuminate whenever output is On;
 - .4 override LED to illuminate whenever H-O-A switch is in either the Hand or Off position.
- .11 Electronic/pneumatic transducers, Johnson Controls Inc. or approved equal, transducers with output of from 3 to 15 psig, an input of from 4 to 20 mA or 10 VDC, manual output adjustment, a pressure gauge, and an external replaceable supply air filter.
- .12 Thermostats:
 - .1 Wall mounting adjustable set-point thermostats, each suitable in all respects for equipment (and operating sequence) they are provided for, equipped with a thermometer, cover and any required mounting and connection accessories.
 - .2 Pneumatic thermostats are to be of bimetal element construction, double valve type, operating without constant waste of air.
 - .3 Line voltage thermostats are to be 115 volt.
 - .4 Low voltage thermostats are to be 24 volt electronic type.
 - .5 Set-point adjustment for thermostats in public spaces is to be concealed behind cover. Set-point adjustment for other thermostats is to be accessible through cover.
 - .6 Covers are to be removable, tamper-proof covers with temperature set-point and thermometer displays.
 - .7 Guards for thermostats are to be clear, ventilated polycarbonate covers with allen key locking hardware.
- .13 Hardware to permit building automation system control and monitoring of input/output points in accordance with Section entitled Building Automation System, points schedule, and drawing control diagrams and operation sequences. Such hardware is to be suitable in all respects for interface with BAS.

2.04 SYSTEM WIRING MATERIALS

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

3 EXECUTION

3.01 DEMOLITION

- .1 Perform required control system demolition work.

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

3.02 GENERAL RE: INSTALLATION OF CONTROLS

- .1 Provide complete systems of control and instrumentation to control and supervise building equipment and systems in accordance with this Section and drawings.
- .2 Control systems are to generally be as indicated on drawing control diagrams and are to have elements therein indicated or implied.
- .3 Control diagrams show only principal components controlling equipment and systems. Supplement each control system with relays, transformers, sensors, etc., as required to enable each system to perform as specified and to permit proper operation and supervision.

3.03 INSTALLATION OF CONTROL AIR COMPRESSOR SET AND DRYER

- .1 Provide a duplex air compressor set. Secure set in place on vibration isolation on a concrete housekeeping pad. Install flexible piping connections supplied with set and connect with required piping, including drain piping extended and terminated at nearest drain.
- .2 Wall mount power and control panel(s) adjacent to equipment. Connect compressor set panel pressure switch with copper tubing to compressor set.

3.04 SUPPLY OF AUTOMATIC CONTROL VALVES AND OPERATORS

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

3.05 INSTALLATION OF THERMOSTATS

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

3.06 INSTALLATION OF CONTROL SYSTEM COMPONENTS

- .1 Provide required control system components and related hardware. Refer to drawing control diagrams and sequences.

- .2 Where components are pipe, duct, or equipment mounted supply components at proper time, coordinate installation with appropriate trade, and ensure components are properly located and mounted.

3.07 CONTROL WIRING

- .1 Perform required control wiring work for control systems except:
 - .1 power wiring connections to equipment and panels, except as noted below;
 - .2 control wiring associated with mechanical plant equipment and systems whose control is not part of work specified in this Section;
 - .3 starter interlock wiring.
- .2 Except as specified below, install wiring in conduit. Unless otherwise specified, final 600 mm (2') connections to sensors and transmitters, and wherever conduit extends across flexible duct connections is to be liquid-tight flexible conduit.
- .3 Control wiring in ceiling spaces and wall cavities may be plenum rated cable installed without conduit but neatly harnessed, secured, and identified.
- .4 Wiring work is to be in accordance with certified wiring schematics and instructions, and wiring standards specified in appropriate Sections of Electrical Work Specification.

3.08 IDENTIFICATION AND LABELLING OF EQUIPMENT AND CIRCUITS

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

3.09 TESTING, ADJUSTING, CERTIFICATION, START-UP, AND TRAINING

- .1 When control work is complete, check installation of components and wiring connections, make any required adjustments, and coordinate adjustments with personnel doing HVAC testing, adjusting and balancing work.
- .2 Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system manufacturer certification requirements.
- .3 Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system start-up requirements.
- .4 Include for 2 full, 8 hour days on-site operation demonstration and training sessions. Training is to be a full review of all components including but not limited to a full operation and maintenance demonstration, with abnormal events.

- .5 Include for 2 follow-up site training and troubleshooting visits, one 6 months after Substantial Completion and other at end of warranty period, both when arranged by Owner and for a full, 8 hour day to provide additional system training as required, and to demonstrate troubleshooting procedures.

END OF SECTION

1 GENERAL

1.01 DESCRIPTION OF WORK

- .1 Provide labour, materials, equipment and services necessary for a complete Building Automation System (BAS) comprised of various types of BACnet Testing Laboratories (BTL) listed BACnet-communicating Direct Digital Control (DDC) controllers (referred to as "BAS Controllers"), BTL listed BACnet-communicating operator interface software, conventional electric/electronic controls, and equipment-mounted controls. System is to be fully functional and include software and hardware for specified capabilities.
- .2 Refer to Section entitled Automatic Control Systems for requirements regarding control valves, control dampers, actuators, sensors/transmitters, switches/auxiliary control devices, and other similar field devices.
- .3 Existing Building Automation System is Honeywell International Inc. with contact information as follows:
 - .1 Har Simar Gill har.gill@honeywell.com, 647.466.4485, Honeywell.
- .4 Integrate and coordinate controls required by this project into a single system as follows:
 - .1 Each supplier of a controls product is responsible for installation, configuration, programming, start-up and testing of that product unless otherwise stated.
 - .2 Coordinate resolution of any incompatibility issues between BAS products provided under this section and those provided elsewhere in Contract Documents. Equipment/system manufacturer/supplier is responsible for supplying technicians that are to be available to troubleshoot any issues and coordinate with contractor.
 - .3 Be responsible for material and labour to interconnect control products provided by multiple suppliers regardless of where these products are described within Contract Documents.
 - .4 Coordinate to ensure sufficient space and power for BAS components is provided/available.
 - .5 Resolve any conflicts that arise in control of same equipment by both BAS and fire alarm systems. Coordinate with fire alarm system manufacturer and installing contractor to resolve any issues that arise. Fire alarm system control is to be given priority, except where stated otherwise.

1.02 DEFINITIONS/ABBREVIATIONS

- .1 Advanced Application Controller (AAC) – Fully programmable controller which is BTL-listed as a B-AAC device and which communicates via BACnet MS/TP to an associated network controller (NC). These controllers are used for terminal unit (including VAV boxes) and small AHU/RTU control.
- .2 Application Specific Controller (ASC) – Low-level MS/TP controller typically not custom-programmable and BTL-listed as a B-ASC device.
- .3 BACnet/IP – Use of Ethernet and IP data/network link protocols to transport BACnet messages.

- .4 B-BC, B-AAC, B-ASC and B-AWS – Abbreviations for BACnet Building Controller, BACnet Advanced Application Controller, BACnet Application Specific Controller, and BACnet Advanced Operator Workstation Software. Used by BACnet standard and BTL to define various device and software profiles, and BACnet functionality to be provided by different classes of DDC devices (for support of interoperability).
- .5 BBMD – BACnet/IP Broadcast Management Device. Method used by BACnet for handling broadcast messages over IP (which does not support broadcasting). Approach involves use of one BACnet/IP device per IP segment to maintain a Broadcast Distribution Table (BDT) listing all other BACnet devices on that network segment. This allows a multi-cast message sent over IP (to each BBMD) to be in turn broadcasted to all other devices on each BACnet/IP segment.
- .6 BTL – BACnet Testing Laboratory. Provides BACnet conformance testing (e.g., to confirm a B-BC device meets minimum requirements for Building Controller profile as defined in BACnet standard). If device passes BTL testing it is said to be "BTL-listed" as, say, a "B-BC device". Devices tested by an ISO accredited laboratory may also issue a certificate, and be referred to as "BTL-certified" device.
- .7 COV (Change of Value) – Optional BACnet service that allows data to be communicated only when it has changed state and/or has changed its value by a pre-defined threshold. This service substantially reduces use of communications bandwidth by BACnet in lieu of using standard "Read" services (which must be polled at regular intervals to ensure changes in values are seen by system).
- .8 FEC – field equipment controller; AAC's and ASC's are field equipment controllers.
- .9 Gateway – Software used to translate one application's protocol data (i.e., BACnet) to another (e.g., Modbus or LonTalk). This software can be installed as a "driver" in a BAS controller (i.e., for Modbus) or provided by a separate gateway device (i.e., for LonTalk) so BAS can connect to "Third Party" devices).
- .10 MS/TP – Master-Slave/Token-Passing, an EIA-485 data link technology unique to and defined by BACnet for transport of BACnet messages.
- .11 NC – Network Controller, highest-level controller in BAS architecture, with B-BC listing, BACnet/IP communications, and routing to/from MS/TP controller sub-networks.
- .12 PICS – Protocol Implementation Conformance Statement, a BACnet form that must be completed for BTL-listing in which device's BACnet device profile (e.g., B-BC), required feature choices (e.g., BACnet/IP vs. MS/TP), and optional features (e.g., COV) are to be documented.

1.03 SUBMITTALS

- .1 For each control device submit shop drawings/product data sheets including manufacturer's name, product name and specific model number, options included, product image, proof of BTL listing, dimensions, functional description and operating characteristics, protocol conformance information, and electrical requirements (AC vs. DC, voltage and current draw, or VA).
- .2 Provide system architecture diagram showing communications wiring topology, model number or designation of each communicating device, HVAC or other system/equipment controlled, location and designation of each enclosure containing communicating device, and connections to 3rd party controls.

- .3 For renovation projects, system architecture is to show complete existing network highlighting where and how new devices are to be added.
- .4 Provide schematic diagram of each controlled system/equipment showing point devices/interfaces with a point naming scheme matching that used on associated control enclosure wiring diagram. Provide a bill of material for devices shown with nomenclature keyed to catalogue data.
- .5 Proprietary services and object types, if used in system, to be thoroughly documented and provided as part of submittal data. Necessary tools to be supplied for working with proprietary information.
- .6 Provide floor plans showing enclosure locations, field devices not mounted in enclosures or on equipment (e.g., space temperature), terminal devices (e.g., VAV box) controller locations, and workstation/server locations.
- .7 Provide enclosure layout and wiring diagram showing BAS controllers, gateways/interfaces to 3rd party controls, enclosure-mounted field devices, internal wiring and wiring to field devices (with wiring tags matching those used on schematic diagrams), a point list with expanded point description information, communications wiring connections, and power supply. Label enclosure devices and key to bill of materials.
- .8 Provide sequence of operation modified and expanded from that provided in this specification to include control details specific to mechanical and controls equipment provided.
- .9 Provide list of data communicated via digital communications interfaces to 3rd party controls (e.g., a chiller or boiler gateway).
 - .1 Prior to completion of submittals, coordinate with 3rd party equipment suppliers to review their documentation and verify data (i.e., BACnet objects and properties, Modbus registers, etc.) required to complete system is available.
 - .2 Prior to completion of submittals, schedule meeting with Consultant to review data lists available for communication to/from 3rd party controls. Based on Consultant's input modify list of data to be communicated from that specified.
- .10 Provide a list of graphic screens, and, for each screen, conceptual layout with points/data to be included and linkages to other screens. Meet with Owner and Consultant prior to submittals to determine their graphic screen format and content preferences.
- .11 Provide, for review, a description of BAS acceptance tests along with forms/checklists to be used during testing.
- .12 Submit a site inspection and start-up report from manufacturer's representative as specified in Part 3 of this Section.

1.04 QUALITY ASSURANCE

- .1 Electrical installation work is to comply with latest version of local governing electrical code and installed by experienced personnel trained by BAS manufacturer/supplier.
- .2 Provide electrical products which have been tested, listed and labelled by CSA or ULC, and comply with NEMA standards.

- .3 Comply with following codes and standards:
 - .1 UL 916, Energy Management Equipment;
 - .2 ASHRAE BACnet Standard 135;
 - .3 local governing electrical code.
- .4 Controls Contractor is to provide an experienced project manager (minimum 10 years of related experience) to oversee all aspects of project including design, installation and start-up.
- .5 Anyone involved in design, installation, programming and verification of BAS are to be authorized and trained by BAS manufacturer.

1.05 WARRANTY

- .1 Provide labour, material and equipment necessary for operation of BAS according to design for a period of 1 year after Substantial Completion of Project. Warranty or final completion service is to be scheduled with Owner to minimize disruptions to facility operations.
- .2 Provide Owner with a telephone number where service representative can be reached at all times. Within 24 hours after receiving a request for service, problem is to be remotely resolved (i.e. via remote communications with BAS) or service personnel are to be at site. Fully restore BAS to proper operating condition within 2 days.

2 PRODUCTS

2.01 MATERIALS

- .1 Use new products manufacturer is currently manufacturing and selling for use in new installations. Do not use this installation as a product test site unless explicitly approved in writing by Owner. Spare parts are to be available for at least 5 years after completion of this contract.

2.02 BAS ARCHITECTURE AND GENERAL REQUIREMENTS

- .1 BAS using a client server architecture based around a modular PC network, utilizing industry standard operating systems, networks and protocols, and meeting system manufacturer's general requirements.
- .2 BAS is to include, but not be limited to, following:
 - .1 operator workstation to use as primary interface into BAS;
 - .2 custom built graphics including an overview, floor plans, individual graphics for each system, and summary graphics for system comfort and major equipment operation;
 - .3 high speed, peer to peer network of DDC controllers, a control system server, and web-based operator interface;
 - .4 utilize distributed control and not rely on any single controller;

- .5 software designed around open standards with the control system server being accessible using a web browser over control system network, Owner's LAN or over the internet, and requiring no special software other than web browser to access system information;
 - .6 utilize BACnet protocol for communication to operator workstation, web server and controllers and designed around ANSI/ASHRAE BACnet Standard 135;
 - .7 open system architecture is to allow system to integrate to multiple vendors;
 - .8 capable of future expansion through addition of control devices, DDC controllers and/or operator devices, and is to include capability of 25% expansion.
- .3 Each NC is to have a spare Ethernet/IP port connection for local connection of an operator interface.
- .4 Each BAS controller is to continue to execute its control software, sample input points, and update output points without connection to its BACnet/IP or MS/TP network or an operator interface. If global variables such as OAT are used within a controller's programming/sequence of operation, the global variable is to maintain its last value prior to network disruption.
- .5 Point termination types include:
- .1 analogue input (AI) - thermistor, 0-10 VDC or 4-20 mA DC;
 - .2 binary input (DI) - monitoring of dry contacts, including contact closure "pulses" up to 10 per second;
 - .3 analogue output (AO) - 0-10 VDC, 0-20 VDC or 4-20 mA DC;
 - .4 binary output (DO) - 2-state DC voltage signal or magnetically held dry contact closure.
- .6 Each BAS controller is to be able detect a changeover to battery-backed power and modify state of control program, if required by sequence of operation.
- .7 Upon reestablishment of power to a BAS controller, devices are to return to normal operation in less than one minute.
- .8 Server computer and operator workstation hardware capable of interfacing to an IEEE 802.3 Standard Local Area Network (LAN), and also capable to operate using IEEE 802.11 Wireless Local Area Network (WLAN).
- .1 Communications not requiring a BAS Gateway (i.e., BACnet) - Design BAS to include NC's and sufficient EIA-485 communications ports (for MS/TP) to support communications and data handling capacities required.
 - .2 Communications Requiring a Network Controller "Driver" (e.g., Modbus) - Design BAS to include NC's and sufficient EIA-485 communications ports (for Modbus-RTU), and any optional software "drivers" and/or hardware if necessary to support communications technology and application protocol gateway interfaces.

- .3 Communications Requiring a Gateway (e.g., LonTalk) - Design BAS to include sufficient BACnet/IP-communicating devices, with sufficient LonTalk communications capacity to support LonTalk 3rd Party devices.
- .9 System is to perform following general functions:
 - .1 building management and control;
 - .2 monitoring and control of controllers, remote devices and programmable logic controllers including sensors, actuators, environmental delivery systems (chillers, boilers, room climate control, lighting systems, electrical systems etc.);
 - .3 operator interface to allow general supervision of room controls;
 - .4 video display integration;
 - .5 data collection and historization;
 - .6 alarm management;
 - .7 trending;
 - .8 report generation;
 - .9 network integration;
 - .10 controller scheduling;
 - .11 data exchange and integration with a diverse range of other computing and facilities systems using industry standard techniques.
- .10 In event of a power failure or disconnection from BAS, controllers are to continue to be fully operational with full time program capability.

2.03 NETWORK CONTROLLER (NC)

- .1 NC is a BTL listed BACnet B-BC device in accordance with following requirements:
 - .1 non-volatile memory for operating system software;
 - .2 read/write memory for custom control programming, trending, and alarming;
 - .3 real time clock;
 - .4 integral point or point expansion terminations;
 - .5 communications support to other NC's;
 - .6 minimum Quad Core 996Ghz processor;
 - .7 global control algorithms and automated control functions to execute using a 64-bit processor;
 - .8 minimum of 1 GB of DDR3 SDRAM on a 533Mhz bus;

- .9 EIA-485 ports capable of supporting various EIA-485 protocols including, but not limited to BACnet MS/TP and Modbus;
- .10 provide normal seven-day scheduling, holiday scheduling and event scheduling;
- .11 logging capabilities for any object type with sample time interval adjustable at operator workstation;
- .12 alarm generation for any object change of value or state;
- .13 built-in, user-configurable demand limiting of energy.
- .2 Each BACnet MS/TP LAN to support a minimum of 50 BACnet devices.
- .3 NC Communications Network: 100baseT Ethernet minimum communications with BACnet/IP support for interconnection to other NC's, operator interfaces, and to an Internet/Intranet connection, if specified.
- .4 Web-Server: Password-protected access directly to controller to view, diagnose and modify operating features/parameters using a web browser with factory provided web pages used for this capability that require no setup other than required for programming controller.
- .5 NC is to provide:
 - .1 Communications support as "master" to up to 3 separate 76.8Kbps minimum BACnet MS/TP data link layer communications connections for advanced application and application specific controllers.
 - .2 BACnet Clause 6 Routing (between specified NC's and controller network technologies) and BACnet/IP Broadcast Management (BBMD).
- .6 NC is to be of scalable design such that number of trunks and protocols may be selected to fit specific requirements of a given project.
- .7 Controller to be capable of running up to six independent control strategies simultaneously. Modification of one control strategy does not interrupt function or runtime others.
- .8 Controllers for critical applications are to be B-BC controllers with IP connectivity.

2.04 FIELD EQUIPMENT CONTROLLERS (FEC)

- .1 Advanced Application Controller (AAC)
 - .1 BTL listed BACnet B-AAC device with:
 - .1 non-volatile memory for operating system software;
 - .2 read/write memory for custom programming;
 - .3 76.8Kbps minimum BACnet MS/TP communications;
 - .4 direct point termination through integral point connections;

- .5 communications support for operator interface and controller network.
- .2 Application controllers to include universal inputs with 12-bit resolution that accept 3K and 10K thermistors, 0–10VDC, Platinum 1000 ohm RTD, 0–5VDC, 4–20mA and dry contact signals. Any input on a controller may be either analog or digital with a minimum of three inputs that accept pulses. Controller to include binary and analog outputs on board. Analog outputs with 12-bit resolution to support either 0–10VDC or 0–20mA. Binary outputs to have LED indication of status. Software to include scaling features for analog outputs. Application controller to include 20VDC voltage supply for use as power supply to external sensors.
- .3 Controller to also include support and modifiable programming for interface to intelligent room sensor with digital display.
- .4 All program sequences to be stored on board application controller in EEPROM. No batteries are to be needed to retain logic program. Program sequences to be executed by controller up to 20 times per second (minimum of 10 times per second) and capable of multiple PID loops for control of multiple devices. Calculations to be completed using floating-point math and system to support display of all information in floating-point nomenclature at operator's terminal.
- .5 Programming of application controller to be completely modifiable in field over installed BACnet LANs or remotely using modem interface.
- .2 Application Specific Controller (ASC)
 - .1 BTL listed BACnet B-ASC device dedicated for use with specific equipment and applications, and provided with:
 - .1 non-volatile memory for operating system software;
 - .2 read/write memory for all other purposes;
 - .3 factory-provided control software;
 - .4 76.8Kbps minimum BACnet MS/TP controller network connection (as an MS/TP master);
 - .5 integral point termination;
 - .6 communications support for operator interface, and controller network.
 - .2 Application controllers to include universal inputs with 10-bit resolution that can accept 3K and 10K thermistors, 0–5 VDC, and dry contact signals. Inputs on controller may be either analog or digital. Controller to also include binary outputs on board. For applications using variable speed parallel fans, provide a single analog output selectable for 0-10 V or 0-20 mA control signals. Application controller to include microprocessor driven flow sensor for use in pressure independent control logic. All boxes to be controlled using pressure-independent control algorithms and all flow readings to be in LPS (CFM).
 - .3 Controller to also include support and modifiable programming for interface to intelligent room sensor with digital display.

- .4 Program sequences to be stored on board application controller in EEPROM. No batteries are to be needed to retain logic program. Program sequences to be executed by controller 10 times per second and be capable of multiple PID loops for control of multiple devices. Programming of application controller to be completely modifiable in field over installed BACnet LANs or remotely using modem interface. Operator to program logic sequences by graphically moving function blocks on screen and tying blocks together on screen. Application controller to be programmed using same programming tool as Building Controller and as described in operator's workstation section. Programming tools to be provided as part of system.
 - .5 Do not use application specific controllers for systems/equipment that require custom application programming to meet sequence of operation (i.e., if an application specific controller is used, factory-provided control software/program is to perform sequence of operation without "upper level" control from another BAS controller).
 - .6 Include an integral differential pressure sensor for controllers used for air flow measurement and an optionally integral damper actuator.
- .3 FEC's for Constant Air Volume (CAV) Terminal Units:
- .1 FEC's for CAV terminal units are to comply to above requirements and following additional requirements:
 - .1 On-board flow sensor is to be microprocessor-driven and pre-calibrated at the factory. Pre-calibration is to be at 16 flow points as a minimum. All factory calibration data is to be stored in non-volatile memory. Calibration data is to be field adjustable to compensate for variations in CAV box type and installation. Operator's workstation, portable computers, and special hand-held field tools are not to be needed for field calibration.
 - .2 All calibration parameters are to be adjustable through intelligent room sensor.

2.05 COMMUNICATIONS

- .1 Capable of supporting greater than 90 separate communications links to networks of control devices. Each connection operates independently of the others and facilities are to be provided by system displays to individually place these links in service or out of service.
- .2 Given sufficient level of system privilege, it is to be possible to view, manipulate and analyze all data in the system from any operator workstation in system, including those operating remotely.
- .3 Once a control device is configured and placed in service, system is to automatically begin background diagnostic scanning of device to ensure communications are monitored independently of any monitoring scanning.
- .4 System is to perform checks on data integrity of all data acquired from device. If an invalid or time-out response is received, data is to be ignored and system will record transaction as an error. Statistics are to be kept and displayed by system on errors encountered in communication by means of a communications barometer. Barometer is to increment for every failed call and decrement for each successful call. In addition, system is to alarm separate marginal and failure conditions based on user-defined limits to advise operator of device and link that has failed. Communications statistics are to be displayed as standard on system and also be available as part of reporting system or custom displays.

2.06 STANDARD SYSTEM DISPLAYS

- .1 Following displays are to be included as part of system:
 - .1 alarm summary display;
 - .2 event summary display;
 - .3 point detail template displays (for each point in database);
 - .4 trend set template displays;
 - .5 group control and group trend template displays;
 - .6 communications status displays;
 - .7 system status displays;
 - .8 face plates for all common point types;
 - .9 configuration displays.
- .2 In the case of trend and group displays, configuration of these displays only require entry of a point name to completely configure display. Alarm summary, event summary, point detail, communications status, and system status do not require any configuration.
- .3 System Status Display
 - .1 Available on each operator workstation and automatically built by BAS system, requiring no engineering to add additional devices to be monitored. It is to display following information in a hierarchical system tree:
 - .1 points in alarm condition pending "acknowledge" command;
 - .2 points which remain in an alarm state but which have been acknowledged;
 - .3 communication failures;
 - .4 printer status;
 - .5 operator workstations status;
 - .6 communication links status;
 - .7 controller status;
 - .8 system interfaces status;
 - .9 additional connected server status.
- .4 Administration Displays
 - .1 System is to provide following full screen displays:
 - .1 master system menu;

- .2 report summary;
- .3 alarm summary;
- .4 event summary;
- .5 display summary;
- .6 system status display;
- .7 system parameters configuration;
- .8 operator workstation configuration;
- .9 scope of responsibility assignment;
- .10 time schedule assignment;
- .11 calendar assignment (holidays/special occasions);
- .12 history assignment;
- .13 push-button assignment;
- .14 operator definition;
- .15 operator message board;
- .16 events archive and retrieval;
- .17 time period summary and configuration;
- .18 point detail for every configured point.

2.07 CREATING CUSTOM DISPLAYS

- .1 Graphic Display Building Editor
 - .1 Include a graphic display building editor for creation of site specific graphic displays allowing one-step online building of display static and dynamic objects. It is a WYSIWYG editor (what you see is what you get) allowing displays drawn using editor to appear exactly same when viewed from an operator workstation.
 - .2 Displays are created in HTML 5 (Hypertext Markup Language) format. This is essential so displays can also be viewed through a web browser as well as normal BAS operator interface. Displays are to be saved in standard HTML format. Graphic elements are to be available as HTML elements. It is not acceptable to have an HTML format which merely links to a proprietary object or bit map of entire display. It is to be possible to view and edit resulting HTML file using a text editor. Systems which do not support HTML displays are not acceptable.

- .3 It is to be possible to link dynamic objects to BAS database. They are to allow information to be displayed from database or to allow an operator to interact with them in order to make changes in database and to perform control actions. Dynamic objects are to include dynamic text, push buttons, indicators, charts, check boxes, combo boxes, pop up boxes, ActiveX controls and scroll bars.
- .4 Graphic display building editor to support multiple features including but not limited to following:
 - .1 one step display building (both background and dynamic information);
 - .2 point and click operation;
 - .3 paste to and from Clipboard;
 - .4 control for display status of system schedules;
 - .5 configurable tool, colour and line palettes;
 - .6 dialog boxes for definition of object properties;
 - .7 import graphics from 3rd party packages including WMF, BMP, TGA, GIF and JPEG formats;
 - .8 standard library of BAS industry objects;
 - .9 live video element;
 - .10 ActiveX controls;
 - .11 ActiveX documents;
 - .12 display scripts written in either JavaScript or VBScript;
 - .13 multilevel undo and redo;
 - .14 transparent images;
 - .15 popup displays;
 - .16 standard alarm symbols;
 - .17 real time and historical trend object supporting up to 32 points on 1 trend.
- .2 Display Scripting
 - .1 It is to be possible to further animate display elements using standard HTML scripts such as JavaScript or VBScript. Include script editor supporting one of standard script languages. By using script programs, individual elements on display may be manipulated. Proprietary scripting language or additional scripting and drawing package is not acceptable.
 - .2 It is to be possible to perform a variety of animations.

.3 Live Video

- .1 Both graphic display building editor and operator interface are to have built in support for creation and display of live video objects without need for programming. Size and position of video object is configured on a per display basis.

.4 Web Technology

- .1 Displays created in graphic display building editor are to be usable in a web browser such as Microsoft's Internet Explorer without modification. Displays are to be usable in this manner enabling operators to completely operate system through a web browser via internet. Displays may also incorporate data from intranet, Internet, or ActiveX documents along with other building data.

.5 Launching External Applications

- .1 It is to be possible to launch applications (such as Microsoft Word, Excel, custom help files or any 3rd party applications) from a custom display. If supported by application, it is to be possible to launch application with a specified file opened within launched application. Launching of such applications is to be possible from operator workstation pull down menus or from a push button on a custom display.

2.08 MONITORING AND CONTROL

.1 System is to support acquisition of data using following techniques:

- .1 periodic scanning;
- .2 report by exception;
- .3 data on demand.

.2 In order to minimize communications traffic, system is to automatically group together data requests using contiguous addresses and scan intervals to generate scan packets, optimizing throughput for a given scanning load. System is to provide utilities to examine scan packet allocation for each scan interval, and compile aggregate statistics on communication link usage.

.3 Where supported by controlling device, use Report by Exception (RBE) protocols to reduce scanning load of system while improving system response. If necessary, periodic scanning may be used in conjunction with RBE to ensure data integrity.

.4 Device Control

- .1 Communicate control transactions issued by operator to control devices using a write followed by read to ensure integrity of transaction. If read following write to device indicates control action has failed, inform operator by means of a control failure alarm. Priority of control failure alarm is to be configurable by user.
- .2 Include option to assign a control confirmation message to individual points. Message is to request operator confirm requested supervisory control action prior to sending entered value to controller.

2.09 SYSTEM DATABASE

- .1 System is to provide a real-time database incorporating data from analogue, logical or pulse inputs. Database is to be configurable by end user without need for any programming and able to be modified on-line without interrupting operation of system. In addition to point-based information, database is to provide historization capabilities for analogue, digital, pulse and event based information. Information is to be accessible by all facilities of system such as custom displays, reports, trends, user written applications, etc.
- .2 Database Structure
 - .1 Real-time database is to support collection of data and storage using following structures:
 - .1 access point structures;
 - .2 analog point structures;
 - .3 status point structures;
 - .4 accumulator point structures;
 - .5 flexible point structures;
 - .6 historical data structures;
 - .7 event data structures;
 - .8 user defined structures.
 - .2 Point database structures are to be comprised as a composite point with a number of associated parameters, which may be referenced relative to a single tag name. Specifically, each of these parameters are to be accessible by various sub-systems such as graphical operator interface, report generation system and application program interface in a simple POINT.PARAMETER format without the need to know any internal storage mechanism.
 - .3 System is to maintain portions of database requiring frequent high-speed access as memory resident information and other less frequently accessed data as disk resident data. Memory resident data is to be checkpoint to disk every minute to minimize loss of data in the event of loss of power or other system failure.
 - .4 Database backup is to be possible with system on-line, including backup of historical based data, via standard Microsoft Windows operating system utilities.
 - .5 Store point data in a composite point database structure that provides a wide range of configurable information including but not limited to:
 - .1 point name and description;
 - .2 multiple locations for data storage and device scanning addresses;
 - .3 scan period;
 - .4 multiple types and instances of alarms;

- .5 multiple deadband or hysteresis settings (analog points);
 - .6 monitoring and control access restriction information;
 - .7 location of operator alarm handling instructions;
 - .8 location of ancillary information associated with the point;
 - .9 list of recent events pertaining to that point.
- .6 Points are to display all recent events on their point detail displays, using a direct link to BAS event system.
 - .7 BAS system is to provide a means by which a number of alarm inputs, outputs and other related points can be grouped together for more convenient monitoring and control without need for custom graphics.

2.10 HISTORY MANAGEMENT

- .1 Collection of historical point data is to be configurable as part of point definition. Once configured, historical data is to be collected automatically. Historical data collection is to be provided for both snapshots and averages with intervals ranging from 1 second to 24 hours.
- .2 Once assigned to history, point data is to be available by POINT.PARAMETER access used in conjunction with a history offset to locate particular value of interest. Graphical operator interface, trend, report generation and application interfaces are to be able to access historical data.
- .3 Modifications to history collection of a point is to be possible on-line without loss of previously collected data for point being changed or any other points in system currently being historized.
- .4 History is to be easily configurable to be archived to an alternative file system or offline media. Different archive settings are to be available for different history types.

2.11 TRENDING

- .1 System is to provide flexible trending allowing real-time, historical or archived data to be trended in a variety of formats. Include ability to combine trend data types to allow for comparisons between data e.g. current real-time data versus archived data. In addition, event database information is to be available for comparison and analysis purposes in same display and allow filtering of event data display based on time and location.
 - .1 Trend is to support annotations with system events within one display window, allowing operators to view historical plant information in a real time window with system events. Include support for filtering events by location and other standard filters available within event management system.
- .2 Trend Types
 - .1 Present real-time, historical or archived data in a variety of formats, including single, dual and multiple value trends of up to 32 points.
 - .2 Allow operator to display trend data in multiple different views.

- .3 Operators are to be able to zoom in on information displayed on trend sets for closer inspection by dragging out an area of interest with mouse or other pointing device.
- .4 Scroll bars as well as time selectors for direct entry of beginning and ending times are to be available to move trend set backwards and forwards across historical records.
- .5 It is to be possible to embed trend objects as part of custom displays in multiple formats.

2.12 EVENT MANAGEMENT

- .1 As a standard function, BAS is to log events automatically into a relational database. Journal is to contain following event information:
 - .1 alarms;
 - .2 alarm acknowledgements;
 - .3 return to normal;
 - .4 operator control actions;
 - .5 operator login and security level changes;
 - .6 on-line database modifications;
 - .7 communications alarms;
 - .8 system restart messages;
 - .9 database changes.
- .2 Event database entries are to contain following information as a minimum:
 - .1 time and date stamp;
 - .2 database partition code;
 - .3 source;
 - .4 operator;
 - .5 event type;
 - .6 condition;
 - .7 action;
 - .8 alarm priority;
 - .9 description;
 - .10 value;

- .11 engineering units;
- .12 comments.
- .3 Events may be sorted by time and date, database partition or source of event. It is to be possible to apply filters to list of events to limit view of events to those which match filter. Filters may include multiple dimensions and wildcards and also able to be saved and restored for reuse.
- .4 Event management system is to be fully integrated with standard reporting system. System is to automatically reference restored archive file if a report is requested containing a time search window covered by current archive file.
- .5 Operator is to be able to restore previously archived files and review or print them from operator workstations.
- .6 It is to be possible to directly generate an event report from event database filtered online without using reporting system.

2.13 ALARM MANAGEMENT

- .1 BAS is to support several different types of alarms for analogue points, including:
 - .1 high alarm;
 - .2 high-high alarm;
 - .3 low alarms;
 - .4 low-low alarm;
 - .5 deviation high alarm;
 - .6 deviation low alarm;
 - .7 rate of change alarm;
 - .8 unreasonable value alarm.
- .2 Any of these alarms are to be assignable to each analogue or accumulator point on an individual point basis as part of point configuration process.
- .3 Status points are to allow each individual state to be alarmed.
- .4 Alarm Priorities
 - .1 Each monitored point in system is to be able to be assigned one of 4 alarm priorities to individual states. Meaning of priorities are as follows:
 - .1 Journal - Changes of state are journalized to alarm/event log and optionally printed on alarm/event printer.
 - .2 Low - Change of state will generate a low priority alarm, which will appear on alarm summary. Optionally, alarm may be printed on alarm/event printer or generate an audible tone.

- .3 High - Change of state will generate a high priority alarm, which will appear on alarm summary. Optionally, alarm may be printed on alarm/event printer or generate an audible tone.
- .4 Urgent - This is highest priority. Change of state will generate an urgent priority alarm, which will appear on alarm summary. Optionally, alarm may be printed on alarm/event printer or generate an audible tone.
- .5 Alarm Enunciation
 - .1 Alarms are to be enunciated by:
 - .1 most recent, highest priority alarm message appearing on dedicated alarm banner on operator interface;
 - .2 alarm message appearing on alarm summary display;
 - .3 available tone based on a "*.wav" or other sound file for each alarm priority;
 - .4 alarm message printed on alarm printer;
 - .5 alarm indicator flashing on operator interface.
 - .2 Indicate alarm conditions in a clear unambiguous manner, and indicate unacknowledged alarms differently to acknowledged alarms.
 - .3 Enunciate alarms at operator workstation even if there is no operator currently signed-on.
 - .4 Points are to be enunciated while in alarm. If a point is set to alarm inhibited, point is to no longer cause annunciation. If a point goes into an alarm state whilst inhibited and then is still in alarm state when point is set to alarm enabled, point is to immediately cause annunciation.
- .6 Alarm Processing
 - .1 Assigning an alarm to point is to automatically cause system to perform following actions when an alarm occurs:
 - .1 alarm is to be time stamped to nearest second and logged in event database with point name (source), alarm type, alarm priority, point description, new value and engineering units;
 - .2 point value which is in alarm is to turn red (or other configurable colour) and flash on any standard or custom display which uses that point;
 - .3 unacknowledged alarm entry is to be made in system alarm summary for low, high and urgent alarms;
 - .4 audible alarm is to sound (if configured);
 - .5 alarm annunciation indicator is to flash synchronously on all displays.
 - .2 In addition, alarm banner of operator interface is to show most recent (or optionally oldest), highest priority, unacknowledged alarm in system.

.7 Alarm Summary

.1 Shows current or pending alarms on system including following requirements:

- .1 standard summary display requiring no engineering to setup and commission;
- .2 support filtering by time and date, database partition or source of alarm;
- .3 capable of displaying a summary of current alarms by location as well as highest priority alarm within corresponding location, and ability to be filtered based on selected locations from location pane;
- .4 recurring alarm counter:
 - .1 support a simple method to reconcile recurring alarms into a common alarm message preventing nuisance alarms from flooding alarm summary display;
 - .2 when same alarm from a plant device recurs, alarm display is to use a counter to represent how many times this alarm has occurred since last acknowledged;
 - .3 alarm consolidation is to minimize alarm messages for operator, but BAS will always track each new alarm into event subsystem thereby ensuring alarms are present regardless of how often they have recurred.

.8 Dedicated Alarm Banner and Alarm Indicator

- .1 Dedicated alarm banner is to appear on all displays showing either most recent or oldest (configurable), highest priority, unacknowledged alarm in system. This banner is to be clear when there are no unacknowledged alarms for operator to process.
- .2 Alarm indicator is to also appear on all displays. This indicator will flash red (or another configured colour) when there are any unacknowledged alarms pending in system. This indicator will remain solid red if there are alarms, which have not returned to normal but which have been acknowledged. Indicator will be clear if there are no points in an alarm condition.

.9 Alarm Logging

- .1 As well as being logged on printer, alarms are to be logged to an event file for future retrieval in alarm reports or archived to removable media.

.10 Alarm Response Function Keys

- .1 Following dedicated function keys are to be provided on keyboard for alarm action:
 - .1 Acknowledge - After moving cursor to point in alarm on screen and selecting point, operator is to be able to acknowledge an alarm by pressing this key. This action is to be logged in event file and on printer showing operator ID with alarm.
 - .2 Alarm Summary - By pressing a dedicated key at any time operator is to be able to view a display showing currently active alarms. Alarm messages are to be colour-coded showing priorities. Operator is to be able to view alarms according to priority or sorted based on other fields. It is to be possible to acknowledge alarms from this display and also go to associated display defined for point.

- .3 Associated Display - After moving cursor to point in alarm on screen and selecting point, operator is to be able to bring up display applicable to that alarm by pressing this key. Just selecting associated display key directly will bring up associated display for point currently on alarm banner. This is generally a custom graphic showing location of alarm in facility.

.11 Alarm Acknowledgement

- .1 On acknowledgement by operator, flashing indicator is to turn steady, and point value is to remain coloured with alarm priority colour, on any system or custom graphic. Acknowledgement is to also be logged in event database identifying operator or station that acknowledged alarm. If point goes out of alarm before being acknowledged by operator, alarm is to be shown by a different indication and remain in list until specifically acknowledged by operator. If a point is not acknowledged within a configurable period of time, then an additional alarm can be generated and reassigned to another location to allow other operators to take action.

.12 Alarm Filtering

- .1 Alarm summary is to be able to filter alarms displayed to operator by limiting view of alarms to those that match filter. Include use of columns on alarm summary as part of a filter allowing sophisticated filters to be configured e.g. alarms from this particular point, with this value, during this period. Filters may include multiple dimensions and wildcards. Filters are to be able to be saved and restored so previously configured filters can be reused. It should also be obvious to operators when a filter has been applied to alarm summary.

.13 Alarm Link to Digital Video Recordings

- .1 System is to allow linking and display of digital video recordings pertaining to alarms. If there is any video footage in digital format which is relevant to an alarm, then alarm summary is to indicate this by use of a special icon on alarm. By selecting icon, operator can then replay relevant digital video footage of alarm incident.

.14 Print Alarms as a Report

- .1 Filtered alarm summary should be able to be printed directly as a report. From alarm summary page, it is to be possible to view current filtered list of alarms via a print preview button. This shows what alarms will look like when printed to configured report printer. From alarm summary, it is to be possible to print alarms directly using print button.

.15 Additional Alarm Information

- .1 BAS system is to provide support for an additional message to be tagged to alarm. This message is to provide operator with additional information on alarm but is to not clutter alarm summary. It is to appear in a separate message summary at same time as alarm appears in alarm summary. Messages can be pre-configured and then simply attached to individual points by means of a message ID.

.16 Advanced Alarm Management

- .1 BAS is to be capable of advanced alarm management, which includes set stages of alarm handling. Stages are to be:
 - .1 silence alarm condition;
 - .2 acknowledge and action alarm condition;
 - .3 respond to alarm condition by using pre-defined responses;
 - .4 optionally reset alarm.
- .2 Record actions in event file for retrieval and auditing purposes.
- .3 When an alarm is silenced, an instruction page for alarm will be displayed. Alarm may then be acknowledged from this page and alarm handling action completed.
- .4 Once alarm is acknowledged and appropriate action has been taken, operator may move to response page to select from up to 100 user-defined responses to be logged in event file. Alternatively, operator is to be able to enter their own response, which will also be logged in event file. At same time, alarm is removed from alarm file. Optionally, point is to remain on alarm summary until a manual reset operation is performed.
- .5 It is to be possible to enable/disable this feature on a point-by-point basis given appropriate system privilege level.

2.14 REPORTING

- .1 Support a flexible reporting package to allow easy generation of report data. Reports provided are to include pre-configured standard reports for common requirements such as alarm event reports and custom report generation facilities configurable by user.
- .2 Reports are to be activated in one or more of following ways:
 - .1 periodic activation at user specified intervals;
 - .2 operator demanded;
 - .3 event initiated e.g. change in point value;
 - .4 application initiated;
 - .5 printed directly from the alarm/event summary.
- .3 Standard Reports
 - .1 Various pre-formatted reports are to be available on system.
 - .2 Configuration of these reports only require entry of schedule information, and other parameters such as point name or wildcard, filter information, time interval for search and destination printer to fully configure report. Specifically, no programming or scripting is required.

.4 Access Level Report

- .1 Lists access levels matching a specified search criteria filtered by zones and allocated time periods.

.5 After Hours Report

- .1 Produces a summary of alarms occurring during period specified by operator as "after hours".

.6 Alarm/Event Report

- .1 Produces a summary of events of a specified type for nominated points occurring in a time period. Time period may be specified as an absolute start and end date and time, or as a period relative to current time. This report is to also be able to produce a summary of changes made by a specific operator.

.7 Alarm/Event SQL Reporting Services Report

- .1 This sample report lists a summary of alarms and events by location and by date and time. It includes a graphic summary.

.8 All Points Report

- .1 Produces a list of point information, including point name, description, point type, engineering units, and current values. Report configuration is to allow filtering based on a wide variety of criteria.

.9 Operator Trail Report

- .1 Produces a summary of operator actions relating to a specific operator in a specified period.

.10 Point Trail Report

- .1 Produces a summary of events of a specified type occurring in a period on nominated points.

.11 Point Attribute Report

- .1 Report is to be provided to points selected by one of following attribute criteria:
 - .1 out-of-service;
 - .2 alarm suppressed;
 - .3 abnormal input levels;
 - .4 in manual mode.

.12 Point State Changes Report

- .1 Lists information about time periods matching specified search criteria.

.13 Time Period Report

- .1 Lists information about time periods matching specified search criteria.

2.15 CUSTOM REPORTS

- .1 In addition to standard reports, configurable report generation facilities are provided allowing custom reports to be produced. They can be configured at any time with system online, and are able to access any database values. At least 3 methods of custom report generation are to be available.
 - .1 Microsoft Excel report;
 - .2 ODBC format for purpose of extracting data and creating custom reports. It is to be possible to access tables of data from BAS through an ODBC compliant tool such as Crystal Reports or SQL Server.
 - .3 SQL Reporting Services custom report.

2.16 USER DEFINABLE DATABASE

- .1 In order to support other types of data such as user entered or calculated data from application programs, system is to provide a user definable database area that can be fully integrated into system. Data contained in this database is to be accessible by:
 - .1 custom graphics;
 - .2 custom reports;
 - .3 application programs;
 - .4 network applications using a Network API.

2.17 POINT INITIATED PROGRAMS (PIPS)

- .1 In addition to standard point processing functions, system is to allow additional processing through use of standard PIPS that may be attached to any points.
- .2 PIPs are to be either configurable standard algorithms, or preference is a VBscript can be written as a library function and attached to points within BAS.

2.18 HISTORICAL DATA ARCHIVING

- .1 Support archiving of historical data allowing a continuous record of history to be built up over a period of time. Archived data may be stored on hard disk of system or a remote network drive or moved off-line to removable media such as DAT tape, or optical disk. Number of archives maintained on system before being transferred to off-line media is to only be limited by size of hard disk or remote network drive. Allow user to define specific intervals of history to be archived to avoid archiving of unnecessary data.
- .2 Once archived, data is to be available for re-trending through system trend facilities in combination with current on-line history or other archives. Providing archived history is present on BAS server's hard disk or remote network drive, trend facilities are to be able to access it transparently for display, when a user scrolls beyond current on-line history limits.

- .3 Support display of trend data from up to 10 years of age. Any required upgrades or updates to BAS system is to be capable of preserving historical information to enable review of data from any earlier release of system.

2.19 TIME SCHEDULES

- .1 Include ability to specify time schedules for control of BAS points and control a range of a single point to a large number of points from a single schedule. Single time schedule is to define control to any combination of day and time.
- .2 Scheduling management system is to be more flexible than providing weekly schedules with a provision for a finite number of special occasions/holidays, allowing schedules to be entered that recur on a non-weekly basis or only occur once on a given day in future.
- .3 Time schedule is to provide ability to override normal schedule for holidays or special occasions, and user is able to create multiple different grouping of dates (Calendars) that can be assigned to individual points as applicable.
- .4 Configuring time schedules is performed through a graphical user interface whereby operator selects appropriate time span from calendar. Systems where times and days are manually entered or managed by an external spreadsheet type form are not acceptable. User interface is to support capability of navigating to any future date to allow user to enter a time schedule. User interface is to provide graphical feedback to indicate various time schedule conditions.
- .5 Allow user to view time schedules that have been configured in past, present, and future in a graphical calendar interface, and increase or decrease amount of time on a schedule which is currently active.
- .6 Where control device supports an internal time schedule program, BAS is to upload, display, modify and download control device time schedules. Support for control device time schedules are to be in addition to BAS time schedules.

2.20 CONTROLLER SCHEDULING TOOL

- .1 Ability to create, edit and maintain controller time schedules. Controller scheduling tool constructed in a way that allows compatibility with new controller types with minimal additional development.
- .2 Allow downloading of schedules to several (supported) controllers in a single operation by provision of an integrated graphical interface.
- .3 Include a clear, graphical indication of status of each downloadable schedule element, and automatically recover and complete any schedule download which, for any reason, has failed or been interrupted.

2.21 OPEN INTEGRATION

- .1 Any of following Open Protocol Standards is to be used as necessary for integration of 3rd party devices or systems.
- .2 Modbus
 - .1 Include an integrated interface to devices using Modbus RTU protocol, where BAS server is to be 'master' and external device or system is to be "slave".

- .2 Support user definable data formats for Modbus devices to accommodate wide variety of formats in use in industry.
- .3 BACnet (ANSI/ASHRAE 135)
 - .1 Capable of communicating to other building subsystems using ASHRAE standard BACnet, and capable of acting as both a BACnet operator workstation and a BACnet gateway and support various standard BACnet objects.
- .4 BACnet Operator Workstation
 - .1 Integrated BACnet operator workstation allowing monitoring of BACnet devices via data acquisition and control.
 - .2 BACnet operator workstation is to support various BACnet Interoperability Building Blocks.
- .5 BACnet Gateway
 - .1 Integrated BACnet gateway allowing 3rd party BACnet clients to access data.
 - .2 BACnet gateway is to support various BACnet Interoperability Building Blocks.
- .6 OLE for Process Control (OPC)
 - .1 Include an integrated OPC Client, integrated OPC Data Access Server, and OPC Alarm and Event Server.
- .7 Data Exchange
 - .1 Capability to interface to point database of other BAS systems (i.e. nodes) on a TCP/IP network enabling both acquiring of point data and issuing control outputs to and from connected BAS systems.
- .8 Data Exchange with Microsoft Excel
 - .1 Capable of exporting bulk data to Microsoft Excel.

2.22 WIRING MATERIALS

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

2.23 ENCLOSURES

- .1 NEMA rated appropriate for location of equipment, for BAS components including controllers, sensors and other devices except space sensors. Refer to Section entitled Automatic Control Systems for additional requirements regarding local control panels.

3 EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

- .1 Provide a complete building automation system in accordance with requirements of this Section, Section entitled Automatic Control Systems, drawings, and input/output points list(s).
- .2 Install BAS components and materials in accordance with manufacturer's instructions. Where drawings conflict with these instructions, submit a written request for clarification.
- .3 Coordinate installation with other trades to avoid field condition conflicts.
- .4 Electrical products and execution are to comply with requirements of applicable Electrical Division Sections.
- .5 Provide sufficient number of BAS controllers to meet memory needs of project programming, alarming and trending along with minimum 25% spare capacity for future use.
- .6 Provide sufficient number of BAS controllers and point expansion modules to meet point needs of project.
- .7 For each system critical system listed below, provide an NC (instead of an FEC) and connect directly to the BACnet/IP network:
- .8 Provide necessary quantities of NC's to meet project requirements and connect NC's together using a BACnet/IP network. Provide sufficient number of NC's to support number of FEC's.
- .9 Comply with system manufacturer's instructions with regards to maximum number of devices to be connected to a power or control circuit.
- .10 Connect operator interface PC installed on project site to BAS via BACnet/IP.
- .11 Provide and connect FEC's to NC's via BACnet MS/TP.
 - .1 To minimize number of mechanical systems that would be inoperative in event of FEC failure, a maximum of 1 major mechanical system is to be controlled by one FEC. Major mechanical systems are as follows:
 - .2 FEC's for equipment (e.g., CAV boxes, VFD's, etc.) are to be connected to same NC used to control associated equipment/system (i.e., AHU, chiller plant, etc.).
 - .3 Failure of a single controller is not to result in system-wide failure.
- .12 Extend and connect wiring in conduit from terminal unit box actuators and connect to 15A-1P circuit breakers dedicated for terminal unit box applications, in branch circuit panelboards in adjacent spaces. Wiring is to be in conduit, and conduits and wiring are to be in accordance with standards and requirements of Electrical Division. Refer to electrical drawings for locations of branch circuit panelboards with dedicated circuits for controls system applications. No more than 15 terminal unit box circuits are to be connected to one dedicated circuit breaker.
- .13 Provide 120 volt/24 volt transformers as required for control devices.

- .14 Submit schedule(s) of input/output points to Consultant for review. Directly connect each NC and FEC to point devices in accordance with control diagrams and schedule of miscellaneous control points as shown on drawings. Sensor wires for each analogue input are to be No. 18 AWG twisted shielded cable. Other types of wire required are to be as recommended by system supplier.
- .15 Supply and turn over to Consultant prior to application for a Certificate of Substantial Performance of the Work, reports to be used in assisting Owner in defining and debugging DDC programs. These reports are to consist, as a minimum, of following:
 - .1 process control language (PCL) logs;
 - .2 control loop logs;
 - .3 PCL master point.
- .16 Submit Point Data Input forms to Consultant that Owner will fill out with DDC system supplier's assistance. Input this point data into system.
- .17 Contacts will be supplied as part of mechanical work or electrical work for alarm and status points for systems and equipment other than building environmental systems and equipment. Connect to DDC system in accordance with point schedule.
- .18 Indicate via number, systems controlled by NC and FEC. Indicate via a Lamacoid label mounted inside panel the identification number of electrical panel supplying power to NC and FEC.
- .19 Meet with Owner and provide required number of hours of field work dedicated to following:
 - .1 developing custom dashboards/graphics;
 - .2 setting up time schedules and optimal start/stop programs;
 - .3 setting up alarms including method for monitoring, annunciating and handling of alarms;
 - .4 setting up trends including establishing and storing trend information for systems as required;
 - .5 ensuring all demand limiting and energy conservation strategies are set up according to Owner's energy plan (if applicable).
- .20 Software provided including software to program operator interface and field level controllers to be licensed to Owner. Provide copy of all software used to Owner.
- .21 Graphics and programs to be property of Owner. Provide backup copies of all programs and graphics. Provide any tool sets required to edit graphics.

3.02 SUPPLY AND INSTALLATION OF ACTUATORS AND CONTROLLERS FOR TERMINAL UNITS

- .1 Supply required 24 volt actuators, controllers and transformers for terminal units.

- .2 Control Contractor shall be responsible to install the actuators, controllers and transformer on site. Electrical Contractor will provide power and terminate in a junction box in the ceiling near the terminal units for Control Contractor's use. Control Contractor is responsible for all required wiring and conduits from the junction box to the terminal units. All wiring shall be in conduit (provided by the Controls Contractor) in accordance with Division 26 requirements.

3.03 CONTROL WIRING AND COMMUNICATIONS CABLING

- .1 Perform required control wiring work for control systems except:
 - .1 power wiring connections to equipment and panels, except as noted below;
 - .2 control wiring associated with mechanical plant equipment and systems whose control is not part of the work specified in this Section;
 - .3 starter interlock wiring.
- .2 Install control wiring in EMT in exposed or concealed, inaccessible locations. ULC plenum rated FT6 cable is acceptable for concealed, accessible locations, neatly harnessed, secured and identified. Unless otherwise specified, final 600 mm (2') connection to sensors and transmitters, and wherever conduit extends across flexible duct connections is to be liquid-tight flexible conduit.
- .3 Field devices provided with pig-tail wiring without any integral means of flexible metal raceway attachment are to be enclosed with a suitable means to allow for flexible metal raceway attachment.
- .4 Install parallel to building lines, supported from structural members. Raceway or plenum wiring supported from or anchored to piping, duct supports (raceway only), ceiling suspension system (raceway only), or other electrical conduits is not acceptable.
- .5 Use flexible metal raceway, not in excess of 0.9 m (3') in length, for termination of raceway on vibrating equipment. Support flexible metal raceway at each end.
- .6 Use shielded wiring where recommended by manufacturer and install in accordance with manufacturer's instructions.
- .7 Install communications wiring as continuous lengths with no splices between termination points.
- .8 Wiring work is to be in accordance with BAS manufacturer's certified wiring schematics and instructions, and wiring standards specified in Electrical Division Specification.
- .9 Provide additional communications bus as required complete with required ancillaries. Connect and extend existing communications bus.
- .10 Provide control wiring for water meters, gas meters, etc., as applicable, and connect to BAS for meter data integration.

3.04 INSTALLATION OF ENCLOSURES

- .1 Provide NEMA rated enclosures, and coordinate enclosure locations with other trades and show in submittals.

3.05 IDENTIFICATION AND LABELLING

- .1 Refer to Section entitled Basic Mechanical Materials and Methods.
- .2 Identify BAS equipment as follows:
 - .1 enclosures and other devices mounted in field: engraved laminated nameplates with lettering such as "BAS Panel CP2", or "BAS Relays", or "BAS E/P Transformers", with all wording listed and reviewed with Consultant prior to manufacture of nameplates;
 - .2 panel points: weatherproof input/output layout sheet for each controller with name of each point connected to controller, and associated wire labelling information;
 - .3 wiring: numbered sleeves or plastic rings at both ends of conductor, with numbering corresponding to conductor identification on shop drawings and "as-built" record drawings;
 - .4 interface components: weatherproof layout sheet clearly illustrating/identifying purpose of each component within enclosure such that an operator or service technician can quickly identify exact use of each relay, transducer, contactor, etc., with each sheet fastened securely to back of enclosure door.

3.06 SOFTWARE SET-UP, CONFIGURATION AND PROGRAMMING

- .1 Provide data base entry, software configuration, initialization of trends and alarms, and custom application programming to meet this specification.
- .2 Set-points, PID tuning parameters, control deadbands, operating differentials, reset schedules, etc. are to be adjustable by an operator without need for accessing/modifying custom control programming code.
- .3 Coordinate number of users, user passwords and user authority profiles with Owner.
- .4 Provide following control software in addition to that described in sequence of operation (where applicable):
 - .1 PID Control: Each control loop is to be controlled by a PID (proportional-integral-derivative) algorithm. Loop is to be tuned using P and I gains as a minimum.
 - .2 Reset: Unless otherwise noted, any set-point required to be reset is to use a cascaded PID loop or an "every x minutes increment/decrement by y" algorithm. Contractor to tune these reset loops to provide stable control.
 - .3 Anti-Short Cycling: AO and DO points are to be protected from short cycling allowing minimum on-time and off-time to be selected. Unless otherwise noted, motors are to be limited to 4 starts per hour (1 per hour for a chiller, 6 for cooling tower fans).

- .4 Optimum Start: Air handlers that do not operate continuously are to be optimally started at latest possible time to meet occupied conditions at time of occupancy. Utilize space temperature inputs associated with air handler, along with outside air temperature. Algorithm is to include tuning parameters for adjusting influence of space and outside air temperature on start time.
 - .1 Warm-up Mode -Optimally started AHU is to operate in warm-up mode until occupancy. Outside air damper(s) close and return air dampers open. If AHU supplies multiple zones (e.g., VAV boxes), supply air temperature is to be space temperature set-point (adjustable).
 - .2 Night Setback - When not in occupied or warm-up modes an AHU is to cycle on to maintain a night setback temperature of 15°C (60°F) (adjustable) if AHU supplies a single zone or if zones that cannot provide heating without operation of AHU (pinch-down VAV boxes with reheat coils).
- .5 Alarm Communications: BAS' alarm/event communications features are to be set up to automatically initiate IP-based alarm/event communications (i.e., to pagers, mobile phones, email, alarm printers, etc.) for selected alarms/events. Consult with Owner to determine what communications method(s) is required, communications devices involved, and what alarm conditions/priority/time-of-day are to initiate these communications.
- .5 Graphic Screens:
 - .1 Provide custom-developed graphic screens for controls included in this project (including points/data specified for digital communication with "3rd party" controls). Screens are to include schematic representations of controlled and/or monitored systems/equipment, points and relevant set-points/parameters (consult with Owner for format and content), and floor plans with space sensing points represented.
 - .2 Prior to creation of graphic screens, meet with Owner to develop, for their approval, a list of screens to be provided, and, for each screen, a conceptual layout of graphics, points/data included, and linkages to other screens. Submit to Consultant for review.
 - .3 Provide operator workstation with a fully programmed operator interface software package. Provide a web-based graphical operator interface. Graphics to be provided as follows:
 - .1 Provide an overall building layout to include overview information related to scheduling and energy consumption of building.
 - .2 Provide floor plans for each floor or area. Operator to be able to switch between various floor plan views as applicable to obtain different information. In all views, floor plans are to provide navigational links to individual control systems. Various floor plans to include:
 - .1 thermal graphics;
 - .2 equipment location;
 - .3 lighting (if applicable);
 - .4 energy consumption (if applicable).

- .3 Provide summary plans to permit a quick overview of facility operations. Individual summary plans are to be provided for:
 - .1 thermal comfort;
 - .2 equipment operation;
 - .3 energy consumption.
- .4 Summary plan for thermal comfort is to utilize a 3 light system (green, yellow, red) to provide indication of temperature/humidity control in all areas on one graphic.
- .5 Summary plan for equipment operation (major systems only) to include an indicator of equipment status (on or off) as well as a 3 light system (green, yellow, red) for alarms and an indicator if any system point is overridden.
- .6 Provide individual graphics for each system. Individual graphics to include all I/O points for system, various control carousels as applicable for operator control of system and dynamic animated graphics (moving fans, dampers, etc.). Graphics will also contain links to all associated system for quick access to heating/cooling plants, air handling units, VFD's and/or pumping systems. Individual graphics to also contain energy consumption data where available as well as links to as-built shop drawings, sequences of operation and O&M manuals. All major system graphics will be composed of at least 2 graphics per system. First graphic will provide general information (all I/O, system enable, main set-points and alarms). Second graphic will provide all operator adjustable parameters in table format.
- .6 Point names, schedules, and space temperature set-points are to be chosen to meet approval of Owner (even if specified herein). Submit to Consultant for review.
- .7 Set up logs (including trended points/data, frequency and number of samples) and alarmed points (including alarm limits, alarm messages, alarm message destination email, phone, printer, etc. addresses; and alarm message transmission formats to be used) to meet approval of Owner (consult with Owner and review with Consultant).
 - .1 As a minimum system is to trend all process variables, setpoints, output devices and equipment statuses for each system.
 - .2 Trend intervals (adjustable) are as follows:
 - .1 space temperature/humidity – 15 minutes;
 - .2 duct sensor – 1 minute;
 - .3 pressure sensor – 1 minute;
 - .4 outdoor sensor – 15 minutes;
 - .5 actuators – 1 minute;
 - .6 binary I/O – on COV;
 - .7 setpoints – on COV or with reading as above.

- .8 Only one NC's BACnet BBMD (broadcast messaging management) capability is to be enabled per IP subnet and configured with list of peer BBMD's and its subnet's devices.
- .9 Duct static pressure set points for VAV air handling units are to be selected based on coordination with TAB agency to provide design air flows.
- .10 Coordinate duct differential pressure high/low limit setting values with TAB agency.
- .11 Pipe static pressure set points for variable pumping systems are to be initially selected based on scheduled pressure drop(s) of coils at which static pressure sensor(s) is installed. Final selection is to be based on coordination with TAB agency to provide design water flows.

3.07 DATA CONTROL (D/C) AND GRAPHICS SUMMARY

- .1 Provide hardware, custom software, application software, graphics, etc., necessary to accomplish control sequences and display graphics specified. Provide controllers, inputs, outputs, valves, dampers, actuators and flow meters required to provide control and graphic data described. Provide software set-points required for display in logical groups and graphics.
- .2 Each digital output is to have a software-associated monitored input. Any time monitored input does not track its associated command output within a programmable time interval, a "command failed" alarm is to be reported.
- .3 Where calculated points (such as CFM) are shown, they are to appear in their respective logical groups.
- .4 Unless otherwise specified or approved prior to bidding, primary analogue input and analogue output of each DDC loop is to be resident in a single remote panel containing DDC algorithm, and are to function independent of any primary or UC communication links. Secondary (reset type) analogue inputs may be received from primary network, but approved default values and/or procedures are to be substituted in DDC algorithm for this secondary input if network communications fail or if secondary input becomes erroneous or invalid.
- .5 In addition to unitary DDC controller data points specified to be presented on colour graphic displays, technical data for each zone mechanical apparatus is to be presented to operators on operator workstation in full English menu text displays including:
 - .1 apparatus name;
 - .2 heating and cooling PID loop P, I and D gains;
 - .3 primary CFM airflow (if measured);
 - .4 damper position (% open);
 - .5 reheat status/value;
 - .6 cooling set-point;
 - .7 heating dead-band;
 - .8 minimum and maximum CFM set-points;

- .9 reheat CFM set-point;
 - .10 unoccupied temperature set-point;
 - .11 temperature sensor calibration offset;
 - .12 bypass push button time, in minutes;
 - .13 smoke purge mode damper position;
 - .14 smoke pressurization mode damper position;
 - .15 smoke depressurization mode damper position;
 - .16 morning warm-up mode damper position.
- .6 Such points are to be presented in complete and direct read-write (command) format, unless they are provided in commandable colour graphic displays.
- .7 Following additional graphics are to be provided:
- .1 facility layout (showing buildings, streets, etc.);
 - .2 individual area layouts or isometrics;
 - .3 any other graphics necessary for logical penetration;
 - .4 individual HVAC systems graphics;
 - .5 facility/area layouts including alarm icon indicating which room has alarm;
 - .6 alarms displayed in alarm console linked to facility/area layout graphics to show where on layout alarm has occurred;
 - .7 sequences of operation;
 - .8 supervisor graphics;
 - .9 system configuration.
- .8 Graphic templates of each system and graphics page to be reviewed by Consultant and approved by Owner, prior to installation and start-up.

3.08 APPLICATION REQUIREMENTS

- .1 Software - Microprocessor-based control system is to rely on software for non-critical interlocks and time delays. Where required by specifications, these functions are to be provided by separate thermostats, relays, and delay timers.
- .2 Interlocks - Safety and other interlocks may require relays depending on specific devices being used. Some devices may require a special power supply as shown in wiring details. Safeties are to be hardwired into control circuit and also monitored by BAS.

- .3 Sensors - Select duct insertion sensors to suit application. For large ducts, use sensors with longer probe lengths. For heating and cooling coil freeze protection, use a long capillary type sensor. For mixed air and coil discharge temperature sensing, use averaging capillary type sensors.
- .4 Valves - Ensure actuators meet job requirements (i.e., control signal, close off, action, etc.). Control valves are to be selected to suit both medium and specified configuration (i.e., straight-thru, 3-way, screwed, flanged, etc.).
- .5 Damper Actuators - Total number of actuators may vary depending on damper size. Consult actuator's application literature to determine sizing requirements and use no less than 30% of minimum number of actuators recommended.
- .6 Graphics - System graphics are to include operator control panels to facilitate working with AHUs such as:
 - .1 Warm-up Panel is to permit operator to monitor status of warm-up mode (on or off), and to change set-point of warm-up temperature.
 - .2 Unoccupied Cycle control panel is to permit operator to monitor status of mode (occupied or unoccupied), and to change unoccupied periods set-points.
 - .3 Mixed Air Dampers control panel is to permit operator to monitor economizer mode (on or off), monitor damper position, and to change minimum position set-point.
 - .4 Optimum Start/Stop control panel is to permit operator to monitor and change optimum start/stop program parameters.
 - .5 Reset Schedule control panel is to permit operator to monitor and change reset schedule program parameters. It is not acceptable to monitor and change these modes of control in a manner other than that specified. Having to edit, compile and reload application programs to achieve monitoring and control of these modes is not acceptable.
 - .6 Provide text of control sequence so it may be displayed on operator screen by clicking on sequence control button on system graphic. Sequence will incorporate parameter values and set-points, and will update them dynamically as they change or are changed.

3.09 SYSTEM PERFORMANCE REQUIREMENTS

- .1 Installed system is to conform to following minimum performance standards:
 - .1 Graphic with 20 dynamic points is to display current data within 10 seconds.
 - .2 Graphic with 20 dynamic points is to refresh every 15 seconds.
 - .3 Screens for tuning are to refresh every 6 seconds.
 - .4 Commands from operator interface to device are to take no longer than 5 seconds.
 - .5 Alarms are to annunciate at workstation within 45 seconds.
 - .6 Field level controllers are to execute PID loops at a response time suitable for application with capability of executing once per second.

.7 Loop stability:

- .1 Space temperature to be maintained within $\pm 1^{\circ}\text{C}$ of set-point.
- .2 Return air humidity to be maintained within $\pm 5\%$ RH of set-point.
- .3 Duct pressure to be maintained within ± 50 Pa of set-point.
- .4 Fluid differential pressure to be maintained within ± 250 Pa of set-point.
- .5 Air volume to be maintained within $\pm 10\%$ of set-point.

3.10 SEQUENCES OF OPERATION AND BAS POINTS

- .1 Refer to mechanical drawings for control diagrams and sequences.
- .2 Points – Points as shown on mechanical and electrical drawings are to be considered minimum. Provide points and point types required to meet sequence of operation.
- .3 DDC Sequence for Manually Started Equipment – Unless noted otherwise, when an operator starts main component (e.g., fan, boiler, chiller, etc.) of an HVAC system (e.g., AHU, hot water plant, chiller plant, etc.) by a manual method outside of BAS (e.g., a motor starter H-O-A), BAS will execute described system (based on sensing motor operation via status input).
- .4 Safeties – Safety sequences for high or low temperature reactions are not to be implemented by "software interlocks". Automatic resets of safeties will not be accepted.

3.11 SYSTEM TESTING AND ACCEPTANCE

- .1 Perform BAS acceptance testing in presence of Owner or Owner-designated representative. System is to not be considered substantially complete until testing is complete and accepted. Perform calibration, start-up and testing procedures necessary to assure completion of system acceptance testing prior to commencement of system acceptance tests.
- .2 Point Tests
 - .1 Perform following tests for each point:
 - .1 Analog Input - Compare sensor reading to that of a calibrated portable measurement device.
 - .2 Binary Input - Manually actuate monitored equipment and compare actual state with that read by system.
 - .3 Analog Output - Through software, set output to 3 or more values across full range of actuation and compare with position of controlled device (or output signal for controlled device positions that cannot be visually observed).
 - .4 Binary Output - Through software, actuate output and compare control command with actual operation of controlled device.

- .5 Data (from digital communications with "3rd party controls") - Perform above tests, though comparison (except for data representing binary outputs) between that provided at 3rd party controller display and BAS. Perform above "Binary Output" test for data that represents digital outputs.
- .3 System Tests
 - .1 Perform following tests for sequences of operation:
 - .1 Demonstrate DDC loop response. Contractor is to supply trend data output in a graphical form showing step response of each DDC loop. Test is to show loop's response to a change in set-point, which represents a change of actuator position of at least 25% of its full range. Sampling rate of trend is to be from 10 seconds to 3 minutes, depending on speed of loop. For each sample, trend data is to show set-point, actuator position, and controlled variable values. Any loop that yields unreasonably under-damped or over-damped control is to require further tuning by Contractor.
 - .2 Simulate loop (i.e. change set-points) to verify reset schedules and temperature lockouts.
 - .3 Manually initiate system start-ups to verify interlocks and sequencing.
 - .4 Simulate safety device and fire alarm system contact actuation to verify emergency, alarm, and life safety sequences.
 - .5 Simulate day/night changeover to observe occupied, unoccupied, optimum start, and warm-up modes.
 - .6 Simulate seasonal changeovers to observe proper operation of heating and cooling modes.
 - .4 In addition, arrange for control system manufacturer to supply at site, qualified control system technicians to make adjustments to control systems to suit air and water balancing and testing.

3.12 CERTIFICATION, START-UP AND TRAINING

- .1 Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system manufacturer certification requirements.
- .2 Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system start-up requirements.
- .3 Include for demonstration and training sessions for each of 2 groups of Owner's operating and maintenance personnel as follows:
 - .1 1 full, 8 hour, day sessions at site using BAS for a "hands-on" demonstration of all BAS functions and features with instruction regarding chronological flow of information from field devices, contacts and sensors to the operator's workstation, an overview of communications network describing interplay between initiating devices, field hardware panels, systems communications, and their importance within operating BAS, and alarm indications and appropriate responses;

- .4 Include for 2 follow-up site training and troubleshooting visits, one 6 months after Substantial Completion and other at end of warranty period, both when arranged by Owner and for a full, 8 hour, day to provide additional system training and troubleshooting as required.

3.13 PROJECT CLOSEOUT WORK

- .1 Include following in as-built record drawings at a minimum:
 - .1 schematic outline of BAS for quick reference of overall system scope;
 - .2 adequate record of Work as installed, including its exact location and wiring and route;
 - .3 adequate record of existing controls retained and/or interfaced, including its exact location and wiring, tubing, etc., route.
- .2 Include following in O&M manual at a minimum:
 - .1 as-built versions of manufacturer's product data with list of equipment supplied, including its make, model number, name of local suppliers and quantity;
 - .2 complete network architecture indicating all network addresses, communication protocols, controllers, controller locations, and equipment controller by each controller;
 - .3 for renovation projects, indicate entire existing system network and clearly show new network devices added to network;
 - .4 maintenance information for all devices;
 - .5 operator's manual including detailed instructions for operations of BAS;
 - .6 programmer's manual including information necessary to perform programming functions;
 - .7 system hardware specification manual, which provides a functional description of all hardware components;
 - .8 system operator's manual which provides concise instructions for operation of the system and an explanation and recovery route for all system alarms;
 - .9 system engineering manual which provides information for system set-up, definition and application;
 - .10 complete project-specific graphic screens, custom sequence programming, system databases, parameter listings, etc. for equipment controlled under this phase of work (backed up to operator interface or web server and onto CD/DVD's);
 - .11 copy of warranty;
 - .12 operating and maintenance cautions and instructions;

- .13 log-in requirements, information, and/or instructions (including any hardware key(s) or software licensing documentation) to allow Owner access (for both viewing and modification) to system set-up databases, custom programming, service software, etc. at highest user level provided by manufacturer;
- .14 recommended spare parts list;
- .15 original issue documentation and software DVD's/CD's (if applicable) for 3rd party hardware and software;
- .16 completed BAS test forms/checklists.

3.14 CONTROLS CONTRACTOR'S RESPONSIBILITIES

- .1 Comply with applicable responsibilities specified in this Section and below:
 - .1 provide and pull power wire to controllers;
 - .2 provide start-up, test procedures and O&M manual;
 - .3 provide print out and electronic copy of all points connected to BAS;
 - .4 provide detailed consolidated wiring diagram showing interface of BAS controls with packaged controls;
 - .5 responsible for component and point to point testing;
 - .6 responsible for sensor calibration and actuator adjustment;
 - .7 provide calibration procedure for each analogue sensor;
 - .8 operate systems during testing;
 - .9 provide training and instruction;
 - .10 responsible for acceptance test for a 21 day period;
 - .11 set-up trend logs and group logs which are to be stored on hard disk;
 - .12 re-visit site during first year of operation to review BAS performance as detailed in this Section in article entitled Certification, Start-Up and Training;
 - .13 any other controls requirements specified in Contract Documents.

END OF SECTION



ELECTRICAL SPECIFICATION

CVH 2D MENTAL HEALTH PICU RENOVATION

CREDIT VALLEY HOSPITAL

ISSUED FOR TENDER

PROJECT NO.: CA0016106.5411
DATE: MAY 31, 2024

WSP
150 COMMERCE VALLEY DRIVE W.
SUITE 10B, 400 AND 500
THORNHILL, ON, CANADA L3T 7Z3

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DIVISION 26

ELECTRICAL

Section 26 00 10	Electrical Work General Instructions
Section 26 05 00	Basic Electrical Materials and Methods
Section 26 05 19	Low Voltage Power Conductors
Section 26 05 26	Grounding and Bonding
Section 26 05 36	Cable Trays and Cable Ducts
Section 26 05 48	Vibration Isolation and Seismic Restraints
Section 26 05 70	Electrical Work Analysis and Testing
Section 26 05 90	Hazard Materials
Section 26 08 00	Electrical Work Commissioning
Section 26 09 00	Lighting Control
Section 26 24 17	Branch Circuit Panelboard
Section 26 27 26	Wiring Devices
Section 26 50 00	Lighting

DIVISION 27

COMMUNICATIONS

Section 27 10 00	Structured Cabling
Section 27 52 23	Existing Nurse Call System
Section 27 53 13	Master Clock

DIVISION 28

ELECTRONIC SAFETY AND SECURITY

Section 28 13 00	Access Control system (ACS)
Section 28 20 00	Video Surveillance System (VSS)
Section 28 35 11	Real Time Locating System (RTLS)
Section 28 46 00	Existing Fire Alarm System Work
Section 28 46 25	Fire Detect Air Sampling

END OF SECTION

1 GENERAL

1.01 REFERENCES

- .1 Division 00 and Division 01 apply to and are a part of this Section.

1.02 APPLICATION

- .1 This Section specifies requirements that are common to Electrical Divisions work Sections and it is a supplement to each Section and is to be read accordingly. Where requirements of this Section contradict requirements of Divisions 00 or 01, conditions of Division 00 or 01 to take precedence, as confirmed with Owner and reviewed with Consultant prior to Bid submission.
- .2 Advise product vendors of requirements of this Section.

1.03 DEFINITIONS

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

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

1.04 DOCUMENTS

- .1 Documents for bidding include but are not limited to issued Drawings, Specifications and Addenda.
- .2 Specification is typically generally arranged in coordination with guidelines of Construction Specifications Institute/Canadian Specifications Canada (CSI/CSC) 50 Division MasterFormat.
- .3 Drawings and Specifications are portions of Contract Documents and identify labour, products and services necessary for performance of work and form a basis for determining pricing. They are intended to be cooperative. Perform work that is shown, specified, or reasonably implied on drawings but not mentioned in Specification, or vice-versa, as though fully covered by both.
- .4 Review Drawings and Specification in conjunction with documents of other Divisions and, where applicable, Code Consultant's report.
- .5 Unless otherwise specifically noted in Specifications and/or on Drawings, Sections of Electrical Divisions generally designate a basic unit of work, and Sections are to be read as a whole.
- .6 Drawings are performance drawings, diagrammatic, and show approximate locations of equipment and materials. Any information regarding accurate measurement of building is to be taken on site. Do not scale Drawings, and do not use Drawings for prefabrication work.

- .7 Drawings are intended to convey scope of work and do not show architectural and structural details. Provide fittings, offsets, transformations and similar items required as a result of obstructions and other architectural and/or structural details but not shown on Drawings.
- .8 Locations of equipment and materials shown may be altered, when reviewed by Consultant, to meet requirements of equipment and/or materials, other equipment or systems being installed, and of building, all at no additional cost to Contract.
- .9 Specification does not generally indicate specific number of items or amounts of material required. Specification is intended to provide product data and installation requirements. Refer to schedules, Drawings (layouts, riser diagrams, schematics, details) and Specification to provide correct quantities. Singular may be read as plural and vice versa.
- .10 Starter/motor control centre (MCC)/variable frequency drive (VFD) schedule drawings are both mechanical and electrical and apply to work of Mechanical Divisions and Electrical Divisions. Be responsible for reviewing starter, MCC, VFD, and motor specification requirements of Mechanical Divisions specifications and drawings, prior to Bid submission. Confirm and coordinate exact scope of work and responsibility of work between Mechanical Divisions and Electrical Divisions.
- .11 If there is conflict or discrepancy between, among or within any provisions of Contract Documents, provisions establishing higher quality, manner or method of performing the Work, using more stringent standards, prevails, with intent that provisions which produce higher quality with higher levels of safety, reliability, durability, performance and service prevails.
- .12 Generally, documents govern in following order:
 - .1 Specification.
 - .2 Drawings of larger scale.
 - .3 Drawings of smaller scale.
 - .4 Drawings of later date when scale of drawings is same.
- .13 Upon finding discrepancies in, or omissions from Documents, or having doubt as to their meaning or intent, notify Consultant.
- .14 Drawings and Specifications are prepared solely for use by party with whom Consultant has entered into a contract and there are no representations of any kind made by Consultant to any other party.

1.05 METRIC AND IMPERIAL MEASUREMENTS

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

1.06 EXAMINATION OF BID DOCUMENTS AND SITE

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

1.07 WORK STANDARDS

- .1 Where any code, regulation, bylaw, standard, contract form, manual, printed instruction, and installation and application instruction is quoted it means, unless otherwise specifically noted, latest published edition at time of submission of Bids adopted by and enforced by local governing authorities having jurisdiction. Include for compliance with revisions, bulletins, supplementary standards or amendments issued by local governing authorities.
- .2 Where regulatory codes, standards and regulations are at variance with Drawings and Specification, more stringent requirement will apply unless otherwise directed by Owner and reviewed with Consultant.
- .3 Supplementary mandatory Specifications and requirements to be used in conjunction with project include but are not limited to following:
 - .1 American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc., (ASHRAE);
 - .2 American National Standards Institute (ANSI);
 - .3 ANSI/ASHRAE Standard 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings;
 - .4 Building Industry Consulting Services, International (BICSI);
 - .5 Canadian Standards Association (CSA);
 - .6 CSA C282, "Emergency Electrical Power Supply for Buildings";
 - .7 CSA Z432, "Safeguarding of Machinery";
 - .8 CSA Z462, "Workplace Electrical Safety";
 - .9 Electrical and Electronic Manufacturers Association of Canada (EEMAC);
 - .10 Electrical Safety Authority (ESA);
 - .11 Electronic Industries Association (EIA);
 - .12 Illuminating Engineering Society (IES);
 - .13 Institute of Electrical and Electronic Engineers (IEEE);
 - .14 Intertek's Electrical Testing Labs (ETL);

- .15 National Building Code of Canada (NBC);
 - .16 National Electrical Manufacturers Association (NEMA);
 - .17 National Fire Protection Association (NFPA);
 - .18 Occupational Health and Safety Act (OHSA);
 - .19 Occupational Health and Safety Act - Ontario Regulation 632, "Confined Spaces";
 - .20 Ontario Building Code (OBC);
 - .21 Ontario Electrical Safety Code (OESC);
 - .22 Technical Standards and Safety Authority (TSSA);
 - .23 Telecommunications Industry Association (TIA);
 - .24 Underwriters' Laboratories of Canada (ULC);
 - .25 Material Safety Data Sheets by product manufacturers;
 - .26 local utility inspection permits;
 - .27 codes, standards, and regulations of local governing authorities having jurisdiction;
 - .28 additional codes and standards listed in Trade Sections;
 - .29 Owner's standards.
-
- .4 Provide applicable requirements for barrier free access in accordance with latest edition of local governing building code.
 - .5 Where any governing Code, Regulation, or Standard requires preparation and submission of special details or drawings for review they are to be prepared and submitted to appropriate authorities. Be responsible for costs associated with these submittals.
 - .6 Unless otherwise specified install, equipment in accordance with equipment manufacturer's recommendations and instructions, and requirements of governing Codes, Standards, and Regulations. Governing Codes, Standards, and Regulations take precedence over manufacturer's instructions. Notify Consultant in writing of conflicts between Contract Documents and manufacturer's instructions.
 - .7 Work is to be performed by journeyperson who perform only work that their certificates permit, or by apprentices under direct on site supervision of experienced journeyperson. Journeyperson to apprentice ratio is not to exceed ratio in accordance with requirements of Bill 47, Making Ontario Open for Business Act - 2018.
 - .8 Journeyperson are to have copy of valid trade certificates available at site for review by Consultant at any time.
 - .9 Maintain experienced and qualified superintendent on-site at times when work is being performed.

- .10 Protect existing areas above, below and adjacent areas of Work from any debris, noise, or interruptions to existing services to satisfaction of Owner and reviewed with Consultant. Maintain in operation existing services to these areas to allow Owner to continue use of these areas. If services that are required to be maintained run through areas of renovations, provide necessary protection to services or reroute, in coordination with Owner and review with Consultant. Include for required premium time work to meet these requirements.
- .11 Work being performed within occupied spaces and work affecting surfaces adjacent to occupied spaces may need to be performed after regular business hours. For areas where spaces are used by Owner on a 24 hours basis or over various hours, coordinate hours of work with Owner on a regular basis to suit Owner's schedule. Execute work at times confirmed with and agreed to by Owner and reviewed with Consultant, so as not to inconvenience Owner's occupation or in any way hinder Owner's use of building. Include for required premium timework to meet these requirements.
- .12 Coordinate work inspection reviews and approvals with governing inspection department to ensure construction schedule is not delayed. Be responsible for prompt notification of deficiencies to Consultant and submission of reports and certificates to Consultant.
- .13 Properly protect equipment and materials on site from damage and defacement due to elements and work of trades, to satisfaction of Owner and reviewed with Consultant. Equipment and materials are to be in new condition upon Substantial Performance of the Work.

1.08 HEALTHCARE FACILITY STANDARDS

- .1 Comply with following standards:
 - .1 CSA Z32, Electrical Safety and Essential Systems in Health Care Facilities.
 - .2 CSA Z317.5, Illumination Design in Health Care Facilities.
 - .3 CSA Z317.10, Handling of Health Care Waste Materials.
 - .4 CAN/CSA Z317.13, Infection Control During Construction, Renovation, and Maintenance of Health Care Facilities.
 - .5 CSA Z8000, Canadian Health Care Facilities.
 - .6 CAN/CSA Z8001, Commissioning of Health Care Facilities.
- .2 Prepare list of areas of work where infection control procedures are to be in force and review list and procedures with healthcare facility's Infection Control Officer or a designated healthcare facility representative prior to commencing work in aforementioned areas. As work proceeds, ensure infection control procedures are being maintained.
- .3 Comply with healthcare facility's latest policies and procedures regarding infection prevention and decontamination measures during work of project. Refer to additional requirements of Division 01.

1.09 PERMITS, CERTIFICATES, APPROVALS AND FEES

- .1 Contact and confirm with local authorities having jurisdiction including utility providers, requirements for approvals from such authorities.

- .2 Submit required applications, shop drawings, electrical distribution system protection device coordination studies, and short circuit calculations, and any other information requested by local authority.
- .3 Provide ample notification to authorities having jurisdiction to perform required on-site inspection of work, allowing sufficient lead time to correct deficiencies in a manner that will not impede schedule of completion of Work. If any defect, deficiency or non-compliance is found in work by inspection, be responsible for costs of such inspection, including any related expenses, making good and return to site, until work is passed by governing authorities.
- .4 Obtain, pay for and submit to Consultant, approval/inspection certificates issued by governing authorities to confirm that Work as installed is in accordance with rules and regulations of local governing authorities and are acceptable by such authorities.
- .5 Include in each copy of operating and maintenance instruction manuals, copies of approvals and inspection certificates issued by regulatory authorities.
- .6 Where electromagnetic locks are provided whether by this Division or by others, be responsible for obtaining and paying for required certificates of work with regards to such electromagnetic lock work.

1.10 REQUIREMENTS FOR CONTRACTOR RETAINED ENGINEERS

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

1.11 WORKPLACE SAFETY

- .1 Comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage, and disposal of hazardous materials. Submit WHMIS SDS (Safety Data Sheets) for products where required and maintain one copy at site in a visible and accessible location available to personnel.
- .2 Comply with requirements of Occupational Health and Safety Act and other regulations pertaining to health and safety, including worker's compensation/ insurance board and fall protection regulations. When working in confined spaces, comply with requirements of Occupational Health and Safety Act - Ontario Regulation 632, "Confined Spaces" and any other applicable Ministry of Labour requirements.
- .3 If at any time during course of existing building work, hazardous materials other than those identified in Documents and pertaining to Project Scope of Work, are encountered or suspected that were not identified as being present and which specific instructions in handling of such materials were not given, cease work in area in question and immediately notify Consultant. Comply with local governing regulations with regards to working in areas suspected of containing hazardous materials. Do not resume work in affected area without approval from Owner and review with Consultant.

1.12 PLANNING AND LAYOUT OF WORK

- .1 Base installation layout, design, terminations, and supply of accessories, on Contract Documents with specific coordination with reviewed shop drawings.
- .2 Plan, coordinate, and establish exact locations and routing of services with affected trades prior to installation such that services clear each other as well as other obstructions. Generally, as confirmed prior to start of Work with each trade and with Owner and reviewed with Consultant, to suit specific project requirements, order of right of way for services to be as follows:
 - .1 piping requiring uniform pitch;
 - .2 piping 100 mm (4") dia. and larger;
 - .3 large ducts (main runs);
 - .4 cable tray and bus duct;
 - .5 conduit 100 mm (4") dia. and larger;
 - .6 piping less than 100 mm (4") dia.;
 - .7 smaller branch ductwork;
 - .8 conduit less than 100 mm (4") dia.
- .3 As reviewed with Consultant, Mechanical Contractor is to generally determine final locations of major work within ceiling spaces.
- .4 Unless otherwise shown or specified, conceal work in finished areas, and conceal work in partially finished and/or unfinished areas to extent made possible by the area construction. Install services as high as possible to conserve headroom and/or ceiling space. Notify Consultant where headroom or ceiling space appears to be inadequate prior to installation of work.

- .5 Do not use Contract Drawing measurements for prefabrication and layout of raceways, conduits, ducts, bus ducts, luminaires, and other such work. Locations and routing are to be generally in accordance with Contract Drawings, however, prepare layout drawings for such work. Use established bench marks for both horizontal and vertical measurements. Confirm inverts, coordinate with and make allowances for work of other trades. Accurately layout work and be entirely responsible for work installed in accordance with layout drawings. Where any invert, grade, or size is at variance with Contract Drawings, notify Consultant prior to proceeding with work.
- .6 Prepare plan and interference drawings (at a minimum drawing scale of 1:50 or 1/4"=1' 0") of work for coordination with each trade Contractor. Arrange for preparation of detailed section drawings of ceiling spaces of corridors and any other congested areas. Sections are to be cross referenced with plan drawings so that trades may make use of section drawings. Section drawings to indicate lateral and elevation dimensions of major services within ceiling space. Lateral dimensions are to be from grid lines and elevations from top of floor slab. Obtain from Consultant, engineering drawings for this use. Contractors' interference drawings are to be distributed among other Trade Contractors. Submit drawings to Consultant for review. Failure of General Contractor to prepare and coordinate overall interface drawings of trades does not relieve respective Division Contractor of responsibility to ensure that work is properly planned and coordinated.
- .7 Carry out alterations in arrangement of work that has been installed without proper coordination, study, and review, even if in accordance with Contract Documents, in order to conceal work behind finishes, or to allow installation of other work, without additional cost. In addition, make necessary alterations in other work required by such alterations, without additional cost.
- .8 Locate control products, products requiring maintenance, junction boxes, and similar products, particularly such products located above suspended ceilings, for easy access for servicing and/or removal. Relocate products which do not meet this location requirement to accessible location, at no additional cost.
- .9 Be responsible for making necessary changes, at no additional cost, to accommodate structural and building conditions that were missed due to lack of coordination.
- .10 Where drawings indicate that acoustic tile ceiling is being suspended below structural ceiling, coordinate design of framework used to support suspended ceiling, lighting, diffusers, and other Divisions components that are mounted within or through ceiling. Do not mount devices to suspended ceiling. Secure and mount to ceiling slab above. Seal ceiling openings to maintain required fire rating.

1.13 PHASING

- .1 Phasing and scheduling of Work is required to maintain existing building operations. Include costs (including costs for "off hours" work) for scheduling, co-ordination, and construction phasing to suit this project as specified in Division 01 and on drawings. Review exact phasing requirements with Consultant prior to start of Work.
- .2 Project partial occupancy permits to be required throughout project. Provide for each partial permit, local governing authority certificate and any other testing/verification certificates for systems.

1.14 COORDINATION OF WORK

- .1 Review Contract Documents and coordinate work with work of each trade. Coordination requirements are to include, but not be limited to following:
 - .1 requirements for openings, sleeves, inserts and other hardware necessary for installation of work;
 - .2 concrete work such as housekeeping pads, sumps, bases, etc., required for work, and including required dimensions, operating weight of equipment, location, etc.;
 - .3 depth and routing of excavation required for work, and requirements for bedding and backfill;
 - .4 wiring work required for equipment and systems but not specified to be done as part of mechanical work, including termination points, wiring type and size, and any other requirements.
- .2 Ensure materials and equipment are delivered to site at proper time and in such assemblies and sizes so as to enter into building and be moved into spaces where they are to be located without difficulty.
- .3 Wherever possible, coordinate equipment deliveries with manufacturers and/or suppliers so equipment is delivered to site when it is required, or so it can be stored within building subject to available space as confirmed with Owner and reviewed with Consultant and protected from elements.
- .4 Ensure proper access and service clearances are maintained around equipment, and, where applicable, access space for future equipment removal or replacement is not impeded. Comply with code requirements with regards to access space provision around equipment. In coordination with Owner and review with Consultant, relocate equipment which does not meet this requirement.
- .5 Where work is to be integrated or is to be installed in close proximity with work of other trades, coordinate work prior to and during installation.

1.15 COMPONENT FINAL LOCATIONS

- .1 Owner and Consultant reserve right to relocate electrical components such as receptacles, switches, communication system, outlets, hard wired outlet boxes and luminaries later, but prior to installation, without additional cost to Owner, if relocation per components do not exceed 3 m (10') from original location. No credits will be anticipated where relocation per components of up to and including 3 m (10') reduces materials, products and labour. Should relocations exceed 3 m (10') from original location, adjust contract price for that portion beyond 3 m (10') in accordance with provisions for changes in Contract Documents.

1.16 SYSTEMS COORDINATION

- .1 Be responsible for and perform specific coordination of various low voltage systems supplied by Electrical Divisions and also with systems supplied by other Divisions of Work. Include for but not be limited to provision of following, as applicable:
 - .1 coordinate with General Contractor and other Subcontractors, various systems of trades which in any way are interfaced with or monitored by or integrated to, or need to be coordinated with;

- .2 prepare systems coordination drawings detailing related system coordination and integration points being monitored and/or controlled; submit coordination drawings as part of shop drawing submission;
- .3 coordinate security system requirements with successful door hardware supplier and prepare detailed coordination drawings of component installations, wiring and conduit layouts, division of responsibility between various trades, etc.; review security system requirements with associated door hardware (electromagnetic locks, electric strikes, etc.), to ensure proper sequence of operation and door functionality is provided to suit each door configuration; prepare detailed door functionality of each door configuration and submit to and review with Consultant;
- .4 review systems requirements for component back boxes and conduits; ensure that system of conduits and boxes meet respective system wiring bending radii requirements;
- .5 review specifications of each trade/Division (i.e. for BAS points, elevator requirements, electrical devices in millwork or prefabricated service consoles, outlet box and back box requirements), to ensure proper power supplies, interconnecting wiring requirements and back box/ outlet box requirements;
- .6 review with manufacturers coordination and integration requirements of their systems;
- .7 review each systems communication protocols to ensure they are compatible and can communicate with each other as required;
- .8 review system shop drawings prior to submission to Consultant, to verify that each system has been coordinated with other systems and that required options and features are selected to meet coordination requirements;
- .9 be present at testing and commissioning functions of each system and provide technical assistance with regards to system operations;
- .10 be "on-site" coordinator of respective system trades with regards to respective system coordination of installation and testing;
- .11 coordinate with various trades and equipment vendors and review with Consultant with regards to ensuring that systems coordinate and integrate properly to meet intent of design and Owner requirements;
- .12 document coordination and integration requirements and maintain records for submission as part of shop drawings;
- .13 respond to coordination and integration requirements and be responsible for such work;
- .14 where a system integrator has been included for, coordinate integration requirements with system integrator.

1.17 PRODUCTS

- .1 Order products (equipment and materials) in a timely manner to meet project-scheduling timelines. Failure to order products to allow manufacturers sufficient production/delivery time to meet project-scheduling timelines is an unacceptable reason to request for use of other suppliers or substitutions.
- .2 Provide Canadian manufactured products wherever possible or required and when quality and performance is obtainable at a competitive price. Products are to be supplied from manufacturer's authorized Canadian representative, unless otherwise noted. Unless otherwise specified, products are to be new.
- .3 Products are to comply with applicable respective Canadian standards, and typically with Canadian Standards Association (CSA) approvals and/or Underwriters Laboratories of Canada (ULC) listings markings. References to UL listings of products to include requirements that products are to be also Underwriters Laboratories of Canada ULC / cUL listed for use in Canada. Other certification organizations accredited by Standards Council of Canada to approve electrical equipment may be acceptable subject to approval from local governing electrical authority and review with Consultant. Applicable products are to meet or exceed latest ANSI/ASHRAE/IES 90.1 standards enforced by local governing authorities.
- .4 Systems and equipment of this Project are to be "State of the Art" and be most recent and up to date series/version of product that is available at time of shop drawing review process. Products that have been stored or "on shelf" for extended period will not be accepted. Software is to be of latest version available and be provided with updates available at time of shop drawing review process. Systems are to be designed such that its software is backwards compatible. Future upgrades are not to require any hardware replacements or additions to utilize latest software.
- .5 Products scheduled and/or specified have been selected to establish a performance and quality standard, and, in some instances, a dimensional standard. In many cases acceptable product manufacturers are specified for products with manufacturer name, series name and/or and model number. Bid Price may be based on products supplied by any of manufacturers base specified or named as acceptable for product. If acceptable manufacturers are not stated for a product, base Bid Price on product supplied by base specified manufacturer.
- .6 Documents have been prepared based on product available at time of Bidding. If, after award of Contract, and if successful manufacturer can no longer supply a product that meets base specifications, notify Consultant immediately. Be responsible for obtaining other manufacturers product that complies with base specified performance and criteria and meets project timelines. Proposed products are subject to review and consideration by Consultant and are considered as substitutions subject to a credit to Contract. In addition, if such products require modifications to room spaces, mechanical systems, electrical systems, etc., include required changes. Such changes are to be submitted in detail to Consultant for review and consideration for acceptance. There will be no increase in Contract Price for revisions. Above conditions supplement and are not to supersede any specification conditions in Division 01 with regards to substitutions or failure to supply product.
- .7 Listing of a product as "acceptable" does not imply automatic acceptance by Consultant and/or Owner. It is responsibility of Contractor to ensure that any price quotations received, and submittals made are for products that meet or exceed specifications included herein.

- .8 If products supplied by a manufacturer named as acceptable are used in lieu of base specified manufacturer, be responsible for ensuring that they are equivalent in performance and operating characteristics (including energy consumption if applicable) to base specified products. It is understood that any additional costs (i.e. for larger starters, larger feeders, additional spaces, etc.), and changes to associated or adjacent work resulting from provision of product supplied by a manufacturer other than base specified manufacturer, is included in Bid Price. In addition, in equipment spaces where equipment named as acceptable is used in lieu of base specified equipment and dimensions of such equipment differs from base specified equipment, prepare and submit for review accurately dimensioned layouts of rooms affected, identifying architectural and structural elements, systems and equipment to prove that equipment in room will fit properly meeting design intent. There will be no increase in Contract Price for revisions.
- .9 Where products are listed as "or approved equal", certify in writing that product to be used in lieu of base specified product, at least meets space, power, design, energy consumption, and other requirements of base specified product and is equivalent or better than base specified product. When requested by Consultant, provide full design detail drawings and specifications of proposed products. Acceptance of these "or approved equal" products is at sole discretion of Consultant. It is understood that there will be no increase in Contract Price by reason of any changes to associated equipment, mechanically, electrically, structurally or architecturally, required by acceptance of approved equal product. There must be no increase in Contract price due to Consultant's rejection of proposed equivalent product.
- .10 Whenever use of product other than base specified product is being supplied, ensure corresponding certifications and product information (detailed catalogue and engineering data, fabrication information and performance characteristics) are submitted to Consultant for review. Failure of submission of these documents to Consultant in a timely manner to allow for review will result in base specified product to be supplied at Consultant's discretion, at no additional cost to Contract.
- .11 In addition to manufacturer's products base specified or named as acceptable, other manufacturers of products may be proposed as substitutions to Consultant for review and consideration for acceptance, listing in each case a corresponding credit for each substitution proposed. However, base Bid Price on products base specified or named as acceptable. Certify in writing to Consultant that proposed substitution meets space, power, design, energy consumption, and other requirements of base specified or acceptable product. It is understood that there will be no increase in Contract Price by reason of any changes to associated equipment, mechanically, electrically, structurally or architecturally, required by acceptance of proposed substitution. Consultant has sole discretion in accepting any such proposed substitution of product. Do not order such products until they are approved by Owner, and reviewed with and recommended by Consultant.
- .12 Substitutions will not be considered by Consultant during Bid period unless:
 - .1 permitted by Owner;
 - .2 directions and submission areas are provided on Bid Form;
 - .3 or formally requested in writing a minimum of 10 working days prior to Bid closing date.

- .13 When issued with Documents, complete and submit as directed, Appendix - List of Acceptable Manufacturers and Suppliers, or when directed by Consultant submit separate list of proposed manufacturers and suppliers.
- .14 Any proposed changes to list of manufacturers initiated by Contractor after award of Contract may be considered by Consultant at Consultant's discretion, with any additional costs for such changes if approved by Owner and reviewed with and recommended by Consultant, and costs for review, to be borne by Contractor.
- .15 Whenever use of product other than based specified products or named as acceptable is being supplied, allow sufficient time for processing of product submissions and time for Consultant's review, such that there will not be significant impact on contract time or work schedule.
- .16 Requirements for low voltage systems of this project that are of technology that changes rapidly and are forever evolving and changing, resulting in systems that may be out dated by time of installation, are to include provisions to allow Owner option to select most updated technology. Shop drawings for such systems and equipment are to include provisions for a minimum 6-week review time for Owner to review degree of technology of each system and determine acceptance. Owner will have right to substitute a more advanced technology subject to negotiated pricing.

1.18 SHOP DRAWINGS

- .1 At start-up meeting review with Consultant, products to be included in shop drawing submission. Prepare and submit list of products to Consultant for review.
- .2 Submit electronic copies of shop drawings unless otherwise directed by Owner or reviewed with Consultant. Review exact requirements with Consultant.
- .3 Submit for review, drawings showing in detail design, construction, and performance of equipment and materials as requested in Specification. Submit shop drawings to Consultant for review prior to ordering and delivery of product to site. Include minimally for preparation and submission of following, as applicable:
 - .1 product literature cuts;
 - .2 equipment data sheets;
 - .3 equipment dimension drawings;
 - .4 system block diagrams;
 - .5 sequence of operation;
 - .6 connection wiring schematic diagrams;
 - .7 functionality with integrated systems.
- .4 Each shop drawing or product data sheet is to be properly identified with project name and product drawing or specification reference. Shop drawing or product data sheet dimensions are to match dimension type on drawings.

- .5 Where any item of equipment is required by Code or Standard or By-Law to meet a specific energy efficiency level, or any other specific requirement, ensure this requirement is clearly indicated on submission.
- .6 Ensure proposed products meet each requirement of Project. Endorse each shop drawing copy "CERTIFIED TO BE IN ACCORDANCE WITH ALL REQUIREMENTS". Include company name, submittal date, and sign each copy. Shop drawings that are received and are not endorsed, dated and signed will be returned to be resubmitted.
- .7 Consultant to review shop drawings and indicate review status by stamping shop drawing copies as follows:
 - .1 "REVIEWED" or "REVIEWED AS NOTED" (appropriately marked) – If Consultant's review of shop drawing is final, Consultant to stamp shop drawing;
 - .2 "REVISE & RESUBMIT" – If Consultant's review of shop drawing is not final, Consultant to stamp shop drawing as stated above, mark submission with comments, and return submission. Revise shop drawing in accordance with Consultant's notations and resubmit.
- .8 Following is to be read in conjunction with wording on Consultant's shop drawing review stamp applied to each and every shop drawing submitted:

"THIS REVIEW BY CONSULTANT IS FOR SOLE PURPOSE OF ASCERTAINING CONFORMANCE WITH GENERAL DESIGN CONCEPT. THIS REVIEW DOES NOT MEAN THAT CONSULTANT APPROVES DETAILED DESIGN INHERENT IN SHOP DRAWINGS, RESPONSIBILITY FOR WHICH REMAINS WITH CONTRACTOR. CONSULTANT'S REVIEW DOES NOT RELIEVE CONTRACTOR OF RESPONSIBILITY FOR ERRORS OR OMISSIONS IN SHOP DRAWINGS OR OF CONTRACTOR'S RESPONSIBILITY FOR MEETING REQUIREMENTS OF CONTRACT DOCUMENTS. BE RESPONSIBLE FOR DIMENSIONS TO BE CONFIRMED AND CORRELATED AT JOB SITE, FOR INFORMATION THAT PERTAINS SOLELY TO FABRICATION PROCESSES OR TO TECHNIQUES OF CONSTRUCTION AND INSTALLATION, AND FOR CO-ORDINATION OF WORK OF SUB-TRADES."
- .9 Submit each system and each major component as separate shop drawing submissions. Submit together, shop drawings for common devices such as devices of each system.
- .10 Obtain shop drawings for submission from product manufacturer's authorized representatives and supplemented with additional items specified herein.
- .11 Do not order product until respective shop drawing review process has been properly reviewed with Consultant.
- .12 Where extended warranties are specified for equipment items, submit specified extended warranty with shop drawing submittal.
- .13 Refer to specific requirements in other Sections.

1.19 ENGINEERED SUBMITTALS

- .1 Submittals for items required to be sealed by a professional engineer (engineered) are to be duly prepared, sealed, and signed under direct control and supervision of a qualified professional engineer licensed in jurisdiction of the work. Professional engineer is to conform to requirements specified in this Section in article entitled Requirements for Contractor Retained Engineers.
- .2 Engineered submittals are to include, but not be limited to, following:
 - .1 complete CAD layout drawings indicating equipment, wiring schematic, conduit routing and sizing, zones, devices, and any other pertinent data;
 - .2 listing of design data used to determine system layout and sizing;
 - .3 complete copies of design calculations and listing of design data used in preparing calculations;
 - .4 list detailing standards, codes, regulations, etc. adhered to when designing system;
 - .5 items as noted in other Sections of the Specification.
- .3 Professional engineer responsible for engineered submittals is to perform periodic field reviews, including review of associated mock-ups where applicable, at locations wherever work as described by engineered submittal is in progress, during fabrication and installation of such work, and submit a field review report after each visit. Submit field review reports to Consultant and authorities having jurisdiction as required.
- .4 Field reviews are to be at intervals as necessary and appropriate to progress of work described by engineered submittal to allow engineer to be familiar with progress and quality of such work and to determine if work is proceeding in general conformity with Contract Documents including reviewed shop drawings and design calculations.
- .5 Upon completion of work as described by engineered submittal, professional engineer responsible for preparation of engineered submittal and for performing periodic field reviews is to prepare and submit to Consultant and, if applicable, authorities having jurisdiction, a letter certifying that work has been supplied and installed in accordance with requirements of Contract Documents, authorities having jurisdiction and engineered submittal.

1.20 EQUIPMENT LOADS

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

1.21 OPENINGS

- .1 Supply opening sizes and locations to Consultant to allow verification of their effect on design, and for inclusion on structural drawings where appropriate.

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

1.22 SCAFFOLDING, HOISTING, AND RIGGING

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

1.23 REQUEST FOR INFORMATION (RFI)

- .1 Review contract documents for information prior to issuance of RFI during performance of Work. Where it is determined, at discretion of Owner and Consultant, that information requested in RFI was readily identifiable as part of contract documents, respective trades Contractor to be back-charged against their contract amount for time spent by Consultant and/or Owner in preparing response to RFI. Minimum amount of \$150 CDN plus GST to be back charged against contract amount for any response to a readily identifiable RFI.

1.24 CHANGES IN THE WORK

- .1 Whenever Consultant proposes in writing to make a change or revision to design, arrangement, quantity, or type of any work from that required by Contract Documents, prepare and submit to Consultant for review, a quotation detailing proposed cost for executing change or revision.
- .2 Quotation to be a detailed and itemized estimate of product, labour, and equipment costs associated with change or revision, plus overhead and profit percentages and applicable taxes and duties.
- .3 If overhead and profit percentages are not specified in Division 00 or 01, but allowable under Contract as reviewed with Consultant prior to contract signing, then allowable maximum percentages for overhead and profit are to be 5% for each.
- .4 Unless otherwise specified in Divisions 00 or 01, following additional requirements apply to quotations submitted:

- .1 when change or revision involves deleted work as well as additional work, cost of deleted work (less overhead and profit percentages but including taxes and duties) is to be subtracted from cost of additional work before overhead and profit percentages are applied to additional work;
 - .2 material costs are not to exceed those published in local estimating price guides; for mechanical work material costs, refer to additional requirements of Section 20 05 05;
 - .3 electrical labour unit costs are to be in accordance with National Electrical Contractors Association Manual of Labor Units at difficult level, less 25%;
 - .4 mechanical labour unit costs are to be in accordance with Mechanical Contractors Association of America Labor Estimating Manual, less 25%;
 - .5 costs for journey person and apprentice labour must not exceed prevailing rates at time of execution of Contract and must reflect actual personnel performing work;
 - .6 cost for site superintendent must not exceed 10% of total hours of labour estimated for change or revision, and change or revision must be such that site superintendent's involvement is necessary;
 - .7 costs for rental tools and/or equipment are not to exceed local rental costs;
 - .8 overhead percentage will be deemed to cover quotation costs other than actual site labour and materials, and rentals;
 - .9 quotations, including those for deleted work, to include a figure for any required change to Contract time.
- .5 Quotations submitted that are not in accordance with requirements specified above will be rejected and returned for re-submittal. Failure to submit a proper quotation to enable Consultant to expeditiously process quotation and issue a Change Order will not be grounds for any additional change to Contract time.
 - .6 Make requests for changes or revisions to work in writing to Consultant and, if accepted by Owner, Notice of Change to be issued.
 - .7 Do not execute any change or revision until written authorization for change or revision has been obtained from Owner and reviewed with Consultant.

1.25 PROGRESS PAYMENT BREAKDOWN

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

1.26 NOTICE FOR REQUIRED FIELD REVIEWS

- .1 Whenever there is a requirement for Consultant to perform a field review prior to concealment of any work, to inspect/re-inspect work for deficiencies prior to Substantial Performance of the Work, for commissioning demonstrations, and any other such field review, give minimum 7 working days' notice in writing to Consultant.
- .2 If Consultant is unable to attend a field review when requested, arrange an alternative date and time.
- .3 Do not conceal work until Consultant advises that it may be concealed.
- .4 When Consultant is requested to perform a field review and work is not ready to be reviewed, reimburse Consultant for time and travel expenses.

1.27 PRELIMINARY TESTING

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

1.28 PROVISIONS FOR SYSTEMS/EQUIPMENT USED DURING CONSTRUCTION

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

1.29 TEMPORARY SERVICES

- .1 Coordinate with Prime Contractor, requirements for temporary services including but not limited to temporary electrical power, lighting, heating and exit pathways. Locations of exit pathways to be as decided at discretion of Prime Contractor and to be illuminated complete with emergency lighting and provided with exit signage and fire alarm devices. Unless otherwise noted, provide required services in accordance with requirements of local governing building code and local governing inspection authorities.
- .2 Maintain fire protection of areas which may include fire watch during temporary shutdowns of existing systems, in accordance with requirements of local governing code and local governing authorities.

1.30 CLEANING

- .1 During construction, keep site reasonably clear of rubbish and waste material resulting from work on a daily basis to the satisfaction of Owner and Consultant. Before applying for a Certificate of Substantial Performance of the Work, remove rubbish and debris, and be responsible for repair of any damage caused as a result of work.
- .2 At time of final cleaning, clean luminaire reflectors, lenses, and other luminary surfaces that have been exposed to construction dust and dirt, including top surface, whether it is exposed or in ceiling space.
- .3 Clean switches, receptacles, communications outlets, coverplates, and exposed surfaces.
- .4 Clean other electrical equipment and devices installed as part of this project.
- .5 For work performed in electrical equipment rooms, electrical closets and communication closets, perform following:
 - .1 HEPA vacuum top of switchboards, panels, cabinets, bus ducts, cable trays and conduits in room, followed by a thorough HEPA vacuuming of floors;
 - .2 do not lay permanent switchboard matting in electrical rooms until rooms are re-cleaned, and floors wet mopped and dried just prior to final turn over to Owner.

1.31 RECORD AS-BUILT DRAWINGS

- .1 Drawings for this project have been prepared on a CAD system using AutoCAD software of release version reviewed with Consultant. For purpose of producing record "as built" drawings, copies of Contract Drawings can be obtained from Consultant. Drawings may also to be used for preparation of layouts and interference drawings.
- .2 As work progresses at site, clearly mark in red in a neat and legible manner on a set of bound white prints of Contract Drawings, changes and deviations from routing of services and locations of equipment shown on Contract Drawings, on a daily basis. Changes and deviations include those made by addenda, change orders, and site instructions. Use notes marked in red as required. Maintain white print red line as-built set at site for exclusive use of recording as-built conditions, keep set up-to-date, and ensure set is available for periodic review. As-built set is also to include following:
 - .1 dimensioned location of inaccessible concealed work;
 - .2 locations of control devices with identification for each;

- .3 location and identification of devices in concealed locations such as accessible ceiling spaces and raised floors;
 - .4 location of concealed services terminated for future extension and work concealed within building in inaccessible locations.
 - .5 location of fire alarm devices and include addresses of devices; identify fire alarm zones;
 - .6 identify routing and location of concealed conduits/ducts of diameter 50 mm (2") and greater.
-
- .3 Before applying for a Certificate of Substantial Performance of the Work, update a clean copy of Contract Drawing set in accordance with marked up set of "as-built" white prints including deviations from original Contract Drawings, thus forming an "as-built" drawing set. Submit "as-built" site drawing prints to Consultant for review. Make necessary revisions to drawings as per Consultant's comments, to satisfaction of Consultant.
 - .4 Use final reviewed "as-built" drawing set to provide CAD files of drawings thus forming true "as-built" set of Contract Drawings. Identify set as "Project Record Copy". Load digital copies of final reviewed by Consultant as-built drawings onto USB type flash drive. Provide 2 complete sets of "as-built" drawings on separate USBs. Submit "as-built" sets of white prints and USBs to Consultant. Save drawings as AutoCAD files and in pdf format and such that each drawing is not x-referenced but as complete drawing.
 - .5 Submitted drawings are to be of same quality as original Contract Drawings. CAD drawing files are to be compatible with software release version reviewed with Consultant.
 - .6 Unless otherwise noted in Divisions 00 or 01, failure to maintain accurate record drawings will incur additional 5% holdback on progress claims until drawings are brought up to date to satisfaction of Owner and reviewed with Consultant.
 - .7 For projects with phased turnover of project (refer to Division 01), review with Consultant completeness of as-built drawings prior to turn over of an area. Copies of hand drawn interim as-built drawings to be made available to Owner's maintenance personnel.
 - .8 Include on single lines, panelboard locations identified by room numbers below panel. When specific identified location is not available, nearest available room number to be used followed by a (Δ) triangle to flag approximate location. Encircle various loads by Building Wings (where applicable) for ease of identification. Group lighting loads on panelboards on top of panel. Identify motor control centres and splitters similar to panelboards. Identify fuse sizing including existing equipment where there is no difficulty in obtaining information. Use these requirements for pricing and review exact requirements with Consultant prior to commencing work.
 - .9 Replace existing posted single line electrical distribution drawings with revised to reflect renovations and revisions to electrical distribution equipment. Drawings to be of type to match existing as confirmed with Owner. Supply electronic files of format confirmed with Owner and reviewed with Consultant for following:
 - .1 fire alarm system test report devices and addresses;
 - .2 network cabling system test report devices and labelling of each device and cable.

1.32 OPERATING AND MAINTENANCE MANUALS

- .1 For each item of equipment for which a shop drawing is required (except for simple equipment), supply minimum 3, project specific, indexed copies of equipment manufacturers' operating and maintenance (O & M) instruction data manuals. Review exact quantity of manuals with Consultant. Consolidate each copy of data in an identified hard cover three "D" ring binder. Each binder to include:
 - .1 front cover: project name label; wording – "Electrical Systems Operating and Maintenance Manual"; and date;
 - .2 introduction sheet listing Consultant, Contractor, and Subcontractor names, street addresses, telephone and fax numbers, and e-mail addresses;
 - .3 equipment manufacturer's authorized contact person name, telephone number and company website;
 - .4 Table of Contents sheet, and corresponding index tab sheets;
 - .5 copy of each "REVIEWED" or clean, updated "REVIEWED AS NOTED" shop drawing or product data sheet, with manufacturer's/supplier's name, telephone and fax numbers, email address, company website address, and email address for local source of parts and service; when shop drawings are returned marked "REVIEWED AS NOTED" with revisions marked on shop drawing copies, they are to be revised by equipment supplier to incorporate comments marked on "reviewed" shop drawings and a clean updated copy is to be included in operating and maintenance manuals;
 - .6 maintenance data as follows:
 - .1 operation and trouble-shooting instructions for each item of equipment and each system;
 - .2 schedules of tasks, frequency, tools required, and estimated task time;
 - .3 recommended maintenance practices and precautions including warnings of any maintenance practice that will damage or disfigure equipment/systems;
 - .4 complete parts lists with numbers.
 - .7 performance data as follows:
 - .1 equipment and system start-up data sheets;
 - .2 equipment test reports;
 - .3 final verification and commissioning reports.
 - .8 explanation of operating principles and sequences;
 - .9 inspection certificates issued by regulatory authorities;
 - .10 wiring and connection diagrams;
 - .11 copies of additional and revised panelboard directories;

- .12 warranties;
- .13 items requested specifically in Section Articles.
- .2 Generally, binders are not to exceed 75 mm (3") thick and not to be more than 2/3 full.
- .3 Operating and maintenance instructions are to relate to job specific equipment supplied under this project and related to Owner's building. Language used in manuals is to contain simple practical operating terms and language easy for in-house maintenance staff to understand how to operate and maintain each system.
- .4 Before applying for a Certificate of Substantial Performance of the Work, assemble one draft copy of O & M Manual and submit to Consultant for review prior to assembling remaining copies. Incorporate Consultant's comments into final submission.
- .5 Provide 2 digital copies of contents of operating and maintenance manuals and load onto separate USB type flash drives and submit to Consultant. Prepare digital copies using version of Adobe Acrobat Portable Document Format or equal as reviewed with Consultant and enhanced with bookmarks and internal document links.

1.33 COMMISSIONING

- .1 Commissioning Agent is appointed by Owner to oversee commissioning activities of contract.
- .2 Interface, cooperate and coordinate with Commissioning Agent and attend commissioning meetings. Perform commissioning activities for aspects of work provided in Electrical Divisions and perform corrective work identified by Commissioning Agent.
- .3 After successful start-up and prior to Substantial Performance of the Work, commission electrical work. Demonstrate to Owner and Consultant, for purpose of final acceptance, by means of successful and documented functional performance testing, that equipment, systems and/or subsystems are capable of being operated and maintained to perform in accordance with requirements of Contract Documents.
- .4 Verify modes and sequences of control and monitoring, interlocks, and responses to emergency conditions. Complete commissioning data sheets to document successful operational performance testing.
- .5 Submit copies of submittals such as O & M manuals, shop drawings, schedules and test reports of systems and equipment to Commissioning Agent, prior to start of commissioning activity or as directed by Commissioning Agent.
- .6 Commissioning Agent may also be present for any testing/commissioning activities. Notify Commissioning Agent in advance of these activities.
- .7 Refer to Division 01 for additional commissioning requirements. Refer to Section entitled Electrical Work Commissioning for additional requirements.
- .8 Where commissioning specifications are included as part of Division 01, requirements of Section entitled Electrical Work Commissioning are to supplement commissioning requirements of Division 01. Where variances or contradictions exist, more stringent requirement will apply unless otherwise directed by Owner and reviewed with Consultant.

1.34 PROJECT CLOSE OUT SUBMITTALS

- .1 Prior to application for Substantial Performance of the Work, submit required items and documentation specified, including following:
 - .1 O&M Manuals;
 - .2 as-built record drawings and associated data;
 - .3 extended warranties for equipment as specified;
 - .4 operating test certificates;
 - .5 final commissioning report;
 - .6 identified keys for equipment and/or panels for which keys are required, and other items required to be submitted;
 - .7 other data or products specified;
- .2 Refer to additional requirements in Division 01.

1.35 INSTRUCTIONS TO OWNER

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

- .5 Before instructing Owner's designated personnel, submit to Consultant for review preliminary copy of training manual and proposed schedule of demonstration and training dates and times. Incorporate Consultant's comments in final copy.
- .6 Obtain in writing from Consultant, list of Owner's representatives to receive instructions. Submit to Consultant prior to application for Certificate of Substantial Performance of the Work, complete list of systems for which instructions were given, stating for each system:
 - .1 date instructions were given to Owner's staff;
 - .2 duration of instruction;
 - .3 names of persons instructed;
 - .4 other parties present (manufacturer's representative, consultants, etc.).
- .7 Obtain signatures of Owner's staff to verify they properly understood system installation, operation and maintenance requirements, and have received operating and maintenance instruction manuals and "as-built" record drawings.
- .8 Submit to Consultant copy of electronic version of training materials loaded on USB flash drive. Include in operating and maintenance manuals submission.
- .9 Provide a flash drive (USB) with recording of operating and instructions training for following systems:
 - .1 fire alarm system;
 - .2 security systems;
 - .3 nurse call system;
 - .4 lighting control and dimming systems;
 - .5 other systems as specifically noted in trades sections.
- .10 Provide custom video on USB format that details on site systems and equipment operations and includes following:
 - .1 professional videographer on site to capture training session; use wireless lavalier microphone to capture crystal clear audio of trainer in association with video footage; edit video to remove unnecessary footage;
 - .2 custom site-specific system/equipment screens that outline key information about system/equipment and devices used on site only;
 - .3 custom site-specific video that details programming procedures in conjunction with a voiceover from on-site technician;
 - .4 USB created with a main menu screen and authored with chapters to allow operator to access specific areas of training instantly.
- .11 Supply such information loaded and submitted on USB flash drives.

1.36 FINAL INSPECTION

- .1 Submit to Consultant, written request for final inspection of systems. Include written certification that:
 - .1 deficiencies noted during job inspections have been completed;
 - .2 field quality control procedures have been completed;
 - .3 maintenance and operating data have been completed and submitted to, reviewed with Consultant and accepted by Owner;
 - .4 tags and nameplates are in place and equipment identifications have been completed;
 - .5 clean-up is complete;
 - .6 spare parts and replacement parts specified have been provided, as confirmed by Owner and reviewed with Consultant;
 - .7 as-built and record drawings have been completed and submitted to and reviewed with Consultant and accepted by Owner;
 - .8 Owner's staff has been instructed in operation and maintenance of systems;
 - .9 commissioning procedures have been completed;
 - .10 fire alarm verification has been 100% completed and Verification Certificate has been submitted to and accepted by Consultant.

2 PRODUCTS

2.01 NOT USED.

3 EXECUTION

3.01 NOT USED.

END OF SECTION

1 GENERAL

1.01 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section of Electrical Divisions and is to be read accordingly.
- .2 Be responsible for advising product vendors of requirements of this Section.

1.02 SUBMITTALS

- .1 Submit shop drawings for products of this Section.
- .2 Additionally, as part of shop drawing submission process, submit following to Consultant for review:
 - .1 samples of materials and any other items as specified in succeeding Sections of Electrical Divisions;
 - .2 weight loads of selected equipment (upon request);
 - .3 equipment nameplate and warning sign proposed nomenclature, print type, symbols, sizing and colours;
 - .4 fire stopping installation drawings with ULC certifications;
 - .5 copies of prior to start of construction approvals from local governing authorities having jurisdiction.
- .3 Prior to application for Substantial Performance of the Work, submit following to Consultant for review (note: funds will be withheld until each of following items have been completed and documented to satisfaction of Owner and reviewed with Consultant):
 - .1 fire alarm system testing and verification report of each component of work; devices to be certified working and in proper order;
 - .2 final distribution system testing and arc flash study performed and documented to satisfaction of Consultant;
 - .3 structured network cabling system tested and verified to be operating and performing in accordance with specified standards.

1.03 PATIENT CARE AREAS

- .1 Comply with requirements for patient care areas (PCA) included in Work as required by Section 24 of OESC. Patient care areas are identified on drawings. Review final PCA nomenclature with Consultant prior to start of Work.
- .2 Note that room and area names/numbers are based on information available at time of preparation of documents and such names/numbers may be revised in later documents or during construction of Work. In no way are patient care area classifications to be reduced due to name/number revisions. Confirm exact classifications as per local governing electrical code requirements to suit final construction and any design changes made by Consultant.

- .3 Provide testing and verification of circuits and devices to confirm compliance with OESC.
- 1.04 PRODUCT REQUIREMENTS IN SPECIAL AREAS**
- .1 Provide certain areas such as Mental Health Areas and children care areas with special provisions such that intended users of area are not exposed to or subject to hazards from supplied products. In non-climate-controlled areas, supplied products are to be manufactured for use in such environments.
 - .2 Provide tamper-proof and vandal/impact resistant receptacles, switches or any communication devices in Mental Health Areas. Such provisions include but are not limited to providing tamperproof screws, polycarbonate covers, or locating such controls out of these areas, as approved by Consultant.
 - .3 Products in non-climate-controlled areas are to include weatherproof provisions such as gasketed covers, corrosion resistant hardware, weatherproof finishes, etc. Devices to be manufactured to operate in extreme temperatures.
 - .4 Products in public areas such as exterior areas and in parking areas are to also be vandal-proof and impact resistant.

2 PRODUCTS

2.01 CONDUITS

- .1 EMT (Thinwall), galvanized electrical metallic tubing to CSA C22.2 No. 83, complete with factory made bends where site bending is not possible and joints and terminations made with steel couplers and steel set screw type connectors with insulated throats, and concrete tight where required by local governing codes. Provide raintight type fittings where EMT is exposed to water spray of activated sprinklers.
- .2 Rigid galvanized steel to CSA C22.2 No. 45, with exterior zinc and interior enamel coatings, galvanized threads where factory cut and red lead coated threads where site cut. Factory made bends where site bending is not possible, factory made and threaded fittings, and connectors, and terminations with rigid couplings, and concrete tight where required.
- .3 Hot dipped zinc galvanized steel core, flexible liquid tight metallic conduit to CSA C22.2 No. 56, with flame retardant PVC jacket, complete with terminations consisting of ULC listed, suitable for wet locations, gasketed, steel or iron construction, liquid-tight flexible conduit connectors at terminations.
- .4 CSA approved and labelled, FT-4 rated, rigid plastic (PVC) conduit complete with site made heat gun bends on conduit to 50 mm (2") diameter, factory made elbows in conduit larger than 50 mm (2") diameter, solvent weld joints, factory made expansion joints where required, and terminations made with proper and suitable connectors and adaptors.

2.02 OUTLET BOXES

- .1 CSA approved stamped galvanized steel outlet boxes.
- .2 CSA certified rigid plastic (PVC) outlet boxes.

- .3 Each outlet box and back box to be suitable in respects for application and complete with suitable securing lugs, connectors suitable for connected conduit, knockouts and, where necessary, suitable plaster rings, concrete rings, covers, carpet flanges and any other required accessory.

2.03 PULLBOXES AND JUNCTION BOXES

- .1 Galvanized or prime coat plated steel, suitable in respects for application and complete with screw-on or hinged covers as required, and connectors suitable for connected conduit.
- .2 Eaton Crouse-Hinds, "Condulet", threaded cast Feraloy outlet boxes of an exact type to suit application, each complete with screw-on gasketed cover.
- .3 Physical size of pullboxes to be as required by local governing electrical code to suit number and size of conduits and conductors.
- .4 Each box to be suitable in respects for application and complete with suitable securing lugs, connectors suitable for connected conduit, knockouts and, where necessary, suitable plaster rings, concrete rings, covers and any other required accessory.
- .5 Boxes exposed exterior of building or in non-climate-controlled locations to be weatherproof boxes complete with gasketed covers.

2.04 SLEEVES

- .1 Galvanized steel sleeves as follows:
 - .1 No. 24 gauge with an integral flange at one (1) end to secure sleeve to formwork construction;
 - .2 Schedule 40 pipe.
- .2 Schedule 40 PVC sleeves.

2.05 FASTENING AND SECURING HARDWARE

- .1 Concrete inserts - Crane Canada Ltd., No. 4-M for concrete work for single or double conduit, cable tray, etc., runs and equipment. Unistrut Ltd. multiple type inserts for runs of three (3) or more conduits etc., or where a grid support system is required.
- .2 Concrete fasteners – "WEJ-IT" anchors, lead cinch anchors and/or "STAR" or "PHILLIPS" self-drilling anchors.
- .3 Masonry inserts – "WEJ-IT" expansion shields and machine bolts or, for light loads, fibre or lead plugs and screws.
- .4 Drywall or plaster wall and/or ceiling fasteners – 2-wing spring toggles.
- .5 Structural steel - Crane Canada Ltd., beam clamps.

- .6 Anchors, fasteners and other securing hardware to be of capacity and type to suit application and for which materials to which hardware are being installed. Include manufacturer's product literature with shop drawing submissions detailing that supplied hardware is suitable for respective applications. Arrange for manufacturer's representative to provide onsite installation training for hardware products.
- .7 Metal framing channels – typical 40 mm (1-5/8") width but increased where required to suit application, galvanized steel channels complete with required fittings and ancillary hardware. Acceptable manufacturers of framing channels are:
 - .1 Unistrut;
 - .2 Thomas & Betts;
 - .3 Hilti;
 - .4 Eaton B-Line.
- .8 Acceptable manufacturers of fastening and securing hardware:
 - .1 Crane;
 - .2 Hilti;
 - .3 Thomas & Betts.
- .9 Pentair Erico metal "J" hooks or Panduit "J-Pro" cable support systems for communications system cabling in accessible ceiling spaces where conduit or cable tray is not being provided. J hooks to be of type and size to maintaining cable minimum bending radii of cable being supported and have smooth edges that cannot damage cable. Clearly identify cable manufacturer's bending radii specifications and submit with shop drawings. Use of J-hooks is subject to approval from Owner and review with Consultant.
- .10 Velcro tie wraps for bundling and securing cables.

2.06 ACCESS DOORS

- .1 Coordinate consistency of look and finish of access doors on project with each Division of Work. Coordinate exact requirements with General Trades Contractor.
- .2 Access doors to be rust resistant steel door panels, with concealed hinges and positive locking and self-opening screwdriver operated lock. Wall type frame to be suitable for wall installation and have integral keys for plaster walls. Doors in tile wall to be stainless steel and in ceilings to be suitable for plaster covering with only frame joint showing. All other doors to be prime painted steel.
- .3 Size access door to suit the concealed work for which they are supplied, and wherever possible they are to be of standard size for all applications, but in any case, they are to be minimum 300 mm x 300 mm (12" x 12") for hand entry and 600 mm x 600 mm (24" x 24") for body entry.
- .4 Lay-in type tiles, properly marked, may serve as access panels. Coordinate marking of ceiling tiles with Consultant. Panels in glazed tile walls to be 12 gauge, 304 alloy stainless steel, No. 4 finish, with recessed frame secured with stainless steel counter-sunk flush head screws.

- .5 Panels in plaster surfaces to have dish-shaped door and welded metal lath, ready to take plaster. Provide a plastic grommet for door key access.
- .6 Other access doors to be welded 12 gauge steel, flush type with concealed hinges, lock and anchor straps, complete with factory prime coat. Submit to Consultant for review, details of non-standard door construction details.
- .7 Access doors in fire rated ceilings, walls, partitions, structures, etc., to be ULC listed and labelled and of a rating to maintain fire separation integrity.
- .8 Where access doors are located in surfaces where special finishes are required, they are to be of a recessed door type capable of accepting finish in which they are to be installed so as to maintain final building surface appearance throughout.
- .9 Acceptable manufacturers include Le Hage, SMS, Pedlar and Acudor.

2.07 IDENTIFICATION NAMEPLATES

- .1 Laminated plastic (Lamacoid) black-white-black with bevelled edges, stainless steel screws, and proper identification engraving. Each nameplate to be sized to suit equipment for which it is provided and required wording. Various colour configurations to be used to differentiate systems. Confirm exact nomenclature, sizing, print type and colour scheme with Owner and review with Consultant.
- .2 Brother "P-Touch" or approved equal, portable electronic labelling system complete with self-adhesive, permanent printed labels with required nomenclature.
- .3 For non-climate-controlled areas: nameplates to be weather resistant, corrosion resistant and UV resistant to prevent fading. Mounting hardware to be corrosion resistant stainless-steel construction.

2.08 SPRINKLER PROTECTION

- .1 Provide drip shields for protection of surface mounted equipment enclosures from water spray and dripping of liquids. Features of shields include:
 - .1 factory constructed by respective equipment manufacturers;
 - .2 constructed from non-combustible materials (sheet steel);
 - .3 enamel painted to match equipment;
 - .4 surfaces and edges filled/sanded smooth prior to painting;
 - .5 supported from equipment with structural steel rods/metal framing or other method reviewed with Consultant;
 - .6 structural support finish painted to match shield.
- .2 Include with equipment shop drawings, detailed dimensions of drip shields and methods of supporting.
- .3 Equipment with top cable/conduit entries to include additional sealing of entries with gasketting and/or waterproof sealant to prevent water from entering enclosure.

- .4 Design ventilation louvers such that live components are not exposed to water spray and dripping liquids.
- .5 Above requirements are additional minimum "sprinkler protection" standards for equipment specified as NEMA / (EEMAC) 1, 2 or 12.
- .6 Obtain CSA approval where required by local governing authorities.

2.09 FIRESTOPPING AND SMOKE SEAL MATERIALS

- .1 Asbestos-free, elastomeric materials and intumescent materials, tested, listed and labelled by ULC in accordance with CAN/ULC S115, and CAN/ULC S101 for installation in ULC designated firestopping, and smoke seal systems to provide a positive fire, water and smoke seal and a fire resistance rating (flame, hose stream and temperature) no less than fire rating for surrounding construction.
- .2 Firestopping and smoke seal material system to be specifically ULC certified with designated reference number for its specific installation. As part of shop drawing submission, submit copies of firestopping drawings with ULC certificate and system number for each specific installation.
- .3 Materials are to be compatible with abutting dissimilar materials and finishes and complete with primers, damming and back-up materials, supports, and anchoring devices in accordance with firestopping manufacturer's recommendations and ULC tested assembly. Coordinate material requirements with trades supplying abutting areas of materials.
- .4 Submit schedule of opening locations and sizes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance ratings.
- .5 For typical standard indoor applications for conduit and cable installations to seal openings up to 25 mm (1"): Hilti "Cable Disc CFS-D 1", pre-formed firestopping solution with features as follows:
 - .1 Approximate Density 1.6 g/cm³;
 - .2 Mold and mildew resistant;
 - .3 Surface burning characteristics (UL 723 (ASTM E84): Flame spread: 0 and Smoke development: 5;
 - .4 Application temperature 0 to 40°C (32-104°F);
 - .5 Percent Fill: up to 100% per tested system;
 - .6 Sound Transmission classification (ASTM E 90): 62 (Relates to specific construction).
- .6 For typical standard indoor applications to seal openings up to 1800 mm x 900 mm (72" x 36"): Hilti "Firestop Block (CFS-BL)", ready-to-use, intumescent flexible block designed for:
 - .1 Sealing single or multiple penetrations of openings;
 - .2 Temporary or permanent sealing of cables and cable tray penetrations;

- .3 Temporary or permanent sealing of conduit penetrations.
- .7 Firestop Block (CFS-BL) features as follows:
 - .1 Tested in accordance with CAN/ULC-S115, UL 1479, ASTM E 814 and ASTM E 84;
 - .2 Halogen, asbestos, solvent free and smoke resistant;
 - .3 Operational immediately after installation;
 - .4 Application temperature 5°C to 40°C (40°F to 104°F);
 - .5 Temperature resistance -15°C to 60°C (5°F to 140°F);
 - .6 Intumescent activation approximately 200°C (392°F);
 - .7 Expansion ratio (unrestricted) Up to 1:3;
 - .8 Surface burning characteristics (ASTM E 84-10b): Flame Spread Index: 10 and Smoke Development Index: 15;
 - .9 Sound transmission classification (ASTM E 90): STC Rating: 52;
 - .10 Suitable for wet areas when applied with additional silicone coating to manufacturer's directions.
- .8 Supply products of a single manufacturer for use on work of this Division.
- .9 Installer to be manufacturer trained and certified on specific product. Submit copy of certificate with shop drawings.
- .10 Refer to Division 01 specification 01 33 00 Submittal procedures 1.8 Project Firestopping manual and Coordination for additional requirements and procedures.
- .11 Include for manufacturer's authorized representative to inspect and verify each installation and application. Submit test report signed and verified by system installer's authorized representative and manufacturer's representative.
- .12 Acceptable certification to also include certification by Underwriters Laboratories of Northbrook IL, using tests conforming to ULC-S115 and given cUL listing published by UL in their "Products Certified for Canada (cUL) Directory".
- .13 Acceptable manufacturers are:
 - .1 Hilti Canada;
 - .2 Specified Technologies Inc.;
 - .3 3M Canada Inc.;
 - .4 Tremco;
 - .5 A/D Fire Protection Systems;
 - .6 Nelson.

3 EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

- .1 Install conduit concealed in finished areas, and concealed to degree made possible by finishes in partially finished and unfinished areas. Conduit may be exposed in unfinished areas such as Electrical and Mechanical Rooms, unless otherwise noted on drawings or specified herein. Refer to and examine architectural drawings and room finish schedules to determine finished, partially finished or unfinished areas of building. Documents do not identify exact routing. Where shown, routing is diagrammatic, identifying general requirements of routing and locations. Include for necessary offsets, fittings, transformations and similar items required as a result of obstructions and other architectural or structural details not shown.
- .2 Where conduits are exposed, arrange them to avoid interference with other work, parallel to building lines and install as high as possible. Do not install conduits within 150 mm (6") of "hot" pipes or equipment unless conduits are associated with equipment. Independently run conduit to be supported from wall/ceiling structure, not from ceiling hangers, ductwork, piping, cable trays, formed steel decking, etc. Do not run conduits within 900 mm (3') of equipment access opening covers.
- .3 So as not to impair required strength of structure, following criteria to be generally followed but which is to be reviewed and coordinated with Consultant prior to start of Work:
 - .1 where conduits pass by a column, stay at least two times thickness of slab and drop away from column;
 - .2 where conduits terminate adjacent to a column or wall, bring conduit in toward column/wall as close to 90° to face of column as possible within two times thickness of slab and drop away from column;
 - .3 maximum size of conduit in structural slabs is 1/5 of solid portion of slab thickness;
 - .4 where more than two conduits are adjacent to each other, they are to be spaced greater of 3 diameters or 100 mm (4") apart;
 - .5 total of depth of conduits crossing over each other is to be less than one-third thickness of slab;
 - .6 place conduit in middle third of thickness of slab; do not lay conduit directly on reinforcing steel;
 - .7 do not run conduit adjacent to parallel reinforcing bars;
 - .8 do not run conduit longitudinally in beam without approval of Owner and review with Consultant; pass through beams at right angles to span of beam;
 - .9 where conduits pass through beams, maintain at least twice depth of beam separation away from supports;
 - .10 do not run conduits in slab beside a drop or beam within twice depth of slab from edge of drop or beam;

- .11 do not run conduits through shear walls or columns without approval of Owner and review with Consultant;
- .12 do not place conduit in structural elements in parking garage structures, water retaining structures or structures subjected to de-icing chemicals, without approval of Owner and review with Consultant.
- .4 For isolation type rooms and other rooms as reviewed with Consultant, seal conduits that penetrate through walls, floors or ceilings, and boxes within these surfaces with suitable elastomeric and intumescent materials around penetrating item and within any openings of item to ensure complete isolation of rooms. Such sealing materials are to be suitable for specific applications and maintain fire rating of penetrated surface and not be of a hazardous material. For wiring devices, provide gasketing under faceplates. Submit shop drawings of proposed materials.
- .5 Conduits are sized on drawings, but in absence of type and sizing, type and size to suit intended application in accordance with applicable local governing electrical code requirements. Sizes identified on drawings are minimum sizes and are not to be decreased unless approved by Owner and reviewed with Consultant.
- .6 Where receptacle type devices are located in existing floors and/or where feeds are required to furniture systems in open spaces, and where chasing of floor slab to run conduit is not acceptable to Owner, after review with Consultant provide fire rated "poke-thru" assembly installed through floor and feed from conduit runs provided in ceiling space of floor below.
- .7 Mounting heights of devices may be typically identified on drawings, but such dimensions are for general pricing only. Review exact mounting heights with Consultant prior to roughing –in, refer to Architectural drawings and comply with local governing codes and standards including building code barrier free requirements.

3.02 INSTALLATION OF CONDUIT

- .1 Provide conduit for conductors except armoured cable and copper sheathed mineral insulated conductors, and except where duct or similar raceway materials are provided.
- .2 Provide conduit as follows:
 - .1 for exposed conduit mounted at a height of less than 1200 mm (4') in electrical, mechanical or other service areas – rigid galvanized steel;
 - .2 for short branch circuit connectors to motorized equipment and distribution transformers (minimum length 450 mm (18"), maximum length 600 mm (24") with 180° loop where possible) – galvanized steel flexible liquid-tight conduit;
 - .3 for branch circuit conductors associated with isolated power systems and located in a concealed space in a wall or in a concrete floor slab-rigid PVC with separate insulated ground conductor;
 - .4 at points, where conductors cross building expansion joints – galvanized steel flexible conduit with no less than 600 mm (24") of extra curve;
 - .5 for branch circuit conductors in poured concrete slab – rigid PVC;

- .6 for interior conduit above 50 mm (2") diameter containing distribution conductors or communication systems conductors (fire alarm, telephone etc.) (except as noted above) – EMT with separate insulated ground conductor;
- .7 for corrosive environments – epoxy coated rigid steel;
- .8 for conductors except as noted above or elsewhere in this Specification – EMT.
- .3 Run rigid conductors in rigid type conduits suitable for application. Do not use flexible conduit.
- .4 Secure conduit located in poured concrete work in place in a manner such that conduit will not float or move when concrete is poured. Adequately protect such conduit from damage prior to and during concrete pour, and from concrete and water penetration.
- .5 Review with Consultant prior to Start of Work, maximum allowable size of conduit for installation in poured concrete. Placement of reinforcing steel in structural concrete work will take precedence over placement of conduit. Spaced adequately multiple runs of conduit in poured concrete work, as reviewed with Consultant.
- .6 Install flexible polyethylene conduit in continuous lengths wherever possible and "snake" conduit in trench. Where joints are necessary, make same with nylon inserts and stainless-steel gear type clamps. Terminate with rigid conduit threadless connectors. Grade bed to provide proper drainage of conduits.
- .7 Support underground conduit on a well-tamped flat bed of earth, free from rocks or protrusions of any kind. Grade and slope bed to provide conduits and ducts with proper drainage. Coordinate with General Trades Contractor for provision of means to carry away drainage water. Obtain required approvals of work from local governing electrical utility and review with Consultant prior to back filling and covering. Provide pull cord in each duct run.
- .8 Provide manufactured expansion joints in rigid PVC plastic conduit at spacing as recommended by conduit manufacturer.
- .9 Provide a separate ground conductor in plastic conduits.
- .10 Support and secure surface mounted and suspended single or double runs of metal conduit at support spacing in accordance with local governing electrical code requirements by means of galvanized pipe straps, conduit clips, ringbolt type hangers, or by other proper manufactured devices.
- .11 Support multiple mixed size metal conduit runs with Unistrut Ltd., Electrovert Ltd. "CANTRUSS" or Burndy Ltd. "FLEXIBLE" conduit racks spaced to suit spacing requirements of smallest conduit in group.
- .12 Unless otherwise noted, provide conduit fittings constructed of same materials as conduit and which are suitable in respects for application.
- .13 Provide proper adaptors for joining conduits of different materials.
- .14 Cut square and properly ream site cut conduit ends.

- .15 Provide conduit as sized on drawings. Size conduit not sized on drawings in accordance with local governing electrical code with consideration that sizes of branch circuit conductors indicated are minimum sizes and must be increased as required to suit length of run and voltage drop in accordance with voltage drop schedule found on drawings or at end of this section. Where conductor sizes are increased to suit voltage drop requirements, increase scheduled or specified conduit size to suit. Unless otherwise noted on drawings or required by local governing electrical code or specified elsewhere, conduit to be of minimum size 13 mm (1/2") diameter. Structured network cabling system conduit to be of minimum 19 mm (3/4") diameter, unless otherwise noted.
- .16 Site made bends for conduit to maintain full conduit diameter with no kinking, and conduit finishes are not flake or crack when conduit is bent.
- .17 Plug ends of roughed-in conduits which are exposed during construction with approved plugs.
- .18 Ensure that conduit systems which are left empty for future wiring are clean, clear, capped and properly identified at each termination point. Provide end bushing and suitable fish wires in such conduits.
- .19 Provide empty conduits to ceiling spaces from flush mounted panelboards located below and/or near hung ceiling. Refer to drawing detail.

3.03 INSTALLATION OF OUTLET BOXES AND BACK BOXES

- .1 Provide an outlet box or back box for each luminaire, wiring device, telephone outlet, fire alarm system component, communications systems components, and each other such outlet.
- .2 Size boxes to accommodate exact supplied components and for bending radii of installed cables. Confirm requirements with respective system vendors.
- .3 Outlet boxes flush mounted in interior construction, surface mounted in concealed interior locations, and surface mounted in exposed interior locations where connecting conduit is EMT, to be stamped and galvanized steel outlet boxes unless otherwise noted.
- .4 Provide sealing around boxes in walls where insulation and vapour barrier is present or for walls of rooms that are sealed. Maintain sealing system of wall.
- .5 Outlet boxes in plastic conduit systems to be rigid PVC plastic outlet boxes, unless otherwise noted.
- .6 Outlet boxes for flush floor mounted devices to be concrete tight formed galvanized steel fully adjustable flush floor boxes. Locate in to position and install in accordance with manufacturer's instructions. Coordinate installation with trades pouring concrete floor slab or trade responsible for floor construction.
- .7 Provide barriered outlet box for switches connected to normal and emergency power and share a common faceplate.
- .8 Provide outlet boxes for special wiring devices, for special equipment and special applications. Refer to requirements specified in other Sections and/or on drawings.
- .9 Size and arrangement of outlet boxes to suit device which they serve.

- .10 Mounting heights and locations for outlet boxes are typically indicated on drawings, however confirm exact location and arrangement of outlets prior to roughing-in. Architectural drawings and Consultant's instructions have precedence over electrical drawing diagrammatic layouts and specified mounting heights and locations.
- .11 Do not install outlet or back boxes "back-to-back" in walls and partitions. Stagger such outlets and seal against noise transmission in accordance with drawing details. "Thru-wall" type boxes will not be permitted for any application.
- .12 Properly support exterior mounted boxes for receptacles as noted on drawings. Where location is not adjacent a structure, provide rigid conduit support properly imbedded into ground and secure box at suitable required height. Review exact installation requirements with Consultant prior to start of work.
- .13 Provide blank coverplates on existing obsolete boxes which are to remain in position.
- .14 Provide blank coverplates over boxes left empty for future installation of devices. Clearly identify each box as to its intended use, to Owner's approval and reviewed with Consultant. Generally, provide stainless steel type blank coverplates.

3.04 INSTALLATION OF PULLBOXES AND JUNCTION BOXES

- .1 Provide pullboxes in conduit systems wherever shown on drawings, and/or wherever necessary to facilitate conductor installations. Generally, conduit runs exceeding 30 m (100") in length, or with more than two - 90° bends, are to be equipped with a pullbox installed at a convenient and suitable intermediate accessible location.
- .2 Size boxes to accommodate exact supplied system and for bending radii of installed cables. Confirm requirements with respective system vendors.
- .3 Provide junction boxes wherever required and/or indicated on drawings and as required by local governing electrical code.
- .4 Provide sealing around boxes in walls where insulation and vapour barrier is present or for walls of rooms that are sealed. Maintain sealing system of wall.
- .5 Boxes in rigid conduit and EMT inside building to be stamped galvanized or prime coated steel.
- .6 Boxes in exterior rigid conduit and boxes in perimeter wall where insulation and vapour barrier is present, to be "Condulet" cast gasketed boxes, unless otherwise noted.
- .7 Boxes in plastic conduit to be rigid PVC plastic boxes complete with required couplings.
- .8 Pullboxes and junction boxes to be accessible after work is completed.
- .9 Accurately locate and identify concealed pullboxes and junction boxes on "As-built" record drawings.

- .10 Clearly identify main pull or junction boxes (excluding obvious outlet boxes) by painting outside of covers. Spray painting is not permitted unless approved by Owner and reviewed with Consultant. Paint colours to be in accordance with following schedule:
 - .1 lighting-yellow;
 - .2 normal power-blue;
 - .3 essential power-orange;
 - .4 fire alarm-red;
 - .5 telephone-green;
 - .6 miscellaneous signals-brown.
- .11 In addition to painting miscellaneous signal boxes, clearly identify specific system in which box is installed.
- .12 Cover boxes in fire walls with aluminium tape and seal with caulking.

3.05 INSTALLATION OF SLEEVES

- .1 Where conduits, round ducts and conductors pass through structural poured concrete, provide sleeves of type suitable for application, and approved by local governing codes.
- .2 Sleeves in concrete slabs, except as noted below, are to be No. 24 gauge or equivalent, with an integral flange to secure sleeves for formwork construction.
- .3 Sleeves in waterproof concrete slabs and in other slabs where waterproof sleeves are required are to be lengths of Schedule 40 pipe sized to extend 100 mm (4") above floor.
- .4 Sleeves in poured concrete walls and foundation are to be Schedule 40 pipe.
- .5 Size sleeves, unless otherwise noted, to leave 13 mm (1/2") clearance around conduit, duct, conductor, etc. Void between sleeves and conduit, duct, conductors, etc., to be packed and sealed for length of sleeves as in accordance with article entitled "Firestopping and Smoke Seal Materials" specified here in this Section. Pack and seal sleeves set in exterior walls with governing authority approved materials suitable for application and pack both ends of sleeves watertight with approved permanently flexible and water tight materials. Coordinate exact responsibility of work with General Trades Contractor.
- .6 Submit to concrete reinforcement detailer at proper time, drawings indicating required sleeves, recesses and formed openings in poured concrete work. Completely and accurately dimension such drawings and relate sleeves, recesses and formed openings to suitable grid lines and elevation datum.
- .7 Supply sleeves of a water protecting type in accordance with detail found on drawings for installation in following locations:
 - .1 in Mechanical and Fan Room floor slabs, except where on grade;
 - .2 in slabs over Mechanical, Fan, Electrical and Telephone Equipment Rooms or closets;

- .3 in floors equipped with waterproof membranes.
- .8 "Gang" type sleeving to be permitted only with approval of Owner and reviewed with Consultant.
- .9 Terminate sleeves for work which is exposed, so that sleeve is flush at both ends with wall, partition, or slab surface such that sleeve may be covered completely by escutcheon plates.

3.06 SUPPLY OF ACCESS DOORS

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

3.07 INSTALLATION OF FASTENING AND SECURING HARDWARE

- .1 Provide fasteners, anchors and similar hardware required for conduit, duct, raceway, conductors, etc. and for equipment hanger and/or support material unless otherwise noted.
- .2 Accurately and properly set concrete inserts in concrete framework. Where multiple type inserts are used, space same to suit requirements of smallest conduit, etc., in group.
- .3 Fasten hanger and support provisions to masonry with expansion shields and machine bolts, or, for light loads, use plugs, and screws.
- .4 In drywall or plaster walls and/or ceilings use two wing toggles and for heavy loads, provide steel anchor plates with two or more toggles to spread load.
- .5 Provide beam clamps for attaching hanging and/or support provisions to structural steel, or where approved by Owner and reviewed with Consultant, weld hanging and support provisions to structural steel.
- .6 Install devices in accordance with manufacturer's instructions to suit each respective application.

- .7 Explosive powder actuated fasteners are not permitted unless specific approval for their use and type has been obtained from Owner and reviewed with Consultant.
- .8 Under no circumstances use ceiling suspension hangers or grids for suspension of conduit and conductors. Install supports to permanent structure of building, limited to areas that will not damage structural stability.
- .9 Provide "J" hooks in accessible ceiling spaces where conduit is not provided for structured cabling runs or other telecommunication cabling, as approved by Owner and reviewed with Consultant.
- .10 Comply with J-hook manufacturer's loading limitations and spacing criteria and cable manufacturer's minimum bending radii. Do not exceed 1.2 m (4') spacing interval. Add additional J-hooks if cabling sags, at discretion of Consultant. Drill anchors for J-hooks into slab not into post tensioned beams. Do not install more than one system on each J-hook.
- .11 Install Velcro tie wraps on bundled telecommunication cables and do not over tighten. Provide FT6/CMP rated wraps in plenum type spaces as per local building code requirements.
- .12 Comply with Consultant's (Structural Engineer's) limitations for maximum penetrations of securing hardware into concrete slabs.

3.08 INSTALLATION OF IDENTIFICATION NAMEPLATES

- .1 For each piece of electrical distribution equipment from electrical source of supply up to and including panelboards, for special control panels and cabinets, and for each other piece of electrical equipment, provide engraved Lamacoid identification nameplates secured to apparatus with stainless steel screws. Nameplates to indicate source of electrical supply and include Consultant's equipment identification number. Identify whether equipment is on "NORMAL POWER SYSTEM" or "ESSENTIAL POWER SYSTEM", where applicable. Comply with CSA Z32 requirements.
- .2 Equip large multiple cell or component apparatus such as switchboards and distribution panels with main nameplates identifying equipment, voltage characteristics, capacity and source of supply, and with sub-nameplates clearly identifying each cell or component and its service.
- .3 Panelboard nameplates to identify panelboard number as designated on drawings, unless otherwise instructed. Nameplates for disconnect switches, control panels, and cabinets to outline their service and source of supply.
- .4 In areas where equipment having removable doors that can be commonly installed on different equipment, ensure that each door is identified to which piece of equipment it is associated with, such that nameplates are with correct equipment.
- .5 Provide nameplates engraved "Dedicated Circuit" on faceplates for receptacles on dedicated circuits in Critical and Intermediate Patient Care Areas. Provide nameplates engraved "Housekeeping" for Housekeeping receptacles generally located in Corridors with exact extent to be determined on site. In these areas where lamacoid nameplates are employed, engrave source of supply (circuit designation) on these nameplates as well.

- .6 Faceplates for devices not in-patient care areas or not in corridors in vicinity of patient care areas are to be labelled with plastic self-adhesive printed labels with similar information as specified for nameplates. Provide labels on inside and outside face of faceplates. Apply a layer of a clear coat finish over each label.
- .7 Nameplates to be mechanically secured lamacoid and be colour coded as follows:
 - .1 Normal Power Black with white letters;
 - .2 Emergency Power Red with white letters;
 - .3 Isolated Power Red with white letters;
- .8 Above identification nameplate and nomenclature requirements are for typical requirements for pricing only.
- .9 In pull boxes, junction boxes and at terminations, identify feeders by use of plastic plates indicating system voltage and circuit designations. Plates to be 25 mm (1") in diameter and have letter stamped 9 mm (5/8") high. Colour coding to be:
 - .1 Phase A – red;
 - .2 Phase B – black;
 - .3 Phase C – blue;
 - .4 Neutral – white;
 - .5 Ground - green.
- .10 Review print size type and size, colours, sizing and nomenclature of nameplates with Consultant prior to ordering. Submit sample board.

3.09 BRANCH CIRCUIT BALANCING

- .1 Connect branch lighting and power circuits to panelboards so as to balance actual loads (wattage) within 5%. If required, transpose branch circuits when work is complete to meet this requirement.
- .2 Perform necessary tests to show compliance with above requirement. Make such tests after building is occupied and document into testing report.

3.10 DISCONNECTION, REMOVAL AND RELOCATION WORK

- .1 Prior to start of any disconnection, removal or relocation work in any areas of building, prepare schedule of work and notify Consultant and Owner to obtain approval of work to proceed.

- .2 Where indicated on drawings or where required to perform Work of this Project, disconnect and remove items of existing obsolete electrical work. Relocate required devices as required to accommodate work of other Divisions. Where luminaires, switches, receptacles, and other devices and/or equipment is removed, disconnect at point of electrical supply, remove obsolete wiring and conduit up to source, unless otherwise noted, and make system safe to Owner's satisfaction and as reviewed with Consultant. Remove obsolete conduit/raceways in accessible ceiling spaces, exposed locations, etc. Where existing obsolete conduit and similar raceway material cannot be removed, such as embedded in concrete, cut back and cap obsolete conduit and raceways. Refer to specific notes on drawings.
- .3 When respective work is deleted, such deletions are to in no way affect operation of any existing interconnected mechanical or electrical components that remain. When existing circuits are being disconnected, maintain supervision of area to ensure that such circuits do not affect essential existing circuits being retained.
- .4 When relocating luminaires, inspect luminaire for circuit identification and if found, identify circuiting on as-builts, if circuiting is maintained.
- .5 Refer to applicable architectural and electrical drawings which define extent of areas being demolished in existing building. Review drawings and site and include for demolition and/or renovation of services as required to accommodate alterations detailed.
- .6 Except where directed by Owner, remove from site and properly dispose obsolete materials which are removed and are not relocated or reused. Obtain from Owner and review with Consultant, list of existing electrical items for removal and turn over to Owner. Said items remain property of Owner. Package items and provide itemized list.
- .7 Where existing services pass through or are in an area to serve items which are to remain, or pass through areas that are to be deleted, maintain services, but re-route as required. Include for rerouting existing services concealed behind existing finishes and which become exposed during renovation work, so as to be concealed behind new or existing finishes. Confirm with Owner services which are to be kept in service and operational.
- .8 Revise panelboard directories accordingly, if affected by any renovation, disconnection, or removal of work. Provide revised typed directory cards. Use Owner's actual room names/numbers. Ensure service to all equipment being demolished, removed, or relocated has been de-energized prior to disconnecting. Label all breakers no longer being used as "spare" on panelboard directories. Revise all other labels for breakers being reused to suit new loads.
- .9 Protect existing devices being relocated or deleted to ensure that they are not damaged. Test such devices prior to disconnection and de-energization, to ensure that each device is in proper working condition. Ensure that motors are in proper rotation direction. Examine each device for damage. Report devices not working or with damage to Consultant prior to initiating any work. It will be assumed that devices are in proper working order and good condition if not reported.

- .10 Provide junction boxes, outlet boxes, wiring, plates, etc., as necessary for complete relocation of devices. Clean relocated or temporary removed devices and equipment, and ensure that they are in good operating condition before being reinstalled. Where existing luminaires are relocated, clean luminaires and inspect for damage. Relamp relocated luminaires. Report defects or damages to Consultant. Do not splice conductors unless approved by Owner and reviewed with Consultant. Utilize junction boxes and terminal devices for proper extension of circuits where approved. Otherwise replace circuits with home run continuous run of suitable lengths.
- .11 Provide blank coverplates on existing obsolete boxes which are to remain in position, as designated by Owner.
- .12 Where Work requires opening of ceilings to allow for mechanical equipment installation work or installation of work of other Divisions. Electrical Division devices including luminaires, telecommunications, fire alarm, communications and other such devices with associated conduits and wiring are to be disconnected, temporarily relocated/supported and when ceiling is re-installed, devices to be properly re-installed, connected, tested and verified. Re-route wiring and conduit to suit work. Services to temporarily relocated equipment shall be maintained at all times. Life safety equipment to be maintained to satisfaction and approval of local governing authorities. Some existing devices/products as noted on drawings are to be replaced under scope of project work. Coordinate work with Mechanical Divisions Contractor.
- .13 After installation is complete, test parts of re-used or relocated electrical equipment and correct faults and grounds. Include for fire alarm verification company to verify any relocated devices and downstream affected devices, and verify system as required by local fire authority to suit actual relocation work. For other existing systems, engage manufacturers authorized representative or existing system maintenance contractor, as confirmed with Owner, to inspect and verify relocated devices. Review exact requirements with Owner and Consultant. Document testing in test reports, signed by testing technician. Submit copies to Consultant. Confirm vendors with Consultant and Owner.
- .14 Interior, exterior or underground electrical services (including auxiliary services, telephone, fire alarm, P.A. System, etc.) to operating parts of building are not to be hampered under any conditions and to that effect, necessary work may have to be carried out on an overtime basis, at no additional cost to this project. Existing risers are to be maintained in service as required to feed other areas of building(s). Do not interrupt any services without prior written approval by Owner and review with Consultant. Submit formal requests to Consultant outlining in detail requirements of proposal and wait for instructions from Consultant.
- .15 Be present when new doors or openings are being cut into existing walls and ceilings. Should any damage occur to electrical system, restore system to a safe and sound condition.
- .16 Where references are made on drawings that existing receptacles, etc., be extended and/or relocated to suit new construction, receptacles, etc., are to be tested and if found defective, be replaced with new devices. Cracked or broken cover plates are to be replaced and match Architectural finishes. Contractor may optionally replace existing basic receptacles, switches, and faceplates with devices matching existing devices.
- .17 Be responsible for disconnecting power supply to branch circuits controlling lighting, receptacles, panels, mechanical equipment, etc., for safe removal of equipment, conduit, wiring, boxes, etc., affected by demolition.

- .18 Close openings in boxes, panels, etc., that result from removal of equipment, conduit, wiring, fixtures, etc. Close openings in a proper manner and properly terminate and insulate cables to restore system to a safe operating condition as reviewed with Consultant and to Owner's satisfaction.
- .19 Be present and supervise removal of electrical equipment, P.A. speakers, etc., during demolition of ceilings, walls, floors, etc. Existing equipment which is not to be relocated but interferes with demolition, are to be temporarily relocated until demolition work is completed. Services to temporarily relocated equipment are to be maintained at all times.
- .20 Remove and re-install existing ceiling tiles as required to perform work. Prior to removal, inspect tiles for damage and report any to Owner and Consultant. Any loose cabling is to be secured, and luminaires additionally supported with cables secured to ceiling slab. After work has been completed and successfully inspected, re-install ceiling tiles to existing standards and re-install devices. Be responsible for replacement of tiles and grid members damaged during work of Electrical Division. Comply with applicable governing authority requirements with regards to ceiling work in special areas.
- .21 Where existing surfaces are damaged by Electrical Divisions work and/or where existing devices are removed from wall, ceilings, floors and other surfaces, and such deleted devices are not being replaced in same locations, patch locations of these removed devices and re-finish. Patching and finishing is to be provided by tradesmen skilled in particular trade or application worked on, to Owner's approval and review with Consultant. Where openings are left in existing ceiling tiles, replace ceiling tiles with new matching tiles approved by Owner and reviewed with Consultant. Unless otherwise included for in other Divisions, include for:
 - .1 preparing existing surfaces to be filled and repainted to be cleaned as required to remove dirt, dust, oil, grease, loose paint, rust and any other foreign matter which would prevent proper bonding of new finish; sand glossy surfaces to uniform dull texture;
 - .2 filling in and patching surfaces with same material as existing surfaces; finished surfaces to match and line with existing adjoining surfaces;
 - .3 providing fire stopping materials to maintain fire rating of the existing surfaces; refer to specification article entitled - Firestopping and Smoke Seal Materials;
 - .4 using paint rollers and/or brushes to apply and extend paint finish over full height and/or width of area affected, to a straight line in location reviewed with Consultant;
 - .5 applying sufficient number of coats such that patched area is indistinguishable to surrounding area;
 - .6 materials used to be of equivalent quality to existing finishes standards and be compatible with finishes to which they are applied;
 - .7 finishes to be approved by Owner and reviewed with Consultant.
- .22 Check luminaires to be deleted for PCB ballasts. Disconnect and remove such ballasts. As specified previously, include for company specialized in such hazardous materials to remove and dispose such materials off-site in compliance with Ministry of Environment, Ministry of Transport and any other governing authority regulations.

- .23 If at any time during course of building work, asbestos containing materials are encountered or suspected, cease work in area in question and immediately notify Consultant. Comply with local governing authority regulations. Do not resume work in affected area without approval from Owner and review with Consultant.

3.11 INTERRUPTIONS TO AND SHUT-DOWNS OF SERVICES AND SYSTEMS

- .1 Shutdowns and interruptions to existing systems and services are to be coordinated fully with and performed at times acceptable to Owner and reviewed with Consultant. Include for costs of premium time to perform work during nights, weekends or other times outside of normal working hours, which may be necessary to comply with stipulations specified herein this Article. Services for operation of existing non-renovated areas of building are to be maintained. Allow for premium time work in the following areas:
 - .1 Corridor of MH 2D ward.
- .2 Upon award of contract, submit to Consultant for review and approval, a list of anticipated shut-down times and their maximum duration.
- .3 Prior to each shut-down or interruption, inform Consultant and Owner in writing minimum 10 working days in advance of proposed shut-down or interruption and obtain written consent to proceed. Do not shut down or interrupt any system or service without written consent. Note that shutdowns of some essential services may require additional advance notification time.
- .4 Work associated with shut-downs and interruptions are to be carried out as continuous operations to minimize shut-down time and to reinstate systems as soon as possible. Prior to any shut-down, ensure that materials and labour required to complete work for which shut-down is required are available at site.
- .5 Confirm any methods of procedures with Owner and review with Consultant prior to start of work.
- .6 Review with Consultant if any feeder (conductor) is designated for special considerations and if designated as such and is to be interrupted, ensure that at least following preparations are met:
 - .1 provide a schedule of proposed feeders to be interrupted; propose one feeder at a time to be worked on per scheduled shutdown;
 - .2 provide a method of procedure for work;
 - .3 prepare above documentation and submit for approval by Owner and review with Consultant at least 10 working days prior to date of each proposed work;
 - .4 on day/night of proposed feeder work, advise Consultant of which feeder is to be worked on; review with Consultant requirements for witnessing work;
 - .5 de-energize feeders and perform work as per Owner approved and Consultant reviewed schedule;
 - .6 after feeders are re-routed, megger test each feeder.

- .7 Where working in close proximity to "live parts" or inside energized panels or energized cubicles of switchboards/substations, provide protection "boots" over bussing and insulating mats to cover areas of exposed live parts.

3.12 CUTTING, PATCHING AND CORE DRILLING

- .1 Unless otherwise provided by General Trades, perform cutting, patching, and core drilling of existing building required for installation of Electrical Divisions work. Perform cutting in a neat and true fashion, with proper tools and equipment. Patching is to exactly match existing finishes and be performed by tradesmen skilled in particular trade or application. Work is subject to acceptance by Owner and review with Consultant.
- .2 Criteria for cutting holes for additional services:
 - .1 cut holes through slabs only; no holes to be cut through beams;
 - .2 cut holes 150 mm (6") diameter or smaller only; review with and obtain direction from Consultant (Structural Engineer) for larger holes;
 - .3 keep at least 100 mm (4") clear from beam faces;
 - .4 space at least 3-hole diameters on centre;
 - .5 for holes that are required closer than 25% of slab span from supporting beam face, use cover meter above slab to clear slab top bars;
 - .6 for holes that are required within 50% of slab span, use cover meter underside of slab to clear slab bottom bars;
 - .7 submit sleeving drawings indicating holes and their locations for Consultant's (Structural Engineer's) review.
- .3 Where conduits and/or conductors penetrate existing construction, core drill or saw cut an opening. Size openings to leave 13 mm (1/2") clearance around conduit and/or conductors, and pack and seal void between opening and conduit and/or conductor for length of opening with ULC listed and labelled material in accordance with article entitled "Firestopping And Smoke Seal Materials" specified herein this Section.
- .4 Do not cut or drill any existing work without approval of Owner and review with Consultant. Be responsible for damage done to building and services caused by cutting or drilling.
- .5 Prior to drilling or cutting an opening, determine, in review with Consultant and Owner, and by use of non-destructive radar scan (magnetic scan) of slab or wall, presence of any existing services and reinforcement bars concealed behind building surface to be cut and locate openings to suit. Be responsible for damage to existing services caused by core drilling or cutting openings. Coring is not permitted through concrete beams or girders.
- .6 Fire stop and seal openings as specified, and patch as required before end of workday. No openings are to be left open overnight unless approved by Owner and reviewed with Consultant.

3.13 FINISH PAINTING OF ELECTRICAL WORK

- .1 Unless otherwise noted, finish painting of exposed Electrical Divisions work is to be performed as part of work of Division 09.
- .2 Provide identification painting for electrical distribution equipment in accordance with application requirements of Division 09. Review exact finish colours with Consultant. Equipment requiring special colour identification painting to include but not be limited to following:
 - .1 pull boxes and junction boxes;
 - .2 communication system conduit;
 - .3 genset exhaust piping.
- .3 Spray painting is not permitted unless approved in writing by Owner and reviewed with Consultant.

3.14 PROVISIONS FOR FURNITURE SYSTEMS

- .1 Ensure that rough-in for electrical devices including but not limited to outlets, switches, thermostats, control devices, fire alarm devices and clocks and communications devices are located to avoid wall mounted systems furniture wall strips. Relocate conduit and devices which do not coordinate with systems furniture requirements identified on systems furniture drawings.
- .2 Coordinate location of electrical conduits/ducts within floor slabs and mounted to underside of floor slabs, with location of free-standing work stations and furniture systems.
- .3 Coordinate connection of electrical and communication devices with systems furniture supplier. Generally, supply and installation of power, data and communication wiring and devices are by Electrical Division. Furniture system connection "whips" to be supplied by furniture system vendor and turned over to Electrical Division for installation. Confirm responsibility of supply of whip with General Trades Contractor. Power conductors are to be installed to a wall/ceiling mounted junction box and extended out to furniture system, through empty conduit, raceways, and back boxes provided within furniture system. Branch circuit conductors in furniture system raceways may be AC-90 flexible armoured conductors. Telecommunication (data/voice) conductors are to be complete home runs from LAN closet to work station outlet. Testing and verification of furniture system devices is responsibility Electrical Division. Confirm exact requirements with furniture system trades. Where furniture systems are not supplied with pre-wired devices, be responsible for supply, installation and wiring of required devices.

3.15 CONDUIT PROVISIONS FOR MISCELLANEOUS SYSTEMS

- .1 Provide following components to accommodate future installation of various miscellaneous systems by system installers who are to provide equipment and wiring:
 - .1 conduit - diameters as sized on drawings with non-metallic fish wires or pull cords and suitable bushings for conduit terminations, and as specified in Part 2; provide labelling at each end to clearly identify each conduit run with respect to system and path;

- .2 outlet boxes - standard galvanized steel, each complete with a blank type faceplate, and as specified in Part 2;
- .3 pull boxes, junction boxes, back boxes and sleeves - and as specified in Part 2.
- .2 Miscellaneous systems are typically as shown on drawings. Unless otherwise noted on drawings, provide dedicated conduit runs for each system. Coordinate sizes of boxes with respective system vendors to ensure proper sizing to accommodate components and that allows for wiring bending radii. Confirm conduit and box requirements also with system vendors.
- .3 Provide pullboxes in conduit runs longer than 30 m (100') or having more than two - 90 bends. Size pullboxes to be at least 8 times entering conduit in length. Pullbox sizes to comply with respective system standards.
- .4 Leave conduits free and clear of all obstructions and terminate as required. Equip terminations with bushing, and clearly identify each run. Provide fish wires in all empty conduits. Run telecommunications conduits to comply with separation from sources of electromagnetic radiation as per standard ANSI/TIA/EIA-569. Site bend telecommunications conduit elbows to comply with system conduit bending radii requirements.
- .5 Review exact requirements and locations of equipment with Consultant and respective system installers prior to roughing-in.
- .6 Refer to system riser diagrams on drawings.
- .7 Quantities for outlets to be as per floor plan drawings and not riser diagrams.

3.16 DOOR HARDWARE

- .1 Generally, Division 08 or another Division not under scope of Electrical Contractor, is responsible for supply and installation of door alarm contacts, door holders, electric strikes, electromagnetic locks, door operator controls, power supplies, door controllers, central electromagnetic lock release controller and other door hardware. Coordinate and confirm with General Trades Contractor and respective equipment vendors (door hardware / security) exact responsibility of each Division of the Work.
- .2 Confirm product and wiring requirements, back box requirements and wiring installation requirements with door hardware trades and with equipment vendors. Provide required wiring in conduit from each device to respective controllers, between each device, and to central control panel and for power connection to such controls and devices. Provide line level voltage power feeds to equipment as required.
- .3 For controls and interconnections between devices, when such device terminations are responsibility of others, supply and run interconnecting wiring in conduit to devices and allow spare length of 1.8 m (6') coiled wiring at each end for final termination to devices by others.
- .4 For applications of electro- magnetically held closed doors, engage fire alarm system vendor to provide fire alarm type pull station with auxiliary contacts as required for interconnection of electro- magnetic door hardware and fire alarm system for release of doors. Provide required wiring in conduit and connections. Coordinate pull station requirements with fire alarm system vendor.

- .5 Exact type of door alarm contacts to be coordinated with door construction and finishes. Contacts to generally be recessed mounted and wiring be installed in concealed conduits. Confirm exact requirements with door hardware/security vendor and General Trades Contractor.
- .6 Where controls are located remotely from door locations, such as in closets, provide wiring in conduit and extend from local above door junction boxes and devices as required with homeruns back to closet location of equipment and leave slack wiring for terminations by others. Confirm exact requirements with door hardware / security vendor and General Trades Contractor.
- .7 Drawing details issued with electrical drawings are for pricing reference only and are based on assumptions. Obtain detailed design drawings from successful door hardware / security vendors and provide wiring in conduit to coordinate with and accommodate final systems designs. Coordinate with General Contractor.
- .8 Submit as part of shop drawing submission, detailed responsibility matrix identifying work and responsibilities of each trade and required interconnections.
- .9 After installation is complete, test and verify operation of components in coordination with General Contractor and door hardware vendor.

3.17 CUTTING, PATCHING AND CORE DRILLING

- .1 Unless otherwise provided by General Trades, perform cutting, patching, and core drilling of existing building required for installation of Electrical Divisions work. Perform cutting in a neat and true fashion, with proper tools and equipment. Patching is to exactly match existing finishes and be performed by tradesmen skilled in particular trade or application. Work is subject to acceptance by Owner and review with Consultant.
- .2 Criteria for cutting holes for additional services:
 - .1 cut holes through slabs only; no holes to be cut through beams;
 - .2 cut holes 150 mm (6") diameter or smaller only; review with and obtain direction from Consultant (Structural Engineer) for larger holes;
 - .3 keep at least 100 mm (4") clear from beam faces;
 - .4 space at least 3-hole diameters on centre;
 - .5 for holes that are required closer than 25% of slab span from supporting beam face, use cover meter above slab to clear slab top bars;
 - .6 for holes that are required within 50% of slab span, use cover meter underside of slab to clear slab bottom bars;
 - .7 submit sleeving drawings indicating holes and their locations for Consultant's (Structural Engineer's) review.
- .3 Where conduits and/or conductors penetrate existing construction, core drill or saw cut an opening. Size openings to leave 13 mm (1/2") clearance around conduit and/or conductors, and pack and seal void between opening and conduit and/or conductor for length of opening with ULC listed and labelled material in accordance with article entitled "Firestopping And Smoke Seal Materials" specified herein this Section.

- .4 Do not cut or drill any existing work without approval of Owner and review with Consultant. Be responsible for damage done to building and services caused by cutting or drilling.
- .5 Prior to drilling or cutting an opening, determine, in review with Consultant and Owner, and by use of non-destructive radar scan (magnetic scan) of slab or wall, presence of any existing services and reinforcement bars concealed behind building surface to be cut and locate openings to suit. Be responsible for damage to existing services caused by core drilling or cutting openings. Coring is not permitted through concrete beams or girders.
- .6 Fire stop and seal openings as specified, and patch as required before end of workday. No openings are to be left open overnight unless approved by Owner and reviewed with Consultant.

END OF SECTION

1 GENERAL

1.01 SUBMITTALS

- .1 Submit shop drawings for products and accessories.

2 PRODUCTS

2.01 GENERAL POWER CABLES

- .1 CSA approved, ULC labelled and certified. Unless otherwise noted, conductors to be copper and be suitable for applications as noted in governing local electrical code.
- .2 "RW90" CSA certified, single copper conductor to CSA C22.2 No. 38, 600/1000 volts, maximum 90°C (194°F) conductor temperature, -40°C (-40°F) minimum installation temperature, X-link polyethylene (XLPE) insulation, colour coded.
- .3 "RWU90" CSA certified, single copper conductor to CSA C22.2 No. 38, 1000 volts, maximum 90°C (194°F) conductor temperature, -40°C (-40°F) minimum installation temperature, extra thickness X-link polyethylene (XLPE) insulation suitable for wet and buried installations, colour coded.
- .4 "AC90" flexible armoured cable with "RW90" conductors and bare copper ground conductor and overall interlocked aluminium tape armour, to CSA C22.2 No. 51 (R2004).
- .5 "AC90 ISO-BX" flexible armoured cable with "RW90" conductors with low temperature Exelene insulation and two additional solid copper bonding conductors (one bare, one insulated) and overall interlocked aluminium tape armour, to CSA C22.2 No. 51(R2004).
- .6 Nexan DriveRX type cable for variable frequency drives: CSA approved to C22.2 no 123; flame, oil and UV resistant cable with copper conductors, corrugated continuous aluminum sheath and 3 bonding conductors; impact and crush resistant; temperature rating is 90°C to -40°C; 1000V 90C rated cross link polyethylene insulation; FT4 PVC jacket;
- .7 Solid conductors to and including No. 10 AWG; stranded conductors in sizes larger than No. 10 AWG; branch circuit conductors constructed of 98% conductive copper; and approved for minimum 600 volts, with minimum 1000 volts where noted.

2.02 CONNECTORS

- .1 General:
 - .1 materials: CSA approved and/or ULC listed and labelled as required by local governing authorities and codes;
 - .2 certification: CSA C22.2 No. 65;
 - .3 connectors marked with certification, manufacturer, manufacturer catalogue number and approval for conductor size and type.
- .2 Armoured cable connectors of proper squeeze type connectors and plastic anti-short bushings at terminations.

- .3 Connectors for conductors connecting to devices in accordance with local governing electrical requirements, equal to Ideal Industries No. 451, No. 452 and No. 453, "Wing-Nut", CSA certified, 600 volts rated, contoured wing design, fire retardant shell, twist on pressure type connectors.
- .4 Splice connectors to line voltage branch circuit conductors and feeders to be CSA approved compression type connectors as follows:
 - .1 of voltage rating to suit application;
 - .2 typically for conductors No 8 AWG and greater;
 - .3 long barrel, double crimp compression;
 - .4 tin plated seamless copper tubing;
 - .5 chamfered barrel;
 - .6 colour coded for die identification;
 - .7 used with manufacturer's matching dies and compression tool;
 - .8 covered with suitable 3M or Raychem flexible polyolefin, fire resistant, heat shrink tubing.
- .5 For conductors sized 3/0 and greater, provide long barrel double crimp, 2-hole compression type lug connectors, unless otherwise noted.

2.03 FIRE RATED CABLES

- .1 nVent - Pyrotenax, model "System 1850", CSA certified, ULC listed and labelled, FM Specifications tested, 600 V, type "MI", 2-hour fire rated, copper sheathed, copper conductor, highly compressed magnesium oxide mineral insulated power cable. Connectors for copper-sheathed mineral conductors to be cable manufacturer's proper connectors and accessories as recommended by manufacturer to suit specific applications. Certified to C22.2 No. 124 and ULC Listed 2-hour fire-resistive cable tested to ULC-S139 fire test standards.
- .2 nVent Pyrotenax, model "System 1850 Twisted Pair", CSA certified as FAS, FAS 90 and FAS 105 cable, ULC listed and labelled, 300 V, type "MI", 2-hour fire rated, copper sheathed, copper conductor, highly compressed magnesium oxide mineral insulated fire alarm and voice communication cable. Connectors for copper-sheathed mineral conductors to be cable manufacturer's proper connectors and accessories as recommended by manufacturer to suit specific applications. ULC Listed 2-hour fire-resistive cable tested to ULC-S139 fire test standards.
- .3 Manufacturer's termination kits: Pyropak epoxy sealing compound kits and "Quick Term" connectors; connectors for MI conductors to be cable manufacturer's proper connectors and accessories as recommended by manufacturer to suit specific applications.
- .4 Unistrut type C-channel supports, cable clips and straps as recommended by cable manufacturer to suit specific installation application. In applications of dissimilar materials, provide tape to insulate cabling and hardware.
- .5 Brass plates for cable openings in ferrous metal enclosures.

- .6 Include for required cable manufacturer's accessories and identification labelling.
- .7 Typically, splices are not permitted, but where required, use of factory or field splices to be approved by Owner and reviewed with Consultant. Refer to drawings for general locations of routing of cables and specific locations of field splices. For applications where splicing is not identified as requirement, factory splicing when approved by Owner and reviewed with Consultant may be provided based on manufacturer's review of routing and length of onsite runs. Field splicing when approved by Owner and reviewed with Consultant, to be performed by electricians trained by cable /splice manufacturer.
- .8 Manufacturer's splice kit – ULC listed, 2-hour fire rated, welded splice for MI cables; temperature rating of 1010°C (1850°F); stainless steel cones at each end of cupro-nickel barrel, and splice boxes.
- .9 Include for manufacturer's authorized technician to be present on site for initial coordination with installing personnel on review of proper installation of cabling runs, termination of cabling and making splices. Manufacturer's technician to be also onsite to witness splicing work. After completion of Work, manufacturer's technician to review installation and splicing work and provide in writing that splicing and installation work has been performed to satisfaction of cable manufacturer.
- .10 Include for manufacturer's authorized technician to perform initial coordination with and providing training to installing personnel on review of proper installation of cabling runs and termination of cabling. After completion of Work, manufacturer's technician to review installation work, test cabling and terminations and provide formal report of test results with observations, certification that installation work is complete and cabling with terminations perform as required, to satisfaction of cable manufacturer.
- .11 Acceptable manufacturer of fire rated MI type cables is nVent.

2.04 STANDARD CONTROL AND COMMUNICATIONS CABLES

- .1 Type LVT 300 V:
 - .1 CSA approved, FT4 rated.
 - .2 Solid annealed copper conductors sized as indicated.
 - .3 Insulation: Polyethylene.
 - .4 Overall covering: PVC jackets.
 - .5 Where installed in plenums, cable to be certified to C22.2 No.214 and FT6 rated.
- .2 Type TEW:
 - .1 ULC listed and labelled, CSA certified to C22.2 No. 127.
 - .2 Solid copper wire rated for 600 volts, No. 18 AWG.
 - .3 Thermoplastic insulated with overall nylon jacket.
 - .4 105°C (220°F) conductor temperature.
 - .5 Complete with required number of copper conductors and colour coding.

- .3 For interconnection of security system elements, including fire protective signaling devices and two-way emergency communication systems:
 - .1 Nexans, "Securex II", FAS 105, 300 volts, 105°C (220°F) conductor temperature rated fire alarm system flexible armoured cable with solid copper conductor, shielding, flame retardant PVC insulation and red colour outer overall jacket, ULC listed and labelled and CSA certified to C22.2 No. 208.
 - .2 When not run in conduit, include interlock aluminum or galvanized steel armour with overall jacket.

2.05 CONDUCTOR PULLING LUBRICANT

- .1 IDI Electric, "Ideal Yellow 77" or "Wire Lube" as required.
- .2 "French Chalk" or "Talcum Powder" conductor pulling lubricant.

2.06 CABLE SPLICE KITS

- .1 3M Company, cold shrink in line splice kits as follows:
 - .1 CSA approved;
 - .2 meets requirements of ANSI C119-1 Standard with voltage ratings up to 1 kV;
 - .3 cold shrink design which requires no application of heat source for installation;
 - .4 open-ended, tubular, rubber sleeves which are factory expanded and assembled onto removable core;
 - .5 core is removed after the tube has been positioned for installation over inline connection, terminal lug, etc., allowing tube to shrink and form water-resistant seal;
 - .6 cold shrink tubing constructed of EPDM rubber;
 - .7 suitable for indoor, outdoor and direct burial applications;
 - .8 additionally, include required compression lugs of type compatible with cable type and electrical vinyl or silicone tape.
- .2 Provide exact splice type as per termination manufacturer's recommendations to match (or exceed where applicable) cable properties including following:
 - .1 voltage class rating and insulation BIL level;
 - .2 conductor material, conductor size and cable/shielding type;
 - .3 indoor or outdoor application.
- .3 Install splice kits in accordance with manufacturer's detailed instructions. Prepare cable for accommodating splice jacketing tubes and body in accordance with splice kit manufacturer's instructions. Install proper lugs to suit application as per cable manufacturer's recommendations, using matching size die and crimping tool. Apply overall taping. After installation has been completed and inspected, test splice as per manufacturer's recommendations.

.4 Acceptable manufacturers are:

- .1 3M Company;
- .2 Tyco Raychem;
- .3 Prysmian Cables.

3 EXECUTION

3.01 PROJECT CONDITIONS

- .1 If identified in documents, verify that field measurements and conditions are as identified.
- .2 Unless specifically noted, cable routing on drawings is schematic and approximate and not reflective of elevations. Route cable as required to meet project conditions. Determine exact routing and lengths on site.
- .3 Confirm fire protection ratings of construction to ensure that rooms and paths of conductors are fire rated in accordance with local governing codes requirements. Include fire rated conductors as required to meet local governing codes requirements.

3.02 CO-ORDINATION

- .1 Co-ordinate work with work provided under other electrical work and work of other trades.
- .2 Determine required separation between cable and other work.
- .3 Determine cable routing to avoid interference with other work.
- .4 Submit any alternative cable routing to Consultant for review prior to proceeding with work.

3.03 INSTALLATION OF CONDUCTORS

- .1 Provide required conductors. Provide fire rated conductors for applications as required by local governing codes and standards, and requirements of local governing authorities.
- .2 In applications where, multiple conductors in conduit are being run, provide trapeze configuration of Unistrut type metal C-channels and threaded rod hangers to support cable/conduit from ceiling slab. Wall mounted cable/conduit brackets and ring type conduit hangers may be permitted in applications approved by Owner and reviewed with Consultant. Provide required cable support system accessories which are not specified herein or shown on drawings but are required for proper installation.
- .3 Conductors, unless otherwise noted, to be as follows:
 - .1 for connections to electric heating coils in supply air ductwork systems, and for connections to other electric heating equipment where use of 90 degrees C. rated conductors are recommended by heating equipment manufacturer - "RW90";

- .2 for conductors requiring fire rating by current regulations and local codes including feeders for emergency systems, fire fighter's elevators, fire alarm systems, other life safety systems and for applicable signal and control circuits of these systems - type "MI" CSA approved, ULC listed and labelled, 2-hour fire rated, copper sheathed mineral insulated copper conductors;
 - .3 branch circuit wiring for patient care areas accessible suspended ceiling spaces consisting of drops down to luminaires - "AC90" flexible armoured cable ("BX"); (maximum 3 m (10') run permitted); flexible armoured cable (i.e. "AC90") is not permitted within walls of patient care areas";
 - .4 branch circuit wiring for non-patient care areas in accessible ceiling spaces and within stud wall construction consisting of drops down to luminaries and drops down stud walls to devices and in furniture systems - "AC90" flexible armoured cable ("BX") (maximum 6 m (20') run permitted);
 - .5 for installation interior of pre-fabricated service consoles – "T90 Nylon" or "RW90" in flexible metallic conduit; or "AC90 ISO-BX" to code requirements; refer also to drawing notes;
 - .6 for isolated power system load side wiring – "RW90";
 - .7 for connections to variable speed drives: Nexan DriveRX type cable for variable frequency drives as recommended by drive manufacturers;
 - .8 for climate-controlled areas wiring except as noted above or specified elsewhere in Specification or as noted on drawings - "T90 Nylon" or "RW90".
- .4 Support flexible armoured cable in ceiling spaces and in stud wall construction with steel 2 holes cable straps to "Code" requirements. Run flexible armoured cables in neat manner parallel to building lines. Utilize centralized conduit runs to maintain maximum permitted runs of flexible armoured cables as recommended by cable manufacturer and as required by local governing codes. Provide insulating grommet at cut ends of flexible armoured cable to protect conductor insulation.
 - .5 Splicing of conductors is permitted for replacement of existing conductors and extension as noted on drawings and where approved by Owner and reviewed with Consultant. Splicing of conductors is subject to following conditions:
 - .1 splicing to extend existing conductors;
 - .2 for low voltage control and signal conductors, splicing made within an electrical box with terminal strips;
 - .3 for interior line voltage conductors, splicing made within an electrical box with cold shrink splice kits and mechanical compression connectors; full assembly to suit type and size of conductors and as reviewed with Consultant;
 - .4 for exterior line voltage conductors, splicing made with outdoor weatherproof cold shrink splice kits and mechanical compression connectors; full assembly to suit type and size of conductors and as reviewed with Consultant;
 - .5 splice/splice box properly identified with suitable painting or labelling;
 - .6 splice/splice box clearly identified on "as-built" drawings;

- .7 use of pressure type twist connectors only for specific applications with prior review with Consultant, but generally not permitted;
- .8 use of "split bolts" is not permitted.
- .6 Install compression connectors with proper dies and compression tool as per connector manufacturer's instructions. Install cold shrink tubing and associated materials as per manufacturer's instructions.
- .7 Install control wiring as required and as indicated. Confirm exact type of control wiring with manufacturers of equipment/systems being interconnected, and as required by local governing electrical code. Provide required fire alarm cables for fire alarm system applications or security system applications as recommended by fire alarm system manufacturer, complying with requirements of local governing code and local governing authorities. Typically run control wiring in conduit. Conductors not installed in conduit or raceways to be fire insulated rated in accordance with latest governing code flame spread ratings requirements, and suitably mechanically protected by means acceptable to Owner and reviewed with Consultant. Ensure that conductors comply with fire rating - FT6 rating requirements when run in plenums and similar construction.
- .8 Coordinate responsibility for provision of control wiring for Mechanical Division equipment and equipment of other Divisions, with respective Divisions of the Work.
- .9 Generally, conductor sizes are indicated on drawings. Such sizes are minimum requirements and must be increased, where required, to suit length of run and voltage drop in accordance with applicable conductor voltage drop schedule on drawings or obtained from Consultant. Conductors not sized or specified of type, to be sized and of type in accordance with requirements of local governing electrical code.
- .10 Do not use conductors smaller than No. 12 AWG in systems over 30 volts, unless otherwise noted. Do not use conductors smaller than No. 6 AWG for exterior luminaire wiring unless otherwise noted.
- .11 Colour code conductors throughout to identify phases, neutrals and ground by means of self-laminating coloured tape, coloured conductor insulation, or properly secured coloured plastic discs. Colours, unless otherwise noted, to be as follows:
 - .1 Phase A - red;
 - .2 Phase B - black;
 - .3 Phase C - blue;
 - .4 Ground - green;
 - .5 Neutral - white;
 - .6 Control - orange.
- .12 Colours for isolated power system "load" side power wiring to be as follows:
 - .1 Live No. 1 - brown;
 - .2 Live No. 2 - orange;

- .3 Ground - green.
- .13 Use "French Chalk" or talcum powder for pulling in isolated power centre "load" side wiring.
- .14 When pulling wires into conduit use lubricant and ensure that wires are kept straight and are not twisted or abraded.
- .15 Control conductors, in addition, to be numbered with Brady Ltd. or Electrovert Ltd. Z type markers.
- .16 Colour code conductors for communications systems in accordance with system component manufacturer's recommendations.
- .17 Neatly secure exposed wire in apparatus enclosures with approved supports or ties.
- .18 Install low voltage conductors in conduits, unless otherwise noted within Documents.

3.04 INSTALLATION OF FIRE RATED CONDUCTORS

- .1 Obtain from local governing electrical authority, approval of proposed fire rated cable to be installed.
- .2 Obtain installation and testing training from cable manufacturer as required for specific cabling type. Installation to be performed by personnel experienced in installation of specific cabling.
- .3 Submit with shop drawings, copy of manufacturer's detailed installation manual and testing procedures. Provide 2-hour fire rated type, CSA approved, ULC listed and labelled, copper conductors for following:
 - .1 conductors to smoke venting fans;
 - .2 conductors to emergency lighting panel boards;
 - .3 conductors to fire alarm control panels and transponders;
 - .4 fire alarm conductors risers;
 - .5 conductors as required by Code requirements;
 - .6 fire alarm system feeders as shown interconnecting existing fire alarm system and additional system;
 - .7 applicable local governing code required applications for control and signalling conductor circuits of and between life safety equipment and systems;
 - .8 conductors as noted on drawings.

- .4 Provide fire rated type cabling for specific conductors as noted and as required for specific applications by local governing codes. Install fire rated type conductors for applications noted above and as shown on drawings in strict accordance with the manufacturer's instructions and recommendations. Installation must be in a neat and professional manner as per manufacturer's approval. Make arrangements for manufacturer's technician to provide onsite services as specified. Conductors not sized on drawings, to be sized in accordance with requirements of local electrical code.
- .5 Provide Unistrut C-channels, clips, wall brackets, etc., as required and as recommended by cable manufacturer to suit the on-site installation conditions. Provide system of Unistrut type C-channel hangers and rods spaced at minimum 1.2 m (4') but which must be confirmed with cable manufacturer, for running of cables. Where clips and other hardware are in contact with cables, insulate cables/hardware with suitable tape as per cable manufacturer's recommendations for applications of dissimilar metals.
- .6 Make terminations of conductors with manufacturer's approved components and connectors in accordance with manufacturer's recommendations. Obtain proper tools for cable terminals from the cable manufacturer. Terminations must be completed immediately once started to avoid moisture ingress from the surrounding air. Connections to ferrous cabinets for single conductor cables shall incorporate brass plates sized as required and as per cable manufacturer's requirements. Brass plates shall be complete with required drilled and tapped holes. Cable lugs to be temperature rated as per manufacturer's instructions.
- .7 Provide factory splices of cables where noted on drawings as approved by Owner and reviewed with Consultant, and by means as per manufacturer's instructions. Splices to include overall weatherproof heat-shrinkable tubing. Clearly identify splice with proper identification labelling/markers and locate on as-builts. Comply with manufacturer's instructions. Where splices are permitted, locate in area accessible. Review locations of splices with Consultant, prior to start of Work.
- .8 When pulling cable, apply pulling tension to the conductor not in sheath of cable. Limit cable pulling tension to as recommended by cable manufacturer.
- .9 Terminate cable in equipment with termination kits as per cable manufacturer's instructions.
- .10 Terminations to be witnessed by manufacturer's authorized technician. Perform terminations in accordance with cable manufacturer's instructions.
- .11 Terminate cables to transformers, motors and other vibrating equipment by use of means to isolate vibration in accordance with cable manufacturer's recommendations.
- .12 Installation of cable splices and terminations to be witnessed by manufacturer's authorized technician. Perform splicing and terminations in accordance with cable manufacturer's instructions. Ensure that space for splices is sufficient to properly accommodate bundled cables and splice box.
- .13 Ground cabling as per cable manufacturer's instructions and as per local governing electrical code requirements.
- .14 Take necessary precautions when handling cable on reel to ensure that no damage will result in the uncoiling process.

- .15 Where cables penetrate fire rated construction, provide ULC listed and labelled, fire stopping and smoke seal materials or fittings to protect integrity of fire rated construction. Install work in compliance with ULC standards and where required by local governing codes, provide tray type suitable for plenum environments.
- .16 Engage with cable manufacturer to test cables and terminations after installation, in strict accordance with cable manufacturer's recommendations. Megger terminations to check that insulation resistance is acceptable to cable manufacturer. Prior to completing each termination, test insulation resistance and follow cable manufacturer's procedures until resistance reaches cable manufacturer's listed acceptable level.
- .17 Include and arrange for cable manufacturer's authorized representative to review installation and associated work and testing of installed cables. Prepare report consisting of test sheets with results of cables tested and a certificate of verification signed by testing engineer/technician. Report to include copy of cable manufacturer's signed inspection letter validating test results and documenting that work was performed to satisfaction of manufacturer. Submit minimum one hard copy and electronic copy to Consultant.

END OF SECTION

1 GENERAL

1.01 SUBMITTALS

- .1 Submit shop drawings for products and accessories.

2 PRODUCTS

2.01 BASIC MATERIALS

- .1 General:
 - .1 Materials: CSA approved and/or ULC listed and labelled as required by local governing authorities and codes.
 - .2 Certification: CSA C22.2 No. 41.
 - .3 connectors marked with certification, manufacturer, manufacturer catalogue number and approval for conductor size and type.
- .2 Ground Rods: Copper-clad steel, 20 mm (3/4") diameter circular cross-sectionalized, with driving cap and bronze tip, overall length of 3 m (10') long.
- .3 Ground Conductors: Solid copper, insulated and bare to suit application and code requirements; and bond conductors.
- .4 Ground Busbar: Solid copper busbar, predrilled for two-hole lug connections, of size of 50 mm x 9 mm x 900 mm (2" x 3/8" x 36"), for wall and backboard mounting using standoff insulators.
- .5 Main Electrical Room Ground Busbar: Solid copper busbar, predrilled for two-hole lug connections, of size of 50 mm x 9 mm (2" x 3/8") and of continuous length around perimeter of room, for wall and backboard mounting using standoff insulators.
- .6 Ground Connections:
- .7 Ground Pit: Flush in grade grounding pits with following features:
 - .1 removable cast concrete cover with recessed lifting handle;
 - .2 cast iron or precast concrete pit;
 - .3 ground rod, ground clamps and grounding conductors as required;
 - .4 clay sewer tile for proper drainage.
- .8 Gravel/Stones: Provide gravel and crushed stones as required by local governing authorities to suit application. Layers to be of thickness not less than required by local governing authorities.
- .9 Miscellaneous ancillary components to complete grounding and bonding work to requirements of local governing electrical authority and codes.
- .10 Acceptable Manufacturers:

- .1 Exothermic Process:
 - .1 Cadweld (nVent - Erico).
 - .2 BURNDYWeld (Hubbell).
- .2 Compression Connectors, Ground Rods, Bus Bars, Fittings and Ancillary Products:
 - .1 Hubbell – Burndy.
 - .2 nVent – Erico.
 - .3 ABB – T&B.
 - .4 ILSCO.

2.02 TELECOMMUNICATIONS

- .1 Telecommunications Equipment Rack and Cabinet Ground Bars: Solid copper ground bars designed for mounting on framework of open or cabinet-enclosed equipment racks with minimum dimensions of 6 mm (1/4") thick by 20 mm (3/4") wide. At any equipment mounting location (backboards and hinged cover enclosures) where rack-type ground bars cannot be mounted, provide screw lug-type terminal blocks. Where bolting to painted surfaces, use paint piercing type washers.
- .2 LAN Room Ground Bus: 50 mm x 9 mm x 300 mm (2" x 3/8" x 12") copper ground bus with eight drilled taped holes; mounted on walls with standoff insulators.
- .3 Ground Conductor for Grounding Grid and Associated Connections: Number 3/0 AWG bare, 7-strand medium hard-drawn copper unless indicated otherwise.
- .4 Ground Braid: constructed from flat 98% conductivity tinned copper grounding braid.
- .5 Acceptable Manufacturers:
 - .1 Hubbell – Burndy.
 - .2 nVent – Erico.
 - .3 ABB – T&B.
 - .4 ILSCO.

3 EXECUTION

3.01 GENERAL GROUNDING AND BONDING REQUIREMENTS

- .1 Provide required grounding and bonding work in accordance with drawings, local governing electrical authority, governing authorities having jurisdiction and local governing electrical inspection authority. Provide local governing electrical utility's grounding requirements for stations, vaults and electrical rooms, as applicable. Confirm requirements with local governing electrical utility. Comply with requirements of local governing electrical codes.

- .2 Provide 50 mm x 9 mm (2" x 3/8") continuous length, copper ground bus around perimeter of electrical rooms, 300 mm (12") above finished floor level. Secure ground bus on 20 mm (3/4") standoff insulators and follow outline of doorframes at door openings to form a continuous bus. At each door to electrical rooms, provide two independent flexible braided copper ground straps, one bolted to door frame, one bolted to door, each connected to ground bus.
- .3 Connect ground electrode to perimeter ground bus with two minimum No. 3/0 copper conductor connected with approved fittings. Connect each electrical room perimeter ground electrode system back to main electrical room ground electrode with two minimum No. 3/0 copper conductors.
- .4 Ground and bond other equipment such as transformers, switchboards, panelboards, and similar metal work to perimeter ground bus. Provide minimum No. 3/0 insulated ground wire from ground bus in electrical rooms to switchboards, transformers, structure, floor, etc.
- .5 Extend conductors to metal piping of main water service and connect ground conductor to street side of water meter. If piping is not metallic, make necessary connections as required by local governing electrical utility.
- .6 Effectively bond metallic pipe services such as, gas mains, water mains, and dry risers, to main grounding terminal at their point of entry. Make connections to services with purpose-made grounding clamps.
- .7 When buses are in place, bolts have been tightened, and lugs have been installed, coat entire installation with two 100% covering coats of suitable shellac to prevent bus from oxidizing.
- .8 Throughout complex, solidly ground systems and make required grounding connections to electrical devices and apparatus. Ground conductors to be insulated copper wire connected with approved fittings in accordance with local governing electrical code.
- .9 Effectively bond building structures to main grounding system (grid).
- .10 Provide separate insulated ground wire for each isolated ground receptacle.
- .11 Extend isolated grounding conductors of computer receptacles to isolated ground bus of computer panel board serving area. From ground bus extend ground conductors to building grounding station.
- .12 In areas of raised floor systems, provide copper ground system as sized and detailed on drawings, and provide in compliance with local governing electrical code requirements. Bond ground system to raised floor supports and floor structure using ground clamps suitable for application, and connect system to building ground system with grounding conductors run in conduit. Bond metallic conduit which penetrates raised floor to raised floor stringer system. Install clamps and other accessories as per manufacturer's recommendations and instructions.
- .13 Connect grounding conductors to motors 10 hp and above or circuits 20A or above, with a solderless terminal and a bolt tapped to motor frame or equipment housing. Connect to smaller motors or equipment by fastening terminal to a connection box. Connect junction boxes to equipment grounding system with grounding clips mounted directly on box or with machine screws. Completely remove paint, dirt, or other surface coverings at grounding conductor connection points so good metal-to-metal contact is made.

- .14 Ground metal sheathing and exposed metal vertical structural elements of buildings. Ground metal fences enclosing electrical equipment. Bond metal equipment platforms which support electrical equipment to equipment ground. Bond rooftop equipment.
- .15 Bond metal work associated with pools such as reinforcing steel, piping, ladders and ancillary devices, above ground loops by copper conductors in accordance with local governing electrical code. Clean water pump prior to bond being using approved clamps. As required, make several bonds at various locations or collect wires and make one bond. Ground electrical equipment associated with these piping systems, adequately by installing flexible conduit and ground jumper wire to motors. Ground telephone boxes, speakers, pull stations and other such equipment within pool area with jumper wires within connecting conduit to ensure proper grounding. Include for ground connections to pool reinforcing steel.
- .16 Provide separate ground connection for bathtubs.
- .17 Provide service conductors exceeding 400 amperes with minimum No. 3/0 AWG grounding conductors, unless otherwise noted.
- .18 Ground and bond various telecommunications, audio visual systems, security, life safety and control systems in accordance with respective system manufacturers' recommendations and in accordance with local governing electrical code requirements.
- .19 Do not use conduit systems as ground conductors in patient care areas or in areas as per local governing electrical code requirements.
- .20 Extend grounding from ground bus in isolated power units to ground busses within panelboard serving area. From ground bus extend ground conductors in PVC conduit which is located in a concealed space in a wall or in a concrete floor slab and connect to building grounding station as close as practical to station.
- .21 Confirm exact method of executing grounding for isolated ground system with governing authorities. Generally, method to comply with CSA Standard Z32 and NFPA No. 56. Testing of grounding of isolated ground system to be performed by independent test company specified for "Distribution System Testing and Coordination Study" work.
- .22 Isolated Power System Grounding:
 - .1 When grounding is complete, arrange for local governing electrical authority inspection and approval of system and work.
 - .2 Testing as specified in isolated power centre section to be conducted in presence of Owner, Consultant, and local governing electrical authority inspector.
 - .3 Include a program of ground leakage testing using approved leakage detector and recording of results. Ohmmeter or megger tests will not be satisfactory.
 - .4 Submit testing report to Consultant for review.
 - .5 Comply with requirements of CSA Z32.
 - .6 Obtain local governing electrical authority's written acceptance of isolated power system ground system and turn over to Consultant. Perform changes as required by local governing electrical authority Inspector.

- .23 Make ground connections in slab or buried underground, or for joining dissimilar metals, using exothermic welding type copper connections. Install in accordance with manufacturer instructions.
- .24 Make exposed ground connections using compression connectors and other grounding fittings suitable for applications. Install in accordance with manufacturer instructions.
- .25 Provide minimum no. 3/0 AWG insulated copper ground conductors and LAN Room copper ground bus mounted on walls with standoff insulators in each LAN room. Connect ground bus to computer equipment racks and to building ground system.
- .26 Ground conductors not sized on drawings are to be sized in accordance with local governing electrical authority requirements. Ground conductor size is to be no smaller than requirements specified herein this article or on drawings.

3.02 ADDITIONAL TELECOMMUNICATIONS GROUNDING

- .1 Comply with TIA/EIA 607 grounding and bonding requirements.
- .2 Provide wire and hardware required to properly ground, bond, and connect communications raceway, cable tray, metallic cable shields, and equipment to a ground source.
- .3 Ground bonding jumpers to be continuous with no splices. Use shortest length of bonding jumper possible.
- .4 Provide ground paths which are permanent and continuous with resistance of 1 ohm or less from raceway, cable tray, and equipment connections to building grounding electrode. Resistance across individual bonding connections to be 10 milliohms or less.
- .5 Bonding Jumpers:
 - .1 Use insulated ground wire of size and type if identified on Drawings, if not identified, comply with local governing code, but which is minimum No. 6-AWG insulated copper wire.
 - .2 Assemble bonding jumpers using insulated ground wire terminated with compression connectors.
 - .3 Use compression connectors of proper size for conductors specified. Use connector manufacturer's compression tool.
- .6 Bonding Jumper Fasteners:
 - .1 Conduit: Fasten bonding jumpers using screw lugs on grounding bushings or conduit strut clamps, or clamp pads on push-type conduit fasteners. When screw lug connection to a conduit strut clamp is not possible, fasten plain end of a bonding jumper wire by slipping this plain end under conduit strut clamp pad; tighten clamp screw firmly. Where appropriate, use zinc-plated external tooth lock washers.
 - .2 Metal Wireway and Cable Tray: Fasten bonding jumpers using zinc-plated bolts, external tooth lock washers, and nuts. Install protective cover; e.g., zinc-plated acorn nuts, on any bolts extending into wireway or cable tray to prevent cable damage.

- .3 Ground Plates and Busbars: Fasten bonding jumpers using two-hole compression lugs. Use tin-plated copper or copper alloy bolts, external tooth lock washers, and nuts.
- .4 Unistrut Type Metal Channel Supports and Raised Floor Stringers: Fasten bonding jumpers using zinc-plated, self-drill screws and external tooth lock washers.
- .7 Building Ground Busbars:
 - .1 Provide busbar hardware at each communications room and connect to pigtail extensions of building grounding ring.
 - .2 Verify that ground ring pigtail is same type and size conductor used for main building grounding ring.
- .8 Telecommunications Ground Busbars:
 - .1 Provide communications room telecommunications ground busbar hardware at cable tray height.
 - .2 Connect busbar to building ground busbar located in same room using two-hole compression lugs and a grounding jumper of same size as pigtail extension of main building grounding ring (usually minimum 3/0 AWG).
- .9 Ground metallic conduits, wireways, and other metallic equipment located away from equipment racks or cabinets to cable tray pan or telecommunications ground busbar, whichever is closer, using insulated minimum No. 6-AWG ground wire bonding jumpers.
- .10 Ground metallic conduit at each end using minimum No. 6-AWG bonding jumpers.
- .11 Comply with cable tray manufacturer's grounding and bonding recommendations. Bond metallic structures of wireway to provide 100% electrical continuity throughout wireway system.

END OF SECTION

1 GENERAL

1.01 SUBMITTALS

- .1 Submit shop drawings for following:
 - .1 cable tray with copy of ULC certificate and/or proof of CSA approvals;
 - .2 cable duct with copy of ULC certificate and/or proof of CSA approvals;
 - .3 copy of installers' training certificate from manufacturer.
- .2 Submit detail drawings of proposed routing and dimensions.
- .3 Submit sample of trays and duct.

2 PRODUCTS

2.01 BASKET CABLE TRAY

- .1 Legrand-Cablofil, CSA approved and labelled, or ULC listed, basket type cable tray system complete with factory made couplers, fittings, tee sections, elbows, universal dropouts, etc., and required supporting and installation accessories. Features include but are not limited to following:
 - .1 minimum 300 mm x 100 mm (12" x 4") unless otherwise noted on drawings;
 - .2 welded wire construction of minimum 5 mm (0.197") diameter carbon steel wires and hardware, conforming to requirements of ASTM A510 Grade 1008 with black powder coated finish paint to ASTM D 3451;
 - .3 continuous, rigid, welded steel wire mesh cable tray system;
 - .4 top wire safety edge;
 - .5 wire mesh welded at intersections;
 - .6 mesh sections having minimum one bottom longitudinal wire along entire length;
 - .7 warning signs;
 - .8 accessories included as required.
- .2 Prior to start of work, prepare and submit detailed installation drawings, including plans, elevations and sections of proposed tray and routing. Coordinate such drawings with coordination drawings of trades. Include for design calculations to determine load limitations.
- .3 Tray to not have sharp edges that may damage cables during running of cables. Final finish to be smooth with no burrs that may damage cables.
- .4 Use manufacturer's trained and certified installers to perform work. Use tools as recommended by and supplied by tray manufacturer. Utilize manufacturer's supplied cutter for cutting tray. Submit with shop drawings, copies of installing technicians' certificates of training on respective tray systems.

- .5 Provide support of a trapeze configuration containing horizontal hanger brackets and vertical threaded rods on each side. Secure rods to brackets as per system manufacturer's instructions. Space supports at maximum 1.5 m (5'), to provide support of loads up to 53 kg/m (36 lbs per foot).
- .6 Where cable tray penetrates fire rated construction, provide ULC listed and labelled, fire stopping and smoke seal materials or fittings to protect integrity of fire rated construction. Install work in compliance with ULC standards and where required by local governing codes, provide suitable for plenum environments.
- .7 Provide tray complete with manufacturer's pre-manufactured accessories including but not limited to:
 - .1 splices, tee sections, elbows and braces to join and run tray in required configurations;
 - .2 cable exits and dropouts as required to protect cables when entering and exiting tray;
 - .3 conduit attachment fittings and clamps as required to connect conduits to tray;
 - .4 grounding/bonding hardware provisions to maintain ground continuity;
 - .5 dividers to separate various system cabling to degree reviewed with Consultant, but typically two dividers in 300 mm (12") wide tray;
 - .6 cable installation rollers for pulling cables safely into tray;
 - .7 mounting brackets, supports and seismic restraints to suit specific applications;
 - .8 top covers and bottom inserts to protect cables, as required.
- .8 System accessories matching construction material of tray, to be supplied by system manufacturer to suit specific applications.
- .9 Manufacturer to provide installer with required certified training of installation of tray system.
- .10 Acceptable manufacturers are:
 - .1 Legrand-Cablofil;
 - .2 Eaton "Flextray";
 - .3 Canadian Electrical Raceways;
 - .4 Hubbell;
 - .5 WBT.

2.02 LADDER CABLE TRAY

- .1 Thomas & Betts, CSA approved and labelled, ladder type cable tray as follows:
 - .1 in compliance with CSA C22.2 No. 126.1 and NEMA VE1;

- .2 sized generally 300 mm W x 100 mm D (12" x 4") unless otherwise noted on drawings;
 - .3 side rails reinforced with flanges;
 - .4 maximum 150 mm (6") rung spacing and supplied in 3 m (10') lengths;
 - .5 rated for minimum CSA load D unless otherwise noted on drawings; cable tray to meet required NEMA/CSA load ratings with safety factor of 1.5 and also be able to support a 90 kg (200 lb) concentrated load at midspan over and above cable load;
 - .6 refer to drawings for approximate tray routings and lengths.
- .2 Accessories:
- .1 Factory made conduit connectors, couplers, fittings, tee sections, elbows, universal dropouts.
 - .2 Dividers constructed of same materials as tray, to separate cables; refer to drawings for quantity.
 - .3 Seismic restraints to local governing building code requirements to prevent horizontal movement.
 - .4 Grounding and bonding jumpers and hardware to maintain electrical continuity.
 - .5 Required supporting and installation accessories.
- .3 Include for a trapeze configuration of threaded rod supports secured to ceiling slab and extending down to secure to steel C-channel support, creating a cradle for support of system. Cable tray to be connected continuously with no breaks.
- .4 Prior to start of work, prepare and submit detailed installation drawings, including plans, elevations and sections of proposed tray and routing. Coordinate such drawings with coordination drawings of trades. Include for design calculations to determine load limitations.
- .5 Clean final finish of burrs and other material or imperfections prior to installation of cabling, to satisfaction of Consultant. Final finish to be smooth with no burrs that may damage cables.
- .6 Provide tray complete with tray manufacturer's grounding/bonding fittings and hardware.
- .7 Provide conduit fittings where conduits enter tray and provide dropouts at ends where cables exit/enter. Supply cable installation rollers for pulling cables safely into tray. Provide rollers or other hardware to maintain cable-bending radii within cable manufacturer's recommended standards to suit type of cable. System accessories to be supplied by system manufacturer and be as recommended by system manufacturer for specific applications.
- .8 Factory fabricate changes in direction, tees, 90° bends, universal dropouts, etc.

- .9 Where cable tray penetrates fire rated construction, provide ULC listed and labelled, fire stopping and smoke seal materials or fittings to protect integrity of fire rated construction. Install work in compliance with ULC standards and where required by local governing codes, provide tray type suitable for plenum environments.
- .10 Acceptable manufacturers are:
 - .1 Thomas & Betts;
 - .2 Legrand;
 - .3 Eaton B-Line;
 - .4 Canadian Electrical Raceways.

2.03 CABLE DUCT

- .1 Legrand -Wiremold "Wallduct", CSA approved and labelled, 250 mm (10") wide, 100 mm (4") deep, unless otherwise noted on drawings, constructed from No. 16 gauge galvanized steel, barriered 3-compartment solid bottom custom cable duct wireway supplied in 3 m (10') lengths with hinged covers supplied in 1.5 m (5') long sections and complete with required dividers, conduit knockouts, elbows, fittings, end closures, grommet ends, couplings, etc., and required mounting and connection hardware.
- .2 Prior to start of work, prepare and submit detailed installation drawings, including plans, elevations and sections of proposed routing. Coordinate such drawings with coordination drawings of trades.
- .3 Lengths of ducts, number of barriers and cover types may vary depending on site installation requirements. For flush or surface mounted applications, provide hinged covers of lengths to avoid supports and to accommodate restricted spaces are required to suit and are to be reviewed and coordinated with Consultant. Ducts within walls do not require removable covers.
- .4 For surface wall mounting applications, cable duct to be complete with drilled holes for mounting and wall brackets.
- .5 For ceiling suspended applications, provide support of a trapeze configuration containing horizontal hanger brackets and vertical threaded rods on each side of duct. Secure rods to brackets and ceiling slab as per system manufacturer's instructions.
- .6 Entire duct system to be provided with powder coat finish of colour reviewed with Consultant.
- .7 Submit with shop drawings, copy of CSA certificate of approval for specified ducts.
- .8 Acceptable manufacturers are:
 - .1 Legrand -Wiremold;
 - .2 Thomas & Betts;
 - .3 Canadian Electrical Raceways.

3 EXECUTION

3.01 INSTALLATION OF CABLE TRAY

- .1 Provide sample of tray and detailed drawing layout of work prior to start of work, accurately dimensioned and showing required routing, penetrations, connections, bends, supports, etc.
- .2 Obtain required training from manufacturer's representative on any special installation procedures. Install tray in accordance with manufacturer's instructions to suit specific installation requirements. Use manufacturer's recommended tools for cutting and installing tray.
- .3 Drawings are diagrammatic and do not identify required changes in elevations and architectural features. Site measure exact routing and lengths. Provide detailed drawing layout of work prior to start of work, accurately dimensioned and showing required penetrations, connections, bends, etc.
- .4 Install and hang cable tray at maximum 1.5 m (5') centres and in accordance with manufacturer's published literature employing horizontal bracket supported to ceiling slab by vertical threaded rod hangers. Do not secure assembly from ductwork, suspended ceiling structures, lighting, etc. Secure rod hangers directly to ceiling slab. Locate supports as not to interfere with removal or opening of covers. Typically locate spans at intervals $\frac{1}{4}$ span from supports, as recommended by tray manufacturer. Refer to drawing details and/or manufacturer's instructions. Include for provision of required seismic restraints as to comply with local governing building code requirements.
- .5 Provide proper fittings in cable tray at points of conduit entry. Terminate conduits at or in tray with proper grommetted and bushed terminations.
- .6 Equip tray with necessary wall flanges, dropouts, enclosures, reducers, fittings, and similar accessories required, maintaining effective free cross-sectional area of tray clear of obstructions that might damage conductor insulation during installation. Accessories are to be typically pre-manufactured by manufacturer to suit specific applications.
- .7 Properly secure, adequately support and neatly harness conductors in tray. Seal cable tray penetrations of building fire barriers by means of ULC listed and labelled fire stopping and smoke sealing material.
- .8 Provide continuous paths along entire lengths of cable tray to maintain proper ground continuity. Utilize system manufacturer's proper grounding and bonding fittings and hardware. Ground and bond system as per local governing electrical code requirements.
- .9 File smooth cuts to tray and re-touch with galvanizing compound.
- .10 Install expansion connectors where cable tray crosses building expansion joints.
- .11 When installing cables into tray, do not exceed manufacturer's recommended load capacities for tray.
- .12 After installation is complete, install warning signs on tray in visible locations.
- .13 Inspect tray for rough finishing burrs, sharp edges, and mechanical deficiencies prior to installing of cabling. Eliminate these deficiencies to satisfaction of Consultant, prior to installing cables.

- .14 Do not install non-plenum rated cable in cable trays located in plenum environments.

3.02 INSTALLATION OF CABLE DUCT

- .1 Provide sample of duct and detailed drawing layout of work prior to start of work, accurately dimensioned and showing required routing, penetrations, connections, bends, supports, etc.
- .2 Obtain required training from manufacturer's representative on any special installation procedures. Install tray in accordance with manufacturer's instructions to suit specific installation requirements. Use manufacturer's recommended tools for cutting and installing duct.
- .3 Drawings are diagrammatic and do not identify required changes in elevations and architectural features. Site measure exact routing and lengths. Provide detailed drawing layout of work prior to start of work, accurately dimensioned and showing required penetrations, connections, bends, etc.
- .4 Provide cable duct with required covers. Provide required components and required mounting and connection accessories.
- .5 Secure surface wall mounted duct in place with mounting hardware recommended by duct manufacturer to suit specific installation.
- .6 Install and hang cable duct at maximum 1.5 m (5') centres and in accordance with manufacturer's published literature employing horizontal bracket supported to ceiling slab by vertical threaded rod hangers on each end. Do not secure assembly from ductwork, suspended ceiling structures, lighting, etc. Secure rod hangers directly to ceiling slab. Locate supports as not to interfere with removal or opening of covers. Refer to drawing details and/or manufacturer's instructions.
- .7 Provide proper fittings in cable duct at point of conduit entry. Terminate conduits at or in duct with proper grommetted and bushed terminations.
- .8 Equip duct with necessary wall flanges, dropouts, enclosures, reducers, fittings, and similar accessories required, maintaining effective free cross-sectional area of duct clear of obstructions that might damage conductor insulation during installation. Accessories are to be typically pre-manufactured by manufacturer to suit specific applications.
- .9 Properly secure, adequately support and neatly harness conductors in duct. Seal cable duct penetrations of building fire barriers by means of ULC listed and labelled fire stopping and smoke sealing material.
- .10 Provide continuous paths along entire lengths of cable duct to maintain proper ground continuity. Utilize system manufacturer's proper grounding fittings and hardware.
- .11 Install expansion connectors where cable duct crosses building expansion joints.
- .12 When installing cables into duct, do not exceed manufacturer's recommended load capacities for duct.
- .13 After installation is complete, install warning signs on duct in visible locations.

- .14 Inspect duct for rough finishing burrs, sharp edges, and mechanical deficiencies prior to installing of cabling. Eliminate these deficiencies to satisfaction of Consultant, prior to installing cables.

END OF SECTION

1 GENERAL

1.01 SUBMITTALS

- .1 Submit shop drawings of products specified in this Section.
- .2 Submit copies of documents requested herein, testing reports, certificate of approvals, and commissioning sheets.

2 PRODUCTS

2.01 VIBRATION CONTROL AND SEISMIC RESTRAINT

- .1 Electrical equipment installation is to meet local governing authority having jurisdiction and code seismic requirements and additional requirements for vibration isolation.
- .2 Provide labour, materials, and equipment required and necessary to seismically restrain electrical equipment and equipment bases including concrete pads, and guarantee function of materials and equipment supplied.
- .3 Make electrical connections to vibration-isolated equipment with flexible conduit or other flexible means acceptable to Consultant and local governing authority having jurisdiction so as not to restrict maximum anticipated movement of equipment under seismic excitation movement.
- .4 In event that inadequate isolation is provided by isolation product manufacturer's isolation package, be responsible for improving isolation to an acceptable standard at no additional cost to contract. Isolation product manufacturer's seismic restraint engineer to verify that seismic restraints and combination isolator/restraints intended for use on project are fit for intended purpose. Be responsible for ensuring that manufacturer's seismic restraints are in compliance with applicable local building code requirements for Place of Work.
- .5 Provide additional seismic requirements for suspended electrical raceways, luminaires, and other equipment as per governing local authority requirements and requirements of current codes and by-laws.
- .6 Acceptable manufacturers of seismic restraints include:
 - .1 Vibro-Acoustics;
 - .2 Mason Industries;
 - .3 Kinetic Noise Control;
 - .4 Eaton B-Line.

3 EXECUTION

3.01 INSTALLATION

- .1 Comply with seismic restraint Engineers and manufacturers design documents, and installation and adjustment recommendations. Refer to detailed shop drawings.

- .2 Obtain required training from manufacturer's representative on any special installation procedures. Install components in accordance with manufacturer's instructions to suit specific installation requirements.
- .3 Refer to Part 2 for additional specific installation requirements.

3.02 INSPECTION AND TESTING

- .1 Inspect for removal of breakaway hardware to ensure proper torques of installed systems.
- .2 Test, adjust, and certify installation.
- .3 Comply with local governing authority requirements for testing, certification, documenting and labeling of seismic restraints.
- .4 For non-visually verifiable product, manufacturers to verify proper torque for a minimum 10% of application, unless otherwise directed by local governing authorities. Document torques for applications per manufacturer's instructions.
- .5 Submit copies of test report to Consultant.

END OF SECTION

1 GENERAL

1.01 SUBMITTALS

- .1 Submit as part of shop drawing submission, copies of:
 - .1 electrical distribution system protective device coordination study and short circuit calculations;
 - .2 system and equipment testing reports;
 - .3 arc flash analysis report;
 - .4 copies of certificate of approvals from local governing inspection authorities.
- .2 Submit electrical distribution system coordination study and short circuit calculations reports prior to or with proposed shop drawings of major electrical distribution equipment. Allow in shop drawing process, sufficient time for Consultant to review and make comments and for Contractor and equipment vendors to incorporate Consultant comments, necessary revisions and results of reports into equipment shop drawings. Do not order equipment until shop drawings have been reviewed with Consultant and Consultant's comments have been addressed. Time for this shop drawing review process will be at Consultant's discretion, but typically allow for 15 working days for initial review submission with additional 10 working days added to accommodate each resubmission.
- .3 If formal completion of studies and reports may cause delay in equipment manufacture, direction from Consultant may be obtained for preliminary submittal of sufficient data to ensure that selection of device ratings and characteristics will be satisfactory. Subsequently, provide formal studies and reports to verify preliminary findings.
- .4 Submit after completion of factory testing, copies of completed product testing reports.
- .5 Submit after installation and testing, copies of:
 - .1 completed testing reports with completed test results sheets;
 - .2 certificate of approvals from local governing authorities, manufacturers of systems and equipment and testing companies.
- .6 Review form of submittals (submission procedures, number of hard copies and requirements for electronic copies) with Consultant at project start-up. For pricing assume minimum 3 hard coloured copies bound and electronic pdf copy.

2 PRODUCTS

2.01 GENERAL SCOPE OF WORK

- .1 Include for but not be limited to following:
 - .1 preparing and submitting preliminary coordination study and short circuit calculations and recommendations on required relays, sensors and CT's for proper system selective coordination and protection;
 - .2 determining short-circuit current ratings to check that electrical distribution equipment can safely withstand level of fault current;

- .3 preparing, determining and submitting arc flash study with calculations to ensure required electric shock and arc flash protection are provided;
- .4 product manufacturers providing equipment inspection, testing, start-up, adjustments and verification;
- .5 independent 3rd party testing of electrical distribution system equipment and associated products;
- .6 independent 3rd party testing of systems and equipment as noted;
- .7 electricians/trades people on site to handle equipment, make temporary connections, operate equipment and make repairs and adjustments and assist manufacturer's / testing organization's personnel during on-site inspection, testing, calibration, start-up, verification work and where supplementary commissioning;
- .8 coordination of work with testing company and equipment/system manufacturer's authorized technician in performing adjustments and start-up procedures to equipment/systems;
- .9 preparing testing reports and documentation for submission to Consultant.

3 EXECUTION

3.01 PRELIMINARY COORDINATION STUDY AND SHORT CIRCUIT CALCULATIONS

- .1 Immediately after award of Contract liaise with proposed manufacturer of electrical distribution equipment to obtain appropriate information and recommended devices to obtain co-ordination of electrical distribution system.
- .2 Prepare preliminary coordination study and calculate available fault currents based on project design requirements and equipment. Combine into preliminary report and submit copies to Consultant for review to allow for comments and findings to be incorporated into equipment shop drawings and to expediate shop drawing process.
- .3 During Bid period, review with Mechanical Division Contractor, proposed major mechanical equipment and identify preliminary short circuit current ratings to allow for more accurate pricing for their proposed equipment.
- .4 Prepare report to typical standards as specified in respective coordination study and short circuit calculation report articles in this Section.

3.02 DISTRIBUTION SYSTEM COORDINATION STUDY AND SHORT CIRCUIT CALCULATIONS

- .1 Prepare final coordination study and short circuit calculations (available fault currents) of system. Perform work to standards of applicable local governing authorities, local electrical inspection authority and CSA Standards.
- .2 Review and survey existing systems and/or obtain where available, coordination study of existing systems to use in ensuring proper protective device coordination and suitable withstand rating for entire existing, additional and revised distribution equipment/systems. Where existing studies are not available, survey existing systems and prepare additional studies as required to provide full and proper coordination and suitable withstand rating of entire existing, revised and additional distribution equipment/systems.

- .3 Final coordination study and short circuit calculations reports to incorporate results and Consultant reviewed comments, into electrical distribution equipment shop drawings, and updated to reflect final equipment being supplied. Check for selective coordination of devices and confirm withstand ratings of equipment meet results from reports. Prepare studies as required to provide full and proper coordination and suitable withstand rating of entire distribution equipment/systems.
- .4 Protective system devices have been selected such that protection is adequate and good coordination is possible, however, since differences do exist between manufacturers, some changes in trip ratings or relay settings may be necessary and are to be carried out. Obtain local electrical utility information on their protective devices and include requirements as necessary.
- .5 Provide and carry out following:
 - .1 prepare a set of coordination curves on K.E. No. 336E Time Current Characteristic graph paper;
 - .2 this is to be accompanied by supporting symmetrical as well as asymmetrical fault current calculation data with tabulations to verify protection of various elements of systems under maximum and minimum fault conditions at various points in systems.
 - .3 Plot time-current characteristic curves for following:
 - .1 main and feeder protective devices at voltage levels used in distribution system;
 - .2 protective devices associated with largest motor in each MCC, refrigeration machine compressors and largest device in each distribution panel;
 - .3 motor generator protective devices, damage curves and current decrement curves.
- .6 Cooperate with and obtain from manufacturers, list of equipment requiring protective devices in distribution system and prepare coordination curves. Verify that proper withstand ratings of equipment are provided and proper control and protective devices are selected for coordination with protective devices. Include major mechanical equipment in studies and coordinate requirements with Mechanical Division Contractor. Identify required short circuit current ratings to Mechanical Division Contractor and respective Division manufacturers of major equipment.
- .7 It is responsibility of equipment manufacturers to examine plans and specifications to ensure that relays and protective devices being installed in distribution system provide satisfactory coordination.
- .8 Where automatic transfer switches are provided, submit coordination results and available fault current values at locations of transfer switches, to transfer switch manufacturer to ensure that transfer switches provided are of suitable withstand current ratings.
- .9 Document testing, coordination study and arc flash analysis in a report stamped and signed by a Professional Engineer licensed in the Place of Work and authorized by testing company. Report to include test results with properly plotted curves, identified trouble areas of coordination, extensive comments regarding test results and recommendations on best course of remedial action. Submit copies of report to Consultant.

.10 Acceptable companies to provide this work include:

- .1 Eaton Electric Services Division;
- .2 Schneider Electric Services Division;
- .3 Siemens Electric Services Division;
- .4 G.T. Woods;
- .5 Brosz;
- .6 Eastenghouse.

3.03 GENERAL ELECTRICAL WORK TESTING

- .1 In addition to tests required by local governing authorities having jurisdiction, local codes and regulations, perform following:
 - .1 after luminaires, switches, receptacles, motors, signals, etc., are installed, whether same are installed as part of this Division or by other Divisions (telephone systems excepted), test work to ensure that there are no leaks, grounds or crosses;
 - .2 establish and ensure proper motor rotation - measure full load running currents and check overload elements - report to Consultant any discrepancies which are found; existing motors which have been worked on (disconnected and reconnected) must be checked with rotation meter to ensure proper rotation; be responsible for any damage caused by reverse rotation;
 - .3 demonstrate to Consultant that branch circuit voltage drop is within specified units;
 - .4 ensure that devices are commissioned and operable.
- .2 Rectify deficiencies to satisfaction of Owner.
- .3 Document results into distribution system testing report. Report must state that testing was successful and Work complies with project documents, applicable CSA standards, and other applicable governing codes and requirements.

3.04 INSPECTION, TESTING, START-UP AND VERIFICATION

- .1 When each system and each major piece of equipment installation is complete and ready for acceptance, include for system and equipment manufacturer or manufacturer's authorized representative to visit site to provide system inspection, testing, start-up, and verification. Perform following:
 - .1 check component connections and overall installation;
 - .2 adjust sound systems for high quality, distortion free performance, free from noise, cross-talk, hum or other interference;
 - .3 test and adjust system and ascertain that components are as specified and ensure that products operate as designed;
 - .4 provide start-up procedures for systems and equipment;

- .5 verify and certify system component operations;
- .6 prepare, document and evaluate test results;
- .7 authenticate test results with signature of authorized testing Engineer/Technician;
- .8 check and verify nameplates;
- .9 provide maintenance and operating instructions to Owner's personnel.
- .2 Integrated Systems Testing:
 - .1 Perform testing of integrated systems and equipment in accordance with CAN/ULC-S1001.
 - .2 Engage respective systems or equipment vendors or trades and relevant building officials to be onsite during inspection and testing work to perform adjustments or remedial work to correct issues identified by inspection and testing work.
- .3 Perform work properly documented, and in accordance with manufacturer's instructions and recommendations.
- .4 Perform work under presence of Owner/Consultant/Commissioning Agent at times approved by Owner and reviewed with Consultant.
- .5 Provide these requirements after each phase (as applicable) to allow Owner option to use area of phase of work. These requirements are also to be provided prior to applying for Certificate of Substantial Performance of the Work of project.
- .6 Include for manufacturers authorized technicians of equipment/systems integrated to equipment/systems being tested to be onsite during full integration testing. Coordinate with each manufacturer.
- .7 Rectify deficiencies to satisfaction of Owner.
- .8 When system inspection, testing, start-up and verification specified above is complete, obtain from supplier/manufacture (or where specified, independent inspection company) a test report with test sheets, and covering verification letter signed by authorized testing technician, stating that system or equipment has been inspected and tested, performs as specified and is ready for acceptance. Include date and time of testing, testing technician's name and specification section number test fulfilled.
- .9 Bind documents under cover and submit copies to Consultant.

3.05 ELECTRICAL DISTRIBUTION SYSTEM TESTING AND VERIFICATION

- .1 Provide services consisting of on-site engineering inspection, testing and verification of electrical distribution equipment and other systems and equipment. Perform work to standards of applicable local governing authorities, local electrical inspection authority and CSA Standards including CSA Z32.

- .2 Services to be performed by an approved independent testing company and be initially conducted prior to system/equipment being energized and further testing when energized, and include following items, where applicable:
 - .1 testing, cleaning when necessary, and calibrating relays and circuit breaker trip devices (calibration of protective devices to conform to requirements of approved coordination curves);
 - .2 function test of associated control devices;
 - .3 replacement of fuses destroyed during testing;
 - .4 acceptance test in presence of Consultant;
 - .5 presence, for length of time required, of qualified and competent equipment manufacturer's service representative during start-up;
 - .6 carry out insulation resistance testing of outgoing feeders with respect to ground;
 - .7 inspection and testing of cables, bus duct, power panels, lighting panels, transformers, power receptacles and switches;
 - .8 inspection and testing of electrical system auxiliary systems and devices such as metering, power factor capacitors, UPS, isolated power centres, transfer switches, inverters, central battery systems, generators sets and load banks;
 - .9 inspection and testing of electrical devices and communication system components installed in service consoles, headwalls, furniture systems, etc., whether or not devices are supplied by Electrical Divisions;
 - .10 inspection and testing of motor control centres, starters and variable frequency drives;
 - .11 inspection and testing of lighting control systems including central control systems, low voltage relays, sensors and dimming controls; ensure that devices perform in conformance with ASHRAE 90.1 requirements;
 - .12 verification and certification work of equipment and systems;
 - .13 witness testing of EMI testing and verification (signing of report) of test results.
- .3 In addition to above testing and tests required by local governing authorities having jurisdiction, local codes and regulations, perform following:
 - .1 after luminaires, switches, receptacles, motors, signals, etc., are installed, whether same are installed as part of this Division or by other Divisions (telephone systems excepted), test work to ensure that there are no leaks, grounds or crosses;
 - .2 establish and ensure proper motor rotation - measure full load running currents and check overload elements - report to Consultant any discrepancies which are found; existing motors which have been worked on (disconnected and reconnected) must be checked with rotation meter to ensure proper rotation; be responsible for any damage caused by reverse rotation;
 - .3 demonstrate to Consultant that branch circuit voltage drop is within specified units;

- .4 ensure that devices are commissioned and operable.
- .4 Perform services procedures properly documented, and in accordance with manufacturer's instructions and recommendations.
- .5 When performing hi-potential testing, disconnect surge protection devices as recommended by SPD manufacturers.
- .6 Where relays, breakers, etc., do not perform to Consultant reviewed coordination curves as prepared for in coordination study, revise as part of work.
- .7 Adjust and calibrate existing trip units, relays, breakers, etc., which do not perform to approved coordination curves. Where defective or incorrectly applied relays or breakers are found in existing distribution system, identify problem areas clearly on curves of test report and provide recommended course of remedial action. Where replacement of existing devices not identified in Documents to be replaced is necessary to provide coordination, submit estimate of costs to Consultant. Where directed by Owner, perform work at additional cost to Contract amount. Clearly show on coordination curves in report and clearly identify recommended remedial course of action.
- .8 Test high voltage cable installation before placing in regular service. Work includes phase verification, grounding verification, hi-pot test of insulation strength to IPCEA Specifications (Leakage Curves to be obtained), and time domain reflectometer tests to give records of cable impedance profiles to draw attention to cable damage. Reference cable manufacturers testing procedures and do not exceed maximum test voltage levels and durations.
- .9 Testing organization to report high voltage cable defects directly to Consultant as soon as such defects are discovered. Re-test affected cables after proper repair. Also, re-test cables in cases where cable damage after installation is suspected. On completion of satisfactory testing of installation, submit a report by testing organization stating that cables concerned have satisfactorily passed required tests and are suitable for service. Submit copies of report to Consultant. Submit recorded test data (properly bound) with report, in each case.
- .10 Test main power transformers before placing in regular service. Work to include voltage ratio test, phase angle test, insulation resistance, oil sampling (liquid type transformer), start-up and other manufacturer's recommended tests.
- .11 Test isolated power centres, remote alarm stations/panels and accessories. Include for grounding testing. Refer to additional requirements in Section entitled "Isolated Power Centres".
- .12 Provide testing and coordination of emergency power distribution system to ensure that system performs in accordance to latest requirements of CSA Standard C282 and CAN/CSA Z32. Ensure that engine-generator set manufacturer and testing and coordination companies co-operate to ensure compliance with CSA requirements. Provide necessary adjustments and coordination to ensure that emergency power distribution system transfers essential loads to emergency power within required response time of loss of normal power.
- .13 Provide visual and mechanical inspection of ground system and verify that it is in compliance with issued documents and local governing electrical code requirements.

- .14 Perform fall-of-potential test or alternative in accordance with IEEE Standard 81 on main grounding electrode or system to determine current status, possible grounding contamination and proper ground resistance value. Perform point-to-point tests to determine resistance between main grounding system and major electrical equipment frames system neutral, and/or derived neutral points. Resistance between main grounding electrode and ground is not to be typically greater than 5 ohms for commercial or industrial systems and 1 ohm or less for generating or transmission station grounds unless otherwise specified. (Reference: ANSI/IEEE Standard 142). Investigate point-to-point resistance values which exceed 0.5 ohm.
- .15 Perform testing of lighting control systems and devices to ensure conformance with ASHRAE 90.1 requirements.
- .16 Coordinate testing of equipment and systems with respective product vendors as required to ensure alliance with product vendor standards.
- .17 Document testing, coordination study and arc flash analysis in a report stamped and signed by a Professional Engineer licensed in the Place of Work and authorized by testing company. Submit copies of report to Consultant. Report to include test results with properly plotted curves, identified trouble areas of coordination, extensive comments regarding test results and recommendations on best course of remedial action. Report must state that testing was successful and Work complies with project documents, applicable CSA standards, and other applicable governing codes and requirements.
- .18 Any work that failed testing that was responsibility of Contractor to be rectified by Contractor and be re-tested and verified, until successful testing, and be at no additional cost to Owner. Rectify deficiencies to satisfaction of Owner and Consultant.
- .19 Acceptable companies to provide equipment and system testing and verification work are to be independent of successful manufacturers providing distribution system equipment and include (unless otherwise approved by Owner, do not use company supplying electrical distribution equipment on project):
 - .1 Brosz.
 - .2 G.T. Woods;
 - .3 Eaton Electric Services Division;
 - .4 Schneider Electric Services Division;
 - .5 Siemens Electric Services Division;
 - .6 Eastenghouse.

3.06 BRANCH CIRCUIT WIRING TESTING FOR PATIENT CARE AREAS

- .1 Provide on-site engineering inspection and testing of branch circuit wiring and branch circuit devices in patient care areas in accordance with CSA Standard Z32.
- .2 Patient Care Areas include applicable critical patient care, intermediate patient care and general patient care areas of renovated and additional areas.

- .3 Branch circuit wiring testing to be performed by an approved independent testing company and be executed immediately upon energizing system prior to occupancy of an area by Owner.
- .4 Thoroughly review requirements of CSA Standard and ensure that entire scope of branch circuit wiring to be tested is understood by testing company.
- .5 Testing to be witnessed by Owner and Consultant. Notify Owner and Consultant in writing minimum of 7 working days in advance of proposed testing date.
- .6 Document testing, deficiencies and failed test results in distribution system testing report and submit copies to Consultant.
- .7 Contractor to perform remedial work on deficiencies and failed test results and retest, till successful testing, all at no additional cost to Owner.
- .8 Acceptable testing companies are as those listed for distribution system testing work.

3.07 SHOCK AND ARC FLASH ANALYSIS

- .1 General:
 - .1 Provide analysis for electric shock and arc flash protection as specified herein, and as required by local governing codes and local governing authorities.
 - .2 Prepare study to determine severity of potential exposure and selecting personal protective equipment (PPE) under general guidelines of governing edition of CSA Z462.
 - .3 Determine arc flash hazard distance and incident energy that workers may be exposed to from electrical equipment under general guidelines of IEEE 1584.
 - .4 Design safety signs and labels for applications to equipment under general guidelines of CSA Z462 and ANSI Z535.4.
 - .5 Incorporate documentation with short circuit calculations and coordination study report submitted to Consultant.
- .2 Arc Flash Hazard Analysis Study:
 - .1 Perform Arc Flash Hazard analysis by calculating arc flash incident energy and arc flash boundaries as outlined in CSA Z462. Analysis to include locations where work could be performed on energized parts of equipment such as switchboards, switchgear, motor-control centres, panelboards, busway and splitters.
 - .2 Retrieve short circuit calculations and clearing times of phase overcurrent devices from short circuit and coordination study specified previously.
 - .3 Arc-Flash Hazard Analysis to include customer owned service entrance equipment down through equipment rated 208 volts with significant locations in 240 V and 208 V systems fed from transformers equal to or greater than 35 kVA.
 - .4 Specify safe working distances based upon calculated arc flash boundary considering incident energy of 1.2 cal/cm^2 .

- .5 Include Arc Flash Hazard analysis calculations for maximum and minimum contributions of fault current magnitude. Minimum calculation to assume that utility contribution is at a minimum and a minimum motor load. Conversely, maximum calculation to assume a maximum contribution from utility and motors to be operating under full-load conditions. Other switching scenarios are to be included as necessitated by power system design and layout.
- .6 Arc Flash computation to include both line and load side of main breaker, where necessary.
- .7 Arc Flash calculations to be based on overcurrent protective device clearing time per coordination study.
- .3 Arc Flash Warning Labels:
 - .1 Provide minimum 90 mm x 127 mm (3.5" x 5") thermal transfer type label of high adhesion polyester for each work location analysed.
 - .2 Typically, use red header label with "DANGER, ARC FLASH HAZARD" wording. Typically, use orange header label with wording, "WARNING, ARC FLASH HAZARD", and include following information:
 - .1 Location/equipment designation;
 - .2 nominal voltage;
 - .3 arc flash protection boundary;
 - .4 incident energy;
 - .5 working distance;
 - .6 engineering report number, revision number and issue date.
 - .3 Machine print labels with no field markings. Submit as shop drawing submissions, sample labels and proposed nomenclature for Owner approval and Consultant review.
 - .4 Provide Arc Flash labels typically for following equipment (and base labels on recommended overcurrent device settings:
 - .1 panelboards;
 - .2 motor control centres/VFDs;
 - .3 distribution transformers;
 - .4 switchboards;
 - .5 transfer switches;
 - .6 genset control equipment;
 - .7 switchgear;

- .8 high voltage equipment;
- .9 other equipment as outlined on drawings, and required by local governing authorities.
- .5 Document in report, method of calculating and data to support information for labels.
- .4 Acceptable companies to provide this work are to be successful manufacturer of electrical distribution system equipment and include:
 - .1 Eaton Electric Services Division;
 - .2 Schneider Electric Services Division;
 - .3 Siemens Electric Services Division;
 - .4 G.T. Woods;
 - .5 Brosz.
 - .6 Eastenghouse.

END OF SECTION

1 GENERAL

1.01 SUBMITTALS

- .1 Submit copies of following as applicable to work:
 - .1 waste tracking procedure;
 - .2 testing reports;
 - .3 completed test results sheets;
 - .4 certificate of approvals;
 - .5 identification of waste treatment facility proposed and description of type of waste that facility is licensed to handle;
 - .6 description of closure plan of facility;
 - .7 copies of insurance and bonding;
 - .8 certificates of destruction.

2 PRODUCTS

2.01 HAZARDOUS MATERIALS

- .1 Hazardous materials and infectious materials are known to be present on site in existing buildings, including but not limited to following:
 - .1 aspergillus;
 - .2 mould;
 - .3 asbestos;
 - .4 Polychlorinated biphenyls (PCBs);
 - .5 lead;
 - .6 mercury.
- .2 Division 00 and/or Division 01 identify additional specific requirements and if such materials are present, include for costs to be educated and trained on special working conditions, to work in areas with hazardous materials, requiring protective clothing, gear, tenting, enclosures, etc., and performing necessary partitioning/tenting/ventilation work to isolate areas and maintain disturbances of such material to a minimum. Comply with infection control requirements and requirements of Health and Welfare governing authority requirements. An asbestos abatement report is available for review from Consultant. Unless otherwise noted, any abatement removal will be responsibility of another Division of Work or is not included under scope of work of this project.

- .3 If proper abatement procedures are not followed, be responsible for bearing full cost of a full time qualified abatement inspector chosen by Owner. In areas where work is being done above or below an area occupied by Owner's staff and/or building occupants, any slab penetrations into vertically adjacent occupied space to utilize a proper enclosure in area of that work on that occupied floor. Be responsible for failure to comply with special requirements in working in areas of hazardous materials.
- .4 Include for company specializing in removal and disposal of materials containing polychlorinated biphenyls (PCBs) to disassemble equipment as required to access material containing PCBs, and remove and properly dispose of such material off site. Any luminaire being deleted to be checked for ballast containing PCBs and such ballasts to be disconnected and disposed off-site. Only companies that are certified and comply with Ministry of Environment and Ministry of Transport regulations with regards to hazardous waste materials to be used to perform this Work. Prior to start of Work, submit to Consultant a copy of PCB disposal certificate and identification of Ministry authorized and designated disposal site. Lamps containing mercury (fluorescent lamps) to be removed and transported to a government approved disposal site.
- .5 Fluorescent lamps being replaced and containing mercury are to be properly transported offsite and disposed of as per local governing Ministry guidelines.

2.02 PCB REMOVAL, TRANSPORTATION AND DISPOSAL

- .1 General:
 - .1 Provide a specialty contractor experienced and certified in province of Work (Ontario), to perform polychlorinated biphenyls PCBs abatement removal work and approved by Ministry of Environment (MOE), to provide removal work of existing transformers and associated cables containing PCBs. Work to include but not be limited to following:
 - .1 disconnection and decommissioning of transformers;
 - .2 properly draining of PCB containing liquid;
 - .3 dismantling and cutting-up of transformers to allow for removal from site;
 - .4 proper packaging of PCB containing and contaminated materials to allow for removal from site;
 - .5 removal from site of materials and transportation of PCB containing materials to a Ministry approved designated site (identify site in shop drawing submissions);
 - .6 work performed to Ministry Of Environment and Transport Canada requirements, including proper permits, approvals and fees;
 - .7 submission to Consultant of detailed report of work, including copies of permits, certificate of approvals and identification of site where materials are to be delivered; submit these details as shop drawings prior to start of Work;
 - .8 remove materials from site and properly dispose of in manner approved by local authority having jurisdiction; identify in shop drawings proposed route and means for moving materials from building.

- .2 Include additionally for administering, supervising, arranging, and coordinating of work and for disconnection and making safe of connections (primary and secondary power cabling, controls and protection circuits, monitoring circuits) to existing transformers. Replace any connectors and wiring that have come into contact with PCBs.
 - .3 Prior to start of Work, obtain approval from Consultant of path of egress for existing transformers and components. Ensure that such egress is protected from spills and other damage that may occur in movement of material.
 - .4 Perform Work at scheduled times approved in writing by Consultant and Owner.
 - .5 Be responsible for removing existing PCB liquid filled power transformers off site. Perform work required for inspecting, characterizing packaging, labelling, loading, transportation and destruction of PCB material.
 - .6 Remove waste in an expedient manner in accordance with agreed project schedule.
 - .7 Supply final Certificates of Destruction For All Waste (solid/liquid) to Consultant no later than 30 days after PCB waste is removed from site.
 - .8 Ensure that people involved in handling, loading, transportation and destruction of PCB Material are appropriately trained and licensed in accordance with Workplace Hazardous Materials Information System (WHMIS) and Transportation of Dangerous Goods Act, Transport Canada (TDG).
 - .9 Act in a manner that is consistent with safe handling, loading, testing, and transporting PCB material.
- .2 Codes and Standards:
- .1 Be responsible for ensuring that recommended solutions are in compliance with applicable current Federal and Provincial Regulations, Codes, Standards and Policies. In Particular, without limiting Contractor's responsibilities, following regulations/guidelines, latest editions as amended, are to apply as required:
 - .1 The Canada Labour Code;
 - .2 National Fire Code;
 - .3 Occupational Health and Safety Act, Revised Statutes of Ontario, as amended (including latest edition);
 - .4 Transportation of Dangerous Goods Act;
 - .5 Canadian Environmental Protection Act, Environment Canada;
 - .6 PCB Transformer Decontamination, Standards and Protocols, Canadian Council of Ministers of the Environment;
 - .7 Any Workplace hazardous materials as outlined in Hazardous Materials Information System (WHMIS) as established in Hazardous Product Amendment Act.

- .3 Obtain Certificate of Approvals as follows:
 - .1 Waste Management Systems;
 - .2 Transportation;
 - .3 Transfer;
 - .4 Treatment.
- .4 Inspections and Characterization:
 - .1 Provide materials and labour required for inspection of PCB Material in storage or use at site prior to each shipment of PCB Material.
 - .2 Characterize and profile PCB material as required in accordance with requirements of TDG and WHMIS and any other applicable federal, provincial, or municipal regulations.
 - .3 Sample, characterize, and profile PCB material as required by any Subcontractors involved in this Contract, including preparation of waste profile sheets (WPS) with WPS Numbers assigned specifically to each existing PCB filled power transformer. A comprehensive bar-coded waste tracking system to be used by treatment facility to ensure accurate tracking of PCB Material. This bar-coding system is to be computerized as to minimize risk of human error when moving waste. Consultant reserves right to inspect waste tracking procedures throughout duration of contract.
- .5 Treatment Facility:
 - .1 PCB samples taken from materials following treatment to be analysed in a Canadian Association of Environmental Laboratories (CAEL) approved laboratory. Prior to commencement of Work, forward to Consultant Certificate of laboratory.
 - .2 Treatment facility to be capable of receiving various types of PCB Materials. A copy of waste tracking procedure to be submitted as part of shop drawings. This procedure to include tracking of PCB material, which is sent to a third party for incineration. This procedure to explain how specific WPS used for this project is tracked throughout work.
 - .3 Ensure that PCB Materials carries this car coding from point of pick-up of PCB Materials from site.
 - .4 Shop drawings to include a copy of Certificate of Approval. Description of types of waste that treatment facility can receive to accompany shop drawings.
 - .5 A description of closure plan of facility to be included with shop drawings. This closure plan to include a closure bond, which can be used in event of insolvency or bankruptcy of Contractor. Amount of this bond is to be included with proposal and is to be sufficient to cover cost of destruction for materials which appear in Certificate of Approval for storage at Contractor's facility at any given time.
 - .6 Include Certificates of Insurance with this proposal. Treatment facility to carry a minimum \$5,000,000.00 Pollution Legal Liability Insurance and a minimum of \$5,000,000.00 Aggregate Consultant's Environmental Liability Insurance. Commercial General Liability Policy to carry a minimum of \$5,000,000.00 Umbrella.

- .7 Test metals continuously after treatment to ensure no contaminated metal leaves site. Sample cleaned metals using hexane ensuring that any PCB residual is transferred to swab.
- .8 Consultant and Owner will not entertain any proposals which include storage of PCB material outdoors. Materials, before and after treatment to be stored inside Contractor's own building.
- .6 Acceptable PCB removal specialist companies are as follows:
 - .1 Aevitis Inc.;
 - .2 Sanexen.

2.03 ELECTROMAGNETIC INTERFERENCE PROVISIONS

- .1 Electromagnetic interference (EMI) provisions to include shielding of applicable structures, systems, and components as outlined herein this article. Include for requirements and costs.
- .2 Cover wall behind vertical bus duct risers with electromagnetic shielding, consisting of solid hot-rolled pickled steel or μ -metal (mu-metal) as required, designed to reduce magnetic field radiated from bus duct to a maximum of 5 milligauss at a distance of 500 mm (20") from wall in adjacent offices and occupied spaces.
- .3 Enclose horizontal bus duct runs in ventilated shielding enclosures to reduce magnetic field radiation from bus duct to floors above and below and maintain full bus duct ampacity. Shielding to have sufficient attenuation ratio to reduce magnetic field to 5 milligauss or less at desk top level 900 mm (3') above floor).
- .4 Cover floor under main power transformers with continuous shielding slab of sufficient grade to reduce magnetic field radiation from transformers to 5mG at desktop level on occupied floors below. Mount transformers on Trelleborg rubber isolators or approved equal.
- .5 Install wall and floor mounted magnetic shields after civil work is finished but prior to installation of electrical equipment. Install shielding enclosure on horizontal bus duct runs after bus duct installation. Test and verify shielding performance in accordance to IEEE 644-94 as specified in Part 3 of this Section. Test results to be presented in a comprehensive engineering report to Consultant.
- .6 Specialist Subcontractor retained for this project to have minimum 10 years experience in engineering design and installation on power frequency electromagnetic shielding, on major projects.
- .7 Acceptable firms include:
 - .1 C-INTECH, 905-472 3949;
 - .2 Power Line Systems Engineering, 905-294-5468.

3 EXECUTION

3.01 PCB MATERIAL PACKAGING, LABELLING AND LOADING

- .1 Package, label, and load dismantled sections of transformer and PCB material.
- .2 Provide labour and material required to repackage PCB material if, for any reason, repackaging is required to conform to TDG, WHMIS or Contractor requirements.
- .3 Provide labour and material to label and placard PCB material and vehicles in accordance with TDG.
- .4 Provide labour, equipment, material, and vehicles required to move and load PCB Material from work area to loading area and from site to designated final destinations for storage/handling. Secure PCB Material into/onto specialty contractor's transportation vehicles, in accordance with TDG requirements.

3.02 PCB MATERIAL TRANSPORTATION

- .1 Provide labour, material and vehicles required for transport of PCB materials to treatment facility.
- .2 Be responsible for obtaining applicable Provincial, Federal and Municipal approvals and or permits required for transportation of PCB materials to treatment facility at Contractor's expense. This includes but is not limited to approvals for transporting material into or through jurisdictions outside province of Work.
- .3 Prior to any shipment leaving site, confirm with Consultant in writing, that required approvals have been received, and that required notifications of other jurisdictions have been made.
- .4 Prior to any shipments leaving site, indicate to Consultant in writing, final destination of shipments, and route that will be used to reach that destination.
- .5 Prior to any shipment leaving site, perform an inspection of vehicle(s). Any loading or repackaging required to satisfy regulations or to ensure safe shipment of PCB Materials to be at Contractor's expense,
- .6 Prior to any shipment leaving site, prepare required waste manifests in accordance with TDG. Be responsible to ensure that waste manifests are completed by vehicle driver and that copies are distributed in accordance with TDG requirements within required time.
- .7 In Section 8.7(b) of TDG, requirements are specified for inspection of loads before and during transport of PCB material. If, Contractor proposes to use road vehicles for transporting PCB Material, then at each inspection stop that is required by TDG, telephone Consultant to provide an update on vehicle location and anticipated progress.
- .8 Proposals that involve interim storage of PCB materials are unacceptable. PCB Materials to be handled by Contractor.
- .9 Provide details on treatment technology to be used. This description to include, but not limited to, any limitations on nature or type of PCB materials that can be treated or stored, and a description of residual waste streams and location for destruction of same. Proposals which include land filling of any residual material are unacceptable. Nor is recycling of metals through scrap dealers acceptable.

- .10 Destroy PCB material, including porous residuals at an approved Canadian destruction facility. Submit to Consultant, documentation confirming that facility is approved to treat or store types of PCB material.
- .11 Upon destruction of PCB material, issue to Consultant a Certificate of Destruction for materials taken from site. Certificate of Destruction to reference waste manifests and specific waste profile sheets used for this project. These Certificates to also be specific to location from which PCB material is removed.

END OF SECTION

1 GENERAL

1.01 APPLICATION

- .1 This Section specifies commissioning requirements that are common to electrical work Sections and Sections of Division 27 and Division 28 unless otherwise noted, and supplements to each Section.
- .2 Where requirements of this Section contradict requirements of Division 01, request for clarification from Consultant.

1.02 REFERENCE STANDARDS

- .1 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
 - .1 ASHRAE Guideline 0-[2019], The Commissioning Process.
 - .2 ANSI/ASHRAE/IES Standard 90.1-[2022] (SI Edition), Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .2 CSA Group (CSA):
 - .1 CSA C282-[19], Emergency Electrical Power Supply for Buildings - Including Maintenance Logbook.
 - .2 CSA Z320-[11(R2021)], Building Commissioning.
 - .3 CSA Z32-[21], Electrical Safety and Essential Electrical Systems in Health Care Facilities.
 - .4 CAN/CSA-Z8001-[13(R2018)], Commissioning of Health Care Facilities.
- .3 Underwriters Laboratories of Canada (ULC):
 - .1 CAN/ULC-S524-[Edition 7, 2019], Standard for the Installation of Fire Alarm Systems.
 - .2 CAN/ULC-S536-[Edition 5, 13-R2018], Inspection and Testing of Fire Alarm Systems.
 - .3 CAN/ULC-S537-[Edition 6, 2019-REV1], Verification of Fire Alarm Systems.
 - .4 CAN/ULC-S561-[Edition 3, 2020-REV1], Standard for Installation and Services for Fire Signal Receiving Centres and Systems.
 - .5 CAN/ULC-S1001-[2023], Integrated Systems Testing of Fire Protection and Life Safety Systems.

1.03 DEFINITIONS

- .1 Commissioning: Process of demonstrating to Owner and Consultant, for purpose of final acceptance, by means of successful and documented functional performance testing, that systems and subsystems are capable of being operated and maintained to perform in accordance with requirements of Contract Documents, as further described below.
- .2 Commissioning Agent: Commissioning authority who supervises commissioning process and recommends final acceptance of commissioned electrical work.

- .3 Start-Up and Adjusting: Process of equipment manufacturer/supplier technical personnel, with respective Division Contractor, starting and operating equipment and systems, making adjustments, documenting process, and submitting manufacturer/supplier start-up reports confirming that equipment is properly installed and is operational as intended.
- .4 Pre-Functional Performance Testing: Testing, adjusting and operating of components, equipment, systems and subsystems, by respective Division Contractor, after start-up but before functional performance testing, confirming that components, equipment, systems and subsystems operate in accordance with requirements of Contract Documents, including modes and sequences of control and monitoring, interlocks, and responses to emergency conditions, and including submittal of pre-functional performance testing documentation sheets.
- .5 Functional Performance Testing: Repeat of successful pre-functional performance testing by respective Division Contractor, in presence of Commissioning Agent and Consultant with completed Commissioning Agent commissioning documentation sheets documenting, validating, and verifying that equipment, systems and subsystems are complete, function correctly, and are ready for acceptance.
- .6 Commissioning Documentation Sheets: Prepared sheets for pre-functional performance testing and for functional performance testing, supplied by Commissioning Agent for each piece of equipment and system commissioned. Each sheet or set of sheets are complete with Project name and number, date of commissioning, equipment or system involved, equipment or system name and model number, and equipment identification as identified on drawings. For each commissioning procedure listed, include on sheets, column giving expected data in accordance with Contract Documents, column to fill in observed data during commissioning, and space for signatures of respective Division Contractor and Commissioning Agent.
- .7 Systems Operating Manual: Manual prepared by Commissioning Agent, presenting overview of building electrical systems and equipment used by building maintenance personnel in assisting them in daily operation of systems.
- .8 Validate: Confirming by examination and witnessing tests, correctness of equipment and system operation.

1.04 COMMISSIONING AGENT

- .1 Involvement of Commissioning Agent performing duties as described in this Section is not in any way to void or alter contractual warranty obligations.
- .2 Commissioning Agent is retained and paid by Owner to perform electrical work commissioning specified. Perform commissioning in accordance with requirements of Owner Commissioning Agent.

1.05 COMMISSIONING OBJECTIVES

- .1 Objectives of commissioning process:
 - .1 Support quality management by means of monitoring and checking installation.
 - .2 Verify equipment/system performance by means of commissioning of completed installations.

- .3 Move completed equipment and systems from "static completion" state to "dynamic" operating state, and transferring complete and properly operating installation from Contractor to Owner and Consultant.
- .2 Prerequisites to successful completion of commissioning:
 - .1 Submittal of signed start-up and test reports.
 - .2 Completion and verification of electrical distribution system testing and coordination study.
 - .3 Permanent electrical and control connections of equipment.
 - .4 Successful completion and documentation of pre-functional performance testing.
 - .5 Submittal of signed letters to Consultant, certifying that systems and subsystems have been started, tested, adjusted, successfully pre-functional performance tested, are ready for functional performance testing, and are in accordance with requirements of Contract Documents.

1.06 TESTING EQUIPMENT

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

1.07 SUBMITTALS

- .1 Submit to Commissioning Agent, at same time as submittal to Consultant:
 - .1 Copy of each shop drawing or product data sheet associated with equipment or systems being commissioned.
 - .2 Commissioning Plan with schedule, commissioning procedures for commissioning events, and Commissioning Agent commissioning data sheets for equipment and systems being commissioned.
 - .3 List of commissioning instruments and for each instrument, indicating purpose of instrument and including recent calibration certificate.
 - .4 Equipment and system manufacturer start-up and test report sheets (submit minimum of one month prior to equipment and system start-up procedures).
- .2 After start-up and successful pre-functional performance testing and submittal of completed forms, submit for each system or subsystem, signed letter confirming that pre-functional performance testing is successfully completed and system or subsystem is ready for functional performance testing and commencement of commissioning process.

1.08 QUALITY ASSURANCE

- .1 Perform commissioning work in accordance with:
 - .1 ASHRAE Guideline 0.
 - .2 CSA Z320.

- .3 CAN/CSA Z8001.
- .4 Documents of Commissioning Agent.
- .5 Division 01.
- .6 Specified requirements.

2 PRODUCTS (NOT USED)

3 EXECUTION

3.01 PHASING OF COMMISSIONING

- .1 Project to be constructed in phases as described in Specification. Phase commissioning work to suit progress and phases of work.

3.02 DEFICIENCIES LISTED DURING COMMISSIONING

- .1 Within 15 calendar days of notification unless agreed otherwise with Consultant and Commissioning Agent, correct deficiencies listed by Consultant or Commissioning Agent during commissioning process.
- .2 When deficiencies have been corrected, notify Consultant and Commissioning Agent.

3.03 SYSTEMS TO BE COMMISSIONED

- .1 Commission electrical systems as specified in Sections of Specification. Perform additional specific commissioning procedures as directed by Commissioning Agent. General commissioning procedures for typical equipment and systems include but are not limited to as listed below. Supplement with additional requirements of Commissioning Agent and AHJ.
- .2 Electrical Distribution Switchgear and Switchboards:
 - .1 Check and record nameplate data.
 - .2 Check and inspect equipment to ensure they are installed in accordance with manufacturer recommendations.
 - .3 Check installation is complete and is ready and safe to carry out testing.
 - .4 Check mechanical operation of switches and breakers.
 - .5 Check indication lights and control switches for correct functions.
 - .6 Set protection devices to correct values according to coordination study or as instructed by Consultant. Properly set protection devices prior to energization of equipment.
 - .7 Perform tests as required by Commissioning Agent.
- .3 Motor Control Centres (MCC) and Drives:
 - .1 Check and record nameplate data.

- .2 Check and inspect equipment to ensure it is installed in accordance with manufacturer recommendations.
- .3 Check installation is complete and is ready and safe to carry out testing.
- .4 Check mechanical operation of switches and breakers.
- .5 Check connecting bolts are tightened to correct torque values.
- .6 Check indication lights and control switches for correct functions.
- .7 Set protection devices to correct values according to coordination study or as instructed by Consultant. Properly set protection devices prior to energization of switchboards.
- .8 Check and set overload relays provided. Set and record overload relays to correct settings.
- .9 Check control functions for proper functioning and connection.
- .10 Check interface contacts for control and indications for proper functioning and connections.
- .11 Check motor running current and readjust overload relays as necessary.
- .12 Coordinate testing and commissioning work with Mechanical Divisions, verifying full testing and commissioning work is completed and recommended for acceptance by Consultant and Commissioning Agent.
- .13 Perform tests as required by Commissioning Agent.
- .4 Distribution Cables:
 - .1 Check for correct cable installation and termination.
 - .2 Check and record cable sizes, types and method of installation.
 - .3 Check and confirm installed cable sizes are of adequate rating, taking into consideration of type of cable, method of installation, correction factors and any other Code requirements.
 - .4 Grounding test to ensure equipment, conduit and cable armour/sheath, where applicable, are properly grounded.
 - .5 Perform tests as required by Commissioning Agent.
- .5 Distribution Panelboards and Branch Circuit Panelboards:
 - .1 Check and record nameplate data.
 - .2 Check and test to verify panelboard directory is correct.
 - .3 Include directory in test records. Directory to contain size of each breaker, equipment served, cable type and size.

- .4 Check and test voltage drop is within specified limit from service entrance switchboard to branch panelboards.
- .5 Test branch circuits voltage drop is within requirements.
- .6 Megger test branch circuits. Disconnect connected SPDs.
- .7 Perform tests as required by Commissioning Agent.
- .6 Patient Care Areas Power Supply Systems:
 - .1 Check and record nameplate data.
 - .2 Carry out following tests where applicable:
 - .1 Conductor insulation resistance test.
 - .2 Voltage drop test.
 - .3 Circuit breaker mechanical operation test.
 - .4 Verification of panelboard directory.
 - .5 Receptacle test pin and plug pull out test.
 - .6 Polarity test.
 - .7 Voltage difference limits test.
 - .8 Ground return path voltage rise test.
 - .9 Impedance to ground test.
 - .10 Hazard index monitoring test.
 - .11 Ground fault circuit interrupter test.
 - .3 Perform tests as required by Commissioning Agent.
- .7 Power System Studies and Onsite Testing:
 - .1 Review testing company prepared electrical distribution testing report, coordination study and arc fault hazard analysis report.
 - .2 Review testing company onsite testing and report findings.
 - .3 Check measured and recorded fault level at service entrance switchboards, motor control centres, transformers, auto transfer switches, generator switchboard and control panels, distribution panels and branch circuit panelboards.
 - .4 Check recorded and set breakers, fuse ratings and protection devices, verifying discrimination of electrical distribution system.

- .5 Review test records for measured prospective fault level and indicated fault ratings of installed equipment such as switchboards, panels, switches, breakers for above systems to confirm adequacy of fault rating of installed equipment.
- .6 Document review and include in review report.
- .7 Perform tests as required by Commissioning Agent.
- .8 Lighting Systems:
 - .1 Check and verify lighting control systems and dimming systems.
 - .2 Check and verify luminaires are connected and switched properly.
 - .3 Check and verify automatic controls are connected and functioning properly.
 - .4 Check and verify emergency lighting system including battery lighting system, are connected and functioning properly.
 - .5 Check compliance with ANSI/ASHRAE/IES Standard 90.1.
 - .6 Check and record nameplate data.
 - .7 Perform lighting level tests.
 - .8 Perform tests as required by Commissioning Agent.
- .9 Security Systems (Access Control and Surveillance CCTV):
 - .1 Check and record nameplate data.
 - .2 Check main panels for proper installation, wiring identification, wire harnessing, and emergency power feed.
 - .3 Test and document each type of alarm from each station, noting station numbers at which signal has been received.
 - .4 Check field devices for proper operation.
 - .5 Test specified sequences of system as specified.
 - .6 Check for integration to other systems.
 - .7 Check and report panel enclosure is suitable for environment in which it is installed.
 - .8 Perform tests as required by Commissioning Agent.
- .10 Fire Alarm System and Emergency Communications:
 - .1 Check and record nameplate data.
 - .2 Check installation for compliance with requirements of CAN/ULC-S524.
 - .3 Check panels for proper installation, wiring identification, wire harnessing, and emergency power feed.

- .4 Test and document each type of alarm from each device, noting device addresses at which signal has been received.
- .5 Check and report panel enclosure is suitable for environment in which it is installed.
- .6 Test specified sequences of system as specified.
- .7 Perform system verifications and tests according to CAN/ULC-S536, CAN/ULC-S537, CAN/ULC-S561, and CAN/ULC-S1001.
- .8 Perform tests as required by Commissioning Agent.
- .11 Other Systems:
 - .1 Check and record nameplate data.
 - .2 Check panels for proper installation, wiring identification, wire harnessing, and emergency power feed (as required).
 - .3 Check field devices for proper operation.
 - .4 Test specified sequences of system as specified.
 - .5 Perform tests as required by Commissioning Agent.
- .12 Perform tests on following systems, where applicable and as reviewed with Consultant and Commissioning Agent:
 - .1 Public address systems.
 - .2 Intercommunication systems.
 - .3 Clock systems.
 - .4 Cable Television systems.
 - .5 Network structured cabling systems.
 - .6 Monitoring systems.
 - .7 Other systems and equipment supplied under Work of Project.
- .13 In addition to requirements of Electrical Divisions, test and commission electrical devices supplied in equipment under work of Divisions other than Electrical Divisions or through Owner.

3.04 COMMISSIONING PROCESS

- .1 Perform commissioning process unless otherwise noted in Division 01 and per owners standards, in stages and include, but not be limited to, following:
 - .1 Stage 1: Commission Work including equipment and systems as listed in this Section, which is a prerequisite to application for Substantial Performance of the Work and includes supervising and validating results of functional performance testing, and submittal of reviewed Systems Operating Manual.

- .2 Stage 2: Commission Work 12 months after issue of Certificate of Substantial Performance of the Work and which includes supervision of Contractor "fine tuning" of equipment and systems through seasonal occupancy, and any other such work to achieve optimal comfort and performance conditions.
- .3 Stage 3: Successful completion of satisfactory equipment and system operation during first month after issue of Certificate of Total Performance of the Work.

3.05 RESPONSIBILITIES OF CONTRACTOR

- .1 Contractor responsibilities during construction phase:
 - .1 Prepare and submit installation schedule that includes time schedule for each activity with lead and lag time allowed and indicated, shop drawing and working detail drawing submissions, and major equipment factory testing and delivery dates.
 - .2 Prepare and submit commissioning schedule that includes time schedule coordinated with installation schedule referred to above, and allowances for additional time for re-tests as may be required. Update schedule on monthly basis as required.
 - .3 When requested by Commissioning Agent, arrange site commissioning meetings with Consultant, and applicable subcontractors present. Meeting chaired by Commissioning Agent who also prepares and distributes meeting minutes.
 - .4 Correct reported deficient work, and report when corrective work is complete.
 - .5 Where required by codes, or Specification, retain equipment manufacturers/suppliers or independent third parties to certify correct installation of equipment and systems.
 - .6 Under supervision of equipment manufacturers/suppliers, start-up and adjust equipment to design requirements, and submit start-up sheets which include equipment data such as manufacturer and model number, serial number where applicable, and performance parameters, all signed by equipment manufacturer/supplier and Contractor.
 - .7 Complete Commissioning Agent commissioning data sheets for multiple items of smaller equipment. Submit sheets to Commissioning Agent, and accompany Commissioning Agent for onsite check of data sheet information for each type of equipment. Perform corrective action as result of site checks.
 - .8 Perform system testing and adjusting, and when complete, issue copy of final report to Commissioning Agent for review and site check of results. Perform corrective work required as result of site checks by Commissioning Agent.
 - .9 In accordance with updated commissioning schedule and actual progress at site, certify in writing to Consultant and Commissioning Agent that equipment and systems are complete, have been checked, started and adjusted, successfully pre-functional performance tested and documented, and are ready for functional performance testing and commissioning procedures. Notify Consultant and Commissioning Agent minimum of 10 working days in advance.

- .10 Perform system and subsystem functional performance testing in presence of Commissioning Agent and under supervision of Commissioning Agent, and submit to Consultant and Commissioning Agent, completed and signed functional performance testing and commissioning data sheets (issued by Commissioning Agent) and also signed by Commissioning Agent.

- .2 Contractor responsibilities during post-construction phase:
 - .1 Optimize system operation in accordance with building occupant needs and comments using System Operation Manual prepared by Commissioning Agent as reference.
 - .2 Complete commissioning procedures, activities, and performance verification procedures that were delayed or not concluded during construction phase.
 - .3 Accompanied by Commissioning Agent, complete system checks and "fine tuning" with signed documentation as follows:
 - .1 Once during first month of building operation.
 - .2 Once during third month of building operation.
 - .4 Correct deficiencies revealed by system checks described above, and, where required, involve equipment manufacturers/suppliers during corrective actions, and report completion of corrective work.
 - .5 3 months after Substantial Completion of the Work conduct question and answer sessions at building with end user operating and maintenance personnel, with duration of sessions dictated by number of questions and concerns that need addressing.

END OF SECTION

1 GENERAL

1.01 SUBMITTALS

- .1 Submit shop drawings for products specified in this Section. In addition to requirements of Section 26 00 10, include for copies of documents of respective manufacturers confirming complete compatibility between lighting controls and luminaires.

1.02 PRODUCT COMPATIBILITY

- .1 Lighting controls and luminaires when integrated together for control purposes must be 100% compatible with each other. Coordinate with ballast/driver and LED/lamp manufacturers, LV relay panel manufacturers, switches/timers manufacturers and dimmer/light sensor/occupancy sensor control manufacturers to ensure that components are compatible with each other and that interconnections do not adversely affect performance, life or any warranties.

1.03 SYSTEM PERFORMANCE REQUIREMENTS

- .1 System Characteristics:
 - .1 The system is composed of the following interconnected digital control devices and connected luminaires:
 - .1 Wallstations – Wired.
 - .2 Ceiling and Tile mount Occupancy/Vacancy Ceiling Sensors – Wired
 - .3 Dimming Switchpack – Wired.
 - .4 Contact Closure Input – Wired and Wireless.
 - .5 Low-Voltage Power modules to power low-voltage luminaires.
 - .6 Touchscreen.
 - .7 Area controller for networked spaces.
 - .8 Area hub to network multiple control areas to an area controller.
 - .9 Supervisory server.
 - .10 Lighting Management Software applications
 - .11 BACnet/IP, API, OpenADR and Shades interfaces.
 - .2 The system shall be able to support the following topologies:
 - .1 Interconnected digital control devices and connected luminaires to control the lights in a standalone room/a space with one or multiple zones.
 - .2 Interconnected digital control devices, connected luminaires, area hubs and area controllers to control the lights in networked rooms/spaces with one or multiple zones per room.

- .3 In a single room/space topology, the lighting control system shall provide the following capabilities:
 - .1 Wired or wireless communication – The devices shall be able to exchange data with each other via low-voltage network cabling or wireless communication.
 - .2 Occupancy sensing – The ability to automatically turn the lights on and off based upon detecting the presence or absence of people in an indoor or outdoor space.
 - .3 Daylight harvesting - The capability of automatically affecting the operation of luminaires based on the amount of daylight present in a space.
 - .4 Zoning - The capability of grouping luminaires to form unique lighting control zones for a control strategy via software or electrical installation details (e.g. wiring).
 - .5 High-end trim - The ability to set the maximum light output to a less-than-maximum state of an individual or group of luminaires/lamps using the software application.
 - .6 Individual Addressability - The ability to uniquely identify and address each luminaire and control device, allowing for configuration and re-configuration of devices and control zones independent of electrical circuiting.
 - .7 Continuous dimming – The ability to offer smooth light level changes by providing high resolution in light output control.
 - .8 Personal Control – The capability for individual users to adjust the lights to their personal preferences using a control interface.
 - .9 Scenes control – The capability of providing two or more pre-programmed light level settings for a group or multiple groups of luminaires.
 - .10 Plug load control – The capability to control the power delivered to receptacles through scheduling or occupancy sensing.
 - .11 Emergency lighting – The capability of having emergency lighting to full on upon loss of normal power.
 - .12 Luminaire Level Lighting Control (connected luminaires) - The capability to have an occupancy sensor and ambient light sensor installed for each luminaire for luminaire level control as well as the ability of individual luminaires to exchange data with other luminaires and control devices on the system (Note: for wireless luminaires and control devices only).
 - .13 Programming – The capability of allowing installers and system owners to configure the system to meet their specifications using an application running on a mobile device or accessible via a web browser running on a computing device.
 - .14 System devices support firmware updates from a mobile app or controller.

- .15 Out-of-box control – For spaces controlled by wired control devices or spaces within connected wireless luminaires, the lights shall be able to go to 75% light level once powered and automatically turn on/off based on the occupancy status of the space with no programming.
 - .16 Standalone Control – The capability for connected luminaires and digital lighting control devices within the same space to provide automatic control from sensors (occupancy and/or photosensor) without requiring connection to a higher-level system component.
- .2 Wired Control Systems Characteristics:
- .1 Wired devices shall be connected in a "daisy-chain" topology. "Hub-and-spoke" topology, requiring all individual networked devices to be connected to a central component, is unacceptable to reduce the total network cable needed for each control zone.
 - .2 Connections to devices within a wired control area shall be accomplished with a single type of low-voltage network cable compliant with CAT5e specifications or higher.
 - .3 Pre-terminated, plenum-rated CAT5e network cabling is to be offered by the manufacturer.
 - .4 The devices connected to the same CA5e cables shall be capable of automatically discovering each other once powered without requiring any provisioning of system or zone addresses.
 - .5 Following proper installation and provision of power, all networked devices connected with low-voltage network cables must automatically form a functional lighting control zone without requiring any programming. The "out of box" feature consists of the sensors auto grouping into a single occupancy set and turning the lights in the space off upon vacancy. The user can also control the lights from any control interface in the space. This feature is intended to offer minimum control before system start-up and programming.
 - .6 The devices shall be capable of detecting improper communication wiring and offer LED notifications to alert installation/start-up personnel.
 - .7 The wired control devices shall have an identification button that, when pressed, will result in the device appearing on the software application with a blinking icon.
 - .8 The control devices suitable for control of egress or emergency light sources shall be able to detect loss of normal power without additional, externally mounted UL 924 shunting or 0-10 V(dc) disconnect devices. These devices shall be capable of supporting the following sequence of operation:
 - .1 Low-Voltage Power Sensing: Devices automatically provide 100 percent light level upon detection of loss of power sensed via low-voltage network cable connection where applicable.
 - .2 Line-Voltage Power Sensing: Devices listed as UL 924 emergency relays automatically close the load-control relay and provide 100 percent light output upon detection of loss of power sensed via line voltage connection to normal power.

.3 System Integration Capabilities:

- .1 The system shall provide the necessary interfaces to integrate with third-party systems such as building management systems (BMS) and smart building platforms.
- .2 The system shall offer the following interfaces:
 - .1 BACnet/IP protocol to integrate with the building automation system and other BACnet/IP supporting systems.
 - .2 RESTful API includes the following system integration capabilities:
 - .1 "Write" messages to control individual devices, including relay and dimming output.
 - .2 "Write" messages to control groups of devices through a single command, including control of relay and dimming output of all devices.
 - .3 "Read" messages for individual device status information. The available status will vary based on device type and capabilities, including relay state, dimming output, power measurement, occupancy sensor status, and photosensor light measurement.
 - .4 "Read" messages for group status information for occupancy, relay state, and dimming output.
 - .3 OpenADR 2.0b to active demand response requests from utility companies' Demand Response Automation Servers (DRAS).

.4 Supported Sequence of Operations:

- .1 Control Zones:
 - .1 Standalone topology: A group of connected luminaires and lighting control devices (ceiling sensor, wallstations, Switchpacks) installed in a single area that communicate with each other and adjust the lights within the space based on the space's occupancy status, daylight levels coming into the room as well as occupants' actions. The lights can be grouped together up to 16 unique control zones to support different and reconfigurable sequences of operation within the area.
 - .2 Networked topology: A group of connected luminaires and lighting control devices (ceiling sensors, wallstations, swithpacks) installed in different areas that communicate to an area controller. The devices communicate with each and adjust the lights within the space based on the space's occupancy status, daylight levels coming into the rooms as well as occupants' actions. The lights can be grouped together up to 30 control zones per area and up to 49 areas to support different and reconfigurable sequences of operation within those areas.
- .2 Wallstation Capabilities:
 - .1 Wall stations support the following capabilities:
 - .2 On/Off of one or many zones.

- .3 Continuous dimming control of the light level of one or many zones.
 - .4 Multi-Way Control: Multiple wallstations capable of controlling the same zones to support "multi-way" switching and dimming control.
 - .5 Minimum actions supported: Specific light level, specific scene, raise, lower, toggle (available in networked topology only)
 - .6 Mechoshades® integration: In a networked topology with a supervisory controller, a wallstation can control a shade controlled by a Mechoshades® control system.
- .3 Occupancy Sensing Capabilities
- .1 Occupancy sensors configurable to control one or multiple zones.
 - .2 Multiple occupancy sensors controlling one or multiple zones.
 - .3 Occupancy sensing sequence of operation modes:
 - .1 On/Off Occupancy Sensing.
 - .2 Partial-On Occupancy Sensing.
 - .3 Partial-Off Occupancy Sensing.
 - .4 Vacancy Sensing (Manual-On / Automatic-Off).
 - .4 On/Off, Partial-On, and Partial-Off Occupancy Sensing Modes Sequence of Operation:
 - .1 When occupancy is detected, occupancy automatically turns lights on to a designated level or scene (0 to 100%).
 - .2 Occupancy sensors automatically turn lights off or to a dimmed state (Partial-Off) when a vacancy occurs or if sufficient daylight is detected.
 - .3 A system capable of combining Partial-Off and Full-Off operations by dimming lights to a designated level when vacant and turning the lights off entirely after an additional time delay.
 - .4 If enabled in the occupancy sensing control zone, photosensor readings automatically adjust light levels during occupied or unoccupied conditions as necessary.
 - .5 Wall station activation changes the dimming level or turns the lights off as the occupant selects. Lights optionally remain in this manually specified light level until the zone becomes vacant. Upon vacancy, the normal sequence of operation resumes.

.5 Vacancy Sensing or Manual-On/Automatic-Off Mode Sequence of Operation:

- .1 Activation of a wall station is required to turn lights on. A system capable of programming the area to turn on to a designated light level. Initially occupying the space without using a wall station must not result in lights turning on.
- .2 Occupancy sensors automatically turn lights off or to a dimmed state (Partial-Off) when a vacancy occurs or if sufficient daylight is detected. Users can change the default unoccupied light level (0%) to another light level.
- .3 Photosensor readings, if enabled in the Occupancy Sensing control set, can automatically adjust the light level during occupied or unoccupied conditions as necessary.
- .4 Wall station interaction changes the dimming level or turns lights off as the occupant selects. Lights remain at the manually specified light level until the zone becomes vacant; the normal sequence of operation resumes upon vacancy.

.6 Occupancy time delays before dimming or shutting off lights separately programmable for all control zones from 15 seconds to two (2) hours.

.7 Energy mode sequence of operation:

- .1 The system shall be capable of dimming the lights when vacant and then turning the lights off entirely after an additional time delay.
- .2 Associated occupancy sets: Networked luminaires and control devices can track occupancy broadcasts from adjacent zones. When this feature is enabled, luminaire output for a vacant zone will reduce to a configurable dimmed state if one or more adjacent zones are occupied. Luminaires will turn off when both primary and adjacent zones are vacant.

.4 General Characteristics:

- .1 System capable of providing a visible "blink warning" prior to a light turning off if required by the sequence of operations.

2 PRODUCTS

2.01 LOW VOLTAGE WALL DIMMERS

- .1 Wavelinx CAT Wallstation [WTN-C-*], ULC listed and labelled, CSA certified low voltage dimmers as follows:
 - .1 Low voltage network cable with 2 x RJ-45 connections.
 - .2 Decorative keypad style;
 - .3 Programmed to default to Manual-On setting;

- .4 If switched to Auto-On mode, defaults to 50% Partial-On if no adjustments are made, and if connected to sensor, lights fade on to preset level and fade off, based on occupancy;
- .5 Type to control and suit intended connected loads;
- .6 24 VDC input and 0 to 10 V dimming control;
- .7 LED indicator light;
- .8 Recalls last-used light level (preset);
- .9 Two-second fade rate;
- .10 supported button configurations:
 - .1 One (1) button.
 - .2 Three (3) buttons.
 - .3 Three (3) buttons + raise/lower.
 - .4 Five (5) buttons + raise/lower.
 - .5 The system shall allow user to define the action of each button using the programming software application.
- .11 Supported actions per button:
 - .1 Select Scene.
 - .2 Scene Toggle.
 - .3 Zone Level.
 - .4 Zone Toggle.
 - .5 Raise Level.
 - .6 Lower Level.
 - .7 Hold/Release Occupied.
 - .8 input connections for occupancy sensors;
- .12 Finish to Consultant's direction.
- .2 Acceptable manufacturers are:
 - .1 Legrand-Watt Stopper;
 - .2 Acuity nLight / Sensor Switch;
 - .3 Leviton;

- .4 Philips;
- .5 Hubbell;
- .6 Lutron.

2.02 OCCUPANCY SENSORS (STANDARD)

- .1 Wavelinx PRO Battery powered Wallstation WB Series,WWB-Series, CSA certified devices to provide automatic control of lighting with following components:
 - .1 power and slave packs;
 - .2 occupancy sensors;
 - .3 controls and daylight sensors;
 - .4 wiring in conduit and mounting hardware.
- .2 Low voltage power delivered via low voltage network cable using communication ports: 2x RJ 45 connectors.
- .3 Sensing Technologies:
 - .1 Motion sensing:
 - .1 PIR multiple-segmented lens, with internal grooves to eliminate dust and residue build-up.
 - .2 Products tested in identical manner, compliant with NEMA WD 7 -2011 Occupancy Motion Sensors Standards.
 - .3 Sensor shall have time delays from 10 to 20 min.
 - .4 Sensor battery life shall be ten years based on approximately 30 daily activations and wireless signals.
- .4 Power failure memory: Device shall incorporate non-volatile memory. Settings and parameters saved in protected memory shall not be lost should power be interrupted and subsequently restored. Programming is stored in each sensor in addition to the Area Controller.
- .5 Sensor reports the following data to the area controller:
 - .1 Occupancy status.
 - .2 Ambient light level.
- .6 LED indicators: LED indicators always provides a visual means to verify that motion is being detected during both testing and normal operation.
- .7 Sensors shall be fully adaptive with the ability to have the sensitivity and timing to be remotely adjusted to ensure optimal lighting control for any use of the space.

- .8 Sensors have remotely adjustable settings for dimming levels, occupied/unoccupied light levels, occupancy/vacancy sensing, and sensitivity to changes in motion and changes in ambient light levels.
- .9 Sensors may remotely adjust the light output to reduced levels and remain at that reduced level for an adjustable period before turning off when the space is unoccupied.
- .10 Where required, power packs to be self-contained, 347/120 VAC/24 VDC (or of voltage shown on drawings) transformer relay system. Slave packs to contain isolated relay. System to allow one sensor to control luminaires circuited to both essential power circuits and normal power circuits. Features also include:
 - .1 switches lighting or plug loads On and Off in response to low voltage control inputs;
 - .2 enables Manual-On sequences of operation, as well as Hold-On, Hold-Off, load shed applications and bi-level switching;
 - .3 field-selectable Auto-On or Manual-On operation;
 - .4 LED indicates status of relay or presence of low voltage overcurrent;
 - .5 plenum rated.
- .11 Override switches to be wall mounting in single gang recessed outlet boxes.
- .12 Where both normal and emergency power circuited luminaires exist, provide emergency power control unit that allows sensor to control both emergency power circuited luminaires as well as normal power circuited luminaires, and when normal power is lost, forces on emergency power circuited luminaires.
- .13 Relays to be provided as required to integrate sensors to BAS. Coordinate exact requirements with central lighting control system vendor and BAS vendor.
- .14 Wiring in conduit, mounting hardware and ancillary devices to be provided as per manufacturer's requirements.
- .15 System to be complete with initial one (1) year parts and labour warranty, with additional extended 5 years parts warranty.
- .16 Include for and arrange for manufacturer's authorized representative to perform on site testing, verification and certification of installed system. Refer to Part 3 installation article for additional requirements.
- .17 Where sensors are interconnected to dimming system, ensure that they are 100% compatible with respective control systems, dimmers and ballasts. Confirm with respective equipment manufacturers and obtain in writing that such integrations are acceptable to each manufacturer.
- .18 Where devices are connected to central lighting control system, acceptable device manufacturers to be as recommended by manufacturers of central lighting control system.
- .19 Generally, acceptable manufacturers are:
 - .1 Legrand-Watt Stopper;

- .2 Acuity nLight / Sensor Switch;
- .3 Leviton;
- .4 Philips;
- .5 Lutron;
- .6 Hubbell;
- .7 Eaton – Fifth Light;
- .8 Osram - Encelium.

2.03 LOW VOLTAGE DIMMING SWITCHPACKS

- .1 Wavelinx CAT Dimming Switchpack with one 0-10V Dimming channel RSP-P-010-347, CSA certified, ULC listed factory tested relays and associated devices for low voltage lighting control, as follows:
 - .1 Low voltage communication via low voltage network cable via 2xRJ-45 connections for communication ports.
 - .2 specification grade, heavy duty, 20 ampere rated plug-in relays complete with auxiliary contacts to provide status indication.
 - .3 Plenum-rated.
 - .4 Integrated, self-contained unit consisting internally of an isolated load switching control relay and a power supply to provide low-voltage power.
 - .5 Input Voltage: 120/277 VAC.
 - .6 Relay Output: Class 1 Latching 20amp Relay at 277VAC.
 - .7 Dimming Output: Single Class 2 0-10V dimming output.
 - .8 Sink Current: 30mA at 0-10 VDC.
 - .9 Power Output: 24VDC; 350 mA.
 - .10 Mounting: Integral 1/2 inch chase nipple.
 - .11 NEMA 1, electrical box sized to accommodate system components and spare future 10%; identify box cover with engraved nameplate; include drip shield for surface mounted boxes.
 - .12 Devices to be listed at ULC924 for devices on Emergency circuit.
 - .13 For emergency circuit, shall override emergency fixture to full brightness upon loss of normal power.
- .2 Acceptable manufacturers are:
 - .1 Legrand Watt Stopper;

- .2 Philips;
- .3 Hubbell;
- .4 Lutron;
- .5 Acuity nLight;
- .6 Leviton.

2.04 TOUCHSCREEN CONTROL INTERFACE

- .1 Wavelinx Touchscreen TSE57-WLX-B. CSA certified, ULC listed and associated devices as follows:
 - .1 Communication: Ethernet.
 - .2 Input power: Power over Ethernet (PoE – IEEE 802.3af) powered.
 - .3 Display: 5.7" diagonal capacitive touch display screen.
 - .4 Mounting: Installs in a standard single gang wall box.
 - .5 Touchscreen provides the following functions:
 - .1 Send user-defined or pre-configured scene commands to an area.
 - .2 Change light levels for lighting in an area or zone.
 - .3 Change color temperatures for lighting in a room or zone.
- .2 Acceptable manufacturers are:
 - .1 Acuity nLight;
 - .2 Legrand.

2.05 SENSOR INTERFACE MODULE

- .1 Wavelinx CAT sensor interface module, ULC listed as follows:
 - .1 Low voltage communication via network cable and 2xRJ 45 connectors for ports.
 - .2 Input Voltage: Low voltage power delivered by low-voltage network cable.
 - .3 Sensor inputs: 2 x inputs from sensor and power out to sensor.
 - .4 LED indicators: LED integrated into device providing visual indication of remote Bluetooth connection.
 - .5 Mounting: Plenum rated, inline wired, and screw mountable.
- .2 Acceptable manufacturers are:
 - .1 Acuity nLight;

- .2 Legrand.

2.06 BLUETOOTH LOW ENERGY PROGRAMMIG DEVICE

- .1 Wavellinx Bluetooth programming interface module, ULC listed CSA certified as follows:
 - .1 Low voltage communication via network cable and 2xRJ 45 connectors for ports.
 - .2 Bluetooth communication allowing connection to smartphone application for programming device setting within local daisy-chain zone.
 - .3 Input Voltage: Low voltage power delivered by low-voltage network cable.
 - .4 LED indicators: LED integrated into device providing visual indication of remote Bluetooth connection.
 - .5 Mounting: Plenum rated, inline wired, and screw mountable.
- .2 Acceptable manufacturers are:
 - .1 Acuity nLight;
 - .2 Legrand.

2.07 BACNET INTERFACE

- .1 Wavellinx BACnet Interface with following features:
 - .1 Monitor (Read):
 - .1 Area scene.
 - .2 Area energy usage.
 - .3 Dimming zone level (0-100%).
 - .4 On/off zone level (on/off).
 - .5 Occupancy sensor's occupied/unoccupied status.
 - .6 Daylight sensor's level.
 - .2 Control (write):
 - .1 System-wide Demand Response enable/disable.
 - .2 Building light level.
 - .3 Floor light level.
 - .4 Area scene.
 - .5 Dimming zone level (0-100%).
 - .6 On/off zone level (on/off).

- .7 Occupancy sensor.
- .3 The system shall allow users to select which object types the system shall expose, i.e. Area, Zones, input devices and output devices.
- .4 The system shall be able to generate the electronic PICS document and allow users to send the PICS document to the proper stakeholders.

3 EXECUTION

3.01 INSTALLATION OF LOW VOLTAGE DIMMERS

- .1 Provide flush wall box dimmers in locations and connect to control lighting as indicated. Confirm exact locations prior to roughing-in. Equip each dimmer with a faceplate. Review faceplate colour with Consultant prior to ordering.
- .2 Install components in accordance with manufacturer's instructions to suit specific installation requirements.
- .3 Provide power packs and emergency power control units as noted for low voltage dimmers. Connect complete.
- .4 Where identified, provide central enclosure cabinet for mounting dimmers within and connect complete. Clearly identify each dimmer and enclosure with engrave Lamacoid nameplates. Review exact nomenclature with Consultant prior to ordering.
- .5 When installation is complete, check and test operation of each dimmer and adjust as required.
- .6 Ensure that each dimmer is properly sized and of type to suit connected load.

3.02 INSTALLATION OF OCCUPANCY SENSORS

- .1 Provide occupancy sensors and daylight sensors and associated devices to control lighting in areas as required. Provide power packs as required with suitable voltage and power ratings.
- .2 Exact type of occupancy sensors and type of lenses to be verified by manufacturer/supplier to ensure proper coverage in sensed areas only, and compatibility to interconnected systems. Confirm with respective manufacturers.
- .3 Confirm device settings for automatic or manual on, and delay-off, with Owner and review with Consultant prior to installation, and make settings adjustments on each device.
- .4 Be responsible for providing, locating, and aiming appropriate sensors in correct location required for complete and proper volumetric coverage within range of coverage(s) of controlled areas per manufacturer's recommendations. Rooms to have 90-100% coverage to completely cover controlled area to accommodate occupancy habits of single or multiple occupants at any location within room(s). Locations and quantities of sensors shown and/or noted are illustrations only and should only be used as guidelines. Provide additional sensors if required to properly and completely cover respective room.

- .5 Verify with manufacturer's factory authorized representative, exact type of sensor to be used in each area, placement of sensors and installation criteria, to best meet requirements of end user. Manufacturer's representative should be consulted for more non-typical installation types. Ensure that sensors connected to dimming system are 100% compatible with dimming system.
- .6 Where luminaires in rooms/areas are fed from normal and emergency power circuits, provide suitable relays and provisions to ensure that operation of luminaires on emergency power are maintained during loss of normal power.
- .7 Proper judgement must be exercised in executing installation so as to ensure that best possible installation in available space and to overcome local difficulties due to space limitations or interference of structural components. Also provide, at Owner's facility, training necessary to familiarize Owner's personnel with operation, use, adjustment, and problem-solving diagnosis of occupancy sensing devices and systems.
- .8 Install devices in accordance with manufacturer's instructions. Provide wiring in conduit. Provide required power connections and interconnection to luminaires and power panels. Provide manual switches to override control system in each area/room as shown.
- .9 Review finishes of sensors with Consultant prior to ordering.
- .10 Review mounting heights with Consultant and manufacturer prior to roughing-in and installation.
- .11 Adjust sensitivity and time delays to best suit Owner's furniture layout drawings. Allow for minor adjustments of locations (1 m [3.3']) of sensors.
- .12 After installation is complete, provide for manufacturer's authorized representative to inspect, test and verify system performance and installation.
- .13 After completion of project and within 30 days after Owner has taken occupancy and furnishings are in place, provide for manufacturer's authorized representative to revisit site to test and make final adjustments.
- .14 Refer also to testing and verification requirements in Section entitled Electrical Work Analysis and Testing and include applicable requirements.

3.03 INSTALLATION OF LOW VOLTAGE LIGHTING CONTROLS

- .1 Provide low voltage lighting components as required. Connect complete.
- .2 Install components in accordance with manufacturer's instructions to suit specific installation requirements.
- .3 Flush mount low voltage switches into wall mounted electrical boxes. Provide suitable mounting bracket and faceplate for each switch. Review finishes with Consultant prior to ordering.
- .4 Install power supplies, transformers and relays in barriered electrical boxes/enclosures and locate adjacent to surface mounted panel boards to which lighting loads are connected or in accessible ceiling space above recessed mounted panel boards to which lighting loads are connected. Review exact locations with Consultant prior to start of work.
- .5 Locate locations of boxes on as-builts.

- .6 Clearly label each box and label low voltage switching circuits.
- .7 Refer also to testing and verification requirements in Section entitled Electrical Work Analysis and Testing and include applicable requirements.

END OF SECTION

1 GENERAL

1.01 SUBMITTALS

- .1 Submit shop drawings for products specified in this Section.

1.02 BREAKERS

- .1 Refer to Section 26 20 00 - Part 1, for general requirements for breakers.

2 PRODUCTS

2.01 BRANCH CIRCUIT PANELBOARDS

- .1 Eaton "Pow-R-Line" series,-factory assembled dead front panelboards as per schedules, manufactured to CSA Standard C22.2 No. 29 and local governing electrical code, and designed for sequence phase connection of branch circuit breakers.
- .2 As scheduled, panelboards are of types:
 - .1 For panels with main breaker or main lugs up to 225 A, 120/208 V: "Pow-R-Line 1", 3-phase and single phase with minimum "BAB" frame, bolt-on moulded case circuit breakers with a minimum interrupting capacity of 10 KA symmetrical at 208 V, unless otherwise scheduled. Where panelboards are schedule to include series rated provisions, provide breakers as recommended by panel manufacturer.
 - .2 For panels with main breaker or main lugs up to 225 A, 347/600 V: "Pow-R-Line 2", 3-phase panelboards with bolt-on moulded case circuit breakers with interrupting capacity as scheduled or in absence of direction to be of capacity for intended application to local governing electrical code requirements.
 - .3 For panels with main breaker or main lugs 400 A to 600 A, 120/208 V and 347/600 V: "Pow-R-Line 3", 3-phase panelboards with bolt-on moulded case circuit breakers with interrupting capacity as scheduled or in absence of direction to be of capacity for intended application to local governing electrical code requirements.
- .3 Where ground fault circuit interrupting (GFCI) type breakers are required by code and/or scheduled, provide "Quicklag" ground fault, CSA Class "A", Group 1, combination thermal magnetic bolt-on circuit breakers with solid-state ground fault interrupters.
- .4 Panelboards to be equipped with one (1) continuous bus bar per phase. Each bus bar to have sequentially phased branch circuit connectors limited to bolt-on branch circuit breakers. Bussing to be fully rated and of plated copper construction.
- .5 Panelboards are to be complete with:
 - .1 NEMA 1 constructed of code gauge galvanized steel with removable box ends, wiring gutter space on sides; conduit entries sealed water-tight; drip shield for surface mounted panelboards;
 - .2 dead-front construction to shield user from energized parts;
 - .3 enclosure constructed of code gauge, hot zinc dipped galvanized steel constructed in accordance with UL 50 requirements; trim for flush or surface wall mounting as shown; front panel to not be removable with the door locked;

- .4 hinged door with concealed fasteners, concealed hinge, chrome plated door latch and keyed alike lock with key;
- .5 steel frame holder and circuit directory card protected by clear acetate and secured to back of door, and Mylar circuit breaker identification strips;
- .6 copper neutral bars;
- .7 200% sized neutrals for panels equipped with SPD units and for panels as scheduled;
- .8 solidly bonded equipment copper ground bar;
- .9 high strength, set screw type, anti-turning wire connectors;
- .10 current-carrying parts be insulated from ground and phase-to-phase by high dielectric strength thermoplastic;
- .11 isolated ground bus for panelboards feeding electrically sensitive equipment;
- .12 filler plates covering unused mounting space;
- .13 non-automatic and automatic main breaker to function as an isolating switch, where shown and as required;
- .14 ground fault circuit interrupting (GFCI) type breakers to feed devices as scheduled and for applications required by local governing codes;
- .15 arc fault circuit interrupter (AFCI) type breakers to feed devices as scheduled and for applications required by local governing codes.
- .6 Panels, doors and trim are to be factory painted with ANSI grey enamel finish. Recessed backboxes (tubs) need not be finished painted.
- .7 Equip breakers of frame size 225 amperes and greater, with solid state adjustable trip units.
- .8 Equip circuit breakers connected to dedicated equipment or devices with handle locks.
- .9 Include spare breakers as sized on schedules and future breaker provisions as noted on schedules. Future breaker provisions to include space for breakers, bussing for full panel size and where future breaker sizes are scheduled, required breaker connector kits.
- .10 Acceptable manufacturers are:
 - .1 Eaton;
 - .2 Schneider Electric (Square D);
 - .3 Siemens Electric Ltd.

3 EXECUTION

3.01 INSTALLATION OF PANELBOARDS

- .1 Provide factory assembled branch circuit panelboards and install into locations and connect complete. Install panelboards with adequate clearance as per code requirements and as required for access for operation and maintenance. Load panels with breakers as scheduled and as required.
- .2 Support cabinets and enclosures independent of connecting conduit, and accurately install with reference to wall finishes.
- .3 Equip panelboards with suitable lugs or provisions to accommodate main and branch conductors scheduled.
- .4 Coordinate with Mechanical Division trades and Consultant to determine extra mechanical loads and BAS panels requiring use of specified additional 15A circuits and connect complete.
- .5 Ground and bond equipment as per local governing electrical code and inspection authority requirements. Refer also requirements of Section entitled – Grounding and Bonding.
- .6 Turn over to Consultant, prior to application for a Certificate of Substantial Performance of Work, minimum quantity of two panelboard cabinet or enclosure keys per panelboard.
- .7 Where two or more panelboards are installed in one cabinet, equip panelboards with double lugs and increase gutter capacity to accommodate additional cabling.
- .8 Identify panelboard breakers in a permanent manner, and complete typed panelboard circuit directories identifying circuit number and type and location of loads supplied from each breaker with nomenclature approved by Owner and reviewed with Consultant.
- .9 Include for spaces for future breakers, spare breakers and additional breakers for miscellaneous mechanical loads are included as per schedules and as specified.
- .10 Test and verify ground fault circuit interrupting breakers as follows:
 - .1 demonstrate in presence of Consultant that protected circuits will "trip" when a simulated ground fault is applied to "load" side of each circuit breaker/ground fault interrupter combination;
 - .2 megger load side neutral on GFCI protected branch circuits to ensure that neutral is not grounded on load side of GFCI;
 - .3 verify GFCI operation with governing authority approved GFCI tester suitable for application;
 - .4 provide a written report confirming that tests have been performed and that system is functioning properly.
- .11 Test and verify arc fault circuit interrupting breakers as per manufacturer's instructions.
- .12 Ground and bond panel as per local electrical code requirements. Refer also to requirements of grounding and bonding article.

- .13 Additionally, refer to testing, coordination and verification requirements in Section entitled Electrical Work Analysis and Testing and include applicable requirements. Document test results and submit copy to Consultant.

END OF SECTION

1 GENERAL

1.01 SUBMITTALS

- .1 Submit shop drawings for products specified in this Section.
- .2 Submit samples of each typical wiring device, faceplates, finishes and colours. Mount to sample board, clearly labelling devices and finishes. Submit for review with Consultant. Do not order any device unless finishes have been approved by Owner and reviewed with Consultant.

2 PRODUCTS

2.01 SWITCHES

- .1 Switches to be CSA certified, ULC listed and labelled devices.
- .2 Hubbell Canada Inc., HBL 1221 Series, CSA certified, heavy duty, industrial grade, back, and side wired, AC quiet action toggle type, 20 ampere, 120-277 V switches. Switches to include steel-nickel plated bridge, nylon toggle, one-piece rivetless copper alloy spring contact arm and terminal plate, silver cadmium oxide contacts, brass binding head screws, one-piece integral grounding terminal and stainless-steel automatic grounding clips. Provide single way, 2-way, 3-way, and key type to suit specific application requirements.
- .3 Hubbell Canada Inc. No. 1221-IL, CSA certified, heavy duty, specification grade, AC quiet action, illuminated polycarbonate handle toggle type, 20 ampere, 120-277 V switches.
- .4 Legrand - Pass & Seymour, No. 1200 series, pressure sensitive door switches complete with metal box, plates, and wire leads, and suitable for flush installation. Light is "ON" when door is open.
- .5 Acceptable manufacturers are:
 - .1 Hubbell Canada Inc.;
 - .2 Eaton - Cooper Wiring Devices (Arrow Hart);
 - .3 Legrand - Pass & Seymour;
 - .4 Leviton.

2.02 RECEPTACLES

- .1 Receptacles to be CSA certified, ULC listed, certified and labelled devices.
- .2 Hubbell Canada Inc., No. HBL 8200/8300 series, extra heavy duty hospital grade with green dot symbol, back and side wired, flush, thermoplastic polyester face/body construction, duplex U-ground, 15/20 ampere, 125 V, 2-pole, 3-wire grounding receptacles complete with one piece nickel-plated brass mounting strip with integral grounding clips, ground retention clips, nickel-plated brass wiring clamps with nickel-plated brass screws, front circuit identification area and reinforced thermoplastic base.

- .3 Hubbell Canada Inc., No. 8200/8300 series, heavy duty hospital grade with green dot symbol, power indicating LED, back and side wired, flush, thermoplastic polyester face/body construction, duplex U-ground, 15/20 ampere, 125 V, 2-pole, 3-wire grounding receptacles complete with one piece nickel-plated brass mounting strip with integral grounding clips, ground retention clips, nickel-plated brass wiring clamps with nickel-plated brass screws, front circuit identification area and reinforced thermoplastic base.
- .4 Hubbell Canada Inc., No. 8200 TR /8300 TR series, heavy duty hospital grade with green dot symbol, tamper resistant with power indicating LED, back and side wired, flush, thermoplastic polyester face/body construction, duplex U-ground, 15/20 ampere, 125 V, 2-pole, 3-wire grounding receptacles complete with one piece nickel-plated brass mounting strip with integral grounding clips, ground retention clips, nickel-plated brass wiring clamps with nickel-plated brass screws, front circuit identification area and reinforced thermoplastic base.
- .5 Hubbell Canada Inc., No. HBL SNAP8200 CSA certified, ULC listed, Hospital grade with green dot symbol, nylon face/body construction, duplex U ground, 15 ampere, 125 V, 2 pole, 3 wire grounding receptacles complete with right angled pigtailed terminal with 150 mm (6") leads, one piece nickel-plated brass mounting strip with integral grounding clips, ground retention clips, nickel-plated brass wiring clamps with nickel-plated brass screws, front circuit identification area and reinforced thermoplastic base.
- .6 Hubbell Canada Inc., No. HBL 8200SG series, extra heavy-duty hospital grade, 15 ampere, 125 V, 2-pole, 3-wire grounding, tamper-resistant (safety shutter) duplex receptacles.
- .7 Hubbell Canada, No. HBL8262SA / HBL8362SA "CIRCUITGUARD" Series, hospital grade, 15/20 ampere, 125 V, duplex, surge suppression receptacles in blue finish, complete with light and alarm, 240 joules/15000A per mode.
- .8 Hubbell Canada, No. GFR8200SG / GFR8300SG "AUTOGUARD" Series, extra heavy duty hospital grade, 15/20 ampere, 125 V, duplex, ULC Class "A", Group One, tamper resistant, weather resistant ground fault circuit interrupting receptacles complete with automatic self-test diagnostics, green power ON LED, red ground fault LED and 10ka short circuit current rating.
- .9 Hubbell Canada Inc., No. USB 8200/8300 series, hospital grade, CSA certified, ULC listed, 2- USB ports (5A, 5V DC, type A and type C port configurations, class 2.0, 3.0 and 3.1) and 15/20 ampere, 125 V rated duplex decorative style power receptacles, tamper resistant, back and side wired. Confirm exact USB port configuration and 15A or 20A power receptacle requirements with Owner prior to ordering.
- .10 Hubbell Canada, No. GFR8200SNAP / GFR8300SNAP "AUTOGUARD" Series, extra heavy-duty hospital grade, 15/20 ampere, 125 V, duplex, ULC Class "A", Group One, tamper resistant, weather resistant ground fault circuit interrupting receptacles complete with right angled pigtailed terminal with 150 mm (6") leads, automatic self-test diagnostics, green power ON LED, red ground fault LED and 10ka short circuit current rating.
- .11 Hubbell Canada Inc., No. HBL5262 / HBL5362 CSA certified, ULC listed, extra heavy duty, specification grade, back and side wired, flush, nylon face/body construction, duplex U-ground, 15/20 ampere, 125 V, 2-pole, 3-wire grounding receptacles complete with one piece nickel-plated brass mounting strip with integral grounding clips, ground retention clips, nickel-plated brass wiring clamps with nickel-plated brass screws, front circuit identification area and reinforced thermoplastic base.

- .12 Hubbell Canada Inc., No. HBL 5361 series, extra heavy duty, specification grade, flush, nylon face, single, 20 ampere, 125 V, 3-wire grounding receptacles.
- .13 Hubbell Canada Inc., No. HBL 5461 series, extra heavy duty, specification grade, flush, nylon face, single, 20 ampere, 250 V, 2-pole 3-wire grounding receptacle.
- .14 Hubbell Canada, No. HBL5262SA / HBL5362SA "CIRCUITGUARD" Series, specification grade, 15/20 ampere, 125 V, duplex, surge suppression receptacles in blue finish, complete with light and alarm, 240 joules/15000A per mode.
- .15 Hubbell Canada Inc., No. BR15TR series, commercial specification grade, 15 ampere, 125 V, 2-pole, 3-wire grounding, tamper-resistant (safety shutter) duplex receptacles.
- .16 Hubbell Canada, No. GFR 5262SG / GFR 5362SG "AUTOGUARD" Series, extra heavy-duty grade, 15/20 ampere, 125 V, duplex, ULC Class "A", Group One, tamper resistant, weather resistant ground fault circuit interrupting receptacles complete with automatic self-test diagnostics, green power ON LED, red ground fault LED and 10ka short circuit current rating.
- .17 Hubbell Canada, No. BR15TR series, specification grade, 15 ampere, 125 V, 2-pole, 3-wire, tamper resistant, safety shutter receptacles.
- .18 Hubbell Canada, No. 4710, specification grade, 15 ampere, 125 V, single, 2-pole, 3-wire grounding twist lock receptacle.
- .19 Hubbell Canada, No. 15 ampere and 50 ampere receptacles complete with neutral and ground conductors required for indicated number of phases as required.
- .20 Where noted that 20 A receptacles are required, include for "T" slot type of respective series of receptacles.
- .21 Colour of special switches and receptacles (unless specified above), to be as specified in PART 3 of this Section of Specification.
- .22 Special switches and receptacles not specified above are to be specified on drawings. Low voltage lighting controls are specified in Section entitled Lighting Control.
- .23 Acceptable manufacturers are:
 - .1 Hubbell Canada Inc.;
 - .2 Eaton - Cooper Wiring Devices (Arrow Hart);
 - .3 Legrand - Pass & Seymour;
 - .4 Leviton.

2.03 FACEPLATES

- .1 Hubbell Canada, high impact strength, and flame resistant wall plates of nylon or thermoplastic construction. Standard and mid sizes are to be provided in various colour finishes, to suit specific applications.
- .2 Legrand - Pass & Seymour, "Jumbo" 302 stainless steel wallplates.

- .3 Galvanized steel stamped faceplates for Equipment rooms.
- .4 Colours and finishes of faceplates are specified in Part 3 of this Section.
- .5 Acceptable manufacturers are as per switches and receptacles.

3 EXECUTION

3.01 INSTALLATION OF SWITCHES

- .1 Provide devices and install in electrical outlet boxes. Refer to drawings to determine flush or surface mounting requirements. Generally, flush mount devices in finished areas. Size electrical boxes to suit device requirements as per device manufacturer's recommendations. Properly ground device to box and ground system as per code requirements and manufacturer's instructions.
- .2 For pricing only, switches to be ivory for devices connected to normal power circuits, red for devices connected to essential power circuits.
- .3 Every switch connected to essential (emergency) power circuits, to be illuminated toggle type.
- .4 Illuminated operation of lighted switches to suit specific applications as confirmed with Consultant.
- .5 Ensure that switches located adjacent to doors are located at strike side of door. Confirm door swing requirements on architectural drawings, not on electrical drawings.
- .6 Coordinate installation of door switches with trades responsible for provision of doors and frames. Review exact locations of switches with Consultant to ensure optimum operation of switch to door position.
- .7 Review final device finishes with Consultant as per sample board submission specified in Part 1. Do not order any devices unless final finishes have been approved by Owner and reviewed with Consultant.
- .8 Additionally, refer to testing and verification requirements in Section entitled Electrical Work Analysis and Testing and include applicable requirements.

3.02 INSTALLATION OF RECEPTACLES

- .1 Provide devices and install in electrical outlet boxes. Refer to drawings to determine flush or surface mounting requirements. Generally, flush mount devices in finished areas. Size electrical boxes to suit device requirements as per device manufacturer's recommendations. Properly ground device to box and ground system as per code requirements and manufacturer's instructions.
- .2 For pricing only, receptacles to be ivory for devices connected to normal power circuits, red for devices connected to essential power circuits. Generally, install receptacles in Patient Care Areas vertically with ground pins up.
- .3 Safety shutter type receptacles to be located where shown and required by code and CSA Z32.

- .4 Install USB charger receptacles in extra deep boxes in accordance with manufacturer's recommendations.
- .5 Install exterior receptacles in accordance with drawing details, and as coordinated and reviewed with Consultant. Comply with local governing electrical code with regards to wiring and installation requirements. Properly ground installations.
- .6 In patient care areas as a minimum, 15A/20A straight blade receptacles to be hospital grade.
- .7 Comply with requirements of CSA Standard Z32, with regards to identifying circuit number and supplying panelboard, permanently identified at outlets. Identify this information in areas on front of each receptacle. In addition, provide engraved lamacoid nameplate on wall below each device faceplate, identifying circuit number and panelboard from where each device is fed. Review exact location for identification with Consultant.
- .8 Where receptacles are indicated in counters and benches, box cut-out to be provided in counter and bench. Provide a box, receptacle, plate and branch circuit wiring. Branch circuit wiring within counters and benches to be flexible armoured cable, under requirements of local governing electrical code and standards. Install and connect complete.
- .9 Review locations and nomenclature of nameplates and labelling with Consultant prior to printing of labels and nameplates. Turn over label maker to Consultant/Owner prior to application for Certificate of Substantial Performance of the Work.
- .10 Review final device finishes with Consultant as per sample board submission specified in Part 1. Do not order any devices unless final finishes have been approved by Owner and reviewed with Consultant.
- .11 Additionally, refer to testing and verification requirements in Section entitled Electrical Work Analysis and Testing and include applicable requirements.

3.03 INSTALLATION OF FACEPLATES

- .1 Provide each device with a faceplate with an opening or openings suitable for device it conceals and covers openings around boxes. Secure faceplates to device frames with screws to match faceplates. Provide larger than standard type faceplates for devices that require engraved nomenclature to define special purpose for that device.
- .2 Provide stainless steel type standard size faceplates for flush mounted devices.
- .3 Provide stainless steel faceplates in operating rooms, laboratories, treatment rooms, test
- .4 Provide nylon type faceplates for switches and receptacles circuited to emergency power sources and/or isolated power centres. Colour finish to be red, but reviewed with Consultant.
- .5 Provide galvanized stamped steel faceplates in service areas and equipment rooms where devices are surface mounted.
- .6 Provide faceplates for housekeeping receptacles with label printed with "Housekeeping Only" lettering.

- .7 Provide weatherproof insulated faceplates with hinged and gasketted receptacle access flaps for weatherproof receptacles denoted "WP" on drawings.
- .8 Generally, oversized faceplates to be provided where engraved lettering is required.
- .9 Faceplates for flush floor mounted receptacles in standard floor boxes to be forged brass rectangular faceplates.
- .10 For flush mounted devices, provide oversized faceplates as required to properly cover wall openings around recessed boxes.
- .11 Provide faceplates with suitable identification labels. Review exact locations for labelling with Consultant.
- .12 In addition to identification requirements specified with devices, provide faceplates with printed self-adhesive label on inside face identifying circuit number and panel feeding device. Turn over label maker to Consultant prior to application for Certificate of Substantial Performance of the Work.
- .13 Review exact material, finish, and colour of faceplates for devices in any particular area with Consultant prior to ordering. Submit sample board as per requirements of Part 1.

3.04

1 GENERAL

1.01 SUBMITTALS

- .1 Submit shop drawings for products of this Section, and on Schedule of Luminaires on drawings.
- .2 Submittals to include:
 - .1 luminaire dimensions, aperture dimensions, cutout dimensions;
 - .2 driver information for each luminaire, including maximum circuit loading limitations, and dimming details;
 - .3 total input watts;
 - .4 lumen rating in accordance with IESNA testing procedures;
 - .5 candlepower summary, candela distribution zonal lumen summary;
 - .6 luminaire efficiency;
 - .7 lamp life rating (based on LM-80 and TM-21);
 - .8 colour temperature;
 - .9 colour fidelity (as per TM-30 preferred);
 - .10 finishes;
 - .11 options being provided;
 - .12 other relevant information to ensure design intent.
- .3 Include copy of certification that lenses, and louvers comply with local governing building code requirements for flame spread ratings.
- .4 Include copies of documents of respective manufacturers confirming complete compatibility between lighting controls and luminaires.

1.02 WARRANTY

- .1 Warranty requirements for luminaires are as follows:
 - .1 warranties to be full comprehensive product replacement direct from luminaire manufacturers;
 - .2 when LEDs and drivers, or lamps and ballasts are supplied with luminaire by luminaire manufacturer, warranty to be under responsibility of luminaire manufacturer;

- .3 unless otherwise noted, warrant LED luminaires and LED drivers for a period of minimum 5 years from date of application for Certificate for Substantial Performance of the Work; include for personnel, equipment and labour for replacing products onsite, for duration of Contract warranty period defined in Division 00 or 01; for remainder of 5 years extended warranties beyond Contract warranty period, include typical conditions of product manufacturers' replacement warranty;

1.03 PRODUCT COMPATIBILITY

- .1 Luminaires and lighting controls when integrated together for control purposes must be 100% compatible with each other. Coordinate with ballast/driver and LED/lamp manufacturers, LV relay panel manufacturers, switches/timers manufacturers and dimmer/light sensor/occupancy control manufacturers to ensure that components are compatible with each other and that interconnections do not adversely affect performance, life or any warranties.

1.04 SUBSTITUTIONS

- .1 Provide luminaires as specified in Schedule of Luminaires and as per documented List of Manufacturers, where applicable. During construction period, no substitutions are permitted unless compelling reasons are given and accepted by Owner and reviewed with Consultant. A delay caused by Contractor's failure to order luminaires to meet construction schedule is not a valid reason.
- .2 Make requests for proposed substitutions as per requirements of Section entitled Electrical Work General Instructions and Division 01.
- .3 Consideration of any proposed substitutions after Bid Period to be at Consultant's sole discretion.

2 PRODUCTS

2.01 LUMINAIRES

- .1 Provide luminaires in accordance with Schedule of Luminaires. Luminaires including integrated LEDs and drivers are to be CSA approved or have special local electrical authority approval. Ensure luminaires and integrated LEDs and drivers are tested for full compatibility operation prior to shipping to site.
- .2 Provide thickness of metal as indicated in Schedule of Luminaires and details, or as required so that luminaires are rigid, stable and resists deflection, twisting, warping or bending under normal installation procedures, re-lamping etc., or no less than requirements specified herein the specifications.
- .3 Unless otherwise noted, linear and continuous linear architectural LED luminaires bodies to be constructed of extruded aluminum and of rigid construction. Unless otherwise noted, provide body finishes of corrosion resistant, chemically treated and electrostatically applied post powder coat finish. Efficiency not to be less than 69%.
- .4 Unless otherwise noted, vandal resistant luminaires to be constructed of heavy duty extruded aluminum rails and die cast end caps, complete with stainless steel torx with centre reject pin and Allen head set screws. Screw heads to be mounted and concealed under lens. Lens to be extruded UV stabilized polycarbonate lens with internal linear ribbed design.

- .5 Provide neoprene or silicone gasketing, barriers and stops where required to prevent light leaks or water/water vapour penetration.
- .6 Fabricate housings to allow for easy accessibility and replacement of parts.
- .7 Fabricate fixtures with a minimum number of joints. Make unexposed joints by acceptable method such as welding, brazing, screwing or bolting. Soldered joints are unacceptable. Do not use blind metal tapping methods or rivets for fastening parts which must be removed during service, or for fastening electrical components and supports. Cast parts, including die-cast members, to be of uniform quality, close grained, rigid, true to pattern, free from blow holes, pores, discoloration, hard spots, shrinkage defects, and cracks or other imperfections that affect strength and appearance or are indicative of inferior metals or alloys.
- .8 Reflectors and reflecting cones or baffles to be free of any tooling marks, spinning lines or marks by other assembly techniques. Iridescence to be low. Finishes to be equal to first quality polished, baffled, and anodized "Alzak".
- .9 Lenses and louvers to comply with local governing building code and other local governing code flame spread rating requirements.
- .10 Unless otherwise noted, construct acrylic lens from 100% virgin acrylic and not less than 3.22 mm (0.125") thick. K12 acrylic lenses to have recessed prismatic pattern with no fade-outs or streaks and be of strain-free and uniform production. Glass lenses to be minimum 9.5 mm (0.375") thick.
- .11 Recessed luminaires with replaceable/serviceable parts such as ballasts, lamps, sockets, etc., must be accessible from lens side (i.e. room side) of fixtures to allow for proper accessibility.
- .12 Luminaires to be factory assembled and tested prior to delivery on site.
- .13 Exposed parts and hardware of luminaires located in non-climate controlled areas to be corrosion resistant and weather resistant. Hardware to be tamper-proof. Manufacturer exterior luminaire poles with corrosion resistant finish and construction. Pole suppliers to ensure that poles supplied are suitable for steady wind velocity and gust velocity of area of installation, and suitable for total effective projected area of lighting equipment. Submit verification of this with shop drawings.
- .14 When requested, submit luminaire samples.
- .15 Dimensions for coves, valances, and strips as shown on drawings are for bidding purposes only. Job measure for exact dimensions of louvers, lenses and strips.
- .16 Dimensions for linear and continuous linear LED as shown on drawings are for bidding purposes only. Job measure for exact dimensions requirements to suit installation location.
- .17 Review exact colours and finishes of luminaires with Consultant after award of contract but prior to ordering. Obtain information in time to meet installation schedule.
- .18 Coordinate with interconnected product manufacturers to ensure that components are compatible with each other and that interconnections do not affect performance, life or any warranties.

- .19 Products of same specified type to be of same manufacturer.

2.02 LEDS AND DRIVERS

- .1 Typically, general features include:
 - .1 CSA approved, ULC listed and labelled;
 - .2 NEMA 410 compliant drivers;
 - .3 typical operating temperatures:
 - .1 Luminaires for applications in extreme cold, non-climate-controlled area: operating temperature range through -40°C (-40°F) to 60°C (140°F);
 - .2 Luminaires for applications in climate-controlled area: operating temperature range through -20°C (-4°F) to 50°C (122°F);
 - .4 with rapid and changing development of LED technology, provide most technically proven and most advanced and successfully tested LED technology at time of installation;
 - .5 specification standards to meet requirements of IES LM 79 and LM-80.
 - .6 where connected to dimmers, be 100% compatible with connected dimmer controls to provide dimming down to 1%. Coordinate with dimming controls vendors to ensure that technical operations of dimmers (i.e. forward phase, reverse phase, etc.) match LED/ driver technology. Clearly identify this information in shop drawing submissions.
- .2 Typical light emitting diodes (LEDs) features to include:
 - .1 LEDs to be selected from same colour bin size for consistency in chromaticity and meet ANSI C78 377A as a minimum;
 - .2 generally, colour temperature range to be from 2700 K to 6500 K; specific temperature requirements to be identified on Schedule of Luminaires and reviewed with Consultant prior to ordering;
 - .3 minimum CRI of 85;
 - .4 minimum rated life (based on LM-80 and TM-21) from 50,000 to 70,000 hours.
- .3 Typical driver features to include:
 - .1 operate from 60 Hz input source of 120 VAC/347VAC (as applicable) with sustained variations of $\pm 10\%$ (voltage and frequency) with no damage to driver;
 - .2 output regulated to $\pm 5\%$ across load range;
 - .3 power factor greater than 0.90;
 - .4 total harmonic distortion less than 20%;
 - .5 Class A sound rating;

- .6 comply with ANSI C62.41 Category A for transient protection.
- .4 LEDs and drivers are to be 100% compatible with each other. Luminaire with LED and driver to be CSA approved or ULC listed, and certified and tested as a complete assembly.
- .5 Above features are general requirements to ensure that any proposed luminaires that are not base specified are to have premium quality LEDs and drivers. Refer to Schedule of Luminaires.
- .6 Acceptable LED and driver manufacturers to be as recommended by luminaire manufacturers.
- .7 For specialty luminaires used for accent or task lighting applications, acceptable manufacturers of LEDs and drivers to be as listed above. Additionally, for these specialty luminaires, acceptable manufacturer of LEDs and drivers to include those of base specified luminaires. Refer to Schedule of Luminaires for additional requirements.

3 EXECUTION

3.01 INSTALLATION OF LUMINAIRES

- .1 Reference electrical drawings for general luminaire location, circuiting, and controls. Reference Architectural reflected ceiling plans (RCPs) for more detailed location of luminaires. Consult both sets of drawings in preparation for installation. Review final locations with Consultant prior to roughing-in.
- .2 Review construction of materials where luminaires are to be located. Comply with local governing building code requirements for providing openings in walls, partitions and floor assemblies required to be a fire separation, to be protected with fire separations and closures. Where luminaires are not specified with fire rated housings, provide other means reviewed with Consultant and meeting local governing building code requirements.
- .3 Installed luminaires may be energized for testing installation and be de-energized until system commissioning. Installed luminaires may not be used as construction lights.
- .4 Protective material to remain on luminaires until prior to commissioning. At commissioning, clean luminaires to in new condition.
- .5 Confirm with luminaire manufacturers that luminaires have been tested at factory with integrated LEDs and drivers to ensure 100% compatibility of operation between products. Document in report signed by manufacturer's authorized representative. Submit copy to Consultant.
- .6 After shop drawing review process has been completed with Consultant, provide luminaires as required. Obtain required training from manufacturer's representative on any special installation procedures. Install products in accordance with manufacturer's instructions to suit specific installation requirements.
- .7 Before placing luminaire orders:
 - .1 verify quantity requirements;
 - .2 thoroughly review ceiling types, finishes and construction details; verify ceiling types with latest Architectural Drawings; order luminaires to suit correct ceiling type;

- .3 ensure that required mounting assemblies, frames, rings and similar features are included;
- .4 review colours and finishes with Consultant.
- .8 Include for assembly and mounting of luminaires and lamps, complete with:
 - .1 wiring and connections;
 - .2 fittings and hangers;
 - .3 aligners;
 - .4 box covers;
 - .5 other accessories required for a complete, safe and fully operational assembly.
- .9 Where outlet boxes locations are shown on drawings, they are diagrammatic only. Position outlet boxes to coincide with suspension hangers and knockouts.
- .10 Install ceiling fixtures in centre of tiles unless dimensioned otherwise on Reflected Ceiling Plans. Locate hangers on tile centres or intersections. Mount recessed downlights, troffers, and surface mounted luminaires in or on full tiles. Install fixtures in and on acoustical tile ceilings in alignment with tile joints.
- .11 Cut holes for recessed luminaires to exact size so that gaps are not visible, or luminaire trims cover gaps.
- .12 Mount surface ceiling luminaires perfectly level or plumb, tightly to ceiling without showing a space or light leak between frame and ceiling.
- .13 Carefully align linear luminaires shown in continuous lines or rows, so that rows appear as straight lines. Variation in alignment not to exceed 6 mm (1/4") for any 5 m (16') run.
- .14 Provide spacers for fixtures mounted on low density ceiling material.
- .15 Provide plaster frames for recessed fixtures in plaster or gypsum board ceilings.
- .16 Prepare fixtures, trim and poles and standards required to be painted.
- .17 Protect wiring with tape or tubing at all points where abrasion may occur. Conceal wiring within fixture construction except where design or mounting dictates otherwise.
- .18 Splices:
 - .1 Minimize number of splices.
 - .2 Make with approved mechanical insulated steel spring type connectors, suitable for temperature and voltage conditions to which splices are to be subjected.
 - .3 Splices are not to be made unless properly terminated in accessible identified junction boxes.

- .19 Support luminaires directly by ceiling slab structure and not to formed steel decking, ceiling hangers, ductwork, piping, cable trays, etc. Review exact requirements with Consultant prior to start of work.
- .20 Do not tighten wing nuts, bolts, or screws that allow fixture adjustment for recessed adjustable fixtures.
- .21 Install spread lenses only where called out on Schedule of Luminaires and Specifications.
- .22 Use cloth gloves when handling reflector cones, louvers, lamps, glass, sconces and all exposed surfaces of luminaires.
- .23 Co-ordinate luminaire installation with work of other trades to ensure that necessary recessing depths and mounting spaces are provided.
- .24 Install luminaires in accordance with applicable architectural drawing reflected ceiling plans and/or wall elevations and/or field instructions issued by Consultant. Review final luminaire locations with Consultant prior to roughing-in. In equipment rooms, shafts and similar secondary areas, install luminaires after mechanical and other major work is roughed in and adjust luminaire locations as required.
- .25 Align and position all adjustable luminaires and ensure that luminaires with adjustable lamp holders are properly positioned to correspond to lamps specified.
- .26 Comply with requirements of local governing electrical code regarding support of luminaires in suspended ceilings.
- .27 Independently suspend luminaires in suspended ceilings from ceiling slab. For each luminaire, provide minimum two cable supports secured to ceiling slab and to luminaire. Confirm with local governing authorities and review with Consultant if a variance to this requirement can be made for specific luminaires of low weight.
- .28 Connect luminaires to power circuits and controls as required. Refer to drawings notes and schedules. Include for both normal and emergency power circuits as required.
- .29 Locate exit signs in final locations reviewed with Consultant and approved by local building code authority. Connect to power circuits as required. Where applicable for emergency power requirements, connect to emergency battery units. Relocate exit sign and re-direct direction arrows to suit local building code authority requirements and directions, and as reviewed with Consultant.
- .30 For emergency lighting controls include required relays compliant with UL924 and applicable CSA C22.2 Standards.
- .31 Notify Consultant immediately and relocate if necessary as reviewed with Consultant, if:
 - .1 fixture placement conflicts with a structural beam, mechanical duct, plumbing pipe, etc.;
 - .2 space above ceiling is not sufficient;
 - .3 any reason that a fixture cannot be located where it is dimensioned or shown on construction documents.

- .32 Existing luminaires designated to be relocated and reused, to be:
 - .1 disconnected, removed and stored in a safe area as designated by Owner and reviewed with Consultant until ready for re-installation;
 - .2 inspected, cleaned, repaired and re-lamped;
 - .3 identified to Consultant of requirement for replacement parts for broken lenses, faulty ballasts, broken mounting hardware, etc., as necessary to return luminaires to good working condition; identify cost to Consultant for repair/replacement parts.
- .33 Provide seismic restraints to suspended luminaires, in accordance with latest local governing building code requirements to suit zone of Place of Work.
- .34 Ground and bond luminaires as per local governing electrical code requirements.
- .35 If requested by Owner or Consultant, demonstrate operation of luminaires intended for special applications such as building floodlights and other decorative purposes. Adjust their locations within reasonable distance to obtain effects desired.
- .36 Test and adjust exterior luminaires at times after sunset, in presence of Consultant and at times acceptable to Owner and reviewed with Consultant.
- .37 Properly identify circuits and components in manner reviewed with Consultant.
- .38 Prior to turn over of Work to Owner, clean luminaires in manner recommended by manufacturer and to satisfaction of Owner.
- .39 Lamps to be new and intact when project is complete and ready for acceptance.
- .40 Include a full lamp listing in Operating and Maintenance Instruction Manuals.
- .41 Additionally, refer to testing and verification requirements in Section entitled Electrical Work Analysis and Testing and include applicable requirements.
- .42 Refer to Section entitled Lighting Controls for related controls work.

3.02 INSTALLATION OF MEDICAL LIGHTS

- .1 Provide medical lighting systems and accessories as specified and as scheduled on drawings. Obtain detailed installation drawings and instructions from manufacturer and install units to ceiling slab structure in accordance with manufacturer's recommendations. Coordinate installation with General Trades responsible for provision of necessary mounting rods, mounting plates, boxes, hardware, etc. to provide a structurally sound and stable installation. Carefully co-ordinate installation of medical luminaires with other trades and provide necessary structural support, recessing depths and mounting spaces.
- .2 Engage manufacturer's authorized representative to review installation.
- .3 Include for assembly and mounting of luminaires and lamps, complete with wiring, connections, fittings, hangers, aligners, box covers, and accessories required for a complete, safe and fully operational assembly. Support luminaires directly by ceiling slab structure and not to formed ceiling decking, ceiling hangers, ductwork, piping, cable trays, etc.

- .4 Install luminaires and control unit in accordance with applicable architectural drawing reflected ceiling plans and/or wall elevations and/or field instructions issued by Consultant. Review luminaire and control unit locations with Consultant prior to roughing-in.
- .5 Flush mount remote control unit into recessed wall box. Connect complete with wiring in conduit.
- .6 Obtain directions from Owner on location for remote hand-held devices and other accessories. Turn over user loose components to Consultant.
- .7 Use cloth gloves when handling reflectors, lamps, glass and exposed surfaces of luminaires.
- .8 Where electrical boxes locations are shown on drawings, they are diagrammatic only. Position boxes to coincide with suspension hangers and knockouts.
- .9 Protect wiring with luminaire manufacturer's recommended tape or tubing at points where abrasion may occur. Conceal wiring within fixture construction except where design or mounting dictates otherwise.
- .10 Splices are not to be made.
- .11 Notify immediately if luminaire placement conflicts with a structural beam, mechanical duct, plumbing pipe, space above ceiling is not sufficient, or any other reason that luminaire cannot be located where it is dimensioned or shown on construction documents. Relocate luminaire, if necessary, where reviewed with Consultant.
- .12 Lamps to be new and intact when project is complete and ready for acceptance.
- .13 Include full lamp listing in Operating and Maintenance Instruction Manuals.
- .14 After installation is complete, engage manufacturer's authorized representative to inspect, test, adjust and verify installation and to document test results into report submitted to Consultant. Sign report and have manufacturer's representative sign also. Submit minimum one hard copy and electronic copy to Consultant.
- .15 Allow for Owner and Consultant to witness final setup, testing and commissioning of luminaires at times acceptable to Owner and reviewed with Consultant.
- .16 Additionally, refer to testing and verification requirements in Section entitled Electrical Work Analysis and Testing and include applicable requirements.

END OF SECTION

SECTION 27 10 00
STRUCTURED CABLING SYSTEM

PART 1 - GENERAL

1.1 REFERENCE STANDARDS

- A. Comply with all applicable national and provincial and municipal codes including, but not limited to, the following:
 - .1 National
 - a) Canadian Standards Association CSA C22.1
 - .2 Provincial
 - a) Ontario Electrical Safety Code
 - b) Ontario Building Code
- B. Comply with applicable industry practices including but not limited to the most recently published version of the following standards in effect at time of bid including all published addenda and errata:
 - .1 Telecommunications Industry Association (www.tiaonline.org)
 - a) TIA-568.0 Generic Telecommunications Cabling for Customer Premises
 - b) TIA-568.1 Commercial Building Telecommunications Infrastructure Standard
 - c) TIA-568.2 Balanced Twisted-Pair Telecommunications Cabling and Components Standard
 - d) TIA-569 Telecommunications Pathways and Spaces
 - e) TIA-606 Administration Standard for Telecommunications Infrastructure
 - f) TIA-942 Telecommunications Infrastructure Standard for Data Centers
 - g) TIA-1152 Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling
 - h) TIA-TSB-184 Guidelines for Supporting Power Delivery over Balanced Twisted-Pair Cabling
 - i) TIA-TSB-190 Guidelines on Shared Pathways and Shared Sheaths
- C. Comply with applicable industry practices including but not limited to the most recently published version of the following guides in effect at time of bid including all published addenda and errata:
 - .1 Building Industry Consulting Services International (BICSI) (www.bicsi.org)
 - a) BICSI/NECA-568 Standard for Installing Commercial Building Telecommunications Cabling
 - b) BICSI 005 Electronic Safety and Security (ESS) System Design and Implementation Best Practices
 - c) Telecommunications Project Management (TPM) reference Manual
 - d) BICSI Telecommunications Distribution Methods Manual (TDMM)
 - e) BICSI: Information Technology Systems Installation Methods Manual
 - .2 Anywhere cabling standards conflict with one another or with electrical or safety codes, Contractor shall defer to the NEC and any applicable local codes or ordinances, or default to the most stringent requirements listed by either.
 - .3 Knowledge and execution of applicable standards and codes is the sole responsibility of the Contractor.
 - .4 Any violations of applicable standards or codes committed by the Contractor shall be remedied at the Contractor's expense.

1.2 DESIGN PERFORMANCE REQUIREMENTS

- A. This document provides the minimum performance criteria for the components and sub-systems comprising a complete cabling system that shall accommodate the Owner's requirements in excess of ten years.
- B. General Scope

- .1 This document defines the cabling system and subsystem components to include cable, termination hardware, supporting hardware, and miscellany required to provide a complete telecommunications system. The intent of this document is to provide all pertinent information to allow the Contractor to bid the labor, supervision, tooling, and miscellaneous mounting hardware and consumables to install a complete system. However, it is the responsibility of the Contractor to propose in their bid any and all items required for a complete system if not identified in this specification.
- .2 Product specifications, general design considerations, and installation guidelines are provided in this written document. If the bid documents are in conflict, the written specification shall take precedence. The successful Contractor shall meet or exceed all requirements for the cabling system described in this document.
- .3 The successful Contractor shall furnish all labor, supervision, tooling, materials, supplies, miscellaneous mounting hardware and consumables for each cabling system installed in compliance with the specifications and drawings.
- .4 The Contractor shall staff each installation crew with the appropriate number of trained personnel, in accordance with their manufacturer/warranty contract agreement, to support system Warranty requirements. After installation, the Contractor shall submit all documentation to support the warranty in accordance with the manufacturer's warranty.
- .5 The Contractor shall provide cabling to all networked, AV and security devices. Where required the Contractor shall supply and install all the required material to form a complete structured cabling system.
- .6 The Contractor is responsible for the supply and installation of all conduits required for structured cabling system.
- .7 The work shall include the supply and installation of the following:
 - a) Data Outlets
 - b) Category 6A horizontal distribution cable
 - c) Category 6A patch cords
 - d) Category 6A security device communication cables
 - e) Rack mounted copper CAT6A patch panels
 - f) Labelling and identification
 - g) Testing and commissioning of structured cabling system;
 - h) Cable management hardware
 - i) Cable trays
 - j) Conduits
 - k) J-Hooks
 - l) Wireless Access Points (WAPs)
 - m) All brackets, anchors, supports or other devices required to install the structured cabling infrastructure, and Wireless Access Points (WAPs).
 - n) As-built Plan Holders

C. System Description

- .1 The Contractor shall provide new cable within protective conduit to all devices as shown.
- .2 Conduit fill rate shall not exceed 40%.
- .3 The structured cabling system consists of two (2) main areas;
 - a) IT/Communications LAN/Data Rooms
 - .1 Existing Communications/LAN/Data Rooms on Level 02.
 - b) Horizontal cabling
 - .1 Network data drops throughout the mental health ward within the scope of areas identified on the drawings.
 - .2 All Category 6A network cable for data shall be provided by the Contractor. All cable to be in a protective conduit from wall to the nearest cable tray/J-Hooks in ceiling space in corridors. Cables to be run to the nearest Communications/LAN/Data room on Level 02 by using existing cable trays with maximum 40% fill ratio where possible. If existing cable trays are full with 40% fill ratio, provide new cable trays or J-Hooks if space is not available in corridors. The new horizontal CAT6A distribution cabling shall be installed on new CAT6A Patch Panels along with new horizontal cable managers mounted on existing IT Rack(s) in existing LAN/Data rooms.

D. Permits, Certificates and Fees

- .1 The Contractor shall include all costs associated with any permits or other fees and charges levied by the municipality or other governing authorities required to execute the work and obtain required inspections and certificates. All permits shall be obtained by the Contractor in a timely fashion.
- .2 When work is complete, supply and turn over inspection certificated from governing authorities to the Owner's representative.

E. IT/Communications/LAN/Data Rooms (Existing)

- .1 Provide any required extensions/modifications to the conduit or cable tray system and new CAT6A Patch Panels along with Horizontal Cable Managers within the existing telecommunication LAN/Data rooms.
- .2 Remove and pull back to source all existing data drops and associated cables from the field data devices as shown within the scope of areas identified on the drawings. Remove all abandoned cables from existing patch panels after pulling back to source in the existing Communications/LAN/Data Rooms.
- .3 Prior to start of installation of any equipment, Contractor shall remove all water, dirt and debris of any kind from the telecommunications room. It shall be the responsibility of the Contractor to keep Communications/LAN/Data rooms clean and free of dust at all times during the installation.

1.3 **WARRANTY**

A. General

- .1 Contractor shall provide a 25-year system warranty on all copper permanent cabling links.
- .2 It is understood the warranty is a system performance warranty guaranteeing for 25 years from acceptance that the installed system shall support all data link protocols for which that Category 6A of copper cabling system is engineered to support according to current and future IEEE and TIA standards.
- .3 The warranty may be invoked only if the cabling channel links are comprised of continuous components, including patch cords, and equipment cords.
- .4 Upon acceptance of warranty, the manufacturer will mail a notification letter to the installer and a notification letter and warranty certificate to the Owner.

B. Contractor Warranty Obligations

- .1 Contractor shall install all racking and support structures according to cited Standards in such fashion as to maintain both cited industry standards as well as manufacturer recommendations for uniform support, protection, and segregation of different cable types,
- .2 Contractor is responsible for maintenance of maximum pulling tensions, minimum bend radius, and approved termination methods as well as adhering to industry accepted practices of good workmanship.
- .3 Contractor is responsible for understanding and submitting to the manufacturer all documents required prior to project start to apply for the warranty.
- .4 Contractor is responsible for understanding and submitting to the manufacturer all documents required at project end. These include, but are not limited to: completed warranty forms, passing test reports and drawings of floor plans showing locations of links tested.
- .5 Test results shall be delivered in the tester native format (not Excel) and represent the full test report, summaries shall not be accepted. Contact the manufacturer representative for a current list of approved testers, test leads and latest operating systems.
- .6 The Communications Contractor will correct any problems and malfunctions that are warranty-related issues without additional charge to the Owner for the entire warranty period.
- .7 The warranty period shall commence following the final acceptance of the project by the Owner and written confirmation of Warranty from the manufacturer.

1.4 **SYSTEM VENDORS**

- A. Vendor selected for provision of system to have following qualifications:

- .1 Being established communications and electronics contractor that has and currently maintains a locally run and operated business for at least five years and holds applicable provincial and local licenses;
 - .2 Be authorized distributor or established franchisee (certified system vendor) for manufacturer of product/system proposed, be experienced in installation and testing of data cabling systems, with full manufacturer's warranty privileges and be capable of providing post warranty service;
 - .3 Employ technicians who are RCDD/BICSI certified and have attended and successfully completed manufacturer's technical certification classes for proposed system;
 - .4 Show satisfactory evidence, upon request, that they maintain a fully equipped service organization capable of furnishing adequate inspection and service to system on a 24-hour/7-day basis;
 - .5 Maintain at their facility necessary spare parts in proper proportion as recommended by manufacturer to maintain and service equipment being supplied.
- B. Vendors not meeting any of above qualifications may be disqualified at Owner's discretion and be replaced with qualified vendor.

PART 2 - PRODUCTS

1.1 GENERAL REQUIREMENTS

- A. The Contractor shall be fully responsible for the ultimate design and implementation of the full system topology (physical and logical) best suited for the project, given identified and recognized physical infrastructure and constraints.
- B. The Contractor shall use matched components from a single manufacturer, certified to deliver end-to-end system performance over the lifetime of the applications, which the cabling system was originally designed to support.
- .1 The communications cabling system shall use matched components from a single manufacturer. Approved manufacturers are:
 - a) R&M
 - b) Approved equivalent
- C. Comply with manufacturer's instructions and recommendations to meet the requirements of the specification.

1.2 NETWORK CABLING SYSTEM REQUIREMENTS

- A. Certified Category 6A horizontal copper cabling types shall be used. Identify clearly with Bid submission which product manufacturer is being carried.
- B. Work must be installed by system manufacturer's certified system installers/vendors who are certified and experienced in implementing selected data cabling system and to perform related testing programs.
- C. Work includes but is not to be limited to following:
- .1 Provision of category grade rating Category 6A cabling system to each work area outlet identified on the drawings.
 - .2 Organized wiring in a structured cabling system using point to point distribution system incorporating modular terminations;
 - .3 Provision of data and voice cabling, data and voice communications outlets, patch panels, patch cords and associated equipment;
 - .4 System testing and verification;
 - .5 Provision of required ancillary devices as required to complete various system extensions work.
 - .6 Provision of required infrastructure of conduits, boxes, cable trays, J-Hooks, raceways, etc., necessary to support system.
- D. The local area network system uses standards based IETF TCP/IP and IEEE 802 protocols and specifications. Wiring configuration is based on "physical star" topology in which cabling runs emanate in radial pattern from data communications room in which intelligent ethernet routing switches are located.

- E. Network cabling system vendor to coordinate with Electrical Contractor to ensure that properly sized conduits, back boxes outlet boxes, junction boxes and floor boxes are provided of sufficient size as per ANSI/TIA/NECA/BICSI Standards to accommodate CAT 6A required Category rating system wiring and devices, with particular emphasis on bending radii of cabling. Conduit and boxes not meeting required Category rating standard requirements to be replaced to suit.

1.3 **CAT6A HORIZONTAL COPPER CABLING**

- A. Horizontal cabling to data/voice outlets: Category 6A FT6 rated (i.e. suitable for use in plenum environments), unshielded twisted pair (UTP) cable in compliance with ANSI/TIA requirements for Category 6A transmission. Cable features include:
- .1 Conductors: 4 pair, 23 AWG. solid copper conductor, UTP;
 - .2 Cable grade: Category 6A;
 - .3 Overall sheath: CMP/FT6 rated outer sheath;
 - .4 Overall outer jacket: low smoke PVC, of specific colors to identify each system as reviewed with Consultant and approved by Owner.
- B. Category 6A system to meet or exceed ANSI/TIA standard for a Category 6A cable. Demonstrate that proposed manufacturer's solution is guaranteed to exceed Category 6A requirements across entire swept frequency range of 1 – 500 MHz minimum, by margin as per base specified product. Submit with shop drawings, ETL test reports to verify full channel performance of cable.
- C. Approved manufacturers;
- .1 R&M
 - .2 Approved equivalent

1.4 **CAT6A UTP CONNECTING HARDWARE (FOR DATA/VOICE)**

- A. Patch panels: Modular patch panels as follows:
- .1 Category 6A patch panels, standard 8-position, RJ-45 style, FCC-compliant receptacle; panel frames to be black powder coated steel and sized in 24 ports configurations for each 1-RU rack mount unit.
 - .2 CAT6A Modular IDC style jacks to be approved by Owner and reviewed with Consultant;
 - .3 Panels designed for 4-pair, 100 ohm balanced UTP cable.
 - .4 Panels to have individual port identification numbers on front and rear of panel.
 - .5 Provide separate panels for each system.
- B. Each jack connector module to have a T568B eight pin RJ 45 jack on front and IDC type connectors on back. Panels to mount onto standard EIA 19-inch racks or cabinets and have capability to be stacked in larger systems. Horizontal data and voice cabling for various telecom rooms to terminate onto patch panels provided into floor standing or wall mounting equipment enclosures, as detailed and as required.
- C. Patch panel system to include required accessories such as bezels, harnesses, pigtails, connectors, jumpers, and retaining rings, interlay racking panels, horizontal wire managers etc., to provide for patch cord management.
- D. Approved manufacturers;
- .1 R&M
 - .2 Approved equivalent

1.5 **CAT6A COPPER PATCHCORDS**

- A. Patch cords: "CAT6A" series as follows:
- .1 Category 6A patch cords constructed with polycarbonate 8-position plug, having vertically staggered, trifurcated gold-plated contacts.
 - .2 Patch cords with snag-less feature and integral to strain relief boot on each end; strain relief boot to be moulded PVC, and color matched to cable jacket.

- .3 Standard patch cord lengths range from 600 mm to 3m;
 - .4 Of specific colors to identify each system as confirmed with Owner and reviewed with Consultant.
- B. Provide sufficient quantity of patch cords at patch panel to activate each additional port. In addition, include required patch cords, jumper assemblies to connect additional ports to active switches / servers. Confirm exact requirements with Owner and review with Consultant.
- C. Approved manufacturers;
- .1 R&M
 - .2 Approved equivalent

1.6 **CAT6A DATA/VOICE OUTLETS**

- A. Data/voice outlets: “CAT6A” and meeting following specifications:
- .1 Flush wall mounting faceplate to fit on single or dual gang recessed outlet box, complete with device bracket or provisions to hold jacks securely in place; with top and bottom labelling windows;
 - .2 Faceplates for wall mount phone applications to include suitable mounting studs;
 - .3 Modules: Category 6A, eight-position, RJ45, T568B configuration pinned; Modular IDC style jacks to be approved by Owner and reviewed with Consultant;
 - .4 Modules to be of specific colors to identify each system and reviewed with Consultant and approved by Owner.
- B. Approved manufacturers;
- .1 R&M
 - .2 Approved equivalent
- C. Modular furniture faceplates:
- .1 Modular furniture faceplates to be installed in furniture outlets that have a modular furniture knockout and unless otherwise noted, to consist of a minimum of 3 ports;
 - .2 Each outlet to be installed with specified and designated termination modules; provide blank cover insert on unused openings;
 - .3 Each outlet to be connected with home run wiring back to designated patch panel; do not splice wiring runs;
 - .4 Verify furniture manufacturer and model, and modular faceplate requirements prior to placing order;
 - .5 Final color and finishes approved by Owner and reviewed with Consultant.
- D. Approved manufacturers;
- .1 R&M
 - .2 Approved equivalent
- E. Wall mounted telephone and data outlets to include features as follows:
- .1 Required Category 6A rating modular jack;
 - .2 Wall plate of stainless-steel construction (vandal resistant);
 - .3 Mounting studs on plate which are positioned to mount standard wall mount telephones with keystone adaptation flush to wall surface;
 - .4 Accepts wall mountable phones with short patch cord connections to jack module.
- F. Approved manufacturers;
- .1 R&M
 - .2 Approved equivalent

1.7 **CAT6A CABLE TESTING AND SYSTEM CERTIFICATION**

- A. The cabling system will require 100% cable testing and verification.

- B. The Contractor shall be required to verify each cable and document results on a cable testing sheet which shall form part of the electronic and hard copy documentation supplied at the end of the installation. The testing sheets will list the detailed performance test measurements as requested and as required to prove compliance with the referenced standards. The Vendor will be required to submit a sample of test sheet with shop drawings.
- C. Compliance with manufacturer's testing and certification procedures will be mandatory.

1.8 **CAT6A CABLE TEST INSTRUMENTS**

- A. Use only one style of test instrument for all measurements: use instruments of only one manufacturer for all measurements of one medium.
- B. Use instruments manufactured by one of the following:
 - .1 Fluke Versiv cable tester (Versiv/DSX-5000/8000)
 - .2 VIAVI/JDSU NGC-4500 series
- C. Adapters
 - .1 Use adapters designated by manufacturer as appropriate for the subject test.
 - .2 Indicate in test reports the product identification number of adapters used in test.

1.9 **WIRE-MESH BASKET CABLE TRAYS**

- A. Approved manufacturers:
 - .1 Cooper B-Line, Inc.
 - .2 MP Husky.
 - .3 Approved equivalent
- B. Description:
 - .1 Configuration: Wires are formed into a standard 50 mm (2 inch) deep by 101 mm (4 inch) wide wire mesh pattern with intersecting wires welded together. Mesh sections must have at least one bottom longitudinal wire along entire length of section.
 - .2 Materials: High-strength-steel longitudinal wires with no bends.
 - .3 Safety Provisions: Wire ends along wire-basket sides (flanges) rounded during manufacturing and T-weld is used to assemble the top longitudinal wires of the basket flanges and the U-shaped cross wires to maintain integrity of cables and installer safety.
 - .4 Certifications
 - a) ULc or UL Canada or Certification acceptable to the AHJ
 - b) CSA 22.2 No 126.1 Metal Cable Tray Systems
 - c) NEMA VE 1
 - .5 Sizes:
 - a) Straight sections shall be furnished in standard lengths and stackable.
 - b) Wire-Basket Depth and Width: 50 mm (2 inch) usable loading depth by 101 mm (4 inch) width.
 - .6 Connector Assemblies: Bolt welded to plate shaped to fit around adjoining tray wires and mating plate. Mechanically joins adjacent tray wires to splice sections together or to create horizontal fittings.
 - .7 Connector Assembly Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.
 - .8 Hardware and Fasteners: Shall be of the same manufacture as cable tray.
- C. Materials And Finishes
 - .1 Steel:
 - a) Straight Section and Fitting Side Rails and Rungs: Steel complies with the minimum mechanical properties of ASTM A 1011/A 1011M, SS, Grade 33 or ASTM A 1008/A 1008M, Grade 33, Type 2 or ASTM A510, Grade 1008.
 - b) Steel Tray Splice Plates: ASTM A 1011/A 1011M, HSLAS, Grade 50, Class 1.

- c) Finishes:
 - .1 Painted black, white
 - .2 Zinc electroplated
- d) Finish: Factory-standard primer, ready for field painting, with chromium-zinc-plated hardware according to ASTM F 1136.
- e) Finish: Black oxide finish for support accessories and miscellaneous hardware according to ASTM D 769.

D. Cable Tray Accessories

- .1 Fittings: Tees, crosses, risers, elbows and other fittings as indicated, of same materials and finishes as cable tray.
- .2 Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.
- .3 Accessories as required.
 - .1 Splicing kit
 - .2 Edge hanger
 - .3 Cantilever brackets
 - .4 Underfloor C bracket
 - .5 Split bolt grounding lug and clamp
 - .6 Divider
 - .7 Radius drop
 - .8 Side bracket
 - .9 Radius control side wall brackets
 - .10 Vertical radius bracket
 - .11 Conduit bracket
 - .12 Solid liner insert
 - .13 Side supported cable hanger brackets

1.10 WIDE BASE CABLE SUPPORTS

- A. J-hooks - Galvanized loop with integrated cable retainers, complies with TIA structured cabling system requirements.
- B. Accessories: Provide applicable accessories to independently support J- hooks from structure. This includes extender bracket for mounting multiple J-hooks on a single support, fasteners and clamps for connecting to wall, beams, rods, dedicated support wires and C and Z Purlins as required for specific construction.
- C. J-hooks shall be made of metal and/or plastic and shall be Plenum rated.
- D. J-hooks shall be supplied and installed with all necessary fastening suitable for the building structure being used to support the cabling and as per the manufacturer's installation requirements or guidelines.
- E. Approved manufacturers:
 - .1 ERICO Caddy CableCat™ series
 - .2 Cooper B-Line
 - .3 Approved equivalent

1.11 CABLE RETENTION WRAPS

- A. Only hook-and-loop ("Velcro") cable ties are permitted and only for use to retain cables in bundles and patch cords in bundles and cables in rack cable management.
- B. Cable retention wraps permitted only of the type and where expressly indicated.
- C. Hard nylon cable retention wraps (Tiewrap™) or like Products not permitted as communications cable retainers nor permitted to be in direct contact with cable jacket.
- D. Velcro wraps shall be black.

- E. Approved manufacturers:
 - .1 Thomas & Betts Corporation
 - .2 Approved equivalent

1.12 **LABELS**

A. General

- .1 All identifier labels shall be of a size, color, and contrast to be readily visible by those maintaining the system.
- .2 All components of the Structured Cabling System shall be numbered including the following components:
 - a) Horizontal cabling
 - b) Face Plates
 - c) Patch Panels
 - d) Patch panel ports
 - e) Patch Cords
 - f) IT Racks/Cabinets
 - g) Wireless Access Points (WAPs)
 - h) Distributed Antenna System (DAS)
- .3 Labels should be resistant to environmental conditions likely to be encountered where they are installed, such as moisture or heat, and should be designed to have a useful life equal or greater to that of the component labelled.
- .4 Where possible, industrial grade adhesive should be used on labels.
- .5 Device labels shall be installed on the exterior of all devices, when possible. Device labels may be installed on the interior of a device at the primary access point.

B. Acceptable manufacturers;

- .1 Brother International Corporation
- .2 Hellermann Tyton
- .3 Approved equivalent

C. Patch Panel, Cable, WAP, DAS and Conduit Labels

- .1 Labels shall use black lettering on a white background.
- .2 To maximize legibility, all labels shall be printed or generated by a mechanical device and shall not be written by hand.
- .3 Hand-written labels are only acceptable on a temporary basis during installation.
- .4 Labels shall be able to withstand high and low temperatures without detaching.
- .5 Labels in exterior spaces shall be able to withstand extended submersion.
- .6 Labels shall be self-adhesive type.
- .7 The minimum font sizes are defined below:
 - a) Patch Panel: Arial 10 point
 - b) Cable Label: Arial 10 point
 - c) WAP Label: Arial 10 point
 - d) DAS Label: Arial 10 point

D. IT Rack/Cabinet Labels

- .1 Each IT Rack/Cabinet shall be numbered and identified with a 19 mm x 50 mm (¾" x 2") engraved lamacoid plate.
- .2 All labels shall use white lettering on a black background.
- .3 Label identifiers shall be Arial 24 font size.
- .4 Nameplates shall be securely fastened.

1.13 **WIRELESS ACCESS POINT (WAP)**

- A. Wireless Access Points (WAPs) shall be provided as indicated on the floor plans.

- B. Contractor is responsible for installation, configuration, integration with existing wireless networks, testing and commissioning of all Wireless Access Points (WAPs).
- C. The WAP shall have the following features;
 - .1 Wi-Fi 6 (802.11ax)
 - .2 Cisco RF ASIC
 - .3 Uplink/downlink OFDMA
 - .4 MU-MIMO technology
 - .5 BSS coloring
 - .6 Dual 5-GHz radio support
 - .7 Cisco Embedded Wireless Controller
- D. Acceptable manufacturer;
 - .1 Cisco Catalyst 9120AX Series Access Point

1.14 **WIRELESS LAN INFRASTRUCTURE**

- A. Provisions for a wireless LAN infrastructure to be provided with 100% coverage of entire ward, utilizing structured network cabling system as a rough-in for future wireless access points (WAP) located in ceiling spaces. Generally, quantity of outlets to be identified on drawings, but Electrical Divisions Contractor to perform site signal survey/audit of coverage areas and confirm if additional rough-in jacks are required. Prepare audit immediately after structure of concrete and metal studs are in place. Submit copy of audit to Consultant to review.
- B. Locations may generally be shown on drawings, however, following criteria to be followed:
 - .1 back-of-house above accessible ceiling tile or high up in open ceiling areas as approved by Owner and reviewed with Consultant;
 - .2 public spaces priority;
 - .3 in service areas adjacent public areas;
 - .4 in light cove if WAP is hidden;
 - .5 with access panel (location identified).

1.15 **FIRE STOP SYSTEM**

- A. A fire stop system is comprised of an item or items penetrating the fire rated structure, the opening in the structure and the materials and assembly of the materials used to seal the penetrated structure. Fire stop systems comprise an effective block for fire, smoke, heat, vapor and pressurized water stream.
- B. All penetrations through fire-rated building structures (walls and floors) shall be sealed with an appropriate fire stop system. This requirement applies to through penetrations (complete penetration) and membrane penetrations (through one side of a hollow fire rated structure). Any penetrating item i.e., riser slots and sleeves, cables, conduit, cable tray, and raceways, etc. shall be properly fire stopped.
- C. Fire stop systems shall be UL Classified to ASTM E814 (UL 1479) and shall be approved by a qualified Professional Engineer (P. Eng), licensed (actual or reciprocal) in Canada.
- D. Acceptable rack manufacturer;
 - .1 EZ Path (STI Firestop)
 - .2 Approved equivalent

1.16 **MISCELLANEOUS EQUIPMENT**

- A. The Contractor shall provide any necessary screws, anchors, clamps, miscellaneous grounding, WAP/DAS mounting brackets and accessories, and support hardware, etc., necessary to facilitate the installation of the equipment cabinets and WAPs/DAS.

1.17 **SPECIAL EQUIPMENT AND TOOLS**

- A. It shall be the responsibility of the Contractor to furnish any special installation equipment or tools necessary to properly complete the System.

PART 3 - EXECUTION

1.1 GENERAL

- A. The cabling system shall be installed in accordance with manufacturer's recommendations and best industry practices.
- B. All cables must be properly handled and installed in accordance with the manufacturer's specifications. Undue pulling tension, abrasion or rough handling must be avoided to ensure that the cables will permit transmission up to their designed speed for data cables.
- C. All cables are to be secured to terminals and connectors such that a 10N pull force shall not affect the connection.
- D. All cables must be installed without splices or cuts to ensure the elimination of reflections, discontinuities, impedance mismatches, etc.
- E. Care shall be taken to ensure that during the installation, nicks, abrasions, burning and scuffing of cable is prevented.
- F. Cables found to be damaged will be replaced at the Contractor's expense regardless of whether the cable passes the performance testing standards or not.
- G. All bundled cables shall be correctly secured by Velcro straps.
- H. All wires and cables shall be formed, neatly laced or tie wrapped, and clamped in position. No adhesive or stick-on clamps are permitted. The use of any tape, such as masking tape or electrical tape is not acceptable.
 - .1 Wires and cables shall be continuous between termination and connection points. Connectors and splices shall be located within secure enclosures and are not permitted inside conduit.
- I. Waterfall (rounded transition) fittings shall be used for cable changing from a horizontal path to a vertical one. This maintains the minimum bend radius for Category 6A cabling system.
- J. All cables placed in the cable tray system in server room must be protected against any damage.
- K. Cable ties shall be tightened so as not to deform cable jackets and thus affect cable performance.
- L. Cables shall be dressed and terminated in accordance with the recommendations made in the ANSI/TIA-568 standard document, manufacturer's recommendations, and best industry practice.
 - .1 Allow easy disconnection of equipment.
- M. Allow a minimum of three re-terminations of each cable or wire in the event of breakage.
- N. In the case of video cameras, 3m of slack cable in flexible conduit shall be provided to enable future relocation at each and every camera location.
- O. All cables placed in cable tray in server room shall have slack placed where expansion joints occur. Expansion joints are installed to handle the effects of a seismic event that may cause tray movement.
- P. Where wires run through holes or conduit, they shall be protected by suitable grommets.

- Q. Wires and cables external to equipment and enclosures shall be run in conduit. PVC conduit may be used underground. Where free movement of equipment is required, flexible conduit shall be employed. Once installed in the conduit, all cable shall be tested for continuity, insulation breakdown (skinning) and ground faults.
- R. Provide conduits and raceways where required, provide stainless steel cover plates for back boxes that are not being used.
- S. Care shall be taken so as not to damage cable during the installation process and that manufacturer's pull tension specification is not exceeded.
- T. Wires and cables shall be located so that inductive and capacitive effects do not degrade system operation.
- U. All wires shall be terminated by soldering or by the use of solder-less terminals. Crimp lug terminals shall only be used on stranded wire. For devices utilizing solid wire, the solid wire shall be soldered to the terminal and the soldered portion insulated.
 - .1 All soldered joints shall be made mechanically sound before soldering. Leads shall not be wrapped more than once around a terminal. The wiring insulation shall not be heat damaged or stripped back more than 2 mm from the joint or termination. Flux residue shall be removed immediately after soldering by appropriate non-corrosive cleaners. Acid flux shall not be used for soldering.
- V. Terminal and connecting blocks shall be of the screw type. As a minimum, all terminal blocks shall have 10% spare capacity. A barrier shall separate each termination. No more than two terminal lugs shall be clamped under each terminal screw. Solder, wire wrap and pressure termination type terminal blocks shall only be used with prior approval and where the need for this type of device has been demonstrated. No more than one wire may be connected to each terminal, except in permanent daisy chaining requirements.
- W. Terminal lugs shall be suitably electroplated or treated by commercially acceptable methods to ensure good electrical contact and prevent corrosion.
- X. No more than one wire shall be connected to each pin of a cable connector unless that pin has been designed to accept more than one wire. All strands of the wires shall fit into the pin receptacle. All cable connectors shall be field replaceable. Provision shall be made to fix the cable connector covers to a chassis or to each other by means of screws.
 - .1 Panels, doors and access shields shall be fastened with a suitable style of fastening compatible with the degree of security required for each enclosure and the frequency of access. There shall be no sign of cross-threading or mutilation on any screws or fasteners. All nuts shall be of standard size and preferably of hexagonal design. All threaded parts shall be secured by the use of lock washers except under counter sunk screw heads, coaxial plugs and similar connectors, terminal binding screws, etc.

1.2 **HORIZONTAL DISTRIBUTION CABLE INSTALLATION**

- A. A plastic or nylon pull cord with a minimum test rating of 90 Kg (200 lb.) shall be co-installed with all cable installed in any conduit.
- B. Cable raceways shall not be filled greater than the ANSI/TIA-569 maximum fill for the particular raceway type or 40%.
- C. The maximum horizontal cable length from the workstation to the network switch shall not exceed 90 m (295').
- D. Cables shall be installed in continuous lengths from origin to destination (no splices) except for transition points, or consolidation points that are within secure enclosures and are not permitted inside the conduit.
- E. Where cables are installed in an air return plenum, riser rated cable shall be installed in metallic conduit.

- F. Where transition points, or consolidation points are allowed, they shall be located in accessible locations and housed in an enclosure intended and suitable for the purpose.
- G. The cable's minimum bend radius and maximum pulling tension shall not be exceeded. Refer to manufacturer's requirements.
- H. Horizontal distribution cables shall be bundled in groups of no more than 50 cables. Cable bundle quantities in excess of 50 cables may cause deformation of the bottom cables within the bundle and degrade cable performance.
- I. Unshielded twisted pair cable shall be installed so that there are no bends smaller than four times the cable outside diameter at any point in the run and at the termination field.
- J. Pulling tension on 4-pair UTP cables shall not exceed 25-lbf for a four-pair UTP cable.
- K. Cables shall not be attached to or rest on liquid carrying pipes, medical gas pipes, electrical conduits.
- L. The support system shall meet requirements for Category 6A bend radii.
- M. Cable shall be installed above fire-sprinkler systems and shall not be attached to the system or any ancillary equipment or hardware. The cable system and support hardware shall be installed so that it does not obscure any valves, fire alarm conduit, boxes, or other control devices.
- N. Cable supports must be installed every 4-5 feet at on irregular interval. At no point shall cable(s) rest on acoustic ceiling grids or panels.
- O. Cables shall not be attached to ceiling grid or lighting fixture wires. Where support for horizontal cable is required, the Contractor shall install appropriate carriers to support the cabling.
- P. The Contractor shall not install cables under such strain as to require tying to supports.
- Q. All cables are to be installed in a neatly-dressed manner to their point of termination.
- R. The Contractor is responsible to obtain and follow the manufacturers' installation instructions for products for correct termination and wire management of cables on respective products.
- S. Cable routing is to avoid crossovers and congestion at all times.
- T. Cables shall be identified by a self-adhesive label in accordance with the System Documentation Section of this specification and the most recent ANSI/TIA-606 standard. The cable label shall be applied to the cable behind the faceplate on a section of cable that can be accessed by removing the cover plate.

1.3 **HORIZONTAL CABLE TERMINATIONS - CABINETS / ENCLOSURES**

- A. All horizontal cable shall be installed per manufacturer instructions to ensure a manufacturer certified solution.
- B. The Contractor shall neatly dress cables to their respective patch panel and within the cabinet with cable management using Velcro cable ties and/or rack cable management loops. Cables shall not be bundled outside of a rack but shall be loose and random in cable tray.
- C. Provide identification labels for each cable.

1.4 **WORK AREA**

- A. Cables shall be coiled in the in-wall or surface-mount boxes if adequate space is present to house the cable coil without exceeding the manufacturer's bend radius. In hollow wall installations where box-eliminators

are used, excess wire can be stored in the wall. No more than 12" of UTP and 36" of fiber slack shall be stored in an in-wall box, modular furniture raceway, or insulated walls.

- B. The Contractor shall leave 3m (10') of slack, be neatly coiled and stored in the ceiling above each drop location.
- C. Prevent undue stress and strain on connectors and cables.
- D. Allow easy disconnection of equipment.
- E. Pair untwist at the termination shall not exceed 13 mm (one-half inch).
- F. The Contractor shall install blank modules in faceplates as needed.
- G. The Contractor shall install work area outlets as shown on the Communications/Systems Layout drawings.
- H. The Contractor shall label outlets as shown on the drawings.
- I. LAN/Data Rooms must be free from dust, dirt, and other foreign materials before the installation of any termination hardware or the termination of copper cables.
- J. Bend radius of the cable in the termination area shall not be less than 4 times the outside diameter of the cable.

1.5 **CABLE MATERIAL ACCEPTANCE**

- A. Before installing any cable on site, perform the following material acceptance tests:
- B. Perform visual inspection tests on communications cables after delivery to site and before installation. Reject material which fails performance tests or appears physically damaged.
- C. Perform full performance testing on samples removed from each spool of communications cable after delivery to site and before installation. Submit the test results to the Engineer for review as a Shop Drawing. Record the manufacturer's production data as imprinted on the cable sheath. Use a cable sample of physical length 50 meters \pm 500 mm. Retain sample for further testing until after Shop Drawings are returned as "Reviewed as Submitted".

1.6 **VISUAL AND MECHANICAL INSPECTION**

- A. Immediately following installation of cables and connector hardware, perform the following visual and mechanical inspections:
 - .1 Compare cable, connectors and splice data with Contract Drawings and Specifications.
 - .2 Inspect cable and connectors and connections for physical and mechanical damage.
 - .3 Verify that all connectors and splices are correctly installed.
 - .4 Verify color and marking identification is correctly installed.

1.7 **CAT6A COPPER CABLE TESTING**

- A. Test CAT6A horizontal copper cables according to the following criteria:
 - .1 Cable length measurement and construction defect inspections.
 - .2 Connector integrity tests.
 - .3 Cable and connector attenuation and performance testing.
 - .4 For CAT6A horizontal UTP cabling, perform tests on the permanent link, testing for length, attenuation, near end crosstalk, far end crosstalk, delay, and delay skew. Comply with TIA 568 standard and limits. Report on actual measured values and deviation (headroom) from the standard values. Channel testing is not acceptable. Permanent links which report as outside the tolerance of the test instrument (*) (conditional PASS) will be interpreted as FAIL.

- .5 For Category 6A cabling, and on request of the Engineer, conduct tests to 500 MHz for alien cross talk measurements on an audit basis as per TIA 568 (latest) standard on two samples of six-around-one cable sets selected by the Engineer.

B. Test Values

- .1 Assemble test results and submit to the Engineer in a timely manner.
- .2 Analyze the results and repair or replace cabling so that the Work results comply with the Specifications.
- .3 Verify that the installed cabling conforms to the manufacturer's Specifications.
- .4 Test all installed cabling to the full extent of the specifications.
- .5 Cables with marginal PASS are not acceptable. A marginal pass is one typically indicated as *PASS.

1.8 REPAIRS

- A. Replace defective or damaged cables and components and re-execute tests.
- B. Replace defective cables without splicing where splicing is not permitted.

1.9 CABLE AND EQUIPMENT LABELLING

- A. Functional or alpha-numerical mechanically printed labelling shall be installed on all equipment. All visible wires and cables typically accessed for service shall be labelled at both ends. As well, all connecting strips, terminal blocks, plugs and sockets shall be labelled. The marking on the labels shall be consistent with the As-Built Drawings.
- B. Approved materials for labels include alphanumeric labels protected by clear heat shrink material, tie-wrap labels, lamacoid strips, etched metal or indelible ink. The use of Dymo tape (or equivalent) labelling is not permitted.
- C. The Contractor is required to submit their cable and equipment labelling standard to the Consultant for prior approval. Handwritten labels are not acceptable.

1.10 CABLE MANAGEMENT – HORIZONTAL

A. General Requirements

- .1 All horizontal and vertical wire and cable management devices or assemblies shall be placed and installed as not to impede the efficient use or connection to adjacent panels, enclosures or equipment.
- .2 All covers, doors, and panels removed for the purpose of placement or fastening shall be replaced upon completion of the task.

B. Horizontal Cable Managers

- .1 When more than one horizontal cable manager is used on a cabinet or group of cabinets, use the same make, and style of cable manager on the rack/frame/cabinet or racks/frames/cabinets.
- .2 The color of the cabinet(s) and cable manager(s) must match.
- .3 Attach horizontal cable managers to the rack/frame/cabinet with four screws according to the manufacturer's installation instructions. Each cable manager should be centered within the allocated rack-mount space (RU).
- .4 Horizontal managers will be located so that the number of ports (cables) they support will not exceed the cable fill capacity of the cable manager.
- .5 Covers should be attached to the cable manager and in the closed position after cabling is complete.
- .6 Equipment rack horizontal cable/wire management panels will be installed directly adjacent to (above and below) all distribution enclosures, patch panels, and termination hardware within the rack as depicted in appropriate project details.

1.11 **J-HOOKS**

- A. Support all cables not supported in conduits and cable tray with J-Hooks.
- B. Suspended ceiling and T-Bar hangers shall not be acceptable in any situation.
- C. J-Hooks shall be installed every 915 mm (36 inch) to 1200 mm (47.24 inch) to support cabling (ensure that the distance between j-hooks is not consistent; do not place j-hooks the same distance apart repeatedly if at all possible).
- D. All cabling shall be installed to have no more than 76 mm (3 inch) sag between J-hooks. All cabling shall be fastened using Velcro Ty-Wraps only. The Communications Contractor will be responsible for all costs associated with removing other fasteners and install the specified product.
- E. Install supports to route cables parallel and perpendicular to building lines. Hang cable supports from 3/8-inch all thread rods, dedicated #8 galvanized ceiling drop wire or wall brackets connected directly to structure. Do not support from the ceiling grid or ceiling wire system.
- F. Provide the appropriately sized J- hooks as required. Minimum 25 mm (1 inch) width and flared edges where cables enter and leave support. 50 mm (2 inch) diameter loop for (25) 4-pair UTP cables and 101 mm (4 inch) diameter loop for (50) 4-pair UTP cables.
- G. Provide multiple hooks at each hanger location as required by cable count and cable segregation requirements.
- H. Install cable bundles no closer than 127 mm (5 inch) in all directions from ballasted light fixtures.
- I. Where main pathways are indicated on the contract drawings, contractor shall follow indicated pathway as closely as possible according to field conditions. Pathway for smaller cable counts shall be laid out and documented on the as-built drawings by the contractor.
- J. Where specific main pathways are not indicated, the cable pathways for all communication systems shall be laid out by the contractor and coordinated with other disciplines and the systems designer.
- K. Do not tie wrap cables to the J-hooks. Provide cable retainers at each J-hook.
- L. Provide applicable accessories to independently support J-hooks from structure, including extender bracket for mounting multiple J-hooks on a single support, fasteners and clamps for connecting to wall, beams, rods, dedicated support wires and C and Z Purlins as required for specific construction.
- M. At a minimum, brace multiple J-hook assemblies from structure with diagonal braces at each change of direction.
- N. Coordinate the allocation of ceiling space and the mounting elevations of various systems to allow maintenance and accessibility for future modifications. Cable supports shall be as close to the ceiling as possible while allowing ceiling tiles to be removed. Supports shall be located to avoid interference with maintenance access to other equipment.
- O. If the quantity of cables exceeds 80% of the manufacturer's capacity rating install the next larger size or substitute with cable slings at no additional cost to the Owner.
- P. J-hooks shall be installed in coordination with other building services and without interruption to the Owner within the building.

1.12 **CABLE CONTAINMENT**

- A. Cable exits shall be strictly controlled such that additional cables can be easily and neatly added in the future.

- B. Loose laid cables shall not be permitted. All cables must enter and leave the cable containment system in the most direct manner.
- C. Cables shall not be laid on areas exposed to external weather conditions. Cable shall not be laid on wet or damp concrete surfaces and any water or moisture subsequently detected after cable placement shall be assessed for remedial action.
- D. Conduits shall not exceed a fill ratio of 40% to allow for future installation of cables.
- E. Cables shall enter and exit conduit such that complete separation between communications and power compartments is maintained.
- F. The number of cables in each conduit shall be controlled to allow for future cable installation and to stay within the manufacturer's maximum allowable cable pulling tension.

1.13 **CABLE RETENTION WRAPS**

- A. Velcro wraps shall be installed at every J-hook, between every pair of J-hooks or within 50 mm (2 inch) of a J-hook to bundle cabling neatly.
- B. Velcro wraps shall be installed every 915 mm (36 inch) to bundle cabling installed in cable tray neatly.
- C. Velcro wraps shall be installed every 152 mm (6 inch) to neatly bundle cabling at all locations on racks, cabinets, patch panels and IDC mounts.

1.14 **SEPARATION FROM SOURCES OF ELECTROMAGNETIC INTERFERENCE (EMI)**

- A. All cables shall be separated from sources of electromagnetic radiation in accordance with TIA Standard Proposal SP 2072 and the following:

Item	Minimum Separation Distances		
	<2kVA	2-5kVA	>5kVA
Unshielded power lines or electrical equipment in proximity to open or non-metallic pathway.	127 mm (5")	305 mm (12")	610 mm (24")
Unshielded power lines or electrical equipment in proximity to a grounded metal conduit pathway.	64 mm (2.5")	152 mm (6")	305 mm (12")
Power lines enclosed in a grounded metal conduit (or equivalent shielding) in proximity to a grounded metal conduit pathway	-	76 mm (3")	152 mm (6")
Motors	1.2 m (4'-0")		
Transformers	1.2 m (4'-0")		
Conduit and cables used for electrical distribution less than 1kV	0.3 m (1'-0")		
Conduit and cables used for electrical distribution greater than 1kV	1.0 m (3'-0")		
Fluorescent Luminaires	300 mm (12")		
Pipes (gas, oil, water, etc.)	120 mm (5")		
HVAC (equipment, ducts, etc.)	150 mm (6")		

1.15 **IDENTIFICATION LOG**

- A. Cable Identification Log shall be recorded in Excel.

- B. A hard and soft copy Cable Identification Log is to be handed over to the Consultant within 30 days of substantial completion.

1.16 **FIRESTOP SYSTEM**

- A. The Contractor is responsible to Fix / Make right all Firestop penetrations that cables have passed through where disrupted existing firestop with the same product.

1.17 **AS-BUILT DOCUMENTATION**

- A. The Contractor shall provide full-size hard copies of each as-built floor plan showing the voice and data outlets on each floor within the scope of areas identified on the drawings.
- B. All cables, patch panel ports and outlet ports with the corresponding existing telecommunications LAN/Data room number shall be recorded in excel spreadsheets for submittal.

END OF SECTION

1 ALSOGENERAL

1.01 REFERENCE STANDARDS

- .1 CSA Group (CSA):
 - .1 CSA C22.2 No. 205-17(R2022), Signal Equipment.
- .2 Underwriters Laboratories (UL):
 - .1 UL 1069-2007, Hospital Signaling and Nurse Call Equipment.
- .3 NEMA:
 - .1 NEMA Installation Guide for Nurse Call Systems (R2007).

1.02 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings:
 - .1 Submit shop drawings for products of this Section, including:
 - .1 Detail assembly and internal wiring diagrams for control units, consoles and auxiliary cabinets. Identify dimensions and layouts.
 - .2 System riser diagram identifying control and annunciation equipment, stations, devices, zones, special conductors and raceways, and integration to other building equipment and systems.
 - .3 System riser wiring diagram identifying control equipment, initiating zones, signaling circuits, terminations, terminal numbers, and conductors.
 - .4 Details for stations and devices.
 - .5 Details and performance specifications for control, annunciation and peripherals.
 - .6 Sample software screens, graphic displays and nomenclature.
 - .7 Step-by-step operating sequence, cross referenced to logic flow diagram.
 - .8 Annunciator schedules.
 - .3 Submit compliance certificates, and testing and verification reports.

1.03 QUALITY ASSURANCE

- .1 Products provided directly by system manufacturers or by system manufacturer authorized and certified regional vendors.
- .2 Products to be standard product of same manufacturer.
- .3 System vendor is authorized and trained by system manufacturer to calculate, design, install, test and maintain system.

1.04 SPARE PARTS

- .1 Supply following spare parts:
 - .1 Patient room call stations: 5.
 - .2 Washroom/shower room call stations: 2.
 - .3 Patient handsets: 5.
 - .4 Pull cords: 2 of each type.
 - .5 Corridor dome Light: 5.

2 PRODUCTS

2.01 NURSE CALL SYSTEM

- .1 Existing Rauland R5 nurse call system presently serves existing building and shall be extended to serve renovated areas. Include for and engage Hospital existing system vendor - Aatel Communications Inc, to provide system work and products. Contact person for existing system vendor is Laura Graham. Telephone (905) 526-2378, Email laurag@aatel.com.
- .2 Existing Rauland 5 voice over IP based audio/visual nurse call system is multiplexed solid-state microprocessor based networked system providing two-way full duplex voice communications between any console and patient stations, and staff/duty stations. Provide equipment, accessories and material required for renovation work.
- .3 System vendor shall be responsible for but not be limited to provisioning the following:
 - .1 Required software, modifications and components to existing system head end units to accommodate additional devices for renovation areas.
 - .2 Product programming and setup.
 - .3 Nurse consoles.
 - .4 Emergency call stations.
 - .5 Staff and duty stations.
 - .6 Single or dual patient bed stations.

- .7 Rauland Enhanced Responder 5 UL 1069 compliant, pillow speakers at each patient bed station, with integrated lighting and TV controls, complete with headphone receptacle and cord with plug; confirm exact requirements to ensure compatibility with TV (by others) and ensure integrated components provide sequence of operation acceptable to Owner.
- .8 Corridor dome lights.
- .9 Remote annunciators.
- .10 Wiring to system manufacturer requirements, run in conduit and provision of required ancillary devices. Coordinate supply and installation of wiring with Electrical Contractor.
- .11 Plexi-covers for stations as noted including emergency response buttons.
- .12 Ring tones to match other devices serving same area.
- .13 Nurse call devices to ring at consoles designated by Owner.
- .14 Ancillary devices as required for complete system.
- .15 Existing system stations and components disconnected and not re-located for use on this project, to be properly decommissioned, packaged, identified with label and turned over to Owner.
- .16 Testing and verification of additional and retrofitted products on system with plant and users as part of verification training. Preparation of test reports.
- .17 Providing technical assistance and coordinate with Electrical Contractor with regards to conduit, wiring and component installation requirements.
- .4 Electrical Contractor is responsible for following:
 - .1 Arranging and coordination of system vendor work to clearly identify responsibilities of system vendor and Electrical Contractor.
 - .2 Supervision of system vendor onsite.
 - .3 Provision of system conduits and boxes, power feeders, to suit system requirements to system manufacturer requirements.
 - .4 Installing system components, wiring, wiring accessories, and identification and labelling of each wiring run. Coordinate supply and installation of system wiring with system vendor.
 - .5 Assist system vendor in onsite system testing, inspection and verification work.
 - .6 Submission of copies of testing and verification reports signed by manufacturer authorized representative and by Electrical Contractor.
 - .7 Preparing as-built drawings and other submittals.

2.02 VOIP NURSE CONSOLE

- .1 The VoIP Nurse Console shall be typically located at a local nursing station, workstation, centralized communications center, or any place where staff receive calls, communicate with staff, or initiate any Responder 5 related features. The console shall be desk or wall mounted. The VoIP Nurse Console shall provide complete information concerning incoming calls including: including patient or staff member's room location, bed (if applicable), call priority, and length of time call has been waiting.
- .2 The VoIP Nurse Console shall be configured for up to twenty-four (24) functions including Setting/Review Service Requirements, Emergency Call Upgrade, Day/Night tones, Staff Follow, Sequential Room Monitor, Swinging Groups of Rooms, etc.
- .3 Features shall include:
 - .1 VoIP device;
 - .2 Full-Duplex audio;
 - .3 Color Display Screen;
 - .4 Over 990 possible unique facility-defined call priorities;
 - .5 Thirty-two (32) programmable functions;
 - .6 5-line display with associated function/scroll/select buttons;
 - .7 Day/Night tones;
 - .8 Console speaker level adjustment;
 - .9 Optional tone mute of calls in progress;
 - .10 Displays up to three (3) incoming calls with the ability to scroll to see additional pending calls;
 - .11 Twelve (12) unique call-in tones;
 - .12 Choice of instant 2-way communication with handset or push-to-talk operation via speaker-microphone;
 - .13 Room swing capabilities;
 - .14 Continuously supervised with self-diagnosing error messages and distinctive console failure audio alert;
 - .15 PoE (802.3af compliant) 26-56VDC 9 watts;
 - .16 Connection: 10/100 Mb Ethernet;
- .4 Approved manufacturer:
 - .1 Rauland (Model # 351206 - VoIP Nurse Console V3)

2.03 STAFF TERMINAL

- .1 The VoIP Staff Terminal shall be a dynamic device that functions as a patient or procedure room communications tool while providing staff with “soft” touch-points to initiate an instantaneous notification of an in room need. Additionally, this terminal shall be used as a functional nurse call console. When configured as a patient or procedure room communications tool, user-configurable soft keys shall be assigned per staff terminal. Specific needs such as Emergency, Staff Assist, Transport, Cleaning Needed, Order, Stat Order, etc. and speed dialing to any location shall be initiated from the staff terminal soft keys. The VoIP Staff Terminal shall also be configured to provide one (1) or three (3) lines for call annunciation.
- .2 A call shall be answered with Push-to-Talk key for a hands-free conversation. When functioning as a Nurse Console, the VoIP Staff Terminal shall be configured for functions including Setting/Review Service Requirements, Emergency Call Upgrade, Day/Night tones, Staff Follow, Sequential Room Monitor, Swinging Groups of Rooms, etc. The VoIP Staff Terminal shall be continually supervised for both power and signal. The VoIP Staff Terminal shall receive operational power via a Power-over-Ethernet (PoE) connection to a Responder 5 system Ethernet switch or the Responder Branch Regional Controller.
- .3 Features shall include:
 - .1 Functions as a patient room communications tool with touch-points to initiate an instantaneous notification of an in room need, duplex intercom station, or nurse call console;
 - .2 VoIP device with Full-Duplex audio;
 - .3 Color Touch Screen;
 - .4 Includes Bio-Seal infection control overlay on Touch Screen;
 - .5 Over 990 possible unique facility-defined call priorities;
 - .6 Up to fifty (50) programmable functions;
 - .7 Optional tone mute of calls in progress;
 - .8 Displays up to three (3) incoming calls with the ability to scroll to see additional pending calls;
 - .9 Ability to dial rooms through touch key pad on screen;
 - .10 Twelve (12) unique call-in tones;
 - .11 Instant 2-way communication with operation via speaker-microphone with Push-to-Talk capability;
 - .12 Continuously supervised with self-diagnosing error messages sent to network status application and distinctive console failure audio alert;
 - .13 PoE (802.3af compliant) 26-56VDC 9 watts;

.4 Approved manufacturer:

.1 Rauland (Model # 351311 – Staff Terminal V3)

2.04 SINGLE PATIENT STATION

.1 The Single Patient Station shall allow both patients and staff to place different call-ins, depending on their requirements, to the assigned nurse console(s), staff terminal(s), along with other annunciation devices such as wireless phones. The patient station shall interface with entertainment handsets and specialty beds to initiate calls, control entertainment, control lighting, and provide nurse call audio and entertainment audio through the respective speakers.

.2 The patient station shall be connected to its associated corridor light or domeless room controller and shall be continually supervised for both power and data. Through programming, a message shall annunciate at the associated console(s) and / or the remote network status application if a problem occurs.

.3 Features shall include:

.1 Multiple call-in priorities available;

.2 Speaker and microphone provide full-duplex audio to speak with the patient;

.3 Tilt/Release DIN receptacle for Pillow Speakers with patient entertainment controls and handset intercom with entertainment muting during nurse call;

.4 Tilt/Release DIN receptacle allows for ease of disconnecting Pillow Speaker from the patient station;

.5 Auxiliary device receptacle with separate call-in priority setting;

.6 Interfaces with specialty beds via separate receptacle and control module;

.7 Interfaces with a remote Pillow Speaker via separate station;

.8 Output for lighting control options direct to low voltage lighting controller;

.9 Cancel button for localized call cancellation;

.10 3-gang adapter plate included;

.11 Continuous supervision of station for loss of data and/or power faults;

.12 Plug-in connectors for easy service;

.13 Bio-seal option to cover cancel button and allow for easy disinfecting of the station;

.4 Approved manufacturer:

.1 Rauland (Model # 353000 – Single Patient Station)

2.05 QUAD PUSH BUTTON

- .1 Quad push button shall be four (4) unique call priorities (Code Blue, Staff Assistant, Code Pink, Code White) from single station.
- .2 It shall include the following features;
 - .1 Bioseal option;
 - .2 Back-lit for easier location in dark room;
 - .3 Outputs for elapsed timers;
 - .4 No visible screws/easy to clean;
 - .5 Customizable for unique call-ins;
 - .6 Continually supervised;
- .3 Approved manufacturer:
 - .1 Aatel (Model # CB-SA-CP-CW)

2.06 BED STATUS STATION

- .1 The Bed Status Station shall provide four (4) distinct call-in priorities: "Transport", "Cleaning Needed", "Cleaning in Progress" and "Bed Ready". These buttons shall be customized for any other types of calls such as "Staff Assist" or for Staff Registration.
- .2 The Bed Status Button Station shall be used to notify Transport when a patient has been discharged. The station shall also be used to notify Environmental Services that a room / bed needs to be cleaned as well as providing the state of cleaning by indicating that cleaning is in progress, or the bed is ready for another patient to be admitted.
- .3 Features shall include:
 - .1 Four (4) call-in buttons with call assurance LED's;
 - .2 Large back-lit buttons for easier activation;
 - .3 Elapsed timer output;
 - .4 Plug-in connectors for easy service;
 - .5 Continuous supervision of station;
 - .6 2-gang adapter plate included;
 - .7 Optional antimicrobial Bio-seal to cover buttons and allow for easy disinfecting of the station;
- .4 Approved manufacturer:
 - .1 Rauland (Model # 354016)

2.07 STAFF STATION

- .1 The Staff Station shall be typically located in a room or on a floor where staff members may be working. The station shall also be used in patient areas such as day rooms or visitor's lounges or wherever call-in and two-way audio communication is desired. The station shall also interface with a patient bed. The station shall provide a call-in pushbutton in the audio-visual system. The staff or patients shall communicate through the stations built-in speaker/microphone.
- .2 Features shall include:
 - .1 Pushbutton for two-way intercom in audio-visual system with built-in Call-Assurance LED;
 - .2 Speaker and microphone provide full-duplex audio to speak with the patient if desired;
 - .3 Cancel button for localized call cancellation;
 - .4 Interfaces with specialty beds via separate receptacle and control module;
 - .5 LED to indicate specialty bed is not connected;
 - .6 Interfaces with a remote pillow speaker via separate station;
 - .7 Output for lighting control options direct to low voltage lighting controller;
 - .8 3-gang adapter plate included;
 - .9 Continuous supervision of station for loss of data and/or power faults;
 - .10 Plug-in connectors for easy service;
 - .11 Bio-seal option to cover buttons and allow for easy disinfecting of the station;
- .3 Approved manufacturer:
 - .1 Rauland (Model # 353101)

2.08 DUTY STATION

- .1 The Duty Station shall be typically located in a utility room or an area where staff members may be working and need notification of active calls within their area. In an audiovisual system, the station shall also provide a call-in pushbutton, which allows for two-way audio communication. The four (4) LED indicators shall provide visual indication of calls by mimicking the corridor light. Each LED can light one of seven colors. The station shall also provides audible indication of calls.
- .2 Features shall include;
 - .1 Four (4) LED indicators mimic the corridor light behavior of a call in progress;
 - .2 Call tone indication of calls are the same as at the nurse console(s);

- .3 Pushbutton for two-way intercom in an audio-visual system with built-in Call-Assurance LED;
- .4 Speaker and microphone provide full-duplex audio to speak from station if desired;
- .5 Day/Night tone level control (from console) with tone mute for calls;
- .6 Monitor LED indicates active audio;
- .7 Cancel button for localized call cancellation;
- .8 3-gang adapter plate included;
- .9 Continuous supervision of station for loss of data and/or power faults;
- .10 Network control through associated corridor light;
- .11 Easy Plug-in connectors for wiring to corridor lights and attached devices;
- .12 Bio-seal option to cover buttons and allow for easy disinfecting of the station;
- .3 Approved manufacturer:
 - .1 Rauland (Model # 353100)

2.09 CODE STATION

- .1 The Code Station is a call pushbutton station that shall provide the ability to place a code call. Pressing the cancel button cancels the call. This station shall provide an output for an elapsed timer supporting a momentary or latched contact closure output. The Code Blue button shall be back-lit for easier location in dark room. Using special buttons, the stations shall be customized for unique call-ins such as “Code Pink”.
- .2 Features shall include:
 - .1 Extra large back-lit button for easier activation;
 - .2 Elapsed timer output;
 - .3 Call-assurance LED;
 - .4 Plug-in connectors for easy service;
 - .5 Continuous supervision of station;
 - .6 1-gang adapter plate included;
 - .7 Optional antimicrobial Bio-seal to cover buttons and allow for easy disinfecting of the station;
- .3 Approved manufacturer:
 - .1 Rauland (Model # 354011)

2.10 STAFF ASSIST/CODE STATION

- .1 The Staff Assist / Code Station is an emergency dual pushbutton station that shall have the ability to place two (2) unique call priorities from a single station. Using special buttons, the station shall be customized for unique call-ins such as: “Code Pink”, “Push for Help”, etc. The buttons shall also be used for staff registration such as: “Nurse in Room”, etc. The Cancel button shall allow for cancellation of the call at the station. This type of station shall be normally located at a patient room head wall for placing a call for help, staff emergency and/or code call.
- .2 Features shall include;
 - .1 Two (2) call points with Call-Assurance LEDs;
 - .2 Back-lit pushbuttons for easy activation;
 - .3 Cancel button;
 - .4 Continuous supervision of station;
 - .5 Plug-in connectors for easy service;
 - .6 Elapsed timer outputs;
 - .7 1-gang adapter plate included;
 - .8 Optional antimicrobial Bio-seal to cover buttons and allow for easy disinfecting of the station;
- .3 Approved manufacturer:
 - .1 Rauland (Model # 354015)

2.11 TERMINAL CABINET

- .1 Features shall include;
 - .1 Flush or surface–mount cabinet;
 - .2 Removable trim ring;
 - .3 Front vented door;
 - .4 Includes conduit knockouts;
 - .5 Four (4) three–prong power outlets;
- .2 Approved manufacturer:
 - .1 Rauland (Model # NC2828)

2.12 BRANCH REGIONAL CONTROLLER

- .1 Features shall include;
 - .1 Data & audio control for four (4) L-Net connections
 - .2 Supports up to ninety-six (96) Corridor Lights and/or Domeless Controllers;
 - .3 One (1) PoE Ethernet connection for network connectivity;
 - .4 Supports up to sixteen (16) Nurse Consoles and up to eighty (80) Staff Terminals;
 - .5 Continuously supervises local consoles, staff terminals, corridor lights, and domeless controllers for power and signal;
 - .6 Stores local console, staff terminal, corridor light, and station configurations;
 - .7 RJ connectors for easy service;
 - .8 Removable power terminal block for easy installation;
- .2 Approved manufacturer:
 - .1 Rauland (Model # 351007 Branch Regional Controller V4)

2.13 POWER SUPPLY

- .1 Features shall include;
 - .1 Self-contained unit;
 - .2 Status LED indicators;
 - .3 Three (3) energy limited outputs (in parallel);
 - .4 Removable Output connector for easy installation;
 - .5 Meets Class 2 energy limited requirements;
 - .6 Power failure output (Battery Backup) built in;
- .2 Approved manufacturer:
 - .1 Rauland (Model # 351003GSA – Power supply with battery back up)

2.14 POE ETHERNET SWITCH

- .1 Features shall include;
 - .1 Provides power over Ethernet (PoE) to the Nurse Consoles and Staff Terminals through any of the eight (8) 10/100 Ethernet ports;
 - .2 Eight (8) 10/100 Mbps Ethernet ports with auto-speed negotiation;
 - .3 Two (2) 10/100/1000Mbps additional ports (No PoE);

- .4 10/100 port LED indicators for active PoE (Amber) and Link/Activity (Green);
- .5 10/100/1000 port LED indicators for speed (Amber) and Link/Activity (Green);
- .2 Approved manufacturer:
 - .1 Rauland (Model # 351004 – 8 Port PoE Ethernet Switch)

2.15 CORRIDOR LIGHT

- .1 Features shall include;
 - .1 LED visual indication for high visibility, long life, low maintenance, and low power consumption;
 - .2 Programmable colors and flash rates to indicate pending calls, service requirements, staff presence, and patient status;
 - .3 Supports up to sixteen (16) call-in stations, three (3) of which can have audio capability;
 - .4 Module status LED indicates when unit is not functioning properly;
 - .5 Serves as hub for all room wiring;
 - .6 Contains a frosted lens for uniform color distribution;
- .2 Approved manufacturer:
 - .1 Rauland (Model # 352010 – Corridor Light – 4 Position V2)

2.16 DOMELESS CORRIDOR CONTROLLER

- .1 Features shall include;
 - .1 Located in areas where a corridor light is not needed or desired;
 - .2 Other corridor lights can be programmed to reflect calls placed on patient stations connected to a domeless room controller;
 - .3 Supports up to sixteen (16) call-in stations, three (3) of which can have audio capability;
 - .4 Serves as hub for all room wiring;
- .2 Approved manufacturer:
 - .1 Rauland (Model # 352020 – Domeless Corridor Controller)

2.17 RESPONDER 5 FEATURE BED RECEPTACLE

- .1 Features shall include;
 - .1 Interfaces Feature Bed Side Rail Controls with Responder 5;

- .2 Simple, easy plug-on connectors to the Responder 5 Feature Bed Control Module;
- .3 Provides dedicated Bed Port for Professional Installation of Feature Beds;
- .4 Stainless Steel Wallplate;
- .5 Dummy Plug for use when Bed is not plugged into the Receptacle;
- .2 Approved manufacturer:
 - .1 Rauland (Model # NCBED5 – Responder 5 Feature Bed Receptacle)

2.18 FEATURE BED CONTROL MODULE

- .1 Features shall include;
 - .1 Interface between feature beds and Responder 5 bed stations;
 - .2 Transfers all nurse call and entertainment functions to the bed with entertainment muting;
 - .3 Simple, easy plug-on connectors;
 - .4 Typically fits in back-box at or near feature bed wall connector;
- .2 Approved manufacturer:
 - .1 Rauland (Model # 350304 – Feature Bed Control Module V2)

2.19 PULL CORD STATION WITH AUDIO

- .1 Features shall include;
 - .1 Plastic pull-cord for easy activation;
 - .2 Smooth, non-porous PVC coating on the cord provides an easily cleaned surface;
 - .3 Large, easy to grab bell;
 - .4 Call-in button provides an additional call-in priority with built-in call-assurance LED;
 - .5 Speaker and microphone provide full-duplex audio to the bathroom to speak with the patient if desired;
 - .6 Monitor LED and Call-Assurance LED with Cancel button;
 - .7 Monitor LED indicates microphone activation;
 - .8 Cancel button for localized call cancellation;
 - .9 Continuous supervision of station;
 - .10 2-gang adapter plate included;
 - .11 Plug-in connectors for easy service;

- .12 Bio-seal option to cover buttons and allow for easy disinfecting of the station;
- .2 Approved manufacturer:
 - .1 Rauland (Model # 354000)

2.20 PULL CORD STATION

- .1 Features shall include;
 - .1 IP68-rated waterproof pull cord station;
 - .2 Sealed design allows continuous contact with water and fluids;
 - .3 Can be located anywhere within a wet environment - (Mounting location subject to Authorities Having Jurisdiction (AHJ));
 - .4 Plastic pull cord for easy activation;
 - .5 Smooth, non-porous PVC coating on the cord provides an easily cleaned surface;
 - .6 Call-Assurance LED;
 - .7 Cancel button;
 - .8 Contains two (2) large, easy to grab bells for placement anywhere on pullcord;
 - .9 Continuous supervision of station;
- .2 Approved manufacturer:
 - .1 Rauland (Model # 354001WP – IP68 Waterproof Pull cord station)

2.21 INTEGRATION TO OTHER BUILDING SYSTEMS AND EQUIPMENT

- .1 IT systems.
- .2 Patient wandering system.
- .3 Staff assist system.
- .4 Telephone system.
- .5 System to be integrated through IP Ethernet connection to hospital LAN with other existing security and communication systems including integration engine for system faults within facility. Review integration points with CVH. These include but are not limited to following:
 - .1 Pocket pagers.
 - .2 Wireless telephone.
 - .3 Integrated to telephone system. Review requirements with CAMH.
 - .4 Facility voice communication (telephone) system.

- .5 Patient database management system.
- .6 Fire alarm system.
- .7 Patient wandering system.
- .8 Integration Engine.
- .9 Video monitoring System.
- .6 Include with system, communications interface to allow system integration such that system annunciates a trouble signal in event of an alarm condition and can communicate location of device in alarm, to designate other building systems and to wireless devices.

3 EXECUTION

3.01 INSTALLATION WORK

- .1 Delete and/or relocate existing nurse call system devices as noted. Include for following:
 - .1 Disconnecting and decommissioning of devices.
 - .2 Removal of obsolete boxes, wiring and conduit.
 - .3 Patching and making good surfaces as coordinated with general trades contractor.
 - .4 Provision of additional boxes, wiring and conduit for relocated devices.
 - .5 Engaging Owner existing system vendor to decommission devices, re-program existing system to suit renovations work, test and verify operation of existing system is in proper order after system changes.
 - .6 Turn over deleted devices to owner if requested by Owner.
 - .7 Proper disposal of materials not wanted by Owner.
- .2 Coordinate work of trades for scheduling, demolition, rough-in, power, and conduit requirements, installation and testing.
- .3 Provide nurse call systems components in areas as noted in the specification and the drawings. Programme system on servers/terminals/nurse consoles. Obtain Owner approval of room nomenclature prior to start of programming. Customize software to suit Owner specific applications. Program sequence of operation and user information. Include for system manufacturer authorized representative to program systems. Programme exact programming requirements as confirmed with Owner and reviewed with Consultant prior to start of Work. Utilize manufacturer recommended configuration chart during installation and record respective device names, serial number, room name and number and comments, as outlined on sheets. Submits sheets with test reports.

- .4 Locate additional head end equipment in locations as noted. Provide terminal cabinets/panels as required and locate in electrical or telecom closets as reviewed with Consultant. Do not locate in ceiling spaces or public/patient areas, corridors, stairways or offices. Ventilate areas as required for proper equipment performance. Confirm cabling standards with system manufacturer and perform installation to suit standards. Clearly label each cable run and port. Install devices to system manufacture instructions and recommendations.
- .5 Provide power receptacles, feeders, data jack/drop as required to accommodate for installation of additional head-end equipment. Confirm locations with Consultant prior to roughing-in. Coordinate work of trades.
- .6 Provide dedicated conduit feeders into equipment cabinets. Generally, required sizing of breakers, feeders and conduits are as noted, but in absence of directions, size distribution to local governing electrical code requirements to suit applications and general requirements herein this Specification. Coordinate exact power requirements with suppliers/manufacturers of equipment. Provide dedicated circuit breakers for each supply. This power feed to not have any other devices connected directly to it. Provide circuit breakers located in electrical panels and label breakers "Nurse Call System". These electrical circuits to be connected to facility essential power circuits of panels serving area of work. Connect network system power supplies and equipment cabinets to common earth ground utilizing copper conductors as required. Comply with governing electrical code requirements. Provide required data drops.
- .7 Provide stations and install into locations. Install components at mounting heights as noted on architectural elevations and as reviewed with Consultant. Generally, wall mount devices onto recessed boxes. Provide conduits and backboxes to accommodate device installations. Confirm back box requirements with system vendor prior to roughing-in.
- .8 Where stations are mounted in headwall units, coordinate dimensions (supply samples of devices) with manufacturer of headwall units.
- .9 Generally, install dome lights in locations as noted but reviewed with Consultant prior to roughing-in. Connect patient room smoke detectors to dome lights and remote communicators, as applicable. Coordinate work with fire alarm system technicians of fire alarm system vendor. Install zone lights to ceilings on recessed boxes in locations confirmed with Consultant and coordinated with other systems and equipment. Review colours for dome lights with Consultant prior to ordering.
- .10 Generally, install emergency call stations of pull cord type in locations as noted. Silicone seal between wall and device to prevent water from entering device for devices located in wet locations including but not limited to showers.
- .11 Provide system wiring of copper conductors, colour coded, and in to system manufacturer recommendations and instructions. Connect equipment to system manufacturer certified wiring diagrams and instructions and under direct supervision of manufacturer. Provide and arrange for authorized system manufacturer representative to make final equipment connections. Run conductors in conduit or where identified on drawings, in cable tray.
- .12 Where existing system wiring is UTP telecommunications type wiring, comply with ANSI/TIA 568 cabling installation requirements for category of cabling. Confirm cabling standards with system manufacturer and perform installation to suit standards. Clearly label each cable run and port.

- .13 training from manufacturer representative on any special installation procedures. Install devices and perform work to manufacturer instructions and requirements and to applicable codes of authorities having jurisdiction.
- .14 Review locations of devices with Consultant prior to roughing-in.
- .15 Perform system integration connections to various systems. Include for system service vendors to perform required integration and programming requirements.
- .16 Ground and bond system as required by governing electrical code and authority and system manufacturer.

3.02 IDENTIFICATION

- .1 Provide product identification.
- .2 Number wiring with markers intended for such applications. Colour conductors for each part of system in accordance with system equipment manufacturer recommendations.
- .3 Nameplates:
 - .1 Provide engraved lamicoid identification nameplates for each equipment or wiring housing and secure to front of housing.
 - .2 Size 4 unless otherwise noted.

3.03 FIELD QUALITY CONTROL

- .1 Manufacturer Authorized Technician Services:
 - .1 Provide technical training and assistance to certified installers of system.
 - .2 Perform onsite inspection, start-up, testing, verification and certification of installed system.
 - .3 Prepare and sign testing and verification reports for submittal to Consultant.
 - .4 Where directed by Owner, perform onsite training of each user (with provision of user guides) prior to project completion and instruct in operation and maintenances of system.
- .2 Submit to Consultant, proposed schedule for testing and verification of system. Notify Consultant and Commissioning Agent minimum 7 working days in advance of testing.
- .3 Arrange for system manufacturer technician to inspect, test, verify, commission and certify system components and wiring, individually and as complete system. Work includes but is not limited to verifying following:
 - .1 Type of equipment installed is that designated by Contract Documents.
 - .2 Wiring connections to equipment components show that installer observed code requirements.
 - .3 Equipment installed in accordance manufacturer recommendations, and signaling devices operated or tested verifying operation.

- .4 Supervisory wiring of equipment connected to supervised circuit is operating and governmental regulations, concerning such supervisory wiring, are in accordance with requirements of AHJ.
 - .5 Sequence of operation is in accordance with specified sequence of operation and approved by AHJ.
 - .6 System and devices are commissioned and operable.
 - .7 Testing system battery power supplies and demonstrate that battery supplies are capable of providing required duration of power.
 - .8 Testing of integrated electromagnetic door locks to verify performance is in accordance with Specifications.
 - .9 Testing of integrated signalling to fire alarm systems.
 - .10 Coordinating with AHJ to obtain certificates of approvals.
-
- .4 Where project work is phased and requires occupancy at various stages, provide system inspection, testing, commissioning, verification and certification after completion of each phase of work, to approval of AHJ. Upon Substantial Performance of the Project Work, include for providing system inspection, testing, commissioning, verification and certification of entire system work.
 - .5 Contact and coordinate with AHJ, for inspections. Integrate AHJ inspection requirements with inspection, testing, commissioning, verification and certification work. Obtain AHJ approval and compliance certifications. Submit copies to Consultant.
 - .6 Correct failures or deficiencies found in system during testing, witnessed or directed by AHJ, Consultant, or Commissioning Agent. Re-test and re-verify failures and deficiencies until successfully passed.
 - .7 Arrange for manufacturers to supply reasonable amounts of technical assistance with respect to changes required to conform to paragraphs above. During periods of inspection, testing, commissioning, verification and certification work, make electricians available to perform correction work and to assist during this Work. Include for presence of trades responsible for integrated components and systems, during inspection, testing, commissioning, verification and certification work.
 - .8 Prepare detailed test sheets of tested components. Submit documentation in form in accordance with referenced standards, acceptable to AHJ, and reviewed with Consultant. Submit testing report documents additionally in electronic format, as reviewed with Consultant.
 - .9 On completion of inspection, testing, commissioning and verification of system, obtain from testing technician and forward to Consultant, compliance certificate together with detailed inspection reports listing each and every system component, its location in building and its acceptability. Prepare compliance certificate and inspection reports signed by certified testing technician. Signed test reports certify that systems are installed and perform in accordance with Specification.

.10 Combine required documentation into reports. Submit to Consultant.

END OF SECTION

1 GENERAL

1.01 SUBMITTALS

- .1 Submit shop drawings for products specified in this Section.

1.02 SOFTWARE NOMENCLATURE REPROGRAMMING

- .1 Include additional costs for system manufacturer to make necessary on-site final changes to applicable system/equipment software. Make such changes after successful testing and verification of systems, but prior to turn over to Owner. After successful final verification of work, confirm and obtain approval of final nomenclature in writing from Owner and Consultant. Software revisions to incorporate final room names/area names/building names and equipment identification.

1.03 SYSTEM SUPPLIER/INSTALLER QUALIFICATIONS

- .1 Supplier/installer of system to be an established communications and electronics contractor that has and currently maintains a locally run and operated business for at least 5 years and holds applicable provincial and local licenses.
- .2 Supplier/installer to be a valid authorized distributor for product/system proposed with full manufacturer's warranty privileges.
- .3 Supplier/installer to employ technicians who have attended and successfully completed manufacturer's technical certification training for proposed system.
- .4 Supplier/installer to show satisfactory evidence, upon request, that they maintain a fully equipped service organization capable of furnishing adequate inspection and service to system. Supplier/installer to maintain at their facility necessary spare parts in proper proportion as recommended by system manufacturer to maintain and service equipment being supplied.

2 PRODUCTS

2.01 POE ANALOG CLOCK SYSTEM

- .1 Primex, Traditional Series Analog clocks as specified in paragraphs which follow. Note that series numbers may be obsolete. Confirm updated series with manufacturer.
- .2 Traditional Series PoE Analog Synchronous Clocks shall include:
 - .1 Power Over Ethernet, Configured;
 - .2 12.5" (31.75cm) Round
 - .3 Color: Black,
 - .4 General 12/24 Dial;
 - .5 Automatic daylight savings adjustment;
 - .6 Clock Lock feature that can be used to securely mount to the wall;

- .7 Clock configuration to access the network is accomplished online prior to delivery for plug-and-play convenience;
- .8 Approved manufacturer:
 - .1 Primex Inc. (Part # 162-PE110A05).
- .3 Provide manufacturer's supplied and recommended suitable power over ethernet and hanging receptacle that is integrated with backbox to allow for recessed wall mounting of clocks.

3 EXECUTION

3.01 INSTALLATION OF POE ANALOG CLOCK SYSTEM

- .1 Provide specified PoE analog clock system and tie into existing master clock system headend equipment. Include for and arrange for system manufacturers authorized representative to program system and to integrate to other low voltage systems if required. Connect complete. Provide wiring in conduit and/or in cable trays where noted. Provide suitable recessed backboxes for mounting of clocks.
- .2 Obtain required training from manufacturer's representative on any special installation procedures. Install devices and perform work in accordance with the manufacturer's instructions and requirements and in accordance to applicable codes of the governing authorities having jurisdiction.
- .3 Coordinate network connections to Owner's LAN with Owner's IT Department. Install software onto server and programme to suit project requirements and Owner's directions as necessarily required.
- .4 Coordinate RJ45 outlet and structured cabling requirements with vendor responsible for providing structured network cabling system. Install telecom jack c/o face plate and back box at each clock outlet and extend telecom UTP cabling back to nearest Communications/LAN/Data Room equipment serving area. Refer to section regarding structured network cabling for product and installation requirements.
- .5 Confirm exact clock requirements with Consultant prior to ordering.
- .6 Confirm locations of clocks and equipment with Consultant prior to roughing-in.
- .7 Ground and bond system as required by local governing electrical code and authority and system manufacturer.
- .8 Provide onsite system inspection, testing, adjusting, start-up, and verification.
- .9 Demonstrate operation to Owner and Consultant.
- .10 Refer to drawings for system riser diagram and locations of equipment.

END OF SECTION

1 GENERAL

1.01 REFERENCE STANDARDS

- .1 Comply with all applicable national and provincial and municipal codes including, but not limited to, the following:
 - .1 National:
 - .1 CSA C22.1-24, Canadian Electrical Code, Part 1 (25th edition) Safety Standard for Electrical Installations or the latest edition I.
 - .2 CSA z8000 Canadian Healthcare Standards.
 - .3 Canadian Standards Association CSA C22.1.
 - .4 UL 294- Edition 7 -Standard for Access Control System Units.
 - .5 C282-15 Emergency Power Supply for Buildings.
 - .6 National Fire Code of Canada (NFC)
 - .7 National Fire Protection Association (NFPA)
 - .2 Provincial:
 - .1 Ontario Electrical Safety Code.
 - .2 Ontario Building Code.
- .2 Comply with applicable industry practices including but not limited to the most recently published version of the following guides in effect at time of bid including all published addenda and errata:
 - .1 ANSI/TIA/EIA-568-B.3 and its addendum
 - .2 BICSI Telecommunications Distribution Methods Manual – Most current Edition
 - .3 BICSI Network Design Reference Manual – Most current Edition
 - .4 BICSI Information Transport Systems Installation Manual – Most current Edition
 - .5 American Society for Testing Materials (ASTM).
 - .6 Institute of Electrical and Electronic Engineers (IEEE).
 - .7 Manufacturer's specifications, latest issue.
 - .8 American Society for Testing Materials (ASTM).
 - .9 Institute of Electrical and Electronic Engineers (IEEE).
 - .10 Manufacturer's installation and specification manuals latest issue.

1.02 DESIGN PERFORMANCE REQUIREMENTS

- .1 Quality Assurance:
 - .1 Product Qualifications:
 - .1 The control equipment for the Access Control System, shall be provided by a qualified Electronic Security System Contractor (ESSC)
 - .2 All equipment supplied by the ESSC shall be by ISO 9001/9002 certified manufacturers.
 - .2 Electronic Security Systems Contractor (ESSC):Qualifications:
 - .1 Project managers and technicians shall be the employees of the ESSC. Technicians shall be factory trained and certified in the various systems. The supplier will be a Microsoft-certified solutions provider (MCSP), staffed with a dedicated Microsoft-certified System Engineer (MCSE) which will be assigned to the project.
 - .2 Acceptable Suppliers: The systems, equipment and materials of this Section shall be provided by an authorized, trained and certified Genetec equipment supplier and trained technical staff. All suppliers, equipment and services will be subject to compliance with the Contract Documents, including the Quality Assurance provisions stated herein.
 - .3 Any request for substitute suppliers other than certified and authorized equipment suppliers shall submit a substitution request in writing to the authority having jurisdiction (AHJ).
 - .3 General Scope:
 - .1 The ESSC shall be responsible for the systems specified in this Section, including coordination with related trades.
 - .2 The ESSC shall coordinate all work and submittal details with the electronic door hardware supplier to ensure proper sizing of control equipment and shall be responsible for proper sizing of interface equipment (i.e., relays, contact ratings, etc.) to eliminate interface problems.
 - .4 Related work specified elsewhere shall be coordinated by the ESSC:
 - .1 Door Hardware/ Electronic Locks.
 - .2 Interface of all related systems.
 - .3 Electrical Work, except as specified herein.
 - .4 Control Work and/or annunciation, except as specified herein.
 - .5 All 120 Volt wiring and connections from power panels to terminal strips in electronic low-voltage panels, power supplies and devices (Division 26).
 - .6 All raceway, conduit to the device(s), including all back boxes and pull strings and the installation of all special back boxes.

.7 Wiring.

1.03 SYSTEM DOCUMENTATION

.1 Submittals:

- .1 The ESSC shall submit complete sets of documentation for approval within thirty (30) days of notification to proceed, pending receipt of all approved information required for coordination. The submittal documents shall include, as a minimum, the following:
 - .1 A complete Bill of Materials. This shall include model numbers, component description, manufacturer name, data sheet reference numbers and quantities of each device to be provided.
 - .2 Original manufacturer's product data sheets for all equipment to be provided. The product data sheets shall be annotated to clearly identify the equipment and devices being supplied that are applicable to the project.
 - .3 System theory of operation that clearly define the operating parameters of all systems being supplied.
 - .4 A functional system block diagram showing single-line inter-connection of all integrated systems and the major components of each system.
 - .5 Final documentation will include copies of a Training Manual tailored for this project as described elsewhere in these documents.
 - .6 Complete Control Panel and device schedules to include:
 - .1 Control Panels and equipment depicting location and designation.
 - .2 All monitored Control Points and Status Indicators.
 - .3 Doors (list door No's.).
 - .4 Misc. Controls.
 - .5 Zone Schedules.
 - .6 All electronic door locking/control panel interface drawings shall be coordinated with the electronic locking hardware. Detailed integrated point-to-point drawings shall be compiled showing all integration between the electronic locking systems, RTLS Systems, Elevator controls, and Door hardware Security Interlock Door Systems as required.
 - .7 Door schedules and control panel schedules are intended to serve as an overall guide to panel requirements and in no way, by omission of content alleviate the ESSC from supplying those items needed to provide a complete and functional panel incorporating all systems and components referenced in this specification.

- .2 The ESSC shall provide a draft copy of the Operator's Training Manual within 30-days from approval of the Equipment Submittals. The Manual must provide a concise overview of all training that will take place during the system commissioning. Training will be tailored for the specific project and will cover all Operator Instructions, Procedures and Operating Sequences. The Training Manual shall provide details on the operation of each individual type of control sequence as well as a screen-by-screen review of the overall operation of the system. Upon review of the draft copy of the manual by the CVH Representative, the ESSC shall make necessary modifications and changes to the satisfaction of the CVH Representative.
- .3 Operations & Maintenance (O & M) Manuals:
 - .1 Draft O&M manuals shall be submitted to the System designer for approval prior to completion of the final documents.
 - .2 Final O&M Manuals shall be provided prior to the project completion. The manuals shall include, but not be limited to:
 - .1 Manufacturer's product data sheets for required equipment and major components provided. The product data sheets shall be annotated to clearly identify only those specific functions and features that are applicable to the project.
 - .2 Two (2) sets of USB keys that contain all submittal information and project documentation as described above. Provide data in Microsoft Word format and Adobe Acrobat .PDF format data sheets.
 - .3 System theory of operations that clearly define the installed operating parameters of all systems supplied.
 - .4 A functional system block diagram showing single-line inter-connection of all integrated systems and the major components of each system.
 - .5 Riser diagram of each subsystem.
 - .6 Device schedules that show relationships between different devices.
 - .7 Operator's Training Manual.
 - .3 All O&M manuals shall be provided in three-ring binders and shall include the project name, Construction Manager's name, architect's name, engineer/consultant's name, and the name of the ESS Supplier. Provide six (6) copies of the O & M manuals.
 - .4 One (1) soft copy of the project manual shall be handed over to the security communication consultant at the completion of the project.

1.04 GENERAL SYSTEM REQUIREMENTS

- .1 The existing Access Control System (ACS) shall be fully integrated with integration with the Graphical Interface Platform System, Video Badging, CCTV, RTLS Systems, Visitor Management, and Intrusion Alarms. The work specified herein is to add the required access control system peripherals to the existing Genetec Security Centre System.

- .2 The ACS shall interface with the RTLS to lock up the respective doors as required by CVH.
- .3 ESSC to provide sufficient Security Control (SCP), power supplies, and micro-control-Alarm Panels to support monitoring and control of field devices as needed per the requirements of this design.
- .4 The system shall be capable of on-site programming to accommodate system expansion and facilitate changes in operation. All software operations shall be stored in a non-volatile programmable memory within an SCP field panel. Loss of primary and secondary power shall not erase the instructions stored in memory.
- .5 Full flexibility for selective input/output control functions based on ANDing, ORing, NOTing, timing, point lists and predefined templates shall also be incorporated in the resident software programming of the system. Inputs and Outputs shall have the ability to be prioritized such that an input or series of inputs of a higher priority will take precedence over events controlled by lower priority inputs. Conversely, lower priority events may not override higher priority events. Priorities of points may be automatically changed on a timed basis.
- .6 Resident software shall allow for full configuration of circuits so that additional hardware or firmware reprogramming shall not be necessary to accommodate field changes. For instance, changing from sensing of normally open contact devices to sensing of normally closed contact devices, or changing from sensing of normally open contact devices to sensing a combination of current limited and non-current limited devices shall be accommodated without the need for special tools, equipment, or firmware replacement.

1.05 POWER REQUIREMENTS

- .1 All 120 VAC power shall be furnished and installed.
- .2 Power supplies for electronic door locks and will be provided by the ESSC, who will be responsible for coordination between the Electrical trade and the electronic door hardware provider.
- .3 Back-up power supplies to support 100% of the systems operation for 24 hours minimum.

2 PRODUCTS

2.01 ACCESS CONTROL SYSTEM (ACS)

- .1 The existing ACS serves the existing system and shall be extended to serve the renovated areas and shall be integrated with the Real Time Locating System (RTLS).
- .2 Furnish and install a complete ACS as described herein and as shown on the plans; to be wired, connected, and left in first class operating condition. The ACS shall consist of redundant network servers with remote Security Control Panels (SCPs), CCTV subsystem integration and Graphical Interface Platform System.
- .3 The system will support data transfer between related IT/ICAT systems. It will be the responsibility of the ESSC to coordinate data transfer protocol procedures with the designated CVH Representative. (where required)

- .4 The ACS is made up of the existing Genetec Security Centre system and this project shall facilitate the addition of ACS door peripherals to fit up the required doors in these shell spaces per the drawings and specifications herein.
- .5 The ESSC shall be fully responsible for the design and implementation of the full system topology, best suited for the project, given identified and recognized existing ACS infrastructure.
- .6 The ESSC shall use matched components from a single manufacturer, certified to deliver end-to-end system performance to extend the existing Genetec system and maintain or increase performance of the system as it is presently.
- .7 All the stated components and peripherals to be installed per Manufacturer recommended best practices.
- .8 The ACS shall use matched components from a single manufacturer. Approved manufacturer is:
 - .1 Genetec.
 - .2 Approved equivalent.
- .9 Comply with manufacturer's instructions and recommendations to meet the requirements of the specification.
- .10 The quantities of following peripherals and devices shall be confirmed by the ESSC based upon the requirements to extend the ACS doors and peripherals onsite based upon using the spare capacity of the existing systems already installed on site presently.
- .11 Power Supplies:
 - .1 The ACS power supplies shall consist of the Genetec Power Management Systems to support the required Access Control peripherals, and the direct integration with the door locking control equipment.
 - .2 The ACS power supply shall adhere to the required quantity of doors, devices and peripherals and the required integration to provide one unified power solution.
- .12 ACS Door Reader Controller:
 - .1 The ACS reader controller shall be made up of HID Mercury Security LP1501 Intelligent controllers.
 - .2 The LP1502 controller has direct hardware support for two doors and can scale up to 64 readers. Supporting a range of wired and wireless technology, the LP1502 is managed by the Synergis Cloud Link gateway appliance over IP.
- .13 ACS Interface Module:
 - .1 The ACS Interface Module shall be made up of the Mercury Security MR52 which seamlessly integrates with the Genetec Synergis IP Access Control System.
 - .2 The MR52 two door interface module connects up to two readers, controlling either one or two doors. Supporting a range of wired and wireless reader technology, the

- .3 MR52 is managed by a Mercury Security EP/LP1501, EP/LP1502, EP/LP2500 and EP/LP4502 controller through a high-speed RS-485 network and ultimately, the Synergis Cloud Link appliance over IP.
- .4 Connects to Mercury Security Controllers over high-speed RS-485 Network.
- .5 ODSP v1 and v2 supported.
- .6 Manages up to four (4) ODSP readers or two (2) doors.
- .7 Readers: two (2) reader ports, supporting two (2) OSDP readers (entry and exit) each.
- .8 Inputs: eight (8) general purpose: programmable circuit type (two (2) dedicated for Tamper and Power Monitor).
- .9 Outputs: six (6) relays: Form C, 5 Amp 30 Vdc.
- .14 ACS Card Readers:
 - .1 The ACS card readers shall be HID Signo readers.
 - .2 HID Signo™ is the signature line of physical access control readers from HID Global.
 - .3 ESSC shall provide the reader that best suits the clients needs. The final selection of the type of card reader and placement shall be accepted by the CVH representative.
- .15 ACS Door Contacts:
 - .1 The recessed door position switch (door contact) shall be a George Risk Industries (GRI) 180 Series ¾ inch and 1 inch steel door recessed switch set.
 - .2 The door position switch shall be provided by the ESSC to meet the requirements of this specification.
 - .3 The SMS shall allow for the segmentation of data in the systems database such that different user groups can access only the data in their own partitions or in partitions designated as shared. The system shall also have the ability to assign any combination of partitions to a particular user, while assigning one as the “home” partition.
- .16 Request to Exit Detector (T-Rex):
 - .1 The request to exit (REX) motion detector shall be a Tyco T.Rex request to exit type motion detector or approved equivalent.
 - .2 The REX shall be installed as per the manufacturer recommendations.

3 EXECUTION

3.01 INSTALLATION

- .1 The new ACS door peripherals are to be connected to the existing Genetec ACS system and provisions made for the required head end equipment and space allocations within the existing telecommunications room.

- .2 Provide and install the system including but not limited to plans and specifications, all applicable codes and the manufacturer's recommendations.
- .3 Installation of equipment and devices that pertain to other work in the contract shall be closely coordinated with the appropriate subcontractors.
- .4 ESSC shall clean all dirt and debris from the inside and the outside of the Electronic Security equipment after completion of the installation.
- .5 The manufacturer's authorized representative shall provide onsite supervision of installation, as required.
- .6 Wiring color code shall be maintained throughout the installation.

3.02 TESTING

- .1 Systems commissioning to be provided per Commissioning Practices for CVH with the AHJ.
- .2 Once all equipment is installed, the completed ACS shall be fully tested by the ESSC in the presence of the CVH Representative. Upon completion of a successful test, the contractor shall so certify in writing to the CVH Representative, and others as deemed necessary.
- .3 Installation of equipment and devices that pertain to other work in the contract shall be closely coordinated with the appropriate subcontractors.

3.03 WIRING

- .1 All systems wiring shall be installed in accordance with the latest edition of the Canadian Electrical Code (CA). All wiring shall be plenum rated and sized to meet distance requirements between panels and remote devices.
- .2 Wiring shall be grouped and laced with nylon tie straps with a maximum spacing of one inch (1"). Straps will be placed within ½" on each side of all bundle breakouts. Wiring will be supported on intervals not exceeding four inches provided each manufacturer meets all requirements.
- .3 The wiring that extends from the electronic control relay terminal strips to the locks, lights, etc., shall be Class 1, 2 or 3 as defined in Article 725 of the National Electric Code. All conductors shall be a minimum number 14 THHN or THWN, 600 volt rated, and shall be installed in raceways and equipment enclosures with other conductors, within limitations defined by Article 725 of the National Electric Code.
- .4 All control wiring systems shall use plenum rated solid or stranded copper conductors.
- .5 Stranded conductors shall be acceptable only where all terminations can be made to lugs. Where stranded conductors are used, all terminations shall be made with crimp type lugs, correctly sized for termination, and applied to conductor with crimping tool intended for use with the lug used.
- .6 Control wiring between relays and terminal strips within the relay cabinets shall be stripped, tinned and fastened to terminal strips with screws fitted with pressure plates.

- .7 All wiring systems shall be labeled, and color coded with labeling and coding shown on shop drawings. White conductors shall be used only for neutral conductors and green only for grounding conductors. All conductors within junction boxes, pull boxes and equipment enclosures shall be grouped and laced with nylon tie straps with identification tags in individual sets, serving individual locks or groups. Conductor group shall be identified on the tag with respect to room or area served. Control system conductors shall not be spliced; control conductors shall be continuous between the control panel and the relay cabinet.
- .8 All locking systems shall be interfaced with the Fire alarm life safety systems as required by applicable codes and the local AHJ to support proper unlocking functions.
- .9 Electronic locking functions during power failures shall be installed in compliance with life safety codes and local AHJ approvals.

3.04 TRAINING

- .1 The ESSC is responsible for providing a custom Operating Training Agenda and Training Manual developed for the specific project. Training shall be provided by to designated Operators, and is intended to provide the trainees with the tools necessary to conduct subsequent training of on-site staff.
- .2 The Training Agenda shall review detailed procedures for operating the entire system, including each subsystem and shall cover the following topics:
 - .1 Actual System Configuration.
 - .2 System Components.
 - .3 Sequence of Operation.
 - .4 System Control Functions.
 - .5 System Maintenance and Troubleshooting Procedures.
- .3 The ACS supplier shall provide a draft copy of the Training Agenda for each Session as part of the original equipment Submittals, and a final approved copy forty-five days prior to project substantial completion.
- .4 Provide a draft copy of the Training Manual within 60 days from the approval of the equipment submittals, and a final approved copy 10 days prior to commencement of the User Acceptance Testing.
- .5 Initial System Administrator Training will take place at the facility on the actual project equipment. This training will be conducted at the time of final testing prior to final acceptance of the equipment, will demonstrate the system capabilities, and will provide a detailed review of System Programming and Administration Operations.
- .6 Provide the following Training Sessions:
 - .1 (coordinate training schedules with the facility representative):
 - .1 One 4-hour Operator Training sessions (on-site).
 - .2 One 4-hour System Administrator session (on-site).

- .7 Provide the CVH Representative with copies of all applicable Training Agendas, user manuals and related training documentation.
- .8 The ACS supplier shall allow all Training Sessions to be videotaped at the CVH Representative Discretion and expense.

3.05 WARRANTY

- .1 ESSC shall warranty the completed Electronic Security system wiring and equipment to be free from inherent mechanical and electrical defects for a period of two (2) years from the date of the completed and certified acceptance test or from the date of first beneficial use.
- .2 The security systems supplier shall provide two (2) -hour response to any service requests during the warranty period within two (2) hours of notification. On site response shall be within four (4)-hours of the notification.

END OF SECTION

28 20 00 – Video Surveillance System

1 GENERAL

1.1 Section Includes

1.1.1 This document defines the VSS and subsystem components to include field devices, termination hardware, supporting hardware, and miscellany required to provide a complete VSS including but not limited to equipment, labour, supervision, tooling, and miscellaneous mounting hardware and consumables to install a complete system.

1.1.2 Electronic Security Systems Contractor (ESSC) to add the new surveillance systems cameras to the existing Genetec Video Surveillance System (VSS). The ESSC shall procure, install, integrate, test, maintain, and demonstrate a fully functional system which is fully integrated with existing VSS.

1.2 REFERENCE STANDARDS

1.2.1 BS EN 60529, Degrees of protection provided by enclosures (IP Code).

1.2.2 BS EN 62262, Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code).

1.2.3 ANSI/NEMA 250, Enclosures for Electrical Equipment (1,000 Volts Maximum)

1.2.4 IEEE 802.1X, Port-Based Network Access Control

1.2.5 IEEE 802.3, IEEE Standard for Ethernet

1.3 Submittal

2 Products

2.2 Design and Performance Requirement

2.2.1 System Requirement:

- .1 The system shall be an IP based, non-proprietary, redundant, enterprise solution supporting IP and IP megapixel camera technologies. The system shall be a complete solution that is scalable from the existing scope of this project to several thousand cameras which can be added on a unit-by-unit basis. This future expansion capacity shall not require significant replacement or upgrading of hardware or equipment provided as part of the initial solution.
- .2 All system testing shall follow the testing, commissioning and acceptance process outlined in Section 28 05 00 Common Work Results for Electronic Safety and Security.
- .3 Provide detailed wiring diagrams. Finalize the wiring diagrams to meet any site-specific conditions and provide a fully functional system.

2.2.2 System Description:

- .1 The VSS shall consist of field and termination equipment necessary to provide a fully automated system.
- .2 The VSS shall be designed on a distributed processing architecture employing remote cameras and operator workstations connected to a redundant central server and storage solution.
- .3 Connect all security cameras to centrally located network switches located in communications rooms.
- .4 The system shall be configured to a maximum of 75% of its device and recording capacity.
- .5 The field device to Telecom Room allocation shall be identified by the ESSC. Ensure that such allocations do not cause cable lengths to exceed a distance of ninety (90) meters. In the case of exterior remote locations fibre optic connectivity shall be employed.
- .6 Location of additional video surveillance cameras shall be based on operational requirements of the Facility and subject to review by CVH.
- .7 All cameras shall be placed and provided in sufficient configurations and quantities to obtain the level of detail required in the output specifications.
- .8 The VSS shall provide all integrated functionality as described in this specification. This includes integration with the Access Control, Intercom, Real Time Locating System, and ICAT Systems. All integration shall be based on IP protocols and included as part of the standard product offering by the system supplier.
- .9 All video streams from cameras shall be digitally encoded using H.264 or latest compatible compression formats for simultaneous monitoring and recording in real time.
- .10 Each camera's bit rate, frame rate and resolution shall be set independently from other cameras in the system and altering these settings shall not affect the recording and display settings of other cameras.
- .11 The system shall not require proprietary recording hardware, hardware multiplexers or time-division technology for video recording and monitoring.
- .12 The system client and server applications shall be based on a true open architecture that shall allow for use of non-proprietary PC storage hardware that shall not limit the storage capacity and shall allow for incremental upgrades of recording capacity.
- .13 The system shall digitally sign recorded video by way of watermarking to prevent image tampering and to confirm image integrity.
- .14 The system server and client software applications shall be able to operate on separate networks.
- .15 The system shall have the capability of simultaneous live viewing and recording of individual cameras at different frame rates and resolutions.

- .16 Full “Fail Over” server redundancy is a mandatory requirement of this specification. It is intended that all system configuration and user authentication parameters be contained on a minimum of two (2) fully redundant mirrored system servers with real time replication be supplied and installed separately in Building Equipment Room. In no case shall both Servers be installed in the same room.
- .17 The VSS shall incorporate SMART diagnostics that monitor the internal operation of a drive (including external storage drives) and provide early warning notification to Guard Room operators for many types of potential problems. This shall allow for the drive to be repaired or replaced before any data is lost or damaged.
- .18 The VSS shall utilize a redundant centralized storage topology. All video system storage shall be located in a Primary Network Core Room or Secondary Network Core Room.
- .19 The VSS shall allow authorized users to save video to a standard recordable DVD. The option to include the player software on the DVD shall be available so that no additional software needs to be purchased.
- .20 The VSS shall incorporate full programming and prioritized control between users and PTZ domes.

2.2.3 Monitoring Locations:

- .1 System monitoring shall be as defined in the OS.
- .2 System monitoring shall also be provided via web browser accessible from any workstation on the converged network. Access shall require a valid user ID and password.
- .3 The system shall be capable of operating even in the event that the system management server is unavailable.
- .4 Following a power failure and the restoration of main or backup power, the VSS shall revert automatically, within 3.5 minutes, to normal service status without the need for operator intervention. The system shall restart in the same state as existed before the power interruption with no loss of functionality or transaction data.

2.2.4 Communications Rooms:

- .1 Provide cable troughs, conduit, and emergency power circuits for equipment configurations. Cable troughs shall be grounded to earth ground.
- .2 All video termination equipment with the possible exception of non-PoE camera power supplies shall be rack mounted in equipment cabinets.
- .3 Keep all video equipment clean and free of dust at all times during the installation.

2.2.5 Power:

- .1 All Source 120VAC power for security equipment shall be Emergency power with UPS backup.

- .2 Provide lockable, hinged covered, terminal cabinets for all power supplies, transformers, and power distribution terminal strips. Provide all conduit and wiring from the 120 VAC facilities to the terminal cabinets.
- .3 Provide protection against surges, spikes, noise, and other line problems for all system equipment and their components. In addition to generator support, all power sources shall be equipped with uninterrupted power supply capable of supporting all attached equipment for a period of sixty (60) minutes.
- .4 All equipment and system components which are powered by more than 48 volts AC or DC shall be ULC listed for safety. This includes equipment or system components classified as non-power limited.
- .5 All video system power supplies shall have battery backup and shall be monitored, by the ACS, for line failure on a dedicated monitoring input point. Therefore, when an AC line fails, a unique alarm condition shall be caused.

2.2.6 Network:

- .1 Ensure all IP addressing schemes used on the converged network are coordinated and approved by the CVH.

2.2.7 Interface with Other Systems:

- .1 ACS:
 - .1 Refer to Section 28 13 00 ACS for Electronic Safety and Security.
- .2 RTLS:
 - .1 Refer to Section 28 20 00 VSS for Electronic Safety and Security.

2.2.8 Building Wires:

- .1 Be fully responsible for the ultimate design and implementation of the system topology (physical and logical) best suited for the project, given identified and recognized physical infrastructure and constraints.

2.3 **FIELD DEVICES**

2.3.1 Interior Fixed Dome Network Camera:

- .1 The fixed dome network camera shall meet or exceed the following design specifications:
 - .1 The camera shall operate on an open source; Linux-based platform and including a built-in web server.
 - .2 The camera shall be equipped with an IR-sensitive progressive scan megapixel sensor.
 - .3 The camera shall provide a removable IR-cut filter, providing day/night functionality.

- .4 The camera shall be equipped with a varifocal lens with P-iris.
- .5 The camera shall provide local video storage utilizing a microSD/microSDHC/microSDXC memory card expansion.
- .6 The camera shall be manufactured with an IP52-rated in accordance with BS EN 60529, and IK08-rated impact-resistant, polycarbonate casing, in accordance with BS EN 62262.
- .7 The camera shall provide a manual 3-axis (pan/tilt/rotation) positioning to allow adjustment for optimum camera rotation and placement.
- .8 The camera shall provide options for clear and smoked lower dome.
- .2 The fixed dome network camera shall meet or exceed the following performance specifications:
 - .1 Illumination:
 - .1 The camera shall meet or exceed the following illumination specifications:
 - .1 HDTV 1080p 25/30 fps with WDR - forensic capture
 - .2 0.15 lux, F1.6 (colour)
 - .3 0.03 lux, F1.6 (B/W)
 - .4 HDTV 1080p 50/60 fps without WDR - forensic capture
 - .5 0.30 lux, F1.6 (colour)
 - .6 0.06 lux, F1.6 (B/W)
 - .7 Camera shall have Lightfinder Technology
 - .2 Resolution:
 - .1 The camera shall be designed to provide at least two (2) video streams in HDTV 720p (1280x720) at up to 60 frames per second (60Hz mode) or 50 frames per second (50Hz mode) using H.264 or Motion JPEG (WDR inactive).
 - .2 The camera shall be designed to provide at least two (2) video streams in HDTV 720p (1280x720) at up to 30 frames per second (60Hz mode) or 25 frames per second (50Hz mode) using H.264 or Motion JPEG (WDR active).
 - .3 The camera shall be designed to provide two (2) individually cropped out view areas.
 - .4 The camera shall support video resolutions including:
 - .1 1920x1080 (HDTV 1080p)

- .2 1280x960
- .3 1280x720 (HDTV 720p)
- .4 1024x768
- .5 1024x640
- .5 The camera shall provide both landscape format (4:3 and 16:9 aspect ratio) as well as corridor format (3:4 and 9:16 aspect ratio).
- .3 Encoding:
 - .1 The camera shall support the following video encoding algorithms:
 - .1 Motion JPEG encoding in a selectable range from 1 up to 25/30 frames per second.
 - .2 Motion JPEG encoding in a selectable range from 1 up to 50/60 frames per second.
 - .3 Baseline Profile H.264 encoding with motion estimation in up to 25/30 frames per second.
 - .4 Baseline Profile H.264 encoding with motion estimation in up to 50/60 frames per second.
 - .5 Main Profile H.264 encoding with motion estimation and CABAC in up to 25/30 frames per second.
 - .6 Main Profile H.264 encoding with motion estimation and CABAC in up to 50/60 frames per second.
 - .7 Support High Profile H.264 encoding with motion estimation up to 25/30 frames per second.
 - .8 Support High Profile H.264 encoding with motion estimation up to 50/60 frames per second.
 - .9 Support H.264 with automatic scene adaptive bitrate control.
 - .2 The camera shall provide independently configured simultaneous H.264 and Motion JPEG streams.
 - .3 The camera shall in H.264 support VBR for video quality adapted to scene content. To protect the network from unexpected bit rate spikes the camera shall support CBR or MBR.
 - .4 The camera shall provide configurable compression levels.
 - .5 Support standard baseline profile H.264 with motion estimation.
 - .6 Support motion estimation in H.264/MPEG-4 Part 10/AVC.

- .7 The camera shall have Zipstream technology, an H.264 implementation that supports scene adaptive bitrate control with the following capabilities to lower bandwidth and storage.
- .8 Automatic dynamic region of Interest to reduce bitrate in unprioritized regions in order to lowering bandwidth and storage requirements.
- .9 Automatic dynamic group of pictures to lower bandwidth and storage requirements
- .10 Automatic dynamic frames per second to lower bandwidth and storage requirements
- .4 Transmission:
 - .1 The camera shall allow for video to be transported over:
 - .1 HTTP (Unicast)
 - .2 HTTPS (Unicast)
 - .3 RTP (Unicast & Multicast)
 - .4 RTP over RTSP (Unicast)
 - .5 RTP over RTSP over HTTP (Unicast)
 - .2 The camera shall support QoS to be able to prioritize traffic.
- .5 Image:
 - .1 The camera shall incorporate automatic and manual white balance.
 - .2 The camera shall incorporate an electronic shutter operating in the range of 1/66500 s to 1 s.
 - .3 The camera shall incorporate capture mode with the following settings:
 - .1 25/30 fps (WDR-Forensic Capture) (50/60 Hz)
 - .2 50/60 fps (no WDR-Forensic Capture) (50/60 Hz)
 - .4 The camera shall incorporate WDR-Forensic Capture functionality providing up to 120dB dynamic range.
 - .5 The camera shall support manually defined values for:
 - .1 Colour level
 - .2 Brightness
 - .3 Sharpness

- .4 Contrast
- .6 The camera shall incorporate a function for optimization of low light behavior.
- .7 The camera shall allow for rotation of the image in steps of 90°.
- .6 User Interface:
 - .1 Web Server:
 - .1 The camera shall contain a built-in web server making video and configuration available to multiple clients in a standard operating system and browser environment using HTTP, without the need for additional software.
 - .2 Optional components downloaded from the camera for specific tasks, e.g., Active X, shall be signed by an organization providing digital trust services, such as Verisign, Inc.
 - .7 Language Specification:
 - .1 The camera shall provide a function for altering the language of the user interface and shall include support for at least ten (10) different languages.
 - .8 IP Addresses:
 - .1 The camera shall support both fixed IP addresses and dynamically assigned IP addresses provided by a DHCP server.
 - .2 The camera shall allow for automatic detection of the camera based on UPnP and Bonjour when using a PC with an operating system supporting this feature.
 - .3 The camera shall provide support for both IPv4 and IPv6.
 - .9 PTZ Functionality:
 - .1 The camera shall:
 - .1 Provide Digital PTZ functionality.
 - .10 Event Functionality:
 - .1 The camera shall be equipped with an integrated event functionality, which can be triggered by:
 - .1 Video motion detection
 - .2 Live stream accessed
 - .3 Day/night mode

- .4 Camera tampering
 - .5 Manual trigger/virtual Inputs
 - .6 PTZ functionality
 - .7 Embedded third party applications.
 - .8 Edge storage disruption detection
- .2 Response to triggers shall include:
 - .1 Send notification, using HTTP, HTTPS, TCP, SNMP trap or email.
 - .2 Send images, using FTP, HTTP, HTTPS, network share or email.
 - .3 Send video clip, using FTP, HTTP, HTTPS, network share or email.
 - .4 Send SNMP trap message.
 - .5 Recording to local storage and/or network attached storage.
 - .6 PTZ control functionality
 - .7 WDR mode
- .3 The camera shall provide memory for pre & post alarm recordings.
- .11 Edge Storage:
 - .1 The camera shall support continuous and event controlled recording to:
 - .1 Local memory added to the cameras microSD-card slot.
 - .2 Network attached storage, located on the local network.
 - .2 The camera shall be able to detect and notify edge storage disruptions.
- .12 Protocol:
 - .1 The camera shall incorporate support for at least IPv4/v6, HTTP, HTTPS, SSL/TLS, QoS Layer 3 DiffServ, TCP, ICMP, SNMPv1/v2c/v3 (MIB-II), RTSP, RTP, UDP, IGMP, RTCP, SMTP, FTP, DHCP, UPnP, ARP, DNS, DynDNS, SOCKS, SSH, NTP, CIFS/SMB, Bonjour.
 - .2 The SMTP implementation shall include support for SMTP authentication.

.13 Text Overlay:

.1 The camera shall:

- .1 Provide embedded on-screen text with support for date & time, and a customer-specific text, camera name, of at least 45 ASCII characters.
- .2 Provide the ability to apply privacy masks to the image.
- .3 Allow for the overlay of a graphical image, such as a logotype, into the image.

.14 Security:

- .1 The camera shall support the use of HTTPS and SSL/TLS, providing the ability to upload signed certificates to encrypt and secure authentication and communication of both administration data and video streams.
- .2 The camera shall provide centralized certificate management, with both pre-installed CA certificates and the ability to upload additional CA certificates. The certificates shall be signed by an organization providing digital trust services.
- .3 The camera shall support IEEE 802.1X authentication.
- .4 The camera shall provide support for restricting access to pre-defined IP addresses only, so-called IP address filtering.
- .5 The camera shall restrict access to the built-in web server by usernames and passwords at three (3) different levels.
- .6 Device Hardening and Security:
 - .1 Camera supplier shall have published hardening guide detailing:
 - .1 Firmware management
 - .2 User and password management
 - .3 Permissions management
 - .4 Configure basic network settings.
 - .5 Disable audio
 - .6 Enabling encryption
 - .7 Ability to disable
 - .8 Discover protocols

- .9 Bonjour
- .10 UPnP
- .11 QoS
- .12 SOCKS
- .13 Telnet
- .14 SSH
- .15 Link-local address
- .15 API Support:
 - .1 The camera shall be fully supported by an open and published API, which shall provide necessary information for integration of functionality into third party applications.
 - .2 The camera shall support relevant ONVIF profiles as defined by the ONVIF Organization.
- .16 Embedded Applications:
 - .1 The camera shall support the ACAP platform allowing the upload of third party applications into the camera.
- .17 Installation and Maintenance:
 - .1 The camera shall be supplied with Windows-based management software which allows the assignment of IP addresses, upgrade of firmware and backup of the cameras' configuration.
 - .2 The camera shall support the use of SNMP-based management tools according to SNMP v1, 2c & 3 / MIB-II.
 - .3 The camera shall allow updates of the software (firmware) over the network, using FTP or HTTP.
 - .4 The camera shall provide the ability to apply a rectangle of customer-defined number of pixels to the image, which can be used as a pixel counter identifying the size of objects in number of pixels.
 - .5 The camera shall store all customer-specific settings in a non-volatile memory that shall not be lost during power cuts or soft reset.
 - .6 The camera shall provide Remote zoom and Remote focus functionality.
- .18 Access Log:
 - .1 The camera shall provide a log file, containing information about the two hundred and fifty (250) latest connections and access attempts

since the unit's latest restart. The file shall include information about the connecting IP addresses and the time of connecting.

- .2 Provide a connection list of all currently connected viewers. The file shall include information about connecting IP address, time of connecting and the type of stream accessed.

.19 Camera Diagnostics:

- .1 The camera shall be equipped with LEDs, capable of providing visible status information. LEDs shall indicate the camera's operational status and provide information about power, communication with receiver, the network status and the camera status.
- .2 The camera shall be monitored by a watchdog functionality, which shall automatically re-initiate processes or restart the unit if a malfunction is detected.
- .3 The camera shall send a notification when the unit has re-booted, and all services are initialized.

.20 Hardware Interfaces:

.1 Network Interface:

- .1 The camera shall be equipped with one (1) 10BASE-T/100BASE-TX PoE Fast Ethernet-port, using a standard connector and shall support auto negotiation of network speed (100 MBit/s and 10 MBit/s) and transfer mode (full and half duplex).

.21 Enclosure:

.1 The camera shall:

- .1 Be manufactured with an IP52-rated in accordance with BS EN 60529, IK08-rated impact-resistant, polycarbonate casing, in accordance with BS EN 62262.
- .2 Be fitted with a dehumidifying membrane.
- .3 Providing encapsulated electronics and captive screws.

.22 Power:

- .1 Power over Ethernet IEEE 802.3af/802.3at Type 1 Class 2
 - .1 Max: 4.8 W
 - .2 Typical 3.5 W

.23 Environmental:

- .1 Operate in a temperature range of 0 °C to +50 °C.
- .2 Operate in a humidity range of 10–85% RH (non-condensing).

2.3.2 Exterior Fixed Dome Network Camera:

- .1 The fixed dome network camera shall meet or exceed the following design specifications:
 - .1 The camera shall operate on an open source; Linux-based platform and including a built-in web server.
 - .2 The camera shall be equipped with an IR-sensitive progressive scan megapixel sensor.
 - .3 The camera shall provide a removable IR-cut filter, providing day/night functionality.
 - .4 The camera shall be equipped with a varifocal lens with P-iris.
 - .5 The camera shall provide local video storage utilizing a microSD/microSDHC/microSDXC memory card expansion.
 - .6 The camera shall be manufactured with an IP66-rated in accordance with BS EN 60529, NEMA 4X-rated in accordance with ANSI/NEMA 250, and IK10-rated impact-resistant casing in accordance with, BS EN 62262.
 - .7 The camera shall provide a manual 3-axis (pan/tilt/rotation) positioning to allow adjustment for optimum camera rotation and placement.
 - .8 The camera shall provide options for clear and smoked lower dome.
- .2 The fixed dome network camera shall meet or exceed the following performance specifications:
 - .1 Illumination:
 - .1 The camera shall meet or exceed the following illumination specifications:
 - .2 HDTV 1080p 25/30 fps with WDR - forensic capture
 - .3 0.16 lux, F1.6 (colour)
 - .4 0.03 lux, F1.6, 0 lux with IR illumination on (B/W)
 - .5 HDTV 1080p 50/60 fps without WDR - forensic capture
 - .6 0.32 lux, F1.6 (colour)
 - .7 0.06 lux, F1.6, 0 lux with IR illumination on (B/W)
 - .8 Camera shall have Lightfinder Technology

.2 Resolution:

- .1 The camera shall be designed to provide at least two (2) video streams in HDTV 720p (1280x720) at up to 60 frames per second (60Hz mode) or 50 frames per second (50Hz mode) using H.264 or Motion JPEG (WDR inactive).
- .2 The camera shall be designed to provide at least two (2) video streams in HDTV 720p (1280x720) at up to 30 frames per second (60Hz mode) or 25 frames per second (50Hz mode) using H.264 or Motion JPEG (WDR active).
- .3 The camera shall be designed to provide two (2) individually cropped out view areas.
- .4 The camera shall support video resolutions including:
 - .1 1920x1080 (HDTV 1080p)
 - .2 1280x960
 - .3 1280x720 (HDTV 720p)
 - .4 1024x768
 - .5 1024x640
- .5 The camera shall provide both landscape format (4:3 and 16:9 aspect ratio) as well as corridor format (3:4 and 9:16 aspect ratio).

.3 Encoding:

- .1 The camera shall support the following video encoding algorithms:
 - .1 Motion JPEG encoding in a selectable range from 1 up to 25/30 frames per second.
 - .2 Motion JPEG encoding in a selectable range from 1 up to 50/60 frames per second.
 - .3 Baseline Profile H.264 encoding with motion estimation in up to 25/30 frames per second.
 - .4 Baseline Profile H.264 encoding with motion estimation in up to 50/60 frames per second.
 - .5 Main Profile H.264 encoding with motion estimation and CABAC in up to 25/30 frames per second.
 - .6 Main Profile H.264 encoding with motion estimation and CABAC in up to 50/60 frames per second.
 - .7 Support High Profile H.264 encoding with motion estimation up to 25/30 frames per second.

- .8 Support High Profile H.264 encoding with motion estimation up to 50/60 frames per second.
- .9 Support H.264 with automatic scene adaptive bitrate control.
- .2 The camera shall provide independently configured simultaneous H.264 and Motion JPEG streams.
- .3 The camera shall in H.264 support VBR for video quality adapted to scene content. To protect the network from unexpected bit rate spikes the camera shall support CBR or MBR.
- .4 The camera shall provide configurable compression levels.
- .5 Support standard baseline profile H.264 with motion estimation.
- .6 Support motion estimation in H.264/MPEG-4 Part 10/AVC.
- .7 The camera shall have Zipstream technology, an H.264 implementation that supports scene adaptive bitrate control with the following capabilities to lower bandwidth and storage.
- .8 Automatic dynamic region of Interest to reduce bitrate in unprioritized regions in order to lowering bandwidth and storage requirements.
- .9 Automatic dynamic group of pictures to lower bandwidth and storage requirements
- .10 Automatic dynamic frames per second to lower bandwidth and storage requirements
- .4 Transmission:
 - .1 The camera shall allow for video to be transported over:
 - .1 HTTP (Unicast)
 - .2 HTTPS (Unicast)
 - .3 RTP (Unicast & Multicast)
 - .4 RTP over RTSP (Unicast)
 - .5 RTP over RTSP over HTTP (Unicast)
 - .2 The camera shall support QoS to be able to prioritize traffic.
- .5 Image:
 - .1 The camera shall incorporate automatic and manual white balance.
 - .2 The camera shall incorporate an electronic shutter operating in the range of 1/66500 s to 1 s.

- .3 The camera shall incorporate capture mode with the following settings:
 - .4 25/30 fps (WDR-Forensic Capture) (50/60 Hz)
 - .5 50/60 fps (no WDR-Forensic Capture) (50/60 Hz)
- .6 The camera shall incorporate WDR-Forensic Capture functionality providing up to 120dB dynamic range.
- .7 The camera shall support manually defined values for:
 - .1 Colour level
 - .2 Brightness
 - .3 Sharpness
 - .4 Contrast
- .8 The camera shall incorporate a function for optimization of low light behavior.
- .9 The camera shall allow for rotation of the image in steps of 90°.
- .6 IR Illumination:
 - .1 The camera shall be equipped with three (3) built-in Optimized IR LEDs with adjustable illumination intensity.
 - .2 The IR LEDs shall have a range of up to 30 m.
 - .3 The IR LEDs shall emit light with a wavelength of 850 nm.
- .7 User Interface:
 - .1 Web Server:
 - .1 The camera shall contain a built-in web server making video and configuration available to multiple clients in a standard operating system and browser environment using HTTP, without the need for additional software.
 - .2 Optional components downloaded from the camera for specific tasks, e.g., Active X, shall be signed by an organization providing digital trust services, such as Verisign, Inc.
 - .2 Language Specification:
 - .1 The camera shall provide a function for altering the language of the user interface and shall include support for at least 10 different languages.

.8 IP Addresses:

- .1 The camera shall support both fixed IP addresses and dynamically assigned IP addresses provided by a DHCP server.
- .2 The camera shall allow for automatic detection of the camera based on UPnP and Bonjour when using a PC with an operating system supporting this feature.
- .3 The camera shall provide support for both IPv4 and IPv6.

.9 PTZ Functionality:

- .1 The camera shall:
 - .1 Provide Digital PTZ functionality.

.10 Event Functionality:

- .1 The camera shall be equipped with an integrated event functionality, which can be triggered by:
 - .1 Video motion detection
 - .2 Live stream accessed
 - .3 Day/night mode
 - .4 Camera tampering
 - .5 Manual trigger/virtual inputs
 - .6 PTZ functionality
 - .7 Embedded third party applications
 - .8 Edge storage disruption detection
- .2 Response to triggers shall include:
 - .1 Send notification, using HTTP, HTTPS, TCP, SNMP trap or email
 - .2 Send images, using FTP, HTTP, HTTPS, network share or email
 - .3 Send video clip, using FTP, HTTP, HTTPS, network share or email
 - .4 Send SNMP trap message
 - .5 Activate/Deactivate IR Illumination
 - .6 Recording to local storage and/or network attached storage

- .7 PTZ control functionality
 - .8 WDR mode
 - .3 The camera shall provide memory for pre & post alarm recordings.
 - .11 Edge Storage:
 - .1 The camera shall support continuous and event controlled recording to:
 - .1 Local memory added to the cameras microSD-card slot
 - .2 Network attached storage, located on the local network
 - .2 The camera shall be able to detect and notify Edge storage disruptions.
 - .12 Protocol:
 - .1 The camera shall incorporate support for at least IPv4/v6, HTTP, HTTPS, SSL/TLS, QoS Layer 3 DiffServ, TCP, ICMP, SNMPv1/v2c/v3 (MIB-II), RTSP, RTP, UDP, IGMP, RTCP, SMTP, FTP, DHCP, UPnP, ARP, DNS, DynDNS, SOCKS, SSH, NTP, CIFS/SMB, Bonjour.
 - .2 The SMTP implementation shall include support for SMTP authentication.
 - .13 Text Overlay:
 - .1 The camera shall:
 - .1 Provide embedded on-screen text with support for date & time, and a customer-specific text, camera name, of at least 45 ASCII characters.
 - .2 Provide the ability to apply privacy masks to the image.
 - .3 Allow for the overlay of a graphical image, such as a logotype, into the image.
 - .14 Security:
 - .1 The camera shall support the use of HTTPS and SSL/TLS, providing the ability to upload signed certificates to encrypt and secure authentication and communication of both administration data and video streams.
 - .2 The camera shall provide centralized certificate management, with both pre-installed CA certificates and the ability to upload additional CA certificates. The certificates shall be signed by an organization providing digital trust services.

- .3 The camera shall support IEEE 802.1X authentication.
- .4 The camera shall provide support for restricting access to pre-defined IP addresses only, so-called IP address filtering.
- .5 The camera shall restrict access to the built-in web server by usernames and passwords at three (3) different levels.
- .6 Device Hardening and Security
- .15 API Support:
 - .1 The camera shall be fully supported by an open and published API, which shall provide necessary information for integration of functionality into third party applications.
 - .2 The camera shall support relevant ONVIF profiles as defined by the ONVIF Organization.
- .16 Embedded Applications:
 - .1 The camera shall support the ACAP platform allowing the upload of third party applications into the camera.
- .17 Installation and Maintenance:
 - .1 The camera shall be supplied with Windows-based management software which allows the assignment of IP addresses, upgrade of firmware and backup of the cameras' configuration.
 - .2 The camera shall support the use of SNMP-based management tools according to SNMP v1, 2c & 3 / MIB-II.
 - .3 The camera shall allow updates of the software (firmware) over the network, using FTP or HTTP.
 - .4 The camera shall provide the ability to apply a rectangle of customer-defined number of pixels to the image, which can be used as a pixel counter identifying the size of objects in number of pixels.
 - .5 The camera shall store all customer-specific settings in a non-volatile memory that shall not be lost during power cuts or soft reset.
 - .6 The camera shall provide remote zoom and remote focus functionality.
- .18 Access Log:
 - .1 The camera shall provide a log file, containing information about the two hundred and fifty (250) latest connections and access attempts since the unit's latest restart. The file shall include information about the connecting IP addresses and the time of connecting.

- .2 Provide a connection list of all currently connected viewers. The file shall include information about connecting IP address, time of connecting and the type of stream accessed.
- .19 Camera Diagnostics:
 - .1 The camera shall be equipped with LEDs, capable of providing visible status information. LEDs shall indicate the camera's operational status and provide information about power, communication with receiver, the network status and the camera status.
 - .2 The camera shall be monitored by a watchdog functionality, which shall automatically re-initiate processes or restart the unit if a malfunction is detected.
 - .3 The camera shall send a notification when the unit has re-booted, and all services are initialized.
- .20 Hardware Interfaces:
 - .1 Network Interface:
 - .1 The camera shall be equipped with one (1) 10BASE-T/100BASE-TX PoE Fast Ethernet-port, using a standard connector and shall support auto negotiation of network speed (100 Mbit/s and 10 Mbit/s) and transfer mode (full and half duplex).
- .21 Enclosure:
 - .1 The camera shall:
 - .1 Be manufactured with an IP66-rated in accordance with BS EN 60529, NEMA 4X-rated in accordance with ANSI/NEMA 250, and IK10-rated impact-resistant casing in accordance with BS EN 62262.
 - .2 Be fitted with a dehumidifying membrane.
 - .3 Providing encapsulated electronics and captive screws.
- .22 Power:
 - .1 Power over Ethernet IEEE 802.3af/802.3at Type 1 Class 3
 - .1 Max: 10.8 W
 - .2 Typical 7.3 W
- .23 Environmental:
 - .1 Operate in a temperature range of -30 °C to +50 °C.

- .2 Operate in a humidity range of 10–100% RH (condensing).

2.3.3 Exterior PTZ Dome Network Camera:

- .1 The PTZ Dome network camera shall meet or exceed the following design specifications:
 - .1 The camera shall operate on an open source; Linux-based platform and including a built-in web server.
 - .2 The camera shall be equipped with an IR-sensitive progressive scan megapixel sensor.
 - .3 The camera shall provide a removable IR-cut filter, providing day/night functionality.
 - .4 The camera shall provide local video storage utilizing a SD/SDHC/SDXC memory card expansion.
 - .5 The camera shall incorporate Speed Dry technology to vibrate the dome in order to provide clear images in rainy weather and to simplify dome cleaning.
 - .6 The camera shall be manufactured with an IK08-rated in accordance with BS EN 62262, IP66-rated in accordance with BS EN 60529, and NEMA 4X-rated metal casing (aluminum), in accordance with ANSI/NEMA 250.
 - .7 The camera shall be manufactured with a repaintable metal casing.
 - .8 The camera shall incorporate a sharp dome design to provide an image up to 20° above the horizon without any loss of image quality.
 - .9 The camera shall incorporate a built-in laser that provides instant and correct focus.
 - .10 The laser shall be classified as of very low risk and safe under reasonably foreseeable use, in accordance with Class 1 standards in IEC/EN 60825-1.
 - .11 The camera shall be equipped with a motorized 30x optical zoom lens with auto-iris, providing a horizontal field of view between 2.36° - 66.7°.
- .2 The PTZ Dome network camera shall meet or exceed the following performance specifications:
 - .1 Illumination:
 - .1 The camera shall meet or exceed the following illumination specifications:
 - .1 0.15 lux at 30 IRE, F1.6 (colour)
 - .2 0.01 lux at 30 IRE, F1.6 (B/W)
 - .3 0.2 lux at 50 IRE, F1.6 (colour)

- .4 0.02 lux at 50 IRE, F1.6 (B/W)
- .2 Camera shall have Lightfinder Technology
- .2 Resolution:
 - .1 The camera shall be designed to provide at least two (2) video streams in HDTV 720p (1280x720) at up to 60 frames per second (60Hz mode) or 50 frames per second (50Hz mode) using H.264 or Motion JPEG.
 - .2 The camera shall be designed to provide at least two (2) video streams in HDTV 1080p (1920x1080) at up to 30 frames per second (60Hz mode) or 25 frames per second (50Hz mode) using H.264 or Motion JPEG.
 - .3 The camera shall support video resolutions including:
 - .1 1920x1080 (HDTV 1080p)
 - .2 1280x720 (HDTV 720p)
- .3 Encoding:
 - .1 The camera shall support the following video encoding algorithms.
 - .2 The camera shall in H.264 support VBR for video quality adapted to scene content. To protect the network from unexpected bit rate spikes the camera shall support CBR or MBR.
 - .3 The camera shall provide configurable compression levels.
 - .4 Support standard baseline profile H.264 with motion estimation.
 - .5 Support motion estimation in H.264/MPEG-4 Part 10/AVC.
 - .6 The camera shall have Zipstream technology, an H.264 implementation that supports scene adaptive bitrate control with the following capabilities to lower bandwidth and storage.
 - .7 Automatic dynamic region of Interest to reduce bitrate in unprioritized regions in order to lowering bandwidth and storage requirements.
 - .8 Automatic dynamic group of pictures to lower bandwidth and storage requirements
 - .9 Automatic dynamic frames per second to lower bandwidth and storage requirement
- .4 Transmission:
 - .1 The camera shall allow for video to be transported over.
 - .2 The camera shall support QoS to be able to prioritize traffic.

.5 Image:

- .1 The camera shall incorporate automatic and manual white balance.
- .2 The camera shall incorporate an electronic shutter operating in the range of 1/60000 s to 2 s.
- .3 The camera shall incorporate WDR-Forensic capture functionality providing up to 120dB dynamic range.
- .4 The camera shall provide backlight compensation functionality.
- .5 The camera shall support manually defined values for:
 - .1 Colour level
 - .2 Brightness
 - .3 Sharpness
 - .4 Contrast
- .6 The camera shall incorporate a function for optimization of low light behavior.
- .7 The camera shall incorporate a function for EIS for real-time image stabilization.

.6 User Interface:

.1 Web Server:

- .1 The camera shall contain a built-in web server making video and configuration available to multiple clients in a standard operating system and browser environment using HTTP, without the need for additional software.
- .2 Optional components downloaded from the camera for specific tasks, e.g., Active X, shall be signed by an organization providing digital trust services, such as Verisign, Inc.

.7 Language Specification:

- .1 The camera shall provide a function for altering the language of the user interface and shall include support for at least ten (10) different languages.

.8 IP Addresses:

- .1 The camera shall support both fixed IP addresses and dynamically assigned IP addresses provided by a DHCP server.

- .2 The camera shall allow for automatic detection of the camera based on UPnP and Bonjour when using a PC with an operating system supporting this feature.
- .3 The camera shall provide support for both IPv4 and IPv6.
- .9 PTZ Functionality:
 - .1 The camera shall:
 - .1 Provide more than two hundred and fifty-five (255) manually set preset positions.
 - .2 Provide a guard tour functionality which allows the dome to automatically move between selected presets using an individual speed and viewing time for each preset.
 - .3 Be able to record a custom PTZ tour, operated using an input device such as a joystick, mouse or keyboard, and then use and recall this as a guard tour.
 - .4 Be able to detect and automatically follow moving objects in the cameras field of view.
 - .5 Provide OSDI functionality.
 - .6 Be equipped with accurate pan-tilt functionality with a pan range of 360° (endless) and a tilt range of +20° to -90°.
 - .7 Provide pan speed between 0.05° - 700°/sec.
 - .8 Provide tilt speed between 0.05° - 500°/sec.
 - .9 Provide 30x optical zoom.
 - .10 Provide 12x digital zoom.
 - .11 Provide adjustable zoom speed.
- .10 Event Functionality:
 - .1 The camera shall be equipped with an integrated event functionality, which can be triggered by:
 - .1 Video Motion Detection
 - .2 Live Stream Accessed
 - .3 Manual Trigger/Virtual Inputs
 - .4 PTZ functionality
 - .5 Embedded third party applications

- .6 Edge storage disruption detection
 - .7 Shock Detected
 - .2 Response to triggers shall include:
 - .1 Send notification, using HTTP, HTTPS, TCP, SNMP trap or email
 - .2 Send images, using FTP, HTTP, HTTPS, network share or email
 - .3 Send video clip, using FTP, HTTP, HTTPS, network share or email
 - .4 Send SNMP trap message
 - .5 Day/Night Vision Mode
 - .6 Overlay Text
 - .7 Recording to local storage and/or network attached storage
 - .8 PTZ control functionality
 - .3 The camera shall provide memory for pre & post alarm recordings.
- .11 Edge Storage:
 - .1 The camera shall support continuous and event controlled recording to:
 - .1 Local memory added to the cameras SD-card slot
 - .2 Network attached storage, located on the local network
 - .2 The camera shall be able to detect and notify Edge storage disruptions.
- .12 Protocol:
 - .1 The camera shall incorporate support for at least IPv4/v6, HTTP, HTTPS, SSL/TLS, QoS Layer 3 DiffServ, TCP, ICMP, SNMPv1/v2c/v3 (MIB-II), RTSP, RTP, UDP, IGMP, RTCP, SMTP, FTP, DHCP, UPnP, ARP, DNS, DynDNS, SOCKS, SSH, NTP, CIFS/SMB, Bonjour.
 - .2 The SMTP implementation shall include support for SMTP authentication.
- .13 Text Overlay:
 - .1 The camera shall:

- .1 Provide embedded on-screen text with support for date & time, and a customer-specific text, camera name, of at least 45 ASCII characters.
 - .2 Provide the ability to apply up to thirty-two (32) individual 3D privacy masks to the image.
 - .3 Allow for the overlay of a graphical image, such as a logotype, into the image.
- .14 Security:
 - .1 The camera shall support the use of HTTPS and SSL/TLS, providing the ability to upload signed certificates to encrypt and secure authentication and communication of both administration data and video streams.
 - .2 The camera shall provide centralized certificate management, with both pre-installed CA certificates and the ability to upload additional CA certificates. The certificates shall be signed by an organization providing digital trust services.
 - .3 The camera shall support IEEE 802.1X authentication.
 - .4 The camera shall provide support for restricting access to pre-defined IP addresses only, so-called IP address filtering.
 - .5 The camera shall restrict access to the built-in web server by usernames and passwords at three (3) different levels.
 - .6 Device Hardening and Security.
- .15 API Support:
 - .1 The camera shall be fully supported by an open and published API, which shall provide necessary information for integration of functionality into third party applications.
 - .2 The camera shall support relevant ONVIF profiles as defined by the ONVIF Organization.
- .16 Embedded Applications:
 - .1 The camera shall support the ACAP platform allowing the upload of third party applications into the camera.
- .17 Installation and Maintenance:
 - .1 The camera shall be supplied with Windows-based management software which allows the assignment of IP addresses, upgrade of firmware and backup of the cameras' configuration.
 - .2 The camera shall support the use of SNMP-based management tools according to SNMP v1, 2c & 3 / MIB-II.

- .3 The camera shall allow updates of the software (firmware) over the network, using FTP or HTTP.
- .4 The camera shall provide the ability to apply a rectangle of customer-defined number of pixels to the image, which can be used as a pixel counter identifying the size of objects in number of pixels.
- .5 The camera shall store all customer-specific settings in a non-volatile memory that shall not be lost during power cuts or soft reset.
- .18 Access Log:
 - .1 The camera shall provide a log file, containing information about the two hundred and fifty (250) latest connections and access attempts since the unit's latest restart. The file shall include information about the connecting IP addresses and the time of connecting.
 - .2 Provide a connection list of all currently connected viewers. The file shall include information about connecting IP address, time of connecting and the type of stream accessed.
- .19 Camera Diagnostics:
 - .1 The camera shall be equipped with LEDs, capable of providing visible status information. LEDs shall indicate the camera's operational status and provide information about power, communication with receiver, the network status and the camera status.
 - .2 The camera shall be monitored by a Watchdog functionality, which shall automatically re-initiate processes or restart the unit if a malfunction is detected.
 - .3 The camera shall send a notification when the unit has re-booted, and all services are initialized.
- .20 Hardware Interfaces:
 - .1 Network Interface:
 - .1 The camera shall be equipped with one (1) 10BASE-T/100BASE-TX Fast Ethernet-port, RJ45 connector and shall support auto negotiation of network speed (100 MBit/s and 10 MBit/s) and transfer mode (full and half duplex).
- .21 Enclosure:
 - .1 The camera shall:
 - .1 Be manufactured with an IK08-rated in accordance with BS EN 62262, IP66-rated in accordance with BS EN 60529 and NEMA 4X-rated metal casing (aluminum) in accordance with ANSI/NEMA 250.

- .2 Be manufactured with a polycarbonate clear dome.
 - .3 Be manufactured with a repaintable metal casing.
 - .22 Power:
 - .1 PoE+ IEEE 802.3at Type 2 Class 4
 - .23 Environmental:
 - .1 Operate in a temperature range of:
 - .1 30 W midspan -20 °C to 50 °C
 - .2 60 W midspan -50 °C to 50 °C
 - .3 Maximum temperature (intermittent): 60 °C
 - .4 The camera shall be equipped with cold weather temperature control allowing camera start-up at temperatures down to -40 °C.
 - .5 Operate in a humidity range of 10–100% RH (condensing).
- 2.3.4 Interior 1080p PTZ Dome Network Camera:
 - .1 The PTZ dome network camera shall meet or exceed the following design specifications:
 - .1 The camera shall operate on an open source; Linux-based platform and including a built-in web server.
 - .2 The camera shall be equipped with an IR-sensitive progressive scan sensor.
 - .3 The camera shall provide a removable IR-cut filter, providing day/night functionality.
 - .4 The camera shall be equipped with a lens providing autofocus and autoiris.
 - .5 The camera shall provide local video storage utilizing a SD/SDHC memory card expansion.
 - .6 The camera shall be manufactured with an IP51-rated aluminum and plastic casing with a polycarbonate dome, in accordance with BS EN 60529.
 - .7 The camera shall provide options for clear and smoked lower dome.
 - .2 The PTZ network camera shall meet or exceed the following performance specifications:
 - .1 Illumination:
 - .1 The camera shall meet or exceed the following illumination specifications:

- .1 0.7 lux in colour
 - .2 0.08 lux in B/W
- .2 Resolution:
 - .1 Be designed to provide video streams in HDTV 1080p (1920x1080) resolution, up to 30/25 frames per second using H.264 or Motion JPEG.
 - .2 The camera shall support video resolutions including:
 - .1 1920x1080 (HDTV 1080p)
 - .2 1280x720 (HDTV 720p)
 - .3 800x450
 - .4 480x270
 - .5 320x180
- .3 Encoding:
 - .1 The camera shall support the following video encoding algorithms:
 - .1 Motion JPEG encoding in a selectable range from 1 up to 25/30 frames per second in all resolutions.
 - .2 Baseline Profile H.264 encoding with motion estimation in up to 25/30 frames per second.
 - .3 Main Profile H.264 encoding with motion estimation and CABAC in up to 25/30 frames per second.
 - .4 High Profile H.264 encoding with motion estimation in up to 25/30 frames per second.
 - .2 The camera shall provide independently configured simultaneous H.264 and Motion JPEG streams.
 - .3 The camera shall in H.264 support VBR for video quality adapted to scene content. To protect the network from unexpected bit rate spikes the camera shall support CBR or MBR.
 - .4 The camera shall provide configurable compression levels.
 - .5 Support motion estimation in H.264/MPEG-4 Part 10/AVC.
 - .6 The camera shall have Zipstream technology, an H.264 implementation that supports scene adaptive bitrate control with the following capabilities to lower bandwidth and storage.

- .7 Automatic dynamic Region of Interest to reduce bitrate in unprioritized regions in order to lowering bandwidth and storage requirements.
- .8 Automatic dynamic Group of Pictures to lower bandwidth and storage requirements
- .9 Automatic dynamic Frames per Second to lower bandwidth and storage requirement
- .4 Transmission:
 - .1 The camera shall allow for video to be transported over:
 - .1 HTTP (Unicast)
 - .2 HTTPS (Unicast)
 - .3 RTP (Unicast & Multicast)
 - .4 RTP over RTSP (Unicast)
 - .5 RTP over RTSP over HTTP (Unicast)
 - .2 The camera shall support QoS to be able to prioritize traffic.
- .5 Image:
 - .1 The camera shall incorporate automatic, manual and one-click white balance.
 - .2 The camera shall incorporate an electronic shutter operating in the range of:
 - .1 1/8000 s to 1/30 s (60 Hz)
 - .2 1/8000 s to 1/25 s (50 Hz)
 - .3 The camera shall incorporate Wide Dynamic Range:
 - .1 Dynamic contrast.
 - .4 The camera shall provide backlight compensation functionality.
 - .5 The camera shall support manually defined values for:
 - .1 Colour level
 - .2 Brightness
 - .3 Sharpness
 - .6 The camera shall incorporate a function for optimization of low light behavior.

- .6 Audio:
 - .1 The camera shall support two-way full duplex audio:
 - .1 Input sources
 - .2 External microphone
 - .3 External line device
 - .4 Output sources
 - .5 External line device
 - .6 Encoding
 - .2 The camera shall support:
 - .1 AAC LC at 8/16 kHz
 - .2 G.711 PCM at 8 kHz
 - .3 G.726 ADPCM at 8 kHz
- .7 User Interface:
 - .1 Web Server:
 - .1 The camera shall contain a built-in web server making video and configuration available to multiple clients in a standard operating system and browser environment using HTTP, without the need for additional software.
 - .2 Optional components downloaded from the camera for specific tasks, e.g., Active X, shall be signed by an organization providing digital trust services, such as Verisign, Inc.
- .8 Language Specification:
 - .1 The camera shall provide a function for altering the language of the user interface and shall include support for at least 10 different languages.
- .9 IP Addresses:
 - .1 The camera shall support both fixed IP addresses and dynamically assigned IP addresses provided by a DHCP server.
 - .2 The camera shall allow for automatic detection of the camera based on UPnP and Bonjour when using a PC with an operating system supporting this feature.
 - .3 The camera shall provide support for both IPv4 and IPv6.

.10 PTZ Functionality:

.1 The camera shall:

- .1 Provide up to one hundred (100) preset positions.
- .2 Provide e-flip functionality, which shall automatically rotate the image 180° electronically when following a moving object passing under the camera.
- .3 Provide true or simulated continuous pan movements over 360°.
- .4 Provide Pan: 360° (with Auto-flip), 1.8° - 100°/s
- .5 Provide Tilt: 180°, 1.8° – 100°/s
- .6 Provide 12x optical zoom
- .7 Provide 10x digital zoom

.11 Event Functionality:

.1 The camera shall be equipped with an integrated event functionality, which can be triggered by:

- .1 Video motion detection
- .2 Audio detection
- .3 Live stream accessed
- .4 Camera tampering
- .5 Fan malfunctioning
- .6 Manual trigger/virtual inputs
- .7 PTZ functionality
- .8 External input
- .9 Embedded third party applications
- .10 Edge storage disruption detection

.2 Response to triggers shall include:

- .1 Send notification, using HTTP, HTTPS, TCP or email.
- .2 Send images, using FTP, HTTP, HTTPS, network share or email

- .3 Send video clip, using FTP, HTTP, HTTPS, network share or email
 - .4 Send SNMP trap message
 - .5 Recording to local storage and/or network attached storage
 - .6 Activating external output
 - .7 Play audio clip
 - .8 PTZ control functionality
 - .9 Day/Night Vision Mode
 - .10 Overlay text
- .3 The camera shall provide memory for pre & post alarm recordings.
- .12 Edge Storage:
 - .1 The camera shall support continuous and event controlled recording to:
 - .1 Local memory added to the cameras SD-card slot
 - .2 Network attached storage, located on the local network
 - .2 The camera shall be able to detect and notify edge storage disruptions.
- .13 Protocol:
 - .1 The camera shall incorporate support for at least IPv4/v6, HTTP, HTTPS, SSL/TLS, QoS Layer 3 DiffServ, TCP, ICMP, SNMPv1/v2c/v3 (MIB-II), RTSP, RTP, UDP, IGMP, RTCP, SMTP, FTP, DHCP, UPnP, ARP, DNS, DynDNS, SOCKS, SSH, NTP, CIFS/SMB, Bonjour.
 - .2 The SMTP implementation shall include support for SMTP authentication.
- .14 Text Overlay:
 - .1 The camera shall:
 - .1 Provide embedded on-screen text with support for date & time, and a customer-specific text, camera name, of at least forty-five (45) ASCII characters.
 - .2 Provide the ability to apply privacy masks to the image.
 - .3 Allow for the overlay of a graphical image, such as a logotype, into the image.

.15 Security:

- .1 The camera shall support the use of HTTPS and SSL/TLS, providing the ability to upload signed certificates to encrypt and secure authentication and communication of both administration data and video streams.
- .2 The camera shall provide centralized certificate management, with both pre-installed CA certificates and the ability to upload additional CA certificates. The certificates shall be signed by an organization providing digital trust services.
- .3 The camera shall support IEEE 802.1X authentication.
- .4 The camera shall provide support for restricting access to pre-defined IP addresses only, so-called IP address filtering.
- .5 The camera shall restrict access to the built-in web server by usernames and passwords at three (3) different levels.
- .6 Device Hardening and Security:
 - .1 Camera supplier shall have published hardening guide detailing:
 - .1 Firmware management
 - .2 User and password management
 - .3 Permissions management
 - .4 Configure basic network settings
 - .5 Disable audio
 - .6 Enabling encryption
 - .7 Ability to disable
 - .8 Discover protocols
 - .9 Bonjour
 - .10 UPnP
 - .11 QoS
 - .12 SOCKS
 - .13 Telnet
 - .14 SSH
 - .15 Link-local address

.16 API Support:

- .1 The camera shall be fully supported by an open and published API, which shall provide necessary information for integration of functionality into third party applications.
- .2 The camera shall support relevant ONVIF profiles as defined by the ONVIF Organization.

.17 Embedded Applications:

- .1 The camera shall support the ACAP platform allowing the upload of third party applications into the camera.

.18 Installation and Maintenance:

- .1 The camera shall be supplied with Windows-based management software which allows the assignment of IP addresses, upgrade of firmware and backup of the cameras' configuration.
- .2 The camera shall support the use of SNMP-based management tools according to SNMP v1, 2c & 3 / MIB-II.
- .3 The camera shall allow updates of the software (firmware) over the network, using FTP or HTTP.
- .4 The camera shall provide the ability to apply a rectangle of customer-defined number of pixels to the image, which can be used as a pixel counter identifying the size of objects in number of pixels.
- .5 The camera shall store all customer-specific settings in a non-volatile memory that shall not be lost during power cuts or soft reset.

.19 Access Log:

- .1 The camera shall provide a log file, containing information about the two hundred and fifty (250) latest connections and access attempts since the unit's latest restart. The file shall include information about the connecting IP addresses and the time of connecting.
- .2 Provide a connection list of all currently connected viewers. The file shall include information about connecting IP address, time of connecting and the type of stream accessed.

.20 Camera Diagnostics:

- .1 The camera shall be equipped with LEDs, capable of providing visible status information. LEDs shall indicate the camera's operational status and provide information about power, communication with receiver, the network status and the camera status.

- .2 The camera shall be monitored by a Watchdog functionality, which shall automatically re-initiate processes or restart the unit if a malfunction is detected.
- .3 The camera shall send a notification when the unit has re-booted, and all services are initialized.
- .21 Hardware Interfaces:
 - .1 Network Interface:
 - .1 The camera shall be equipped with one (1) 100BASE-TX Fast Ethernet-port, using a standard male RJ45 connector and shall support auto negotiation of network speed (100 MBit/s and 10 MBit/s) and transfer mode (full and half duplex).
 - .2 Multifunctional connector
 - .2 The camera shall, by using a “multi wire cable”, provide connectivity for:
 - .1 Digital I/O(alarm) ports. These ports shall be configurable as input or output, and when configured as input respond to NO or NC dry contacts.
 - .2 One (1) line/mic input and one (1) line out.
 - .3 AC power
 - .4 DC power
- .22 Enclosure:
 - .1 The camera shall be manufactured with an IP51-rated aluminum and plastic casing with a polycarbonate dome, in accordance with BS EN 60529 standard.
- .23 Power:
 - .1 PoE IEEE 802.3af/802.3at Type 1 Class 3
 - .2 20-24 V AC, max. 22 VA, typical 11 VA
 - .3 20-28 V DC, max. 13.5 W, typical 6 W
- .24 Environmental:
 - .1 Operate in a temperature range of 0 °C to +50 °C.
 - .2 Operate in a humidity range of 15–85% RH (non-condensing).
- .25 Enclosures, Mounts & Supports:
 - .1 Enclosures:

- .1 Cameras shall be installed in lockable enclosures capable of being pendant or pole mounted on a wall, in a corner, or fitted into a drop ceiling depending on the specific application.
- .2 Indoor fixed cameras shall be mounted in low profile ceiling mount enclosures for installations in fixed and drop ceilings, and wall mounted enclosures for installations in service areas.
- .3 Outdoor enclosures shall be equipped with a thermostatically controlled heater and blower.
- .4 All connections shall be contained within secure enclosures. If external to equipment and enclosures, cabling shall be run in rigid or flexible conduit.
- .2 Mounts/Supports:
 - .1 For outdoor cameras mounted on buildings and structures provide mounts/supports to match the camera enclosures. Incorporate a camera mount with an adjustable head. Video displacement, as viewed on a monitor,
 - .2 To guard against potential vandalism in low ceiling public areas, the camera assemblies shall be capable of withstanding an 80kg person grabbing hold of the enclosure and attempting to pull it free from its mount without the aid of tools or weapons. In addition, it shall not be possible to crack, penetrate or damage an enclosure in any way without the aid of tools or weapons. Provide detail how the proposed enclosure and mounting technique shall meet this requirement.
 - .3 Provide indoor camera mounts/supports fabricated and finished to match the camera enclosures and equipped with an adjustable head. It shall be possible to lock the position of the head after adjustments are complete.
- .26 Power Supplies:
 - .1 All indoor cameras shall be powered via PoE (Power over Ethernet)
- .27 Outdoor Camera Power Supplies:
 - .1 All camera power supplies shall be connected to UPS and emergency power.
 - .2 An outdoor rated lock shall be supplied and installed on the power supply cabinet to protect the unit from unauthorized access and tampering.
 - .3 Three (3) sets of keys shall be provided for the outdoor power supply lock.

- .4 If multiple locks are supplied, they should be keyed alike.
- .5 For outdoor cameras provide local 120V AC emergency power to all camera power supplies and install within fifteen (15) meters of the camera. All efforts shall be made to install the power supply on the inside of the building where possible.
- .28 Tamper Alarms:
 - .1 All security equipment cabinets (including camera power supply cabinets) shall be equipped with sensors monitored by the ACS, which detect and remotely annunciate their opening.

2.4 **DISPLAY AND CONTROL EQUIPMENT**

2.4.1 Central Management Servers:

- .1 The computer hardware described in this section shall be used to run the Central Management System Server software used for storage of the VSS.
- .2 Specifications for these servers shall be in compliance with the software developers recommended requirements for all software applications that are installed on the system. Servers provided shall match at minimum the Supplier's minimum recommended specifications at time of procurement, in addition to the minimums noted below.
- .3 Operating System:
 - .1 Microsoft Windows Enterprise Server (latest version) or approved equivalent.
- .4 Database:
 - .1 SQL Server (latest version) or approved equivalent.
- .5 Hard Disk Drive:
 - .1 Hot swappable, 250 GB or more. It shall be possible to expand this capacity by upgrading the fixed disk or through additional disk drives.
- .6 Redundancy:
 - .1 minimum of RAID 1 (operating system), RAID 5 (storage array).
- .7 Accelerated Video Card
- .8 Dual Network Interface Card:
 - .1 10/100/1000 Mbps Ethernet Fast Ethernet Controller, IEEE Compliance - 802.3, 802.3u, 802.3x, 802.3z, Compatible with Cat 6 cabling.
- .9 DVD:
 - .1 DVD+/-RW drive

2.4.2 Keyboard Controller

- .1 The control unit joystick shall include integral camera zoom lens control, allowing one hand operation.
- .2 The controller shall provide, but not be limited to, selection of the following remote camera site functions:
 - .1 Joystick control of pan/tilt/zoom
 - .2 Focus, and iris lens control
 - .3 Auto pan, auto tour
 - .4 Selection of up to ninety-nine (99) pre-positioned scenes per camera.
- .3 Mechanical Specifications
 - .1 Controls:
 - .1 Momentary push buttons.
 - .2 Pan/tilt/zoom joystick.
 - .3 Control unit shall be supplied as a desktop model.
 - .2 Operating Temperature: 0°C - +40°C.
 - .3 Humidity: 10 to 80% relative, non-condensing

2.4.3 Video System Storage

- .1 Supply, install, and configure network storage devices.
- .2 Recorders and associated storage shall be deployed to data center rooms only. Include all current software, firmware and licenses.
- .3 The storage system shall:
 - .1 Support storage of video images from cameras that terminate in remote communications room plus spare capacity and event storage capacity as required in OS.
 - .2 Support record and playback of H.264 video streams to all monitoring locations from any or all cameras simultaneously.
 - .3 Be IP attached via 10GBaseT PoE+ Ethernet using commonly available networking configurations and equipment.
 - .4 Conform to and be deployable in industry standard 19" rack configurations. Mounting of equipment on shelves is not acceptable.
 - .5 Storage system shall support high availability with no single point of failure causing loss of data or interrupting access to data:

- .1 Protect data for up to three (3) simultaneous disk failures with no loss of data or loss of access to data.
- .2 Protect against loss of a storage appliance or controller with no loss of data or loss of access to data.
- .3 Protect against loss of a networking path between servers and storage, including network interface card, cables and switches, with the ability to dynamically reroute IO activity to an alternate network path.
- .6 Support dynamic replacement of hardware components without interrupting access to data:
 - .1 Support the ability to replace disk drives without the need to interrupt data access.
 - .2 Provide redundant power supplies to support the ability to replace power supplies without the need to interrupt data access.
 - .3 Support the ability to replace fan modules without the need to interrupt data access.
 - .4 Support the ability to replace entire appliances without the need to interrupt data access.
 - .5 Support the ability to replace network switches without the need to interrupt data access.
- .7 Support dynamic management features to insure continuous data access:
 - .1 Be expandable by the addition of disk capacity without the need to interrupt data access.
 - .2 Be expandable by the addition of processing capacity without the need to interrupt data access.
 - .3 Be expandable by the addition of network bandwidth without the need to interrupt data access.
- .8 Be scalable in capacity to four (4) petabytes.
- .9 Provide capacity and performance usage statistics.
- .10 Allow dynamic configuration of volumes.
- .11 Provide administrator security controls.
- .12 Detect controller and drive failures and shall export and annunciate / notify the monitoring locations defined in the OS, via the ACS client application. The system shall also provide a local audible alarm.
- .4 Include SNMP management support.

2.4.4 Rack Mounting:

- .1 All equipment to be located within termination equipment cabinets shall be rack mounted.
- .2 Equipment to be security fastened in racks with supplier supplied or approved rails and mounting fasteners.

2.4.5 Information Backup/Retrieval:

- .1 The system server(s) shall be capable of transferring all programmed data and transactional history to an appropriate archive storage media. All programmed data shall be restorable from the back-up media in case of system hardware failure.

2.4.6 Communication Rates:

- .1 The system shall be capable of supporting 1GB Ethernet communications rates to client workstations.

2.4.7 Printers:

- .1 The system server shall support report printers. The report printers shall be network printers connected to the Security local area network.

2.4.8 Communication Ports:

.1 Network Ports:

- .1 The system server shall support the use of Ethernet networks as the communications path between the server and end devices, and other systems for the purpose of integration. This communications path shall be the same network used for communications between the system server and the operator workstations. The communications between the system server and the field devices shall be encapsulated in a TCP/IP network/transport layer.

.2 Port Name:

- .1 Each communications port shall be addressed with the system by a unique name.

.3 Port Description:

- .1 The system server shall provide the ability to add a communication port description to each port configuration. There shall be no limit to the amount of text that can be used to describe the communications port.

.4 On-line/Off-line:

- .1 The system server shall allow the operator to put a communications port on-line or off-line. If the communications port is placed off-line, the system server shall not use the port to communicate to field device configured on that port. If the communications port is put on-line, the system server shall use the port to communicate to field devices configured on that port.

.5 Communications Failure:

- .1 If the communications port is on a network device, such as a terminal server, the system server shall indicate if there is a loss of communications to that network address. All field units connected to that network address should also be reported as being in communications failure.
- .2 To allow for network delays, the system server shall allow the system administrator to define a wait time before annunciation of a communications failure.
- .3 The system server shall provide the administrator the ability to set a reconnect retry period. This is the time period the system shall wait before attempting to re-establish communications with a network port which is in communications failure.
- .4 Configuration of the remote communications port characteristics, i.e. baud rate, parity, error-checking etc. shall be done either on the network device or through network management tools. The configuration is not required to be executed by the Central Management System.
- .5 IP Address:
 - .1 For communications ports on a network device, the system server shall allow the operator to define the IP address of the device, as well as the local port address, to which the remote field devices are connected.

2.4.9 RAID

- .1 The system shall support a RAID that provide high performance and fault tolerance. The RAID array shall appear to the System Server as a single storage unit or as multiple logical units.
- .2 RAID 5:
 - .1 The System Server shall support the use of RAID level 5. RAID level 5 provides complete data redundancy.

2.4.10 Redundancy

- .1 Through the use of third party software and associated hardware, the system server shall support a second system server for redundant capability. During normal operation, data shall be written to either server and shall be mirrored to its counterpart in a bi-directional mirroring process.
- .2 If a failure is detected, it shall be verified across both the network and the mirrored data links through the ESB. When the failure has been verified, the surviving server shall assume the functions and identities of the failed server without having to sacrifice its own identities or functions. Applications originally running on the failed server are restarted on the surviving server.
- .3 Shall send alerts via SMS or email.

2.5 TECHNICAL REQUIREMENTS – SOFTWARE

2.5.1 General

- .1 Provide all required hardware and software required to allow for complete system installation and in compliance with the scope required to add the additional cameras.
- .2 The System shall be an IP based solution which shall include the following functions:
 - .1 Live Viewing
 - .2 Recording & Playback
 - .3 Support of system integration where needed for these new cameras to operate as presently on site.
 - .4 Interactive Maps
 - .5 Centralized Administration
 - .1 Device discovery
 - .2 User groups
 - .3 Multiple administrator users
 - .4 System diagnostics
- .3 Virtual Matrix:
 - .1 Enable CCTV keyboard control similar to matrix switcher.
- .4 Analytics tools such as:
 - .1 Video Motion Detection
 - .2 Directional Video Motion Detection
 - .3 Abandoned Object Detection
 - .4 Virtual Tripwire
 - .5 Shape-based detection
 - .6 Theft detection
- .5 Remote Video Management:
 - .1 The system shall work with a single remote software program that enables video management from a remote computer.
- .6 Password Protection:

- .1 To limit user access to the system, password log-on protection for up to sixty-four (64) users shall be provided. To increase user flexibility or restriction, eight (8) programmable levels of priority shall be provided for each user's password.
- .7 On-screen Monitor Display:
 - .1 Each system output shall be configured to provide on-screen display of site number and title, video input number and title, time, date, camera and monitor status.
 - .2 The monitor display shall show the keyboard number or user number in situations where a higher priority keyboard or user has control of a camera or has locked a camera.
- .8 Time Synchronization:
 - .1 Synchronize all video system devices to IP Ethernet NTP for integration with other network devices.
- .9 Communication Ports:
 - .1 The system shall be configured to provide external connection to computers, printers, alarm interface units, recorder interface units, and additional system control keyboards.
- .10 Macros:
 - .1 Program and configure macro commands per keyboard as required.
- .11 Alarms:
 - .1 The matrix switcher/controller shall be configured to provide e-mail messaging of specific alarms and diagnostic alarms when activated.
- .12 Activity Logging:
 - .1 The system shall have activity logging and reporting to an IP network PC used for setup and file storage.
- .13 Provide all programming and configuration of Tours, Salvo's and camera patterns as required.
- .14 Recorder Control:
 - .1 The system shall provide for remote management to directly control important video management system functions such as play, stop, pause, record, rewind, and fast-forward.
- 2.5.2 Server Applications:
 - .1 Windows Server latest version, or as specified by VSS manufacturer.
 - .2 All compatible necessary hardware/software drivers

- .3 RAID management and diagnostics
- .4 DVDRW/CDRW management software for video and data back-ups.
- .5 Lightweight antivirus software ideal for storage intensive servers

2.5.3 VSS (Video Surveillance System):

- .1 The VSS shall have the capability of viewing live and recorded video of all field cameras from all sites simultaneously.
- .2 The term VSS and VMS (Video Management System) are interchangeable and shall be referred to when addressing the Video Surveillance requirements herein.
- .3 As a minimum the VSS shall be capable of quick analysis of thousands of recordings using Events triggering, Video Motion Detection, Time, Date and Camera search criteria, saving valuable incident search time and the ability to playback recordings from remote sites without interrupting current recordings.
- .4 NVR recordings shall have the ability to be accessed simultaneously locally or remotely using the Video Management System Client Software by any number of users. It shall be possible to assign user rights and privileges to each user to restrict access to authorized users.
- .5 NVR management and configuration shall be performed using a client application that forms part of the digital VSS.
- .6 NVR recorded video shall not have the ability to be altered, ensuring the audit trail is intact for evidential purposes. Recordings exported from the system shall be protected by a watermark and a digital signature.
- .7 VSS shall work with other 3rd party IP components, e.g., cameras, monitors, keyboards and PTZ units. The system shall enable users to control PTZ cameras when viewing live video. In addition, administrators can have the capability of configuring custom commands and pre-sets for each PTZ camera and also set user priorities and privileges by preventing other users from controlling it.
- .8 PTZ cameras shall be controlled by using an external joystick, or directly in the video pane from the VSS using a mouse. The camera to be easily panned and tilted in different directions at variable speeds by simply moving the mouse and zoomed by clicking.
- .9 The VSS operator shall have the ability select any of the encoded camera video streams, live or recorded and manually link to a display monitor.
- .10 The VSS shall support motion detect, binary and video loss alarms and to also trigger relays and send IP triggers when an alarm occurs.
- .11 The ability to playback simultaneously recordings from a minimum of eight (8) cameras.
- .12 The VSS Shall come equipped with an interactive facility and site mapping graphical user interface to allow for all site locations including camera and alarm positions accurately plotted.

- .13 The Client Monitoring Application shall allow level access control per user to every camera.
- .14 Several users shall have the ability to simultaneously view, manage and record across the network from any point on the network.
- .15 The video management system software shall provide the ability to cut video streams from remote client workstation at any time.

2.5.4 VSS Client Application:

- .1 The VSS Client Application shall consist but not be limited to the following tasks:
 - .1 Live camera viewing,
 - .2 Live PTZ control
 - .3 NVR Playback
 - .4 Alarm event processing,
 - .5 Device configuration,
 - .6 System administration,
 - .7 Video and event archiving,
 - .8 Mapping
 - .9 Event reporting.
- .2 The Client Application shall perform all the necessary standard monitoring functions simultaneously without interfering with any of the System Server operations
- .3 The Client Application shall support any form of IP network connectivity, including LAN, WAN, VPN, Internet, and WLAN technologies.
- .4 All Client Applications shall support IP Multicast and Unicast (UDP) video streaming.
- .5 Client Application shall provide an authentication mechanism, which verifies the validity of the user.
- .6 Each workstation shall be able to use a CCTV keyboard controller or PC keyboard/mouse that can control the entire set of cameras throughout the system, even if the system consists of motorized cameras produced by different Suppliers.
- .7 The Client Applications shall allow for multiple instances to run simultaneously, by one or multiple users on separate workstations.
- .8 The Client applications shall provide administrators with the ability to block video streams to lower level users.
- .9 The Client Application graphical user interface shall include the following tasks and functions:

.10 Live Viewing:

- .1 Display live video from any encoded camera on the workstation video panes.
- .2 Display live video from any encoded camera on external monitors.
- .3 Capability to view a set of cameras in succession.
- .4 Perform camera to monitor call up, PTZ, focus, edit and enable pre-sets and perform customized actions using internal or external keyboard controller.
- .5 Record live video and take snapshots of images.
- .6 Performance
- .7 The Live Viewer shall allow live viewing of video streams.
- .8 Multiple users shall be able to view the same camera sequence simultaneously; users are able to pause the sequence without affecting other viewers.
- .9 Shall enable live monitoring of one (1) to sixteen (16) video streams simultaneously on a single monitor and one (1) to thirty-two (32) video streams simultaneously on a dual monitor.
- .10 Shall display all cameras, monitors and camera sequences in the system.
- .11 Shall allow operators to control including pause, play, skip forwards, and skip backwards camera sequences.
- .12 Shall have the option to perform drag and drop functions to an external monitor (decoder) or workstation to view a camera.
- .13 The operator shall be able to control camera pan-tilt-zoom, iris, focus, call pre-sets and configure integrated PTZ dome features by using an external or internal application keyboard controller.
- .14 Each operator shall be assigned a PTZ priority to allow a prioritization between operators on who has control over a camera.
- .15 Users shall be able to take snapshots of live video feeds in the Live Viewer and be able to save or print the snapshots.
- .16 Users shall be able to control PTZ functions with a CCTV style joystick using the workstation.
- .17 Shall have the ability to view minimum of sixteen (16) simultaneous live video streams from the DVSS Client Application in two (2) windows using dual head monitors. Live and recorded video to be viewed at the same time.
- .18 The operator shall be able to start/stop recording on any camera in the system.

- .19 The video management system software shall provide the ability for Guard Room operators to stop video streams from displaying on a specific or group of remote client workstation at any time via an operator initiated command. Should the selected client workstation(s) be viewing the video stream at the time a Guard Room operator activates this feature, the remote client workstation(s) shall stop displaying the selected video stream, and automatically change the display to a black screen.
- .11 NVR Playback and Video Event Archiving:
 - .1 Search through past recorded footage.
 - .2 Playback recordings.
 - .3 Save snapshots and recordings to file as evidence on workstation and export to DVD.
 - .4 View thumbnails of a fixed number of images, distributed at equal intervals across the current range of the timeline.
 - .5 Export and protect recordings
 - .6 Find motion in sections of recorded footage.
 - .7 View a thumbnail image of each time that the motion profile in the current timeline range exceeds the threshold.
 - .8 Shall allow for multiple recording schedules to be assigned to a single camera. Each schedule shall have the capability to vary parameters such as, Video quality, Recording mode and Time and date settings.
 - .9 The NVR shall have the ability to dynamically change recording quality settings on alarm and events.
 - .10 The NVR shall keep a log and compile statistics on disk space usage.
 - .11 The NVR shall have the capacity to schedule backups of the video archives, with associated database events to an appropriate device.
 - .12 The NVR shall keep log of the system events for maintenance purposes.
 - .13 Shall support video playback of any time span.
 - .14 Shall enable operators to choose from a number of possible camera display patterns ranging from one (1) tile to sixteen (16) tiles patterns.
 - .15 Shall allow the operator to select between synchronous playbacks of all selected video streams.
 - .16 Shall allow the operator to simultaneously view the same camera in multiple tiles at different time intervals.

- .17 Shall be able to query archived video from one or multiple archived video servers using various search criteria, including but not limited to, time, date, camera, site and past alarms.
- .18 Shall allow operators to define an area of the video field in which to search for motion as well as define the amount of motion that shall trigger search results.
- .19 Shall allow operators to validate if a digitally signed video sequence has been tampered with or not.
- .20 Shall provide still image export to JPEG and BMP format with Date and Time stamp on the image.
- .21 Shall provide tools to export video sequences in standard video formats, such as AVI and ASF.
- .22 Shall provide tools to export video sequences and any required video player on DVD.
- .23 Shall support playback of archived video to NTSC system monitors.
- .12 Alarm Processing:
 - .1 View and acknowledge all alarms that have occurred on sites.
 - .2 Respond to alarms as specified by an administrator
 - .3 Play back recordings associated with alarms.
 - .4 View live video of the scene where an alarm has occurred.
 - .5 View a thumbnail image for each alarm in the current timeline range.
 - .6 Display a map of the site where an alarm has occurred
 - .7 The VSS shall receive all incoming events (motion detection, IP trigger) in the system and take appropriate actions based on user-defined event/action relationships.
 - .8 The VSS shall receive and log all alarm events and system generated events.
 - .9 The VSS shall have the capability to automatically execute any necessary actions in response to generated events.
 - .10 The VSS shall use an event and timestamp database for advanced search of video archives.
 - .11 The VSS shall provide the functionality of storing of video streams based on triggering events such as, Digital motion detection, Digital input activation or on a schedule.

- .12 Each entry in a sequence shall have the capacity to trigger camera pre-sets, patterns or auxiliaries.
- .13 The Client Application shall have Advanced Alarm Management, which shall have the ability to assign alarms and procedures to specific users or user.
- .13 Mapping:
 - .1 Client Application shall support Mapping functionality, where digital maps are used to represent the physical location of cameras, alarms, NVR's and other devices throughout the entire system.
 - .2 Operators shall have the ability to double click on a camera map link to display live video to be displayed on the workstation on the first available monitor.
 - .3 Maps to automatically display alarm activity of a particular site.
 - .4 Administrators shall have the ability to create the following:
 - .1 Creating multiple maps of sites and linking sub maps to sites.
 - .2 Adding and modifying Alarm sources to maps
 - .3 Adding and modifying cameras to maps, including editable field of view illustrations
 - .4 Dual workstation display capabilities
 - .5 System Administration
- .14 Provide as part of their solution all associated cost for the supply, install, configuration, and coordination of the quantity of Client Licenses and Workstations required by OS.
- .15 Black Screen:
 - .1 For monitoring of video at the primary monitoring location defined in the OS, the system shall be configured as a "Black Screen" system such that incoming alarms shall be displayed on a block (group) of monitors with which they are associated. The first incoming alarm is displayed on the first (lowest numbered) monitor of the block. The second alarm is displayed on the next lowest numbered monitor of the block, and so on. When all monitors in a given block are displaying alarm video signals, all subsequent alarms shall be placed in sequence and shall cycle continuously until each is cleared. Each alarm shall be displayed for a pre-programmed dwell time before it is succeeded by the next received alarm. When the last alarm on a given monitor within a group is cleared, a "Black Screen" shall automatically appear indicating there are no further alarms to be displayed.
 - .2 During alarm response, the system shall provide programming for automatic call-up of a camera pre-set and provide on-screen text indicating the occurrence of an alarm.

PART 3 - EXECUTION

3.1 **Installation**

3.1.1 Install products in accordance with product manufacturer's written instructions for type and use.

3.2 **Commissioning**

3.2.1 Commission products and system in accordance with manufacturer's written procedures.

END OF SECTION

1 GENERAL

1.01 SUBMITTAL

- .1 Submit shop drawings for equipment and accessories specified in this Section.

1.02 SOFTWARE NOMENCLATURE REPROGRAMMING

- .1 Include for system manufacturer to make necessary on-site final changes to applicable system/equipment software. Make such changes after successful testing and verification of systems, but prior to turn over to Owner. After successful final verification of the work, confirm and obtain approval of final nomenclature in writing from Owner and review with Consultant. Software revisions to incorporate final room names/area names/building names and equipment identification.

1.03 SYSTEM SUPPLIER/INSTALLER QUALIFICATIONS

- .1 Supplier/installer of system to be an established communications and electronics contractor that has and currently maintains a locally run and operated business for at least 5 years and holds applicable provincial and local licenses.
- .2 Supplier/installer to be a valid authorized distributor for product/system proposed with full manufacturer's warranty privileges.
- .3 Supplier/installer to employ technicians who have attended and successfully completed the manufacturer's technical certification training for proposed system.
- .4 Supplier/installer to show satisfactory evidence, upon request, that they maintain a fully equipped service organization capable of furnishing adequate inspection and service to system. Supplier/installer to maintain at their facility necessary spare parts in proper proportion as recommended by system manufacturer to maintain and service equipment being supplied.

2 PRODUCTS

2.01 REAL TIME LOCATING SYSTEM

- .1 The existing CenTrak Real-Time Location System (RTLS) systems onsite shall be extended and support the phasing of the CVH 2D Mental Health PICU Renovation project. RTLS to provide location of personnel, patients and equipment. System provides real-time whereabouts of tagged individuals graphically overlaid onto relevant floor plans. System monitors whereabouts of tagged equipment and triggers an event if equipment passes an access point.
- .2 System utilizes battery-powered, triple-technology RF/IR/LF tags affixed to assets that are to be protected and a fixed Ethernet/Wi-Fi compatible infrastructure comprised of RTLS RF Readers, IR Readers and LF Exciters strategically installed throughout facility. System software is Eiris Visibility and Security software.
- .3 Include for providing system manufacturer's local authorized system vendor, to provide work including but not limited to provision of following:
 - .1 head end equipment including system server, software programming and licenses; system to be suitable for enterprise-wide applications;

- .2 RF IP readers: supervised; 433 MHz fixed indoor RTLS receiver, flush ceiling mounting;
 - .3 IR readers supervised, fixed infrared RTLS location receiver that provides sub-room location awareness, flush ceiling mounting;
 - .4 Standard local controllers: user programmable RTLS appliance that provides indoor distributed, serverless location awareness and control;
 - .5 LF beacons: supervised 125 KHz field emitter, flush ceiling mounting;
 - .6 Asset tracking tags: active RFID transmitter, includes a user programmable wireless call button, which when pressed transmits Tag's location data identifying its exact location; include for supply of quantity of 500 asset tracking tags;
 - .7 Personnel identity badge: active RFID tag that provides wireless monitoring and tracking of personnel; a photo ID personnel badge and card holder; two programmable buttons for transmitting preconfigured messages/commands or for manual duress alerting; delivers instant near-exit, sub-room or hallway location awareness; include for supply of quantity of 500 identity badge tags;
 - .8 Ancillary devices including solid state network junction boxes, antennae and other devices to complete system installation;
 - .9 Wiring in conduit and required backboxes and mounting hardware;
 - .10 Inspection, testing and adjustments after installation are complete.
- .4 Manufacturer's Technicians Onsite Services:
- .1 Survey coverage areas and determine if device locations properly cover required areas of project;
 - .2 Programme system sequence of operation as confirmed with Consultant and CVH Project lead.
 - .3 Final system inspection, testing, adjusting, inspection and verification.
- .5 Acceptable manufacturers are CenTrak.

3 EXECUTION

3.01 INSTALLATION OF RTLS

- .1 Programme system as required for renovations work.
- .2 Obtain required training from manufacturer's representative on any special installation procedures. Install devices and perform work in accordance with the manufacturer's instructions and requirements and in accordance to applicable codes of the governing authorities having jurisdiction.
- .3 Mount ceiling devices flush to ceiling. Confirm exact requirements and locations of equipment with Consultant and system installers prior to roughing-in.

- .4 Where applicable, interconnect system to electromagnetic locks supplied by door hardware trades or General Trades Contractor.
- .5 Where applicable, interconnect system to central security system and central nurse call system as required to annunciate system calls on each system.
- .6 Ground and bond system to code and manufacturer's requirements.
- .7 Refer to the system riser diagram on the drawings.
- .8 Quantities for devices shall be as per the floor plan drawing and not the riser diagram.
- .9 When work is complete, arrange for attendance at site of system manufacturer's authorized representative to make final equipment connections and provide system testing, start-up and verification requirements.
- .10 Additionally, refer to testing and verification requirements in Section entitled Electrical Work Analysis and Testing and include applicable requirements.

END OF SECTION

1 GENERAL

1.01 SUBMITTALS

- .1 Submit shop drawings for products specified in this Section. Include annunciator schedules, revised system programming and sample of revised graphic annunciator layout and nomenclature.
- .2 Submit copies of final system testing and verification reports and certificates of approvals from local governing inspection authority.

2 PRODUCTS

2.01 EXISTING FIRE ALARM SYSTEM

- .1 Existing fire alarm system serving complex is Siemens Desigo. Provide additional devices and work to retrofit and extend system to serve additional and renovated areas. Additional devices to be 100% compatible with and of same manufacturer as per existing system. Include provision of necessary control panel and annunciator work of existing system to accommodate integration of additional devices.
- .2 Include for and engage Owner's existing system manufacturer's authorized technicians to provide and perform required system products and work. Contact for existing system is Gerry Thibeault – Siemens Canada Ltd. gerry.thibeault@siemens.com
- .3 Verify with existing fire alarm system manufacturer during Bid period, exact requirements needed to provide renovation work. If necessary, visit site with manufacturer to review existing conditions. Confirm and coordinate exact work responsibilities with system vendor. Review items of clarification or proposed revisions to Bid Documents with Consultant during Bid Period.

2.02 ADDITIONAL FIRE ALARM SYSTEM WORK

- .1 System retrofit work to include but not be limited to provision of following:
 - .1 modifications to existing head end equipment including provision of additional device connection modules, zone modules, amplifiers and system re-programming;
 - .2 additional initiating devices (manual stations, heat/smoke/flame detectors);
 - .3 additional alarm indicating devices (speakers, horns, strobes);
 - .4 additional interfaces and interconnections to auxiliary building systems;
 - .5 review of existing battery backup capacity and amplifiers (as applicable) and increasing capacities to accommodate additional device loading and to meet applicable governing local code requirements;
 - .6 additional wiring in conduit and/or fire rated cables, and ancillary devices.

- .2 Additional system components to be listed as products of a single manufacturer under appropriate category, by Underwriter's Laboratories of Canada and bear ULC label. System components and work in conjunction with system installation to meet specific application requirements of local governing authorities, codes, standards, regulations and requirements of following:
 - .1 CAN/ULC-S524, Standard for Installation of Fire Alarm Systems;
 - .2 CAN/ULC-S527, Control Units for Fire Alarm Systems;
 - .3 CAN/ULC-S537, Standard for Verification of Fire Alarm Systems;
 - .4 CAN/ULC-S1001, Integrated Systems Testing of Fire Protection and Life Safety Systems;
 - .5 local governing building code;
 - .6 local governing electrical code;
 - .7 local governing building permit applications for approvals;
 - .8 other requirements of local governing authorities.

2.03 RETROFIT WORK AND DEVICES

- .1 Retrofit control panels and annunciators to supervise and annunciate additional and relocated devices. Additional initiating devices shall be devices that are 100% compatible with existing controls and be ULC listed and labelled for connecting to respective control units. Include costs for manufacturer's authorized representative to perform control panel/transponder work and to reprogram system software to accommodate renovation work. Provide additional zone modules as required and additional batteries as required to supply back-up battery capacity to the additional components.
- .2 Additional devices to be ULC listed and labelled devices suitable for fire alarm applications. Power supplies and other components to be CSA certified where required by local governing authorities and codes.
- .3 Exact type of device to be used in each area of installation to be as recommended by system manufacturer to suit specific applications and to be approved for such use as per ULC standards. Devices in non-climatic controlled areas to be weatherproof, corrosion resistant and ULC listed for use in below freezing temperatures. System manufacturer to be responsible for ensuring compliance with these requirements.
- .4 Devices:
 - .1 Additional manual stations, smoke detectors and heat detectors: to be of type and rating to suit specific application as per existing system manufacturer's recommendations.
 - .2 Audible Devices: of type to match existing system device standards.
 - .3 EVC Speakers: units to include speaker, baffle, back box and ancillary devices to match existing speaker units; speaker grilles to be of finish reviewed with Consultant,

- .4 Strobes and combinations strobes/audible devices: of type to match existing system device standards; include additional strobes to meet latest governing building code requirements.
- .5 Signal devices (audible and visual) to have similar sound and pattern matching existing devices.
- .6 Addressable modules as required for connection of additional devices.
- .7 Ancillary devices as required to complete system.
- .5 End-Of-Line Resistors and Isolators:
 - .1 End-of-line resistors for standard alarm and signalling circuits to be sized to ensure correct supervisory current flows in each circuit, as per local governing code requirements and system manufacturer's recommendations.
 - .2 End-of-line resistors to be mounted on a stainless steel plate for mounting on a standard single gang box and bear ULC label.
 - .3 Isolators to be provided in accordance with local governing code requirements and installed as per system manufacturer's requirements to isolate/monitor zones, loops, group of devices within building and between buildings.
- .6 Devices in non-climate controlled areas to be weatherproof, corrosion resistant, ULC listed for operation in below freezing temperatures, and as recommended by system manufacturer for use for each specific application. Where electronics are not recommended for cold temperature applications, include for manufacturer's recommendations and directions in remotely locating addressable modules in closest heated areas and connecting to respective device in non-climate controlled areas.
- .7 Refer to drawings for additional device requirements.
- .8 Wiring:
 - .1 CSA certified and ULC listed wire and cable, approved for fire alarm circuits; with colour coded, insulated solid copper conductors; of type as per local governing electrical code and local governing fire authority requirements.
 - .2 Sized and installed in accordance with system manufacturer's instructions and local governing electrical code.
 - .3 Fire rated MI for wiring as required by local governing building code, local governing authorities and as noted on drawings, for connections and interconnections to equipment for life safety applications.
 - .4 To be mechanically protected to satisfaction of local fire authority.
 - .5 nVent "Pyrotenax" type "MI" ULC listed and labelled, 2-hour fire rated, mineral insulated, copper sheathed, copper conductors for power, control and signal wiring to and between each transponder/control panel, and for other local code required or local governing authority required applications with regards to life safety equipment.

2.04 TESTING AND VERIFICATION WORK

- .1 Refer to Part 3 for system testing, verification and certification Work.

3 EXECUTION

3.01 INSTALLATION – GENERAL

- .1 Prior to start of Work as part of shop drawing submission process, review with system manufacturer following:
 - .1 device types to ensure that selected type is suitable for intended application on project;
 - .2 locations of devices to ensure proper operation and coverage are in compliance with requirements of local fire authorities;
 - .3 device mounting heights to ensure proper operation and coverage are in compliance with requirements of local fire authorities;
 - .4 device back box requirements to ensure size and depth suit system manufacturer's recommendations for specific devices;
 - .5 types of system wiring and required sizing taking in consideration applications and voltage drop;
 - .6 system circuiting and device quantities per circuit while maintaining limitations in Specifications;
 - .7 proposed revisions required to existing system sequence of operation.
- .2 Immediately advise Consultant of any requirements of above that may necessitate revisions to design documents.
- .3 Install fire alarm system components and connect complete.
- .4 Perform Work in conjunction with this installation to meet requirements of latest editions of local governing building code, local governing electrical code, ULC Standards including Installation Standard CAN/ULC-S524, and any applicable local governing codes. If any requirements of these specifications are different, omitted or contrary to ULC-S524 Standard, then ULC Standard governs and overrides these specifications, but in no instance will standards established by drawings and specifications be reduced by any of Codes referred to previously. Control units and annunciators to be in accordance to latest requirements of ULC Standard CAN/ULC-S527 "Control Units for Fire Alarm Systems.
- .5 In addition, work to meet Owner's standards, and recommendations and instructions from system manufacturer.

- .6 During work to existing fire alarm system, obtain Owner approval of proposed time and duration of interruption and review with Consultant. At any time due to emergency situations, Owner may request by-passed zone(s) to be re-instated immediately. In areas where renovation work requires shutdown of any part of fire alarm protection system, provide manual fire alarm protection (Fire Warden) by means of supervising area as approved by local governing authorities. At no time allow fire alarm system or any one zone to be left inoperative overnight. Provide required bypass wiring and temporary wiring to maintain all parts of fire alarm system operative during construction and alterations.
- .7 Fire alarm system manufacturer's authorized technician to supervise control panel, transponder, and annunciator work.
- .8 Provide sequence of operation for fire alarm system as approved by local fire authority and reviewed with Consultant. Refer to additional requirements on drawings.
- .9 Demonstrate system to local Fire Department and obtain their approval for complete system.

3.02 INSTALLATION OF DEVICES

- .1 Install required devices. Do not install devices in locations that may hamper proper operation of devices including adjacent devices.
- .2 Obtain required training from manufacturer's representative on any special installation procedures. Install devices and perform work in accordance with manufacturer's instructions and requirements and in accordance to applicable codes of local governing authorities having jurisdiction.
- .3 Review device finishes with Consultant prior to ordering.
- .4 Install manual stations in boxes as required, recessed outlet boxes with plaster rings, except in unfinished areas where manual stations are surface mounted, in which case, install stations in surface mounted boxes. Comply with mounting height requirements for local governing building code barrier free access.
- .5 Install mounting plate of thermal detectors to ceiling mounted boxes as required. Secure detectors to plates. Refer to floor plans and drawing symbol list to determine rating of detectors in any given area. Generally, do not install rate-of-rise type detectors in areas subject to sudden changes in temperatures, such as entrance vestibules. Confirm application requirements with system manufacturer and ensure that devices are ULC listed for such applications and are approved by local fire authority for such use.
- .6 Secure base of each ceiling mounted products of combustion detectors to boxes as required, either flush or surface mounted as required. Secure detector heads to bases.
- .7 Interconnect patient room smoke detectors with annunciator at local nurse station and to room nurse call dome lights, as required. Coordinate work and requirements with nurse call system vendor and include required conductors, interconnections and programming.
- .8 Install cross zoned connection of detectors and remote indicating devices for areas of raised floors or within accessible ceiling spaces or for applications detailed on drawings.

- .9 Mount each duct mounted products of combustion detector on duct in question and connect with smoke sampling tubes which extend into duct air stream. Install a remote alarm lamp assembly for each duct mounted detector. Wall mount each lamp assembly on a standard 100 mm (4") outlet box as close as possible or practicable to detector. Do not locate duct detectors within 1 m (3') of duct size increaser or decreaser fittings or any duct elbow. Provide wiring in conduit and extend to connect back to system control unit.
- .10 In application with hold open devices on doors, ensure compliance with NFPA regarding smoke detectors tied to hold open devices such that a signal received directly from smoke detector to cause release of door. Where electromagnetic locks are used on doors of egress, provide required automatic release of locks upon activation of fire alarm (i.e. via connection to auxiliary contact of adjacent manual station). Provide required conductors and connections to fire alarm system and to electromagnetic locks.
- .11 Provide required horns and combination horn/strobes. Horns are flush and surface mounted type as indicated to suit architectural wall/ceiling types, each complete with a proper backbox and as required trim plate.
- .12 Provide required speakers. Speakers are flush and surface mounted cone type and as indicated to suit architectural wall/ceiling types, each complete with a proper backbox.
- .13 Exterior speakers/horns to be weatherproof and mounted with weather sealed gland nut connection at proper dispersion angle.
- .14 Provide corridor speakers with dedicated dual zone speaker circuits. Provide patient room speakers with dedicated dual zone speaker circuits. Extend both zone A and zone B wiring to each speaker but connect speakers to designated A or B zones of paging as approved by local fire authority and reviewed with Consultant.
- .15 Mount speakers in stairwells and wire vertically connected to specific zone as approved by local fire authority and reviewed with Consultant. Refer to drawing riser and annunciator schedule.
- .16 Generally, audible device locations are indicated on drawings, however, exact audible device quantities and locations to be in accordance with results of audibility device coverage site tests. Provide suitable sound detection metering and personnel to make necessary tests. Relocate audible devices and/or provide additional audible devices as required.
- .17 Support flush ceiling mounted speaker backboxes from structure and not suspended ceiling grid or tiles. Connect speakers to specified taps and ensure that sound levels are in accordance with local authority and sound level requirements. Adjust as required and certify that levels are in compliance with Code level requirements. Audible devices to be synchronized.
- .18 Install amplifiers sized as required to power additional speakers and include spare capacity as specified.
- .19 Install specified telephone handsets and mount in recessed wall mounting boxes. Connect complete with wiring in conduit to local transponder.
- .20 Provide double voltage relays, with multiple contacts as required, to shut down fans as noted on drawings. Arrange relays to be energized at all times from fire alarm system to ensure that they are fail safe.

- .21 Typically, install visual notification appliances 2400 mm (8') above floor or 300 mm (12") below finished ceiling line. Provide visual notification devices in areas subject to high ambient noise levels, such as mechanical equipment rooms, computer equipment rooms, parking garage, etc., and areas designated for hearing impaired as per local building code requirements. Typically, provide minimum 2 circuits per floor and connect devices in alternating scheme.
- .22 Provide required additional devices and install existing devices as required. Circuit device's to existing standards and in compliance with local governing codes and authorities. Determine exact quantities of circuits based on requirements of governing codes and standards, and recommendations of system manufacturer.
- .23 Install and circuit as required in accordance with manufacturer's instructions for specific applications. Unless otherwise noted in Contract Documents, do not load device circuits more than 80% capacity.
- .24 Devices in non-climate controlled areas to be weatherproof, corrosion resistant, ULC listed for operation in below freezing temperatures, and as recommended by system manufacturer for use for each specific application. Where electronics are not recommended for cold temperature applications, include for manufacturer's recommendations and directions in remotely locating addressable modules in closest heated areas and connecting to respective device in non-climate controlled areas.

3.03 REQUIREMENTS FOR INTEGRATED SYSTEMS AND EQUIPMENT

- .1 Perform required fire alarm system wiring connections to mechanical equipment and other building systems to perform required interrelated functions. Provide required wiring, relays and/or contactors between fire alarm system and various equipment to achieve automatic or manual control and monitoring of equipment and to perform required integrated to fire alarm system functions. Provide shunt trip breakers as required. Provide fire rated conductors where required by local codes and local authorities.
- .2 Provision of fire alarm supervisory wiring connections to include but not be limited to following (where applicable):
 - .1 fire protection system piping supervised valves and flow switches for alarm initiation;
 - .2 fire protection system piping supervised valves and flow switches for trouble indication;
 - .3 fire protection piping pressure detectors for loss of pressure trouble indication;
 - .4 fan equipment starters;
 - .5 pumps;
 - .6 dampers;
 - .7 fire suppression systems;
 - .8 door holders/releases and electromagnetic locks;
 - .9 integrated equipment such as gensets, elevators, BAS and dimming systems;

.10 devices and equipment as shown on drawings.

3.04 ADDITIONAL REQUIREMENTS

- .1 Provide required system wiring in accordance to requirements of applicable governing electrical code, other local governing code and standards requirements, system manufacturer's recommendations and based on specific applications and consideration of voltage drop.
- .2 Install wiring in conduit unless otherwise approved by Owner and reviewed with Consultant, and except for MI fire rated type conductors. Do not splice wiring. Perform wiring connections associated with fire alarm system on terminal strips in junction boxes and colour coded. Provide wiring colour coding consistent for entire length of each run. When pulling wires into conduit, use lubricant and run wires straight and not twisted or abraded. Neatly secure exposed wires in apparatus enclosures with approved supports or ties. Clearly identify wiring at each termination point. In addition, number wiring with Brady Ltd. or Electrovert Ltd. Z-type markers. Colour conductors for each part of system in accordance with system equipment manufacturer's recommendations. Paint conduit couplings red of paint type suitable for application to standards of Division 09.
- .3 Where existing devices are relocated and existing wiring is of insufficient length to connect to relocated position, provide replacement wiring and conduit of sufficient length.
- .4 Where required by local governing codes and/or local governing authorities, provide ULC listed, fire rated conductors (MI) for connections to and interconnections between equipment for life safety applications requiring fire rating. Install MI type conductors in accordance with manufacturer's instructions and requirements in Specification.
- .5 Run alarm indicating circuits (speakers) and alarm receiving circuits (manual stations, detectors) in separate conduits from each other.
- .6 Arrange sprinkler system alarm valve alarm zones to be separate from manual station, thermal detector and products-of-combustion detector device zones, which may be connected together into zones.
- .7 Provide engraved Lamacoid identification nameplates for each equipment or wiring housing and secure to front of housing. Review exact wording designations and sizes to with Consultant prior to manufacture. Label devices as required by ULC S524 and local governing authorities.
- .8 Review nomenclature of annunciator identification with Consultant prior to ordering.
- .9 Install end-of-line resistors to electrically supervise wiring. Generally, locate end-of-line resistors at ceiling lines above manual station location. Provide isolators and install in accordance with ULC standards. Properly label and identify. Do not locate end-of-line resistors and isolators in concealed locations. Generally install in equipment rooms.
- .10 Refer to drawing riser diagram. Riser drawings are diagrammatic and are not to be used for determining quantities or lengths. Quantities of components to be as per floor plans. Determine exact quantities of circuits based on drawings information, connected devices, requirements of governing codes and standards, and recommendations of system manufacturer.
- .11 Review exact location of components with Consultant prior to roughing-in.

- .12 Ground and bond system as required by local governing electrical code and authority and system manufacturer.

3.05 SYSTEM TESTING, VERIFICATION AND CERTIFICATION

- .1 Manufacturer Authorized Technician Services:
 - .1 Provide technical training and assistance to certified installers of system.
 - .2 Perform onsite inspection, start-up, testing, verification and certification of installed system.
 - .3 Prepare and sign testing and verification reports for submittal to Consultant.
 - .4 Perform onsite training of each user (with provision of user guides) prior to project completion and instruct in operation and maintenances of system.
- .2 Testing Technicians:
 - .1 Registered technicians in good standing with Canadian Fire Alarm Association (CFAA) or be Certified Fire Alarm Electrician (CFAE) with local Electrical Contractors Association as deemed acceptable to Provincial Fire Marshall.
 - .2 Submit with test reports, copies of valid certification of testing company and technicians.
 - .3 Engage Integrated Testing Coordinator with qualifications in accordance with CAN/ULC-S1001.
- .3 Submit to Owner and Consultant, proposed schedule for inspection, start-up, testing and verification of system. Obtain such reviews prior to start of work. Consultant and/or other Owner's representatives to have option to witness all or part of testing and verification work. Notify Consultant and Owner minimum 7 working days in advance of work.
- .4 Include for fire alarm system manufacturer to inspect, start-up, test, verify and certify system components and wiring, individually and as a complete system, in accordance with requirements of CAN/ULC S537 and CAN/ULC-S1001. Work to include but not be limited to following:
 - .1 to ensure that type of equipment installed is that designated by Contract Documents;
 - .2 to ensure that wiring connections to equipment components show that installer observed ULC and CSA requirements;
 - .3 to ensure that equipment was installed in accordance with ULC S524 and manufacturer's recommendations, and that signalling devices of whatever manufacture were operated or tested to verify their operation;
 - .4 to ensure that supervisory wiring of those items of equipment connected to a supervised circuit is operating and that governmental regulations, if any, concerning such supervisory wiring, have been met to satisfaction of inspecting officials;

- .5 to ensure that sequence of operation is in accordance with existing sequence of operation and any modifications identified on documents and are approved by local fire authority;
- .6 to ensure that system and devices are commissioned and operable.
- .5 Integrated Testing:
 - .1 Engage Integrated Testing Coordinator to prepare Integrated Testing Plan and provide requirements in accordance with CAN/ULC-S1001.
 - .2 Include for but not be limited to full review, testing and verification of operation of integrated systems such as fire suppression systems, life safety systems, elevators and their emergency sequence of operation, HVAC equipment, supervisory annunciation of sprinkler/standpipe monitor switches, pressure switches and flow switches, diesel genset alarms, security alarms, BAS alarms, release of door holders and electromagnetic locks, and other integrated components.
 - .3 Coordinate requirements with trades responsible for integrated components and systems, and arrange trades to be present at time of testing, and verification and commissioning work.
- .6 System manufacturer to also be responsible for but not be limited to provision of following additional work to existing systems:
 - .1 Test system battery power supplies and demonstrate compliance with local governing building code and local fire authority requirements that battery supplies are capable of providing required duration of supervisory power followed by local governing building code required time (or time directed by local fire authority) of full load power; exact method of testing to be approved by local fire authority, Consultant and Owner; confirm and review exact procedures with previously named parties prior to testing; include for sufficient sound measurement devices and personnel in order to successfully comply with this requirement.
 - .2 Full review, testing, and verification of operation of building ventilation and smoke exhaust system and its integrated operation with fire alarm system and various pieces of air handling equipment.
 - .3 Test that system audible devices provide alarm sound levels in areas as per local governing building code and local fire authority requirements; site adjust tap settings of audible devices as required to achieve required audibility levels; also test that emergency voice communication system meets or exceed requirements of local governing building code and is approved by local fire authority.
 - .4 Assist in testing and verification of electromagnetic door locks to meet requirements of authorities having jurisdiction and to obtain overall approval of installation.
 - .5 Coordination with Electrical Divisions and local fire authority to provide requirements to obtain certificates of approvals from local fire authority.

- .7 Where project work is phased and Owner requires occupancy at various stages, include for providing system testing, verification and certification after completion of each phase of work, to approval of local governing authorities. Upon Substantial Performance of the Work, include for providing system testing, verification and certification of entire system work.
- .8 Contact local fire authority inspector and coordinate and arrange for Fire Inspector to perform required inspections. Integrate local fire authority inspection requirements with testing and verification work to extent as per Fire Inspector's directions. Obtain full approval and compliance certifications. Submit copies to Consultant.
- .9 Local fire authority inspector, Consultant and Commissioning Agent to at their discretion test system or parts of system in their review of test reports. Correct/repair any failures or deficiencies found in system, whether or not identified in test reports. Re-test and re-verify until successfully passed, at no extra cost to Owner.
- .10 Arrange for manufacturers to supply reasonable amounts of technical assistance with respect to any changes required to conform to paragraphs above. During period of inspection, testing and verification, make Electricians available to do any required correction work and to assist during this Work. Include for trades responsible for integrated components (i.e. exhaust fans, sprinklers, elevators, gensets, etc.) and systems to be present at time of testing and verification work.
- .11 Provide full detailed test sheets of tested components and provide certification that system work has been fully tested, that devices have passed testing and that system is in proper work order in compliance to local governing code requirements and project documents. Documentation to be in form in compliance with referenced standards, acceptable to local governing authorities and reviewed with Consultant. Testing report documents to be additionally provided in electronic format as confirmed with Consultant.
- .12 On completion of verification, inspection and testing of system, obtain from manufacturer and forward to Consultant, a verification certificate together with detailed inspection reports listing each and every system component, its location in building and its acceptability. Verification certificate and inspection reports to be prepared and signed by certified testing technicians of manufacturer. Signed test reports to confirm that systems are installed and perform in accordance with requirements specified above.
- .13 Obtain from system manufacturer and testing agency and forward to Consultant a certificate of liability insurance of minimum amount of Two Million Dollars (\$2,000,000.00 CDN) that is to be registered for this project to show satisfactory proof of manufacturer's liability coverage for both their product and personnel.
- .14 Do not use open flame and/or smoke for testing unless approved by Owner and reviewed with Consultant.
- .15 Additionally, refer to testing, coordination and verification requirements in Section entitled Electrical Work Analysis and Testing and include applicable requirements.

3.06 MONITORING OF SYSTEMS

- .1 In areas that remain occupied and used by Owner during Work, daily monitor and supervise existing fire alarm system and other fire protection systems serving renovation/working areas. Ensure that system is left in proper operating condition at end of each working day. Include for but not be limited to performing following:
 - .1 under presence of Owner's representative, check each morning and evening (start and end of work) of each day, system to ensure that it is in proper working condition;
 - .2 if portions of system are not in proper working order, provide temporary bypass wiring (if fire alarm system, must be subject to approval of local fire authority), and/or provide supervisory personnel to monitor systems for area affected;
 - .3 document and sign off with Owner's representative signing off also, each respective daily check condition;
 - .4 retrofitting work to system in manner that does not affect portion of system serving areas outside of renovation/working areas.
- .2 Maintain fire protection of areas which may include fire watch during temporary shutdowns of existing systems, in accordance with requirements of local governing code and local governing authorities.

END OF SECTION

1 GENERAL

1.01 SUBMITTALS

- .1 Submit shop drawings for products specified in this Section. Include annunciator schedules and sample of graphic annunciator layout and nomenclature.
- .2 Include with shop drawings, detailed piping layout drawings and operational calculations, performance criteria and proposed sequence of operation (system itself and as an integrated system with main fire alarm system and Mechanical Divisions fire suppression systems). Submittal Information to include:
 - .1 catalogue sheets and technical data for each component or device used in system;
 - .2 design layout drawings consisting of floor plans and equipment locations, obstruction items, piping runs, conduit runs, detail, etc.; include proposed routing of air sampling pipes and tubes;
 - .3 air sample transport calculations, including suction pressures, transport times, performance criteria, and flow characteristics;
 - .4 secondary (standby/battery) power supply calculations;
 - .5 electrical wiring diagrams showing point-to-point wiring schematics and circuit connections to external or add-on relays and interface modules;
 - .6 integration of smoke sampling system into main building fire alarm system and into main building fire alarm system sequence of operation (including Owner's information package and system description information package);
 - .7 system commissioning data supplied in a format recommended by manufacturer and per instructions provided by manufacturer, within 30 days of completion of installation.
- .3 Drawings and calculations to bear name of individual in responsible charge of design and installation of system.
- .4 Perform air sampling network calculations using latest version of manufacturer's approved air sampling pipe aspiration modelling software. Supply pipework calculations with proposed pipe layout design to indicate following performance criteria:
 - .1 Manufacturers recommended transport time (time taken for smoke to enter pipe and reach detector) for least favourable sampling point is 60 seconds or less. Local codes or end users standards may also apply.
 - .2 Sample point balance for pipe to not be less than 70% as indicated by modelling software; volume of air drawn from last sampling point to not be less than 70% of average volume of air through other holes.
 - .3 Sample hole share for pipe to not be less than 70% as indicated by modelling software; sum volume of air drawn through sampling holes must always be greater than 70% of total volume of air entering pipe (i.e. End Vent must not exceed 30% of total flow).

2 PRODUCTS

2.01 STANDARDS

- .1 System components to be listed as products of a single manufacturer under appropriate category, by Underwriter's Laboratories of Canada and bear ULC label. System components and work in conjunction with system installation to meet specific application requirements of local governing authorities, codes, standards, regulations and requirements of following:
 - .1 CAN/ULC-S524, Standard for Installation of Fire Alarm Systems;
 - .2 CAN/ULC-S527, Control Units for Fire Alarm Systems;
 - .3 CAN/ULC-S537, Standard for Verification of Fire Alarm Systems;
 - .4 CAN/ULC-S1001-Edition 1, 2011-REV2, Standard for Integrated Systems Testing of Fire Protection and Life Safety Systems;
 - .5 Other applicable ULC Standards;
 - .6 NFPA 70;
 - .7 NFPA 72;
 - .8 NFPA 7;
 - .9 Factory Mutual Global;
 - .10 local governing building code;
 - .11 local governing electrical code;
 - .12 local governing building permit applications for approvals;
 - .13 other requirements of local governing authorities.
- .2 Regulatory Requirements: installation to conform to applicable local building code requirements. Be responsible for obtaining and purchasing necessary permits prior to beginning work. System equipment and devices used to be listed in ULC Fire Protection Equipment List.

2.02 FIRE DETECTION AIR SAMPLING SYSTEM

- .1 Air sampling system to be integrated with fire alarm system to provide fire detection smoke sampling. System to be based on Vision Xtralis "LaserSCANNER" and "LaserFOCUS" as scheduled on drawings, very early smoke detection (VESDA) system, consisting of highly sensitive laser based smoke detectors with aspirators connected to networks of sampling tubes. Detectors to be able to identify which pipe is carrying smoke.
- .2 System is based on model numbers VLS-700 LaserSCANNER and VLS-700 LaserFOCUS detectors with remote displays for each detector located in VESDA sub-rack at a central location and all required relays for proper operation and interface to main building fire alarm system.

.3 General requirements include:

- .1 For rooms/areas that currently do not have air sampling installed, provide an air sampling smoke detection system at ceiling (include low level ports if required – refer to sampling point network requirements later in this specification) and in front of return air (at AC units, walls and/or ceilings, and areas under raised floor) with spacing to be as specified by manufacturer for this application.
- .2 For rooms/areas that currently do have air sampling installed, verify if installed systems (ceiling and return air) meet requirements of this specification (including port spacing, piping material, number of ports, transport times, etc.).
- .3 For rooms/areas that have return air (at AC units, walls and/or ceilings), return air must be protected with an air sampling system that meets requirements of manufacturer and this specification. If no air sampling is currently provided across return air, furnish and install such a system in accordance with requirements of manufacturer and this specification.
- .4 Air sampling equipment shall be equipped with all required relays, interface modules and network interfaces so that Air Sampling equipment can communicate with each other via a network and with FACP.
- .5 Provide separate air sampling detectors for each equipment room, where possible.
- .6 Provide primary 120 VAC regulated electric power supply for air sampling detectors from facility protected power supply. Review existing provisions on site prior to submitting Bid, to take into account existing conditions, provisions within existing panelboards, routings of conduits, lengths of runs, and any other related work. Include for required provisions for this work, including new breakers, wiring, conduits, junction boxes, pull boxes, offsets, and other required products. Include associated costs required for this work. Coordinate VESDA AC power requirements with manufacturer and include for required provisions. System emergency power to be integral 24-hour, minimum 30-minute alarm battery reserve, 24 VDC secondary (standby) power supply.
- .7 Provide CSA approved battery backup power supplies for detector units, also meeting system manufacturer's approvals.
- .8 Provide monitor modules as necessary to annunciate loss of primary or backup power to FACP as Common Air Sampling Trouble.

.4 Examination of Documents and Site Conditions:

- .1 Review drawings to ensure that items that will affect operation of system, such as other fire detection equipment, ventilation systems, room equipment, and other factors, are considered in design of system, and final system provisions. Provide work required to accommodate existing site conditions and provide final quantities of detectors, sampling pipe layouts, and associated components and devices, and associated work to adapt to existing site conditions.
- .2 Examine other work shown on drawings and conditions at job site. Coordinate routing of work with other construction trades to avoid interference with other installations. Select detection locations as required to avoid equipment, plumbing, drain pipes, HVAC piping and ductwork, lighting fixtures, electrical bus ducts, wiring, conduits, and structural elements.

- .3 Visit site to become familiar with site and site conditions prior to submitting pricing.
- .4 Smoke-sampling network to provide sensing ports. System to provide sensing for area and for any return air (at AC units, walls and/or ceilings, and areas under raised floor), as required.
- .5 Prepare design drawings under supervision of a professional engineer licensed in Place of Work. Design drawings to be stamped and signed by that engineer.
- .6 System to be complete including piping, detectors, and other equipment necessary for a complete operational system.
- .7 Prior to commencing work, submit and receive approvals from local governing authority having jurisdiction and system manufacturer and review with Consultant.
- .5 System Design Requirements – LaserSCANNER:
 - .1 Consists of air sampling pipe network to transport air to detection system, supported by calculations from computer-based design-modelling tool.
 - .2 Consist of highly sensitive LASER-based smoke detector, aspirator, and filter.
 - .3 Detection unit also includes a scanning valve mechanism to identify which sampling pipe is carrying smoke.
 - .4 Modular, with each detector monitored by Display featuring LEDs and sounder. System equipped with required provisions to allow each VESDA system to be configured by a Programmer.
 - .5 System shall allow programming of:
 - .1 four smoke threshold alarm levels per pipe (sector);
 - .2 time delays;
 - .3 faults including airflow, detector, power, filter and network as well as an indication of urgency of fault;
 - .4 configurable relay outputs for remote indication of all four alarm signals and fault and trouble conditions.
- .6 Performance Requirements:
 - .1 Tested and approved to cover up to 1858 m² (20,000 ft²).
 - .2 Approved by local governing standards and authority to provide very early smoke detection and provide four output levels corresponding to Alert, Action, Fire 1 and Fire 2 per pipe (sector). These levels to be programmable and able to be set at sensitivities ranging from 0.0015–6% obsc/ft. Exact settings to be as per manufacturer's recommendations for specification applications.
 - .3 Report any fault on unit by using configurable fault output relays.
 - .4 Self-monitoring for filter contamination.

- .5 Incorporate flow sensor in each pipe and provide staged airflow faults.
- .7 Technology:
 - .1 Device utilizes both light scattering and particle counting as follows:
 - .1 Laser detection chamber to be of mass light scattering type and capable of detecting a wide range of smoke particle types of varying size. A particle counting method to be employed for purposes of:
 - .1 preventing large particles from affecting true smoke reading;
 - .2 monitoring contamination of filter (dust & dirt etc.) to automatically notify when maintenance is required.
 - .2 Particle counting mechanism not to be used for purpose of smoke density measurement.
 - .3 Laser detection chamber incorporates a separate secondary clean air feed from filter to provide clean air barriers across critical detector optics to eliminate internal detector contamination.
 - .4 Detector not to use adaptive algorithms to adjust sensitivity from that set during commissioning. Learning tool is provided to ensure best selection of appropriate alarm thresholds during commissioning process.
- .8 Detector Assembly:
 - .1 Only manufacturer's most current models of system equipment and apparatuses to be used. Detector and accessories to be ULC listed and labelled for their intended use.
 - .2 Detector, Filter, Aspirator and Relay Outputs are housed in mounting box and arranged in such a way that air is drawn from fire risk and sample passed through dual stage filter and detector by aspirator.
 - .3 Detection unit also includes scanning valve mechanism to identify which sampling pipe is carrying smoke. Valve mechanism:
 - .1 is integrated into detector;
 - .2 begins to sample each pipe individually upon detection of smoke;
 - .3 is used to identify level of smoke in each pipe;
 - .4 is used to indicate in which pipe an alarm was first detected;
 - .5 operates upon manual activation of scan button on LaserSCANNER display;
 - .6 automatically tested daily to ensure uninterrupted protection.

- .4 System utilizes principle of sampling all sectors simultaneously. When scan smoke level is reached, automatic sequence is initiated to sample each sector individually. If alarm threshold level is reached, First Alarm Sector is indicated and signalled. Unit then continues its sequence monitoring until smoke level signal reduces below scan level.
- .5 Detector to be LASER-based type and have an obscuration sensitivity range of 0.0015%/ft – 6% obs/ft.
- .6 Detector includes four independent field programmable smoke alarm thresholds per pipe (sector) and a programmable scan time delay.
- .7 Detector also incorporate facilities to transmit following faults:
 - .1 detector;
 - .2 air flow;
 - .3 filter;
 - .4 system;
 - .5 zone;
 - .6 network;
 - .7 power.
- .8 Urgent and Minor faults: minor faults considered as servicing or maintenance signals; urgent faults indicate unit may not be able to detect smoke.
- .9 Detector includes four in-line sample pipe inlets that contain flow sensor for each pipe inlet. Both Minor and Urgent flow faults to be reported and indicated as Trouble Signals on Main Building Fire Alarm System Panels and Annunciators.
- .10 Filter is two-stage disposable filter cartridge. First stage capable of filtering particles in excess of 20 microns from air sample. Second stage is ultra- fine, removing more than 99% of contaminant particles of 0.3 microns or larger, to provide clean air barrier around detector's optics to prevent contamination and increase service life.
- .11 Aspirator is purpose-designed rotary vane air pump, capable of allowing for multiple sampling pipe runs up to 180 m (600') in total, (4 pipe runs per detector) with a transport time of less than 120 seconds or as appropriate codes dictate.
- .12 Assembly contain relays for alarm and fault conditions. Relays are software programmable to required functions. Relays rated at 2 AMP at 30 VDC. Remote relays to be provided to suit operation sequence.
- .13 Assembly able to be surface mounted to wall or recessed in wall cavity (unit may be inverted in either option).
- .14 Assembly to have built-in event and smoke logging and store smoke levels, alarm conditions, operator actions and faults. Date and time of each even to be recorded. Each detector (zone) to be capable of storing up to 18,000 events and does not require presence of display in order to do so.

.9 Laser Scanner Displays:

- .1 Detector to be provided with LED indicators as reviewed with Consultant.
- .2 Displays for each detector to be centrally monitored. Display module monitors a visual representation of air sampling system smoke levels and fire alarm and fault conditions. Display modules to be located remotely at central location. One display module required per detector. Refer to further requirements noted elsewhere in this specification.

.10 Device Networking and Communication Ports:

- .1 Devices in smoke detection system communicate with each other via twisted pair RS485 cable. Network to be able to support up to 250 devices (detectors, displays and programmers), of which at least 100 detectors can be supported.
- .2 Network configured in fault tolerant loop for both short circuit and open circuit. Any communication faults to be reported unambiguously and be clearly attributable to individual device or wire link in fault messages.
- .3 PC based configuration tools are provided to configure and manage network of detectors.
- .4 Communication port to comply with EIA RS485 Protocol.

.11 Detection Alarm Levels:

- .1 Laser based aspirating detection system to have 4 alarm thresholds per pipe (sector). Alarm levels may be used as follows:
 - .1 Alarm Level 1 (Alert) 0.0125% Obs/ft;
 - .2 Alarm Level 2 (Action) 0.0225% Obs/ft;
 - .3 Alarm Level 3 (Fire 1) 0.03% Obs/ft;
 - .4 Alarm Level 4 (Fire 2) 2.0% Obs/ft;
 - .5 Refer to Sequence of Operation for details.
- .2 Detector Alarm Parameters: Initial (Default) Alarm Delay Thresholds: Initial settings for alarm delay threshold:
 - .1 Alarm Level 1 (Alert): 10 seconds;
 - .2 Alarm Level 2 (Action): 10 seconds;
 - .3 Alarm Level 3 (Fire 1): 10 seconds;
 - .4 Alarm Level 4 (Fire 2): 10 seconds.
- .3 Each pipe to have its alarm thresholds set by a Sector Factor. Sector Factor range to be between 0.5 and 2.0 (where 2.0 doubles normal alarm threshold settings).

.12 Fault Alarms:

- .1 Detector Fault relay to be connected to appropriate alarm zone on Main Building Fire Alarm Control Panel in such a way that a Detector Fault would register a fault condition on FACP. Minor Fault and Isolate relays to also be connected to appropriate control system.
- .2 Trouble Signals: Trouble signals to be transmitted to FACP via an addressable input module and annunciate at FACP without causing a general FACP trouble.
- .3 Initial (factory default) settings as follows:
 - .1 Scan Delay: 10 seconds;
 - .2 Fault Alarm: 5 seconds.

.13 Displays:

- .1 Display module monitors a visual representation of air sampling system smoke levels and fire alarm and fault conditions. Display modules are located remotely at a central location, within a lockable enclosure complete with front glass panel, VESDA subracks, and required mounting hardware, as shown on drawings. One display module required per detector.
- .2 Each Display provides at least following features:
 - .1 20-segment bar graph display;
 - .2 four independent high intensity alarm indicators, Alert, Action, Fire 1 and Fire 2, corresponding to four alarm thresholds of indicated sector;
 - .3 alarm threshold indicators for Alert, Action, Fire 1 and Fire 2;
 - .4 LED indication that First Alarm Sector is established;
 - .5 LED indication of which pipe(s) is carrying smoke;
 - .6 detector fault and airflow fault indicators;
 - .7 faults originating in particular VLS zone (Zone Fault) to be distinguished from those produced by overall smoke detection system and from those resulting from network wiring errors (Network Fault); LED indicators to be provided for each fault category;
 - .8 minor and urgent fault LED indicators.
- .3 Each remotely mounted Display equipped with required configurable relays for signalling alarm and fault conditions, and for communications with main building fire alarm system.

- .4 Four buttons supporting Mode/Test, Silence/Scan, Reset and Isolate functions. Four buttons support following features:
 - .1 Mode/Test: Scrolls through information on Display's digital display: Sensitivity (Fire 1 Threshold setting), current smoke level, VLS Zone number and First Alarm Sector. When pressed and held, initiates lamp test on individual display module.
 - .2 Silence/Scan: Silences all devices on system. When pressed and held, initiates a manual scan test.
 - .3 Reset: Unlatches latched alarm conditions on assigned VLS zone.
 - .4 Isolate: Isolates individual VLS zone (inhibits Alarm and Fault relays and initiates Isolate relay).
- .14 Programmers:
 - .1 LCD programming module provides means to configure single or networked series of detectors. Event log retrieval and viewing is also possible as is trouble and fault conditions. One LCD Programmer module required for entire installation and be located within remote central monitoring location (VESDA subrack enclosure).
 - .2 Each Programmer supports at least following features:
 - .1 programming of any device on VESDAnet system;
 - .2 viewing of status of any device in system;
 - .3 adjustment of relative alarm thresholds for each pipe (sector factor);
 - .4 adjustment of period of sampling for each pipe;
 - .5 software configuration for either 7 or 12 relays;
 - .6 setting of Day/night, weekend and holiday sensitivity threshold settings;
 - .7 initiation of AutoLearn™, to automatically configure detector's alarm threshold settings to suit current environment;
 - .8 multi-level password control;
 - .9 programmable latching or non-latching relay operation;
 - .10 programmable energized or de-energised relays;
 - .11 programmable high and low flow settings for airflow supervision;
 - .12 programmable aspirator speed control;
 - .13 programmable maintenance intervals;
 - .14 facilities for referencing with time dilution compensation;
 - .15 testing of relays assigned to a specific zone to aid commissioning.

.15 Power Supply and Batteries:

- .1 System powered from main building fire alarm control panel battery.
- .2 Subject to review with Consultant, system may be powered from a regulated supply of nominally 24 VDC.
- .3 Verify and coordinate supply and power requirements with main building fire alarm system manufacturer and VESDA manufacturer.
- .4 If used, battery charger and batteries to comply with relevant Codes, Standards or Regulations including CSA and ULC and be sized for 24 hours standby, followed by local governing building codes required time but minimum 30 minutes, in an alarm condition. Coordinate required power provisions with Electrical Division and ensure required provisions are included.

.16 Sub Rack Enclosure:

- .1 Glass door enclosure complete with 482 mm (19") sub racks as required for system, and houses power supply. Refer to drawings for details and further requirements.

.17 Sampling Pipe:

- .1 UL 1887 CPVC piping, listed for use with manufacturer's Air Sampling Smoke Detectors (including use in plenum rated areas). Where local governing authority having jurisdiction does not allow use of this piping material, propose alternative and review with Consultant before proceeding with Work.
- .2 Sampling pipe to be smooth bore. Size piping as determined by engineered calculations.
- .3 Pipe material to be suitable for environment in which it is installed.
- .4 Pipe colour to be orange so it is easily distinguished from other piping and wiring in room/area.
- .5 Make joints in sampling pipe air tight and with solvent cement, except at entry to detector.
- .6 Identify pipe as Aspirating Smoke Detector Pipe (or similar wording) along its entire length at 6 m (20') intervals, or not exceeding manufacturer's recommendation or that of local governing codes and standards, whichever is less.
- .7 Support pipes at not less than 1.5 m (5') centres, or that of local governing codes or standards.
- .8 Fit far end of each trunk or branch pipe with an end cap and drilled with a hole appropriately sized to achieve performance as specified and as calculated by system design.

.18 Sampling Holes:

- .1 Sampling holes of 2 mm (5/64"), or otherwise appropriately sized holes as per manufacturer's instructions, to not be separated by more than maximum distance allowable for conventional point detectors as specified in local code or standard. Intervals may vary according to calculations. Comply with local applicable codes with regards to maximum allowable distance between sample points.
- .2 Identify each sampling point in accordance with local governing codes or standards.
- .3 Comply with manufacturers recommendations and standards in relation to number of Sampling Points and distance of Sampling Points from ceiling or roof structure and forced ventilation systems. Provide work as per manufacturer's requirements.

.19 System Programming, Testing, Commissioning and Verification:

- .1 Include for manufacture's onsite programming of system, commissioning, testing and verification. Integrate system programming with main fire alarm system work.
- .2 Include for testing and verification to be included as part of Part 3 specification for main fire alarm system testing and verification work.
- .3 Include for additional two (2) on site programming sessions after successful testing and commissioning of system, to allow for any revisions by Owner.

.20 Warranty:

- .1 Warrant equipment, workmanship and materials, including installation, for a period of one (1) year after date of final acceptance by Owner and review with Consultant.

.21 Acceptable Manufacturers:

- .1 Air sampling detector shall be manufactured by Honeywell (Xtralis Fire & Security), contact Michael Whaling (508-631-3050).

.22 Acceptable Installers:

- .1 Acceptable system installers must be manufacturer's authorized and valid approved companies which includes vendors providing main building fire alarm system.

3 EXECUTION

3.01 INSTALLATION – GENERAL

- .1 Prior to start of Work as part of shop drawing submission process, review with system manufacturer following:
 - .1 device types to ensure that selected type is suitable for intended application on project;
 - .2 locations of devices to ensure proper operation and coverage are in compliance with requirements of local fire authorities;
 - .3 device mounting heights to ensure proper operation and coverage are in compliance with requirements of local fire authorities;

- .4 device back box requirements to ensure size and depth suit system manufacturer's recommendations for specific devices;
- .5 proposed revisions required to existing system sequence of operation.
- .2 Immediately advise Consultant of any requirements of above that may necessitate revisions to design documents.
- .3 Install system components and connect complete.
- .4 Obtain required training from manufacturer's representative on any special installation procedures. Install devices and perform work in accordance with the manufacturer's instructions and requirements and in accordance to applicable codes of the governing authorities having jurisdiction.
- .5 Work in conjunction with this installation to meet requirements of latest editions of local governing building code, local governing electrical code, ULC Standards including Installation Standard CAN/ULC-S524, and any applicable local governing codes. If any requirements of these specifications are different, omitted or contrary to ULC-S524 Standard, then ULC Standard governs and overrides these specifications, but in no instance will standards established by drawings and specifications be reduced by any of Codes referred to previously. Control units and annunciators to be in accordance to latest requirements of ULC Standard CAN/ULC-S527 "Control Units for Fire Alarm Systems.
- .6 During work to existing fire alarm system, obtain Owner approval of time and duration of interruptions. At any time, due to emergency situations, Owner may request by-passed zone(s) to be re-instated immediately. In areas where renovation work requires shutdown of any part of fire alarm protection system, provide manual fire alarm protection (Fire Warden) by means of supervising area as approved by local governing authorities. At no time is fire alarm system or any one zone to be left inoperative overnight. Provide required bypass wiring and temporary wiring as may be required to maintain all parts of fire alarm system operative during construction and alterations.
- .7 Perform Work in phases as specified in Divisions 00 and/or 01 and/or as noted on drawings.

3.02 INSTALLATION FIRE DETECTION AIR SAMPLING SYSTEM

- .1 Installation Contractor to be authorized and trained by system manufacturer to model/design, install, program and maintain air sampling system and able to produce manufacturer's valid certificate stating such on request. Maintain appropriate licensing for operating within place of Work. Be responsible for obtaining and paying any necessary permits prior to beginning work on project.
- .2 Equipment distributor to have a minimum of five years' practical experience in applying air sampling smoke detection technology. Employ at least one factory certified fire alarm system designer on staff to supervise the design and installation of system.
- .3 Obtain required training from manufacturer's representative on any special installation procedures. Install devices and perform work in accordance with the manufacturer's instructions and requirements and in accordance to applicable codes of the governing authorities having jurisdiction.

.4 Installation of Control Units:

- .1 Install required control units and annunciators.
- .2 Programme system to provide required sequence of operation as confirmed with Consultants and local fire authority.
- .3 Re-programme system to accommodate system modifications and to accommodate additional devices and zones, as required. Submit proposed software programming revisions to Consultant and local fire authority for review and approval prior to start of work.
- .4 Provide sequence of operation for system as approved by local fire authority and Consultant. Refer to additional requirements on drawings.
- .5 Install units in accordance with manufacturer's instructions.
- .6 Connect control units to dedicated 15 A breakers in nearest emergency panel as shown or as scheduled. Ensure that room housing control units have fire rating to local governing code requirements.
- .7 Properly ground and bond control units to building ground. Conduit ground will not be acceptable. Provide green coloured grounding loop, a minimum #10 AWG. insulated copper run in conduit. Connect ground loop to main building ground system source. Do not run ground wire in same conduit as fire alarm and communication wiring.

.5 Air Sampling Smoke Detector Assembly:

- .1 Mount detector assembly recessed into a wall in room at an elevation of approximately 1.5 m (60") above finished floor. Mount assemblies at a serviceable height in a fully accessible and visible location. Do not mount or attach to telecommunication equipment, cable trays, movable walls, or other equipment or frames.
- .2 Install detector assembly in accordance with manufacturer's installation and instruction manual.
- .3 Equip detector assembly with a secondary (battery) power supply capable of minimum 30 minutes at full alarm following 24 hours of normal (quiescent) operation.

.6 Sampling Pipe Network:

- .1 Design and install network so that air sample transport time from most remote sampling point in system to detector assembly does not exceed 60 seconds.
- .2 Mount piping as close to ceiling as possible. Where beam pockets exist, attach piping to underside of beams and not necessarily to extend into beam pockets.
- .3 Coordinate routing of piping network with potential obstructions, including cable trays, grounding bars, and HVAC ductwork.
- .4 Install horizontal sampling pipe at same elevation. Where changes in elevation are necessary, incorporate uniform elbow and vertical pipe lengths.
- .5 Make changes in direction with standard elbows or tees.

- .6 Main sampling pipes and sampling point drops to be a minimum 20 mm ($\frac{3}{4}$ ") diameter or that recommended by system manufacturer.
- .7 Make joints air-tight by using solvent cement, except at entry to detector assembly and end caps. Refer to ASTM F402-88 standard practice for safe handling of solvent cements, primers and cleaners used for joining thermoplastic pipe and fittings.
- .8 Support pipes by mechanical hangers attached to structure of building, at not greater than 2.1 m (7') centres. Not more than 300 mm (12") of pipe to extend beyond last hanger of each sampling pipe. Final installation to result in no noticeable deflection in piping network.
- .9 Do not attach air sampling pipes to cable trays "gray iron" and telecommunications equipment.
- .10 Branch lines to have a removable "end cap" for maintenance back flushing of system.
- .11 Label piping with system manufacturer's identification at least 6 m (20') intervals visible from floor.
- .12 Install sampling pipe network parallel to network equipment keeping aisles free of obstructions. Also, install piping runs parallel.
- .13 Spacing of parallel sampling pipes not exceed 8 m (24'). Sampling pipes located closest to a wall to not be greater than 3.6 m (12') from wall.
- .14 Seal sampling pipe penetrations of fire-rated partitions with an ULC listed and labelled and/or FM Global approved through-penetration firestop material.
- .7 Sampling Point Network:
 - .1 Determine diameter and separation of individual sampling points by hydraulic calculations.
 - .2 Balance system in accordance with manufacturer's requirements.
 - .3 Where sampling points are drilled directly in sampling pipe, identify with a label or sticker surrounding hole indicating sampling point.
 - .4 Direct sampling points (with the exception of those serving return air grilles) downward toward floor.
 - .5 Fit far end of each trunk or branch pipe with removable end cap (to facilitate maintenance back flushing), drilled with a hole(s) (with exception of those serving return air grilles) to diameter determined by system design calculations.
 - .6 Install sampling ports at ceiling level (high). Locate ceiling elevation sampling points within 50 mm to 150 mm (2" to 6") of underside of "smooth" ceiling above.
 - .7 Treat ceiling beam and waffle slab pockets not exceeding 300 mm (12") in depth as smooth ceiling. Where pockets are deeper than 300 mm (12"), extend sampling point to within required distance from ceiling. Sampling points are not required within every pocket.

- .8 Provide one or more sampling points for every 18.6 m² (200 ft²) of floor area. Maximum floor area that each sampling point may cover is 18.6 m² (200 ft²).
- .9 Spacing of sampling points on a pipe not exceed 4.5 m (15').
- .10 Locate sampling points so they are at least 300 mm (12") above any horizontal obstructions, i.e., duct, cable tray, etc.
- .11 Sampling points to be a minimum of 900 mm (3') from air supply registers.
- .12 Sampling points to be a minimum of 300 mm (12") from corners or walls.
- .13 Label sampling points with manufacturer's identification sticker.
- .14 Where top of equipment frames are within 1.2 m (4') of ceiling, only one level of ceiling detection is required.
- .15 Where top of equipment frames is greater than 1.2 m (4') from ceiling, both ceiling and low elevation sampling ports to be provided. Extend low elevation sampling points from main sampling pipe down to within 450 mm (18") of top of equipment frames (where no cable grid exists) and/or within 50 mm to 150 mm (2" to 6") of underside of cable grid.
- .16 Where ceiling and low elevation sampling points are required, alternate sampling points between ceiling and low elevations. Provide one ceiling and one low elevation sampling point for every 37.2 m² (400 ft²) of floor area.
- .8 Capillary Sampling Network:
 - .1 In areas with a suspended ceiling, install pipe network above ceiling with sampling points extended through ceiling using a short length of 9 mm (3/8") diameter capillary tubing attached to a manufacturer-supported capillary sampling point. Label points with manufacturer's standard identification marking. Provide capillary tube and attachment to sampling pipe in accordance with manufacturer's requirements.
 - .2 Maximum length of capillary tube to be 3.6 m (12').
 - .3 Terminate capillary tube at a ceiling sampling hole specifically designed and approved by manufacturer. Take into account performance characteristics of sampling holes during system design.
- .9 Power Supplies: Locate power supplies, including battery units, directly adjacent to an air sampling detection unit in an accessible location that is clearly visible.
- .10 Tests - "Burn-In":
 - .1 Allow for manufacturer's representative or licensed distributor to test entire installation in presence of Consultant and Owner. Provide at least 10 working days' notice to Consultant.
 - .2 "Burn-In" for system to occur over a minimum 14-day period during which a building environment history buffer can be established. This information may be used to configure alarm levels and delays. Perform and complete "Burn-In" prior to Acceptance Test specified later in this Section.

- .3 Include necessary instrumentation, equipment, materials, and labour for “burn-in” and testing.
- .4 Compare level of ambient base line with alarm threshold levels selected. Minimum acceptable range between ambient base line and first alarm threshold to be 20 percent of detector’s full-scale sensitivity calibration setting.
- .5 Automatic calibration and setup features on detection systems may be used for initial calibration of detectors, but be used only when also combined with a final review (at conclusion of automatic calibration) by installer to ensure appropriate settings.
- .6 Investigate each peak record to determine its cause. Analysis to consider peak recurrence is at regular intervals or whether it is a single event. Recurring peaks are usually related to activities within fire zone (example: HVAC system startup/shutdowns, unauthorized smoking, etc.).
- .7 Non-recurring peaks are generally results of other types of activities including fires. Consideration of normal activity within fire zone, time of day and day of e week may be of assistance in determining cause of a peak.
- .8 Compare magnitude and duration of recorded peaks to alarm threshold levels selected and initial time delay settings to determine if a false alarm would have occurred.
- .9 Based on data review, make adjustments to alarm level and/or time delay settings in order to reduce e potential for false alarms.
- .10 If data indicates that adjustments to alarm threshold levels or time delay settings will not eliminate false alarm, detector sensitivity to be changed and/or a reference detector to be installed in fresh air makeup unit of HVAC system.
- .11 If more than two bar graph divisions illuminate under normal conditions (no smoke test), monitor event log for two weeks from date of commissioning and make appropriate adjustments to alarm and delay thresholds.
- .12 Record tests and system calibrations’ using manufacturer’s standard commissioning form.
- .11 System Checks:
 - .1 Visually check pipe to ensure that joints, fixing, bends, sampling points, etc., comply with specification.
 - .2 Check system to ensure following features are operational and programmed in accordance with specification:
 - .1 alarm levels and indicators;
 - .2 set clock function to local time;
 - .3 time delays;
 - .4 bar graph display;
 - .5 air flow fault indicators;

- .6 detector status test and indicator;
- .7 detector test and indicator;
- .8 isolate/reset buttons;
- .9 set day/night sensitivity and offset if applicable.
- .3 Secondary power supply (voltmeter should indicate 22-27 VDC).
- .12 Acceptance Tests:
 - .1 Submit to Consultant for review and Owner approval, proposed schedule for testing, verification and certification of system. Obtain acceptance of schedule prior to start of work. Consultant and/or other Owner's representatives to have option to witness all or part of testing and verification work. Notify Owner and Consultant at least 10 working days prior to test date.
 - .2 Subject each air sampling smoke detector assembly to a complete operational "acceptance test" including tests listed herein.
 - .3 Introduce smoke into the furthest sampling point on each main sampling pipe segment of sampling pipe network to provide a "go/no-go test". Smoke test and verify each sampling hole/port.
 - .4 Suction Pressure Test: Test to verify that system has been installed in accordance with approved design and calculations. Measure pressure at specified sampling points with a magnahelic gauge, recorded, and compared to submitted and approved design calculations. If any measured result from suction pressure tests differs from those predicted by calculations by more than +15% / - 20%, cause of deviation to be determined and corrected before system is considered acceptable. Each sampling points in each branch line to be subjected to this test. Tested points to always include points hydraulically nearest to and farthest from detector (which is not end cap). Minimum allowable suction pressure is 25 Pascals (0.1 inches of water). Retain suction pressures noted in project file for future benchmark comparisons.
 - .5 Smoke Transport Time Test: Test to verify that system has been installed in accordance with the approved design and calculations. Establish time required for smoke to travel from most hydraulically remote sampling point of each sampling branch (pipe) line individually to detector as measured, recorded and compared with approved design calculations. Transport time is defined as, "clocked time from smoke introduction into most remote sampling pipe". Transport/response time is not to exceed 60 seconds. Measured transport time not to deviate from transport time calculated in approved design calculations by more than +15% / -20%.
 - .6 Air Flow Tests: Test to verify system airflow alarms. Remove one of sampling pipes and record time for e air sampling smoke detector assembly to indicate a high airflow alarm. Block one of sampling pipes and record time for air sampling smoke detector assembly to indicate a low airflow alarm.
 - .7 Each and every device, appliances, and operational mode to be functionally tested. This includes but is not limited to each air sampling smoke detector and associated devices or appliances. This testing encompasses interactions, interlocks, and automatic features that are part of fire alarm system.

- .8 Record tests and system calibration using manufacturer's standard commissioning form. Supply copy of these results to manufacturer for review and approval and a copy supplied with operation and maintenance manuals to Consultant. Include minimum one hard copy and electronic pdf copy for initial review.
- .13 General Requirements:
 - .1 Provide minimum 3 hard copies and electronic pdf version of final reviewed manufacturer's installation, operation and maintenance manuals.
 - .2 Provide "as-built drawings" showing actual installation details. Show equipment locations, point to point wiring, and piping network details. Provide electronic as-built drawings on USB flash drive or disk, and printed, reproducible drawings. Submit full-size (36" x 48") and half-size drawings and AutoCAD files.
 - .3 Provide operational training to Owner's designated personnel. Training to include, at a minimum, emergency procedures, alarms, abort functions, system control unit overview, system testing and maintenance procedures, trouble procedures, and safety requirements. Provide minimum of one 2-hour training session. Schedule sessions at convenience of Owner.
 - .4 Temporary utility connections which may be required to be installed, maintained and removed. Removal of such connections to be accomplished prior to final acceptance of the systems.
 - .5 Installation of system to not interfere with installation, operation or check-out of Owner's equipment, which may occur concurrently with systems' installation work. Plan work carefully in advance to preclude any damage to facility or equipment.

3.03 ADDITIONAL REQUIREMENTS

- .1 Perform required system wiring connections to interconnected mechanical equipment (i.e. FM 200) and main building fire alarm stem, to perform required interrelated functions and required sequence of operation. Provide required wiring, relays and/or contactors between system and various equipment to achieve automatic or manual control of equipment.
- .2 Install wiring in conduit unless otherwise approved by Consultant. Perform wiring connections associated with system on terminal strips in junction boxes and colour coded. Ensure that wiring colour coding is consistent for entire length of each run. When pulling wires into conduit, use lubricant and ensure that wires are kept straight and are not twisted or abraded. Neatly secure exposed wires in apparatus enclosures with approved supports or ties. Clearly identify wiring at each termination point. In addition, number wiring with Brady Ltd. or Electrovert Ltd. Z-type markers. Colour conductors for each part of system in accordance with system equipment manufacturer's recommendations.
- .3 Install wiring in accordance to requirements latest edition of applicable governing electrical code and to requirements of local governing authorities.
- .4 Generally, do not load circuits to no more than 80% of manufacturer's or local governing code requirements.
- .5 Provide engraved Lamacoid identification nameplates for each equipment or wiring housing and secure to front of housing. Exact wording designations and sizes to be reviewed and confirmed with Consultant prior to manufacture.

- .6 Verify nomenclature of annunciator identification with Consultant and obtain necessary approvals prior to ordering.
- .7 Install end-of-line resistors to electrically supervise wiring. Generally, locate end-of-line resistors at ceiling lines above manual station location. Provide isolators and install in accordance with ULC standards. Properly label and identify. Do not locate end-of-line resistors and isolators in concealed locations. Generally, install in equipment rooms.
- .8 Refer to drawing riser diagram. Riser drawings are diagrammatic and are not to be used for determining quantities or lengths. Quantities of components to be as per floor plans. Determine exact quantities of circuits based on drawings information, connected devices, requirements of governing codes and standards, and recommendations of system manufacturer.
- .9 Confirm exact location of components prior to roughing-in.
- .10 Ground and bond system as required by local governing electrical code and authority and system manufacturer.

3.04 SYSTEM VERIFICATION AND CERTIFICATION

- .1 System verification and certification to be performed in coordination with previously specified testing.
- .2 Testing Technicians:
 - .1 Registered technicians in good standing with Canadian Fire Alarm Association (CFAA) or be Certified Fire Alarm Electrician (CFAE) with local Electrical Contractors Association as deemed acceptable to Provincial Fire Marshall.
 - .2 Submit with test reports, copies of valid certification of testing company and technicians.
 - .3 Engage Integrated Testing Coordinator with qualifications in accordance with CAN/ULC-S1001.
- .3 Include for system manufacturer to inspect, test, verify and certify system components and wiring, individually and as a complete system, in accordance with requirements of latest edition of CAN/ULC S537 and CAN/ULC-S1001. Work to include but not be limited to following:
 - .1 to ensure that type of equipment installed is that designated by Contract Documents;
 - .2 to ensure that wiring connections to equipment components show that installer observed ULC and CSA requirements;
 - .3 to ensure that equipment was installed in accordance manufacturer's recommendations, and that signalling devices of whatever manufacture were operated or tested to verify their operation;
 - .4 to ensure that supervisory wiring of those items of equipment connected to a supervised circuit is operating and that governmental regulations, if any, concerning such supervisory wiring, have been met to satisfaction of inspecting officials;

- .5 to ensure that sequence of operation is in accordance with existing sequence of operation and any modifications identified on documents and are approved by local fire authority;
- .6 to ensure that devices are commissioned and operable.
- .4 Integrated Testing:
 - .1 Engage Integrated Testing Coordinator to prepare Integrated Testing Plan and provide requirements in accordance with CAN/ULC-S1001.
 - .2 Include for but not be limited to full review, testing and verification of operation of integrated systems such as fire suppression systems, life safety systems, elevators and their emergency sequence of operation, HVAC equipment, supervisory annunciation of sprinkler/standpipe monitor switches, pressure switches and flow switches, diesel genset alarms, security alarms, BAS alarms, release of door holders and electromagnetic locks, and other integrated components.
 - .3 Coordinate requirements with trades responsible for integrated components and systems, and arrange trades to be present at time of testing, and verification and commissioning work.
- .5 System manufacturer to also be responsible for but not be limited to following additional work:
 - .1 coordinate with local fire authority inspector and Electrical Division Contractor, required testing and verification work in order to obtain certification and meet local fire code and local fire authority requirements;
 - .2 test system battery power supplies and demonstrate compliance with local governing building code and local fire authority requirements that battery supplies are capable of providing required capacity output time of power;
 - .3 full review, testing and verification of operation of integrated systems; coordinate requirements with trades responsible for integrated components and systems who will be present at time of testing and verification work;
 - .4 coordination with local fire authority to provide requirements needed to obtain certificates of approvals from local fire authority;
 - .5 provide full detailed test sheets of tested components and provide certification that system work has been fully tested, that devices have passed testing and that system is in proper work order in compliance to code requirements and project documents; test documents to be additionally provided in electronic format as confirmed with Owner and Consultant.
- .6 Contact local fire authority inspector and coordinate and arrange for Fire Inspector to perform required inspections. Integrate local fire authority inspection requirements with testing and verification work to extent as per Fire Inspector's directions. Obtain full approval and certification by local fire authority.
- .7 Local fire authority inspector, Consultant and Commissioning Agent to at their discretion test system or parts of system in their review of test reports. Correct/repair any failures or deficiencies found in system, whether or not identified in test reports of manufacturer. Re-test and re-verify until successfully passed, at no extra cost to Owner.

- .8 Obtain from local fire authority required certificate of approval of system and forward to Consultant.
- .9 Arrange for manufacturers to supply reasonable amounts of technical assistance with respect to any changes required to conform to paragraphs above. During period of inspection, testing and verification, make Electricians available to do any required correction work and to assist during this Work.
- .10 On completion of verification, inspection, testing and commissioning of system, obtain from manufacturer and forward to Consultant, a verification certificate together with detailed inspection reports listing each and every system component, its location in building and its acceptability. Verification certificate and inspection reports to be prepared and signed by certified testing technicians of manufacturer. Signed test reports to confirm that systems are installed and perform in accordance with requirements specified above.
- .11 Obtain from system manufacturer and testing agency and forward to Consultant a certificate of liability insurance of minimum amount of Two Million Dollars (\$2,000,000.00) that is to be registered for this project to show satisfactory proof of manufacturer's liability coverage for both their product and personnel.
- .12 Testing technician to be certified and approved for fire alarm system testing by Canadian Fire Alarm Association (CFAA) and local Fire Marshall as applicable.
- .13 Prepare and submit Integrated Testing report in accordance with CAN/ULC-S1001.
- .14 In addition to requirements specified in this Section, refer to requirements of Section entitled Electrical Work Analysis and Testing.
- .15 Combine required documentation into reports. Submit to Consultant.

3.05 TRAINING

- .1 Manufacturer's trained technician to perform onsite training of each user (including the provision of user guides) prior to project completion to ensure that users are properly trained in the operation and maintenances of system.
- .2 Refer to Instructions to Owner specified in Section entitled Electrical Work General Instructions.

3.06 MONITORING OF SYSTEMS

- .1 In area that remain occupied and used by Owner during Work, monitoring and supervision of existing fire alarm system serving renovated areas, to be daily monitored to ensure that system is left in proper operating condition at end of each working day. Include for but not be limited to performing following:
 - .1 under presence of Owner's representative, check each morning and evening (start and end of work) of each day, system to ensure that it is in proper working condition;
 - .2 if portions of system are not in proper working order, provide temporary bypass wiring (if fire alarm system, must be subject to approval of local fire authority), and/or provide supervisory personnel to monitor systems for area affected;
 - .3 document and sign off with Owner's representative signing off also, each respective daily check condition;

- .4 ensure that work to system does not affect portion of system serving areas outside of renovation/working areas.
- .2 Maintain fire protection of areas which may include fire watch during temporary shutdowns of existing systems, in accordance with requirements of local governing code and local governing authorities.

END OF SECTION